AN EVIDENCE-BASED EVALUATION OF MEDICATION BARCODE SCANNING ACCEPTANCE IN A COMMUNITY HOSPITAL

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Abstract

Barcode scanning during medication administration is a powerful tool to prevent errors and support patient safety. In spite of the significant patient safety benefits, there is a lack of adoption and acceptance of barcode scanning. The purpose of this project was to implement an evidence-based assessment, utilizing a survey instrument based on the technology acceptance model, to understand adoption and acceptance of barcode scanning at a community hospital. Forty-four people, 38 nurses and 8 respiratory therapists, participated in the survey. Data analyses were performed using descriptive statistics, Kruskal-Wallis, Mann-Whitney *U*, and Spearman's rho tests. The subscales for the *intention to use barcode scanning* and *the influence of others* were rated highest by the survey participants. The subscales for the *training* and *technical support* received the lowest ratings. There were significant differences among the departments on the subscale scores, with the acute inpatient area reporting the highest subscale ratings and the surgical services/procedural area reporting the lowest subscale ratings. There were no differences in the scores for the survey subscales in regards to participants' age and years of computer use at work and at home. There were several themes identified related to barcode scanning issues and concerns. Recommendations to address the survey results and the barcode scanning issues were developed.

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Chapter One

Introduction

The Institute of Medicine (IOM; 1999) identified in the landmark report *To Err is Human: Building a Safer Health System,* that healthcare information technology, including the electronic medical record (EMR), is a powerful tool to prevent errors and support patient safety. The IOM identified that the EMR provides clinicians ready access to patient data at any time, supporting prompt treatments and early recognition of complications. In addition, the EMR provides data from large numbers of patients, which can be aggregated to track population outcomes. The IOM stated "organizations, individually and in collaboration, must commit to using information technology to manage their knowledge bases and processes of care" (p. 178).

Numerous studies conducted since the IOM report have, in fact, confirmed the significant impact of the EMR on patient safety (Hassink, Jansen, & Helmons, 2012; Zlabek, Wickus, & Mathiason, 2011). Correspondingly, the American Recovery and Reinvestment Act of 2009, in recognition of the patient safety benefits of the EMR, provides financial incentives to healthcare systems and individual providers to implement and demonstrate “meaningful use” of the EMR (Blumenthal & Tavenner, 2010; U. S. Department of Health and Human Services, Agency for Healthcare Research and Quality [U.S. DHHS, AHRQ] 2013). In spite of the significant patient safety benefits, lack of adoption and acceptance of the EMR by organizations and individual health care providers is a well-documented problem (Koppel, Wetterneck, Telles, & Karsh, 2008; McCoy et al., 2012; U.S. DHHS, AHRQ, 2009a; 2009b).

The scholarly project was an evidence-based assessment utilizing the technology acceptance model (TAM; Holden & Karsh, 2010) at a community hospital in a rural

setting. The TAM is a widely used theoretical framework to understand healthcare information technology acceptance and use (Holden, Brown, Scanlon, & Karsh, 2012). The TAM is applicable to all types of healthcare information technology, and therefore, prior to the TAM assessment, an overall organizational assessment was conducted at the community hospital, including a review of quality metrics. The information from the organizational assessment was utilized to determine that barcode scanning for medication administration (BCMA) would be an appropriate focus of the evidence-based assessment The initial overall organizational assessment also provided information to determine which of the several published TAM-based questionnaires most closely aligned with BCMA adoption issues at the community hospital. The findings from the TAM-based assessment provided the community hospital with information and insights for the on-going optimization of BCMA.

Definition of Terms

The terms EMR and EHR are often used interchangeably (Turner, 2010). EMR generally refers to the electronic record at one facility or service, for instance, one physician's office, or one hospital (Turner, 2010). The EMR may include laboratory and radiology results, surgical or procedural reports, physicians' orders entered through computerized provider order entry (CPOE), and nursing and other clinical discipline documentation. An EMR also generally includes an electronic medication administration record (eMAR).

The term EHR is more inclusive and refers to all of the patient's information stored electronically at *any* location the patient receives healthcare, and the transmission or interoperability of the information across settings of care (IOM, 2011). Healthcare

information technology refers broadly to the computer software and hardware that produce the EHR and may involve several different computer applications and types of hardware interfacing (IOM, 2011; Osheroff, Pifer, Teich, Sittig, & Jenders, 2005). The scope of the scholarly project was BCMA, a component of using an EMR.

EMR and Patient Safety

As mentioned earlier, the IOM (1999) in the report *To Err is Human: Building a Safer Health System,* identified the EMR as a powerful tool to support patient safety. Studies conducted since the IOM report have consistently demonstrated that the EMR does in fact contribute significantly to patient safety and quality care. This occurs through several mechanisms including the reduction of medication errors and influencing quality measures.

EMR Impact on Medication Errors

Bates et al. (1995) conducted landmark research studying the adverse drug events involving all 4031 admissions to 11 medical and surgical units in two tertiary care hospitals. They reported 6.5 adverse drug events, defined as "an injury resulting from a medical intervention related to a drug" (p. 29), per 100 admissions. Twenty-eight percent of the adverse drug events were identified as being preventable. Bates et al. concluded that adverse drug events are common and preventable. In a follow-up study, these researchers (Bates et al., 1998) evaluated the influence of CPOE on medication errors. Baseline data for the rate of adverse drug events was collected on 2491 admissions to six inpatient units, over six months. Post- CPOE implementation data was collected on 4220 admissions to eight units, over nine months. Bates et al. (1998) found a 55% reduction in

medication errors or adverse drug events, comparing the error rate pre- and post- CPOE implementation.

Poon et al. (2010) studied the impact of BCMA and the electronic medication record (eMAR) on medication error rates at the same hospitals the Bates et al. (1995, 1998) studies were conducted. Briefly, BCMA is an inter-professional process, which begins with computerized provider order entry and finishes with administration of the medication to the patient. While BCMA does not require computerized provider entry, an electronic medication record is a dependency. Alerts related to the patient's allergies and any contraindications for the medications being ordered are presented to the providers (physicians and advanced practice providers), nurses, and pharmacists throughout the ordering and verification process (Poon et al.). In addition, upon scanning the barcode on the patient's identification band and medications, BCMA will also alert the nurse if the "rights" of medication administration are not met (Smith, Duell, & Martin, 2012).

The Poon et al. (2010) study involved the direct observation of 6,723 medication administrations on units that had not implemented BCMA and eMAR, and 7,318 medication administrations on units that had implemented BCMA and eMAR. There was a 41.4% ($p < .001$) medication error reduction from the non-BCMA/eMAR units compared to the units that had implemented. Poon et al. (2010) had one of the largest sample sizes of the studies included in a systematic review of ten investigations (Hassink et al., 2012). The authors of the systematic review of the literature (Hassink et al.), similar to Poon et al., concluded that BCMA reduces medication administration errors.

Zlabek et al. (2011) conducted a retrospective study of all hospital patients except those seen in the emergency department, and compared the actual medication error rate

and near-miss error rate between pre-and post-EMR implementation. The EMR included the implementation of CPOE. The medication errors per 1000 hospital days declined from 17.9 pre-implementation to 15.4 post-implementation, which is a 14% reduction ($p < .030$). However, there was an increase in near misses from 9.0 pre-EHR to 12.5 post-EHR, which represents a 38.9% increase ($p < .037$). The increase in near-miss errors is possibly the result of the additional safety checks that are inherent in an EMR, which result in errors triggering alerts that would not have been noticed without the EMR.

EMR Impact on Hospital Quality Measures

Similar to the research demonstrating the significant impact of the EMR on medication errors, several studies have also found the EMR to impact quality measures. McCullough, Casey, Moscovice, and Prasad (2010) collected data between 2004 and 2007 regarding hospital characteristics and quality measures for 3,401 U.S. hospitals. The hospital characteristics data were obtained from the Health Information and Management Systems Society (HIMSS) Analytics database and the American Hospital Association's (AHA) annual survey results. The study focused on hospitals that had implemented the EMR, including CPOE. Quality measure information was obtained from the Centers for Medicaid and Medicare Services (CMS) Compare database. The CMS quality measures related to the care of heart failure and pneumonia. Specifically, the measures were angiotensin-converting enzyme inhibitor (ACE)/angiotensin receptor blocker (ARB) use; smoking cessation advice given to both heart failure and pneumonia patients; pneumococcal vaccination administration; a blood culture preceding an antibiotic for pneumonia; and the most appropriate antibiotic being ordered for pneumonia. There were significant differences for the pneumococcal vaccination, and the most appropriate

antibiotic being ordered ($p < .05$) between hospitals that had both EHR and CPOE, compared to hospitals that had implemented neither.

Appari, Carian, Johnson, and Anthony (2012) also studied the impact of the eMAR on quality measures. The sample consisted of 2,603 hospitals and involved 11 quality process measures. The quality measures related to the administration and prescription of medications during the hospital stay and at discharge for acute myocardial infarction, heart failure, pneumonia, and surgical care infection prevention. Similar to McCullough et al. (2010), Appari et al. obtained hospital data from the HIMSS Analytics database, including whether the hospital used eMAR and CPOE, and quality data from the CMS Hospital Compare database. Appari et al., found that hospitals which had implemented eMAR *only*, performed better on 10 of 11 process quality measures, in contrast to non-adopters of both eMAR and CPOE. The odds of adhering to recommended medication guidelines were 14-29% higher than for non-adopters. The only measure that was not significantly impacted by the eMAR implementation was a beta-blocker being ordered at discharge for an acute myocardial infarction patient.

Hospitals that implemented CPOE *only* showed a lower magnitude difference in quality measure adherence, compared to non-adopters. For only two of the 11 measures did CPOE-only adopters have significantly higher compliance with the quality measures than non-adopters. Those two measures were giving the most appropriate initial antibiotic to pneumonia patients, and giving appropriate medication to prevent blood clots within 24 hours before or after surgery to surgical patients.

Hospitals that adopted *both* eMAR and CPOE performed better on 10 of 11 measures. The odds of adherence to medication guidelines were 13-38% higher among

adopters of both technologies compared with non-adopters. Appari et al. (2012) concluded that use of just an eMAR and the combination of eMAR and CPOE had a significant impact on quality measures related to medications.

Both McCullough et al. (2010) and Appari et al. (2012) studied the CMS Quality Measures of ACE inhibitor/ARB use for heart failure patients, and pneumonia patients receiving the most appropriate antibiotic. McCullough et al. found no difference between EMR and non-EMR hospitals in ACE inhibitor/ARB use (0.4 percentage points, *ns*). Appari et al. found a significant difference in adherence to the measure for hospitals that had implemented eMAR only (AOR = 1.16, 95% CI [1.03, 1.31]) and both eMAR and CPOE (AOR = 1.22, 95% CI [1.06, 1.39]), but not hospitals with just CPOE (AOR = 1.08, 95% CI [0.78, 1.48]).

Both McCullough et al. (2010) and Appari et al. (2012) found a significant difference after EMR implementation for the quality measure of the most appropriate antibiotic being prescribed. McCullough et al. report a 1.3 increase in percentage points (p = .01). Similar to the ACE inhibitor/ARB measure, Appari et al. found a significant difference for hospitals with eMAR only (AOR = 1.19, 95% CI [1.05, 1.35]) and hospitals with both eMAR and CPOE (AOR = 1.26, 95% CI [1.12, 1.41]), but not hospitals with just CPOE (AOR = 1.20, 95% CI [0.96, 1.49]). In the Appari et al. study the odds of meeting ten of the eleven measures in that study increased by 14 to 29% for hospitals with just an electronic medication record, and 13 to 38% for hospitals with both an electronic medication record and computerized provider order entry. McCullough et al. found only two of six measures to be significantly impacted by the EMR.

When McCullough et al. (2010) focused on only academic hospitals, they found a larger difference in percentage points for the two measures that were significantly impacted by the EMR, compared to non-academic hospitals. They suggest that academic medical centers may have a more robust EMR, and that the context of the implementation may be a factor in the impact of the EMR. Similarly, Appari et al. (2012) suggest the differences in the impact of the EMR between hospitals that had implemented just the eMAR and eMAR/CPOE, and hospitals that had implemented only CPOE in the absence of eMAR, may have been related to other factors, not studied such as the capabilities of the CPOE system and usability factors. These views of McCullough et al. and Appari et al. are consistent with the sociotechnical view of healthcare information, which suggests that the context has an impact on healthcare information technology adoption and utilization. The sociotechnical view is discussed further in a later section.

EMR Impact on Clinical Reasoning

BCMA, CPOE, and the eMAR, all healthcare information technology associated with an EMR, and the focus in several of the studies discussed in the preceding sections, utilize clinical decision support to promote clinical reasoning (U.S. DHHS, AHRQ, 2009a, 2010). Clinical reasoning is the higher-level cognitive process of gathering and analyzing patient information. Through evaluation of the significance of the information, a plan of action and goals are identified (Simmons, 2010).

Clinical decision support in the EMR is comprised of a knowledge base, the combination of the knowledge base with patient specific information, and a communication mechanism with the user (U.S. DHHS, AHRQ, 2009a). The knowledge base may be algorithms, rules, or classification models. The patient specific information

may be entered into the EMR by an end-user, as in the case of a physical assessment, or inputted from laboratory or pharmacy software into the EMR. For instance, if an order is entered into the electronic medical record for a medication, and the laboratory values which may be impacted by the medication are outside of the normal range, an algorithm embedded in the electronic medical record will generates an on-screen alert to the person entering the medication order. Clinical decision support encourages clinical reasoning by communicating to the user information or knowledge at appropriate times through some type of alert such as an on-screen pop-up, change in test font or color, or an icon appearing in the EHR (Cho, Staggers, & Park, 2010; U.S. DHHS, AHRQ, 2009).

EHR Under-Utilization

While there several studies demonstrating the impact of the EMR on patient safety and quality, there is also significant under-utilization of the EMR (AHRQ, 2009b). A primary form of clinical decision support for nurses is the BCMA to confirm the "rights" of medication administration (Smith et al., 2012) resulting in the reduction of medication errors (Poon et al., 2010). However, nurses ignoring the BCMA alerts, a type of clinical decision support, is a well-documented problem. Koppel et al. (2008) found in a mixed-method study involving 307,698 medication administrations across five hospitals, nurses ignored 10.3% of the alerts.

McCoy et al. (2012) evaluated the appropriateness of clinical decision support to the patient's clinical situation, and whether the physician receiving the clinical decision support followed the recommended action. They determined the physician's response to the clinical decision support was inappropriate 17% of the time. Similarly, an integrative review of seventeen studies found the clinical decision support drug safety alerts visible

during the CPOE process were ignored between 49% and 96% of the time (U.S. DHHS, AHRQ, 2009b; van der Sijs, Aarts, Vulto, & Berg, 2006).

Staggers, Clark, Blaz, and Kapsandoy (2011) conducted a qualitative study concerned with nurses' information management during "hand-offs", a process recognized as potentially compromising patient safety. This study was conducted on two surgical and one medical unit at a 425 academic medical center; and one medical and one surgical unit at a 50 bed oncology specialty hospital. The data collection occurred on 25 occasions, which included the observation of 26 nurses and information exchange, regarding about 93 patients. Nurses giving report were observed because the study authors believed that nurses giving report needed to synthesize information. One observer focused on the context of the report, such as interruptions, and the second observer paid attention to the content of the report, such as how many computer screens were accessed. The reports were also audiotaped and the audiotapes were transcribed verbatim. The findings were similar across all units in the study. Although there was an electronic nursing summary report that was intended to be utilized during hand-offs, the nurses also either printed a paper copy of the report or developed their own paper report sheet.

Von Krogh and Naden (2011) studied hermeneutics interpretation statements in nursing documentation pre- and post-implementation of an EMR in five psychiatric units. The authors make a distinction between analytic documentation, which is factual and objective, and narrative documentation, which is more subjective and “discerned” or “reasoned”. They suggest that narrative documentation is equally important in reflecting nursing practice as narrative documentation is where the caring aspect of nursing is found. Hermeneutic interpretation statements, in other words documentation based on

"thoughts, feelings, and notions" (p. 3525), are a type of narrative documentation. The newly developed EMR documentation was purposely designed to reflect narrative documentation, and thus hermeneutics interpretive statements in the EMR. Even with the EMR documentation, specifically designed to reflect hermeneutics interpretation statements, there was a decline in the number of these statements in the EMR after the implementation of the new electronic documentation.

Factors Contributing to EHR Under-Utilization

There are several potential factors contributing to the under-utilization of the EMR. For instance, the clinical decision support alerts associated with CPOE and BCMA may be viewed as irrelevant; the clinical issues the clinical decision support is intended to address may be viewed as insignificant; or the evidence or knowledge source on which the alert is based may not be accepted (Koppel et al., 2008; van der Sijs et al., 2006). In addition, the alert itself may be unclear or too lengthy and complex, and the technology used to interact with the alert may be unreliable or require a high level of technical expertise. Finally, the alert may be perceived as disruptive to the workflow.

Similar to the possible human-computer interface issues with the clinical decision support, there may be issues with the CPOE functionality and usability (Appari et al, 2010) and also the environment in which the EMR is being utilized (Appari et al., 2010; McCullough et al., 2010). The technology acceptance model (TAM) is a framework with several published evidence-based corresponding questionnaires, which can be utilized to understand and address possible issues with BCMA under-utilization at the practicum site.

The TAM

The TAM is based on social/psychological/behavioral theories utilized to explain patterns of behavior such as voting and exercise. It was developed in the 1980s to understand the lack of adoption in many industries of newly available information technology in the workplace, such as desktop personal computers. In the 1990s, healthcare informatics professionals began to utilize the TAM (Holden & Karsh, 2010), and currently, the TAM is "the most widely used theoretical framework in the health IT acceptance and use literature" (Holden et al., 2012, p. 1050). The TAM is further described in the next chapter.

The Practicum Site

The practicum site was a community hospital located in a rural community in Michigan and was a regional health care center for the county. The hospital had 61 acute-care beds, with adult and obstetrical patients being the primary acute-care patient populations. There were 270 clinical staff and 200 medical staff members at the hospital.

The hospital implemented clinical documentation in the EMR for nurses and other clinical disciplines, except providers, in 2006. Computerized provider order entry and BCMA were implemented in 2010. At the time the scholarly project was being conducted physician progress notes in the EMR were being implemented, along with several EMR enhancements to achieve the Meaningful Use objectives (U.S. DHHS, CMS 2013).

Summary

Several studies have demonstrated the contributions of the EHR and healthcare information technology to patient safety (Hassink et al., 2012; Hensing et al., 2008; Zlabek et al., 2011). However, lack of adoption of the EHR is a well-documented

problem (Koppel et al., 2008; McCoy et al., 2012; U.S. DHHS, AHRQ 2009a, 2009b). The goal of the scholarly project was to increase the acceptance and adoption of BCMA, a component of the EHR, at the practicum site through an evidence-based assessment utilizing the TAM. The next chapter is a literature review of additional studies related to the benefits of, and barriers to using BCMA.

Chapter Two

Literature Review

A questionnaire utilizing the technology acceptance model (TAM) was the intervention for this evidence-based assessment of the perception of nurses at the community hospital of the barcode scanning at medication administration (BCMA) process. Research conducted over the past decade has consistently demonstrated a significant reduction in medication administration errors because of the utilization of BCMA. Research has also found that nurses under-utilize BCMA or do not utilize it appropriately (Koppel et al., 2008). This literature review discusses research that demonstrates that BCMA reduces medication errors, as well as evidence related to the lack of appropriate utilization of BCMA by nurses.

The Influence of BCMA on Medication Errors

Most research studies examining the relationship between BCMA and medication errors utilized a direct observation pre- and post-BCMA implementation design. Nurses, pharmacists, or pharmacy residents collected data by observing nurses (Bonkowski et al., 2013; Cochran & Haynatzki, 2013; Helmons, Wargel, & Daniels, 2009; Seibert, Maddox, Flynn, & Williams, 2014). The studies defined medication errors as a deviation between the medication order and the medication that was administered during the observation. While all of the studies demonstrated a statistically significant reduction in medication administration errors after the implementation of BCMA, the results varied in level of reduction. The medical service lines on the patient care units also varied across the studies.

Bonkowski et al. (2013) studied BCMA in the emergency department (ED) of a Level I trauma center in an academic medical center. The ED had implemented an integrated electronic medical record (EMR) including computerized provider order entry (CPOE), BCMA, and an electronic medication administration record (eMAR). A total of 996 and 982 medication administrations were observed pre- and post-implementation, respectively. The post-BCMA implementation observations were conducted four months after the implementation. In this study, wrong time errors were excluded from the data collection because most medications in the ED are ordered for one-time administration. A weakness of this study was the medication administration observations did not occur on all days and shifts, but were conducted when the observers were available. Therefore, the medication administration observations may not be a representative sample.

Bonkowksi et al. (2013) found an 80.7% reduction in medication errors after the implementation of BCMA ($p < .0001$). The pre-BCMA medication error rate was 6.3% and the post-BCMA error rate was 1.2%. The error types of wrong drug, no drug order, and wrong route decreased from pre- to post-implementation, but not significantly. Wrong dose errors were the only error type that was significantly impacted by the implementation of BCMA. There was a 90.4% error reduction ($p < .0001$) in wrong dose errors. Therefore, it was the significant and dramatic reduction in the wrong dose errors that contributed to the reduction in the medication administration error rate.

Helmons et al. (2009) studied BCMA on two medical-surgical units and two intensive care units of a 386-bed academic teaching hospital. BCMA and eMAR were implemented together, and computerized provider order entry (CPOE) had previously been implemented. Data collection occurred three months after BCMA implementation.

Observations were conducted on weekends and weekdays at 9 a.m. as most medications on these units were administered at that time. A total of 888 and 697 medication administration observations were conducted in the medical-surgical units pre- and post-implementation, respectively. In the intensive care units 374 and 394 medication administrations were observed pre- and post-BCMA respectively. Similar to Bonkowski et al (2013) wrong-time errors were excluded from data collection.

Helmons et al. (2009) found the medication administration error rate decreased by 58% (*p* not reported), from 8% to 3.2 % in the medical/surgical units comparing pre- and post-implementation rates. The medication omission rate decreased significantly in the medical/surgical units from 3.8% to 1% ($p < .0001$). This reduction was the primary change contributing to the overall error reduction rate of 58%.

There was not a change in the total error rate in the intensive care units pre- and post-BCMA implementation. The omission rate was relatively low in the intensive care units at baseline at approximately 1.5%. While the overall medication error rate did not change in the intensive care units the charting of the medication, another outcome measure in this particular study, did improve significantly ($p <.0001$). However, the same improvement in medication charting was not observed in the medical-surgical units after the implementation of BCMA.

Seibert et al. (2014) studied BCMA at two community hospitals. The units involved in the study across the two hospitals were medical-surgical, telemetry, rehabilitation, ED, inpatient and outpatient oncology, and intensive care. The

post-implementation data collection occurred between 6 and 12 months after implementation for each unit. There were 2,061 observations pre-implementation, and 773 post-implementation medication administration observations.

Seibert et al. (2014) reported accuracy rates rather than error rates. The overall medication administration accuracy rate improved at the first hospital from 89% pre-implementation to 90% post-implementation ($p < .0015$). When wrong time errors were excluded, the accuracy rate improved from 92% pre-implementation to 96% post-implementation ($p = .000008$). The units at this hospital that individually had a significant improvement in the accuracy rate were the telemetry unit ($p = .05$) and the emergency department ($p = .0015$). When the wrong-time errors were excluded the accuracy rate for the emergency department was again improved ($p = .000002$) and the rehabilitation unit had a significant increase in accuracy ($p = .005$).

There was no change in the medication administration accuracy rate at the second hospital post-BCMA implementation for the accuracy rate in general, and when wrong rate errors were excluded. Individually the rehabilitation unit exhibited a significant increase in the accuracy rate overall ($p = .0005$,) and when wrong-time errors were excluded ($p = .002$). The telemetry unit also had a significant improvement in accuracy after wrong-time errors were excluded ($p = .006$).

There were no significant improvements in the accuracy rate after the implementation of BCMA in the medical-surgical units at both hospitals, and in the inpatient and outpatient oncology units at the first hospital. Seibert et al. (2014) suggest that there was no improvement on the oncology units because these units already had many double checks in place and the pre-implementation accuracy rates were relatively

high. The outpatient oncology unit's pre-implementation accuracy rate was the highest in the study at 97%. The inpatient oncology unit's rate was one of the highest at 89%. The researchers do not explain the lack of improvement on the medical-surgical units. It should be noted that the intensive care unit accuracy *decreased* both overall ($p < .004$) and when wrong-time errors were excluded ($p < .003$). During the study period, there were multiple "medication technique misadventures" (Seibert et al., p. 216). No additional details are provided except that the "misadventures" were unrelated to BCMA, but contributed to the decrease in accuracy rate.

The Paoletti et al. study (2007) is similar to the aforementioned studies in that data were also collected by direct observation, the study was about BCMA, and the outcome variable was the medication error rate. A 20-bed cardiac unit and a 36-bed telemetry medical-surgical unit had implemented an eMAR and BCMA several months before the post-implementation observations. There was a 35.9% ($p < .035$) reduction in medication errors overall and a 54% reduction ($p < .045$) when time errors were excluded in the 36-bed telemetry medical-surgical unit after the implementation of eMAR and BCMA. There was a reduction in the error rate in the 20-bed cardiac unit but it was not significant ($p < .065$) for the overall medication error rate, and the error rate with the time errors excluded.

It was found in the pre-implementation observation that the medication administration error rate was significantly lower in the 20-bed cardiac unit (15.6%) compared to the 36-bed telemetry medical-surgical unit (25.3%). The 20-bed cardiac unit with the lower pre-BCMA implementation error rate had fewer variations noted in the medication orders because of the homogeneous patient characteristics, all being cardiac

patients. In addition, standardized order sets were being utilized in this unit, but not the telemetry unit. These factors may have contributed to the lower medication error rate in the 20-bed cardiac unit pre-BCMA, with less opportunity for improvement post-BCMA implementation.

The Influence of BCMA and Pharmacy Support

Cochran and Haynatzki (2013) involved nine critical access hospitals (CAHs) in their research. CAHs are defined as having 25 or fewer acute care beds, must be located at least 35 miles from another hospital, and receive cost-based reimbursement from Medicare. In addition to the setting being different from those of the previously discussed studies, the design of this study is also different. The nine CAHs were assigned to one of three groups. The current state at each hospital was observed and then the three groups were compared in regards to the medication error rates. Two CAHs had on-site pharmacists for less than ten hours per week and had not implemented BCMA. These hospitals comprised the first group. The second group was comprised of four hospitals who had an on-site pharmacist for more than 40 hours per week but had not implemented BCMA. The third group consisted of three hospitals that had on-site pharmacist coverage for more than 40 hours per week, and had implemented BCMA.

Direct observation was the data collection method in this study. A total of 3,103 medication administrations were observed. At least 350 administrations were observed at eight of the hospitals. Due to lower census, 138 administrations were observed at the ninth hospital. Observations occurred on all days and shifts. Similar to the studies discussed previously, a medication error was defined as a medication that was administered, and differed from what was ordered. Wrong-time errors were included in

this study and defined specifically as the medication administration occurring at least one hour before or one hour after the scheduled administration time.

The percentage of medication administration errors were highest in the hospitals with less than 10 hours per week of on-site pharmacy support, but no BCMA (3.27%); *lower* in the hospitals with 40 hours per week of on-site pharmacy support, but no BCMA (1.49%); and *lowest* in the hospitals with 40 hours of on-site pharmacy support and BCMA (0.53%). These results were significant when the medication error rate for the hospitals with less than 10 hours of pharmacy time was compared to the error rate for the hospitals with 40 hours of pharmacy support, but no BCMA ($p = .02$) and the hospitals with BCMA ($p = .01$). The result was also significant when the error rates for the two groups with 40 hours per week of pharmacists' support, one group with BCMA and one group without BCMA, were compared ($p < .02$). The study authors concluded that both pharmacists' assistance and BCMA are effective safety measures to decrease medication administration errors.

Summary

All of the investigations reported a reduction in the medication error rate or an increase in the medication administration accuracy rate. There were differences in the types of units where the improvements were reported, and the aspect of the medication order that was improved. For instance, Helmons et al. (2009) reported a decrease in the medication error rate on two medical-surgical units. Seibert et al. (2014) found no improvement in the medication accuracy on the medical-surgical units. Helmons et al. found the medication omission rate decreased significantly with BCMA, which was the primary reason the overall medication error rate decreased. Bonkowski et al. (2013)

reported a decrease in the wrong dose errors to be significant, and a factor in the overall decrease in the medication error rate.

A common theme among the studies was that factors other than BCMA influence the medication error or accuracy rates. The other factors may explain why the error rates changed on some units, while the error rates on other units in the same hospital did not change. For instance, the premise of Cochran and Haynatzki (2013) was that pharmacy support also influences medication errors. Paoletti et al. (2007) suggest that standardized provider order sets may contribute to a decrease in medication errors. Seibert et al. (2014) found that manual double-checks reduced the medication error rates, and BCMA-unrelated events could actually increase the medication error rates. These findings are consistent with the socio-technical view of healthcare information technology. This view is discussed further in Chapter Three. Briefly, this view proposes that the interaction of the technology and the environment determines the effectiveness of the technology (Ammenwerth, Iller, & Mahler, 2006; Berg, Aarts, & van Der Lei, 2003).

BCMA Work-Arounds

As discussed in Chapter One, lack of adoption of healthcare information technology is a well-documented problem (Koppel et al., 2008; McCoy et al., 2012; U.S. DHHS, AHRQ 2009a, 2009b) and there are consistently references in the BCMA literature related to lack of adoption and work-arounds of that healthcare information technology. However, in comparison to the volume of studies on the benefits of BCMA there is a dearth of studies related to work-arounds. Voshall, Piscotty, Lawrence, and Targosz (2013) conducted a systematic review related to various aspects of BCMA in order to inform nurse executives. Thirteen studies were included in the literature review.

Three of the studies in the systematic review specifically addressed work-arounds. The study by Koppel et al. (2008) was previously discussed. Discussions of the two additional studies are below In addition, the findings from a quality improvement project are discussed.

The Veterans Health Administration (VHA) was one of the first organizations to implement BCMA across hospitals and settings of care. Patterson, Cook, and Render (2002) conducted a study to identify the unintended consequences and work-arounds associated with BCMA at three VHA hospitals. This research was some of the first studying BCMA and is frequently cited. A few years later Patterson, Rogers, Chapman, and Render (2006) conducted another study at three VHA hospitals to identify the types and extent of workaround strategies.

Patterson et al. (2002) used direct observation to conduct an ethnographic study on the acute care unit at two hospitals, and the acute care and nursing home units at a third hospital. The hospitals varied in size from 3000 acute care admissions per year to 9000 admissions per year. One of the acute care hospitals and the hospital with acute and extended care units were affiliated with a university. In all of the hospitals, BCMA had been in use for at least one month. Nurses were observed during all shifts. The observations occurred at one of the acute care hospitals pre-BCMA and at all three hospitals post-BCMA. Seven nurses were observed pre-BCMA and 26 nurses post-BCMA.

The observer noted that nurses at all three hospitals consistently used work-around strategies that negated the safety features of BCMA. The work-arounds involved either not scanning the wristband or delaying scanning medications. Instead of

scanning the wristband, nurses typed the patient's social security number in the field on the computer screen or scanned a duplicate wristband rather than the band on the patient. Nurses identified that wristband barcodes that did not scan reliably and some patient conditions, such as being in isolation, contributed to the patient identification wristband-scanning work-arounds. It was observed that the medication barcodes scanned more reliably than the patient bands and the same scanning work-arounds were not noted with medication scanning.

The other primary scanning work-around discovered was not scanning medications when they are supposed to be scanned. For instance, some nurses were observed to "batch" scan medications for multiple patients before administration. Another common work-around was to scan medications after administration. The nurses' explanation for these work-arounds was that the variation in the acceptable scanning process increased efficiency. Patterson et al., (2002) concluded that the redesign of BCMA and medication administration workflow, addressing the scanning barriers such as patient wristbands that are difficult to scan, and BCMA re-education could reduce the work-arounds.

Patterson et al. (2006) studied 15 acute care and 13 long-term care nurses from three different hospitals, each with an acute care and long-term care unit. BCMA had been in use for at least 2 months on each of the study units. The ethnographic study design involved direct observations. The observations occurred on all shifts and involved the direct observation of a medication administration. The work-arounds were categorized into the two categories of work-arounds that were identified in the Patterson et al. (2002) study: patient identification, and medication administration.

More work-arounds were observed in the long-term care units than in the acute care units. Seven of 15 nurses in acute care and 7 of 13 nurses in long-term care were observed to type in the patient's social security number rather than scan the wristband. Similar to the earlier Patterson et al. study (2002) nurses indicated that the work-around was more efficient than scanning the patient's wristband. In fact, the work-around had become routine practice for many nurses in the study.

Factors identified by the observers that may have contributed to the work-arounds were large medication carts at the long-term care units that were difficult to maneuver. In addition, barcodes on the patient wristbands on the long-term care units were often faded and difficult to scan. In terms of medication administration, one acute care and 10 long-term care nurses were observed to pre-pour medications. Similar to the conclusions of the research study conducted earlier (Patterson et al., 2002), Patterson et al. (2006) concluded that if the BCMA tools and processes were improved, the adherence to BCMA would increase. For instance, the location and type of computer/scanner carts and the quality of the patient identification bands were identified as barriers to BCMA.

Early, Riha, Martin, Lowdon, and Harvey (2011), like the Patterson et al. studies (2002, 2006), found that deficiencies in the BCMA tools contributed to non-adherence to BCMA. Early et al. conducted a quality improvement project at an adult acute-care facility in a seven-hospital system after there was a near-miss sentinel event involving the override of BCMA. In addition, the scanning compliance was 82% and the industry standard is 90% (Paoleti et al., 2007). The largest numbers of overrides, 41%, were due to equipment, simple noncompliance, and multiple barcodes on medication packages. The equipment problems included aging scanners, new barcode symbology that was

unreadable by the current software, and organizational changes to manufacturer barcodes. Feedback from the nursing staff was that a large number of medications would not scan.

The quality improvement team addressed several of the issues contributing to overrides. A process was implemented to return non-scanning medication packages to pharmacy for follow-up. The scanning issues with labels produced in the pharmacy were addressed by the implementation of new label printers. For pharmaceutical manufacturer barcodes that were consistently not scanning pharmacy notified the manufacturers of the issue, and in the interim the hospital pharmacy produced and applied a label. The outdated scanners were replaced with new scanners. These improvements occurred over approximately six months. After the changes were fully implemented, data were collected related to the overrides and scanning compliance. There was a 12.8% decrease in overrides and the scanning compliance rate improved to 97%.

Nursing Satisfaction and Perceptions

In spite of the challenges and barriers with BCMA identified through the work-around studies there is evidence that nurses value the safety benefits of scanning. Fowler, Sohler, and Zarillo (2009) conducted a descriptive, comparative design study to understand nurse satisfaction with BCMA at three and six months post-implementation. The authors used a questionnaire with a six-point scale. The convenience sample consisted of 68 staff nurses. At both 3 and 6 months post-implementation, nurses were most satisfied with the safety BCMA introduced and most dissatisfied with the decreased time spent with patients. Nurses perceived that medication administration took longer with BCMA, which decreased time spent with patients.

Zadvinskis, Chipps, and Yen (2013) conducted a qualitative study to understand the perceived advantages and concerns related to BCMA. The study was conducted on a medical-surgical unit in an academic center, three to four months after the implementation of BCMA. Ten nurses participated. The number of participants was determined by the investigators using information saturation. Semi-structured interviews were used to collect data. Field notes were written during and after the interview, and the audiotaped interviews were transcribed verbatim. Three researchers read the transcripts independently and generated common themes.

The thematic findings related to the positive perceptions of BCMA included that it assisted nurses to be better organized, provided immediate feedback through alerts, and automatically charted medications. Negative themes were scanning issues such as the computer screen freezing, multiple scanning attempts, and difficulty scanning a particular medication, for instance, insulin. Nurses believed that BCMA influenced the quality of patient care through decreasing errors and possibly increasing patient satisfaction. The nurses' perception was patients might feel more secure when their identification band is scanned. A negative finding from the study was that nurses perceived BCMA might disrupt patients' sleep, particularly during the scanning of the identification band. The authors concluded that organizational leaders must create an environment that supports the effective incorporation of healthcare information technology into the workflow.

Summary

The studies reviewed in this chapter demonstrated evidence that BCMA reduces medication errors and increases medication administration accuracy. Studies identifying the barcode scanning and medication process work-arounds were also discussed. Lastly, a

few studies related to nursing perception of the impact of BCMA on patient care, both positive and negative were also discussed. A common theme throughout the literature review was the interaction of BCMA with other aspects of the environment. As was noted, this theme is in concert with the socio-technical view of healthcare information technology. In the next chapter, the social-technical view and the theory of planned behavior will be discussed in detail. In addition, the TAM, the basis for the evidence-based survey used to assess nurses' perceptions of BCMA at the practicum site, will also be discussed.

Chapter Three

Conceptual Framework

In the previous chapter, research that barcode scanning at medication administration (BCMA) reduces medication administration errors, and evidence related to the under-utilization and "work-arounds" associated with BCMA were discussed. A questionnaire utilizing the technology acceptance model (TAM; Holden & Karsh, 2010) was the intervention for this evidence-based assessment of the perception of nurses at the community hospital towards the BCMA process, in order to understand enhancers and barriers to the utilization of BCMA. The TAM was developed based on the theory of planned behavior, and is in alignment with the *socio-technical* framework for healthcare information technology. In this chapter, the theory of planned behavior, the socio-technical view, and TAM are described, followed by a discussion of the factors to be considered in order to determine organizational readiness to participate in the evidence-based assessment. The organizational assessment will be presented utilizing the model based on frames (Bolman & Deal, 2013).

The Theory of Planned Behavior **and the TAM**

The original TAM was developed in the 1980s to understand workers' lack of adoption of information technology, for instance, desktop computers (Davis, 1989; Holden & Karsh, 2010). The TAM was developed based on the theory of planned behavior. The theory of planned behavior is a social/psychological/ behavioral theory used to explain behaviors such as voting and exercise (Ajzen, 2011; Ajzen & Fishbein, 1969). A key premise of the theory of planned behavior is that a determinant of an individual's behavior is his or her beliefs (Ajzen, 2011; Ajzen & Fishbein, 1969). A

behavioral belief refers to the individual's belief that performing a certain behavior will result in an associated outcome (Evans, Ndetan, & Williams, 2009). The individual evaluates the outcome and attaches a value to it. Based on his or her beliefs about the behavior and the evaluation of the outcome, the individual develops an attitude or evaluation of the behavior. If the beliefs and evaluation of the outcome is positive, the individual is more likely to perform that behavior. Conversely, the individual is not as likely to perform the behavior if it is perceived that the behavior would result in a negative outcome.

Other constructs from the theory of planned behavior that also influence behavioral intention, are *normative beliefs* and *motivation to comply* (Ajzen, 2011; Ajzen & Fishbein, 1969; Evans et al., 2009; Holden et al., 2012). Normative beliefs refer to the belief that an individual has about whether other individuals to whom they refer, such as parents, physicians, and peers, support the behavior. Motivation to comply refers to the individual's motivation to perform behaviors that the people to whom they refer think the behavior should be performed. Normative beliefs and motivation to comply influence *subjective norms* (Ajzen, 2011; Ajzen & Fishbein, 1969; Evans et al., 2009; Holden et al., 2012). Subjective norms refer to the individual's belief about whether most people think the behavior should be performed. Together, the attitude toward the behavior and subjective norms influence *behavioral intention*, or the individual's perception of the likelihood of performing the behavior. Behavioral intention then influences behavior. In other words, behavioral intention determines whether the action actually occurs.

The Socio-Technical View of Healthcare Information Technology

The original TAM is in concert with the socio-technical view that an interrelationship exists between technology and the social environment in which the technology is implemented (Ammenwerth et al., 2006; Berg et al., 2003). From this perspective, the technology and the social environment, or practices occurring in the social environment, transform and influence each other. In other words, technology and the organization or environments are not separate entities, but are rather completely interwoven. The premise of the socio-technical view is that healthcare is very complex and thus, implementing technology in healthcare is very complex.

This socio-technical view is in contrast with the traditional view that information technology simply involves the automation of single tasks (Berg et al., 2003). In addition, the socio-technical view emphasizes addressing work processes rather than a single task that one individual or individual disciplines might perform. Therefore, an understanding of the processes in the social environment cannot fully occur or be captured by just one "snap-shot" or flowchart. For instance, the practice of a nurse or physician cannot be totally understood or captured in a written standard such as an electronic order set. While the electronic order set, consisting of suggested laboratory, radiology, medication, and patient care orders, may guide care, the provider may not order all items in the electronic order set, based on critical thinking.

In addition to emphasizing a thorough understanding of the processes and practices, the socio-technical view places significance on understanding the attributes and roles of the various people who will be impacted by the healthcare information technology implementation (Berg et al., 2003; U. S. DHHS, AHRQ, 2009b). The

end-user has a particularly significant role in the socio-technical perspective and must be intimately involved throughout the design, implementation, and on-going maintenance of the healthcare information technology (Berg et al., 2003). The TAM is widely utilized to understand and address the end-user's acceptance of healthcare information technology. Correspondingly, several investigations have been conducted evaluating the TAM and the relationships between the constructs of the model. The next section presents a detailed description of the TAM constructs and pertinent evidence-based findings.

The TAM

A key premise of the TAM, similar to the theory of planned behavior, is that to increase actual healthcare information technology utilization, acceptance or *behavioral intention* to use the technology must first be increased. Behavioral intention is influenced by *attitude* and attitude is determined by *perceived usefulness (*PU) and *perceived ease of use (*PEoU) of the healthcare information technology. In addition, PU has an independent effect on behavioral intention and PEoU has an effect on perceived usefulness (Holden & Karsh, 2010). Briefly, PEoU refers to the perceived effort for the user in navigating the EMR or healthcare information technology, while PU refers to the perception that using the EMR/healthcare information technology will enhance the individual's work (Holden & Karsh, 2010).

There are several revised versions of the original TAM with additional predictor variables proposed to influence behavioral intention to use an EMR or healthcare information technology, in alignment with the socio-technical view. For instance, the influence of leadership, and patients and families (Holden et al., 2012; Kowitlawakul, 2011), technical support (Moores, 2012), and knowledge about technology (Dunnebeil,

Sunyaev, Blohm, Leimeister, & Krcmar, 2012; Melas, Zampetakis, Dimopoulou, & Moustakis, 2011) have all been found to significantly impact PEoU and PU, or to directly influence the user's attitude towards and intention to use the electronic health record (EHR). In addition, in several of the revised models, both PU and PEoU directly influence attitude and behavioral intention, for instance, in the Melas et al. (2011) model.

Overview of TAM Studies

Studies included in the TAM literature review met the following criteria: the direct effects of both PU and PEoU on the outcome variables were studied; the study participants were all clinicians; the study was conducted in a healthcare setting such as a hospital, ambulatory care facility, or clinic; the technology in the study was a component of healthcare information technology; and the study had been conducted in the past five years. Following is a brief description of the study characteristics such as methodology and number of participants. Information for each study related to the predictor and outcome variables is included in those respective sections.

Escobar-Rodriguez and Romero-Alonso (2013), Holden et al. (2012), Kowitlawakul (2011), and Lu, Hsiaso, and Chen, (2012) studied nurses' intention to use technology in the hospital setting. Their sample sizes were 118, 83, 117, and 277, respectively. Escobar-Rodriguez and Romero-Alonso studied the healthcare information technology of an automated unit-based medication storage and distribution system. Holden et al. studied medication barcode scanning technology and process. Kowitlawakul (2011) explored telemedicine in the intensive care unit, and Lu (2012) examined a healthcare information system in general.

Melas et al. (2011) and Moores (2012) studied both nurses and physicians in the hospital setting. Moores' investigation is the only one in this literature review that also included other members of the inter-professional team such as dieticians. Their sample sizes were 604 and 346, respectively. Healthcare information technology in general, in other words, the hardware and software that produced the EHR, was the focus in both the Melas et al. and Moores' studies.

Dunnebeil et al. (2012) and Morton and Wiedenbeck (2009) studied physicians in an ambulatory care setting, while Ketikidis, Dimitrovski, Lazuras, and Bath (2012) also included nurses, in addition to physicians, in an ambulatory setting. The sample sizes were 117, 239, and 133, respectively. The foci for all three studies were very similar, with both Dunnebeil et al. and Ketikidis et al. examining healthcare information technology in general. Dunnebeil et al., Morton, and Wiedenbeck specifically looked at the electronic health record.

PEoU and PU. All of the studies in the TAM literature review retained PEoU and PU as primary predictor constructs. PEoU refers to the perceptions that the healthcare information technology is understandable, with easy navigation and minimal physical or mental effort required (Holden & Karsh, 2010). In addition, supplemental instructions about the functionality are readily available and the healthcare information technology is integrated into the clinician's workflow. For instance, the timing of a clinical decision support alert occurs when it is most useful to influence and support the reasoning of the clinician (Seidling et al., 2011).

The predictor concept PU refers to the perception that using the healthcare information technology will enhance the individual's work. This construct includes

enabling clinical decisions and improving patient care management (Holden & Karsh, 2010). The TAM concept of PEoU addresses *usability*, a significant concept when considering human-computer interactions (Yen & Bakken, 2012). The traditional definition of usability referred to the ability of the information technology user, for instance a nurse, to effectively and efficiently complete a specific task in a specific setting (American Nurses Association, 2008; Yen & Bakken, 2012). More recent definitions of usability also include the concepts of goal achievement, user satisfaction (IOM, 2011), and clinical reasoning (Yen & Bakken, 2012), which align with the TAM concept of PU.

While both PEoU and PU were the key constructs in the original TAM (Holden & Karsh, 2010) there is some thought in recent literature that PU is the dominant construct and PEoU is no longer significant (Melas et al., 2011; Moores, 2012). However, a review of the TAM literature found that both PEoU and PU had a statistically significant direct effect on the outcomes. Across eight studies, there are ten PEoU/PU pairs as Melas et al. (2011) studied both attitude and behavioral intention, and Holden et al. (2012) had the outcome variables of behavioral intention and satisfaction. For eight of the ten pairs, representing six studies, both PEoU and PU were reported to have a significant impact on the dependent variable(s). Holden et al. found PEoU and an additional construct added to the model in that study, perceived usefulness for patient care to have an impact on the outcome variables. Specifically, as displayed in Table 1, these studies are Dunnebeil et al. (2012), Holden et al. (2012), Kowitlawakul (2011), Lu et al. (2012), Melas et al. (2011), and Moores (2012).

In contrast to the other six studies, Morton and Wiedenbeck (2009) reported only PU to have a significant impact on attitude ($\beta = .63$, $p < .001$). Ketikidis et al. (2012) reported only PEoU to have a significant impact on behavioral intention ($\beta = .513$, $p \leq .001$). There are no major differences in the study participant characteristics and settings in the Morton and Wiedenbeck, and Ketikidis et al. studies compared to the other six studies.

Table 1

Studies Reporting PEoU and PU to Influence Outcome Variables

Study	Outcome Variable	PEoU Value β p	PU Value β p
Dunnebeil et al. (2012)	BI	$\beta = .235$, $p < .01$	$\beta = .557$, $p < .001$
Holden et al. (2012)	BI	$\beta = .25$, $p \leq .01$	$\beta = .39$, $p \leq .01$
	SATIS	$\beta = .38$, $p \leq .01$	$\beta = .16$, $p \leq .05$
Kowitlawakul (2011)	ATT	$\beta = .466$, $p < .01$	$\beta = .297$, $p < .01$
Lu et al. (2012)	ATT	$\beta = .29$, $p < .001$	$\beta = .61$, $p < .001$
Melas (2011)	ATT	$\beta = .23$, $p < .01$	$\beta = .69$, $p < .01$
	BI	$\beta = .38$, $p < .01$	$\beta = .13$, $p < .01$
Moores (2012)	ATT	$\beta = 0.23$, $p < 0.001$	$\beta = 0.35$, $p < 0.001$

Note. ATT = attitude, BI = behavioral intention, SATIS = satisfaction.

For five of the eight study pairs in which both PEoU and PU directly influenced attitude and/or behavioral intention, PU had a greater predictive effect than PEoU. In contrast, Kowitlawakul (2011) reported a greater predictor effect for the influence of PEoU on attitude. In the study by Melas et al. (2011) for prediction of attitude, PU had a greater influence. In prediction of behavioral intention, however, PEoU was more

influential. These unique findings by Kowitlawakul and Melas et al. support the premise that both PU and PEoU are significant constructs. It is noteworthy that these two studies had relatively high survey return rates, with Kowitlawakul's return rate being 84% and Melas et al.'s percentage of 60%. In addition, Melas et al. reported the largest sample size of the eight studies at 604 participants.

In addition to studying the influence of PU and PEoU on the outcome constructs, five of the eight studies also measured the effect of PEoU on PU. Four of the five studies found PEoU to have a significant impact on PU. In addition, these studies also reported the best combination of PEoU and other study variables to explain the variance in the study outcomes, as displayed in Appendix A. Dunnebeil et al. (2012) reported a coefficient of $\beta = .492$ ($p < .001$) between PEoU and PU. PEoU and three other variables collectively explained 67.7% of the variance in PU ($R^2 = .676$). The other three variables with a direct impact on PU were intensity of information technology utilization ($\beta = .204$, $p < .01$), importance of data security ($\beta = .172$, $p < .05$), and importance of documentation ($B = .187$, $p < .05$).

Kowiltawakul (2011) reported a coefficient of $\beta = .420$ ($p \leq .01$) for the impact of PEoU on PU. PEoU and the variables of support from physicians ($\beta = .270$, $p \leq .01$) and years working in the hospital ($\beta = .200$, $p < .01$) collectively explained 35% ($R^2 = .35$) of the variance in PU. Morton and Wiedenbeck (2009) report a coefficient of $\beta = .55$ ($p < .001$) for the impact of PEoU on PU. PEoU and the perceived impact of healthcare information technology on the doctor-patient relationship ($\beta = -.20$, $p < .01$) explained 46 % of the variance of PU ($R^2 = .46$). Melas et al. (2011) also reported a positive relationship between PEoU and PU ($\beta = .52$, $p < .01$). PEoU and the clinicians'

expectations for healthcare information technology sophistication (r = -.43, p < .01) explained 29 % of the variance in PU (R^2 = .29). Moores (2012) found no impact of PEoU on PU. In summary, the direct relationship between PEoU and PU reported by these four studies, as well as the inclusion of PEoU in the models explaining the variance in PU, is significant as this indicates that PEoU may have an additional indirect effect, through PU, on attitude and/or behavioral intention.

Outcome constructs. The original TAM proposed attitude and behavioral intention as outcome variables predicted by the variables of PEoU and PU, and attitude and behavioral intention being antecedents of actual healthcare information technology use. Attitude refers to an individual's evaluation and judgment (Holden & Karsh, 2010) and his/her voluntary acceptance of the healthcare information technology (Escobar-Rodriguez & Romero-Alonson, 2013). Behavioral intention is an individual's motivation, willingness, acceptance of and plan to use the healthcare information technology (Holden & Karsh, 2010).

All of the studies in the literature review used behavioral intention or acceptance (Dunnebeil et al., 2012; Holden et al., 2012; Ketikidis et al., 2012); attitude (Escobar-Rodriguez & Romero-Alonso, 2013; Lu et al., 2012; Moores, 2012; Morton & Wiedenbeck, 2009); or attitude & behavioral intention (Kowitlawakul, 2011; Melas et al., 2011) as the dependent variables for PEoU and/or PU. Ketikidis et al. used behavioral intention and acceptance as interchangeable terms. However, behavioral intention and acceptance are operationalized two differing ways in the Holden et al. model. One operationalization is the intention to use the technology, which is similar to the concept of behavioral intention in the original TAM model (Holden & Karsh, 2010). The second

outcome of acceptance in the Holden et al. model is the user's satisfaction with the technology. This is an alternative measure of acceptance.

Additional predictor constructs. Several of the recent studies related to the TAM included additional predictor constructs. The additional predictor constructs relate to the influence of others (Holden et al., 2012; Kowitlawakul, 2011), the technology itself (Melas et al., 2011; Lu et al., 2012), and individual characteristics of the user (Escobar-Rodriguez & Romero-Alonso, 2013). In the following sections, the additional predictor constructs hypothesized to directly influence the outcome constructs are discussed first, followed by a description of the relationship between the same predictor construct and PEoU and/or PU. The predictor constructs found to significantly influence the outcome constructs, PEoU, and /or PU are displayed in Appendix B.

***Influence of others*.** Several of the studies utilizing the TAM added a predictor variable related to the influence of others on an individual's use of healthcare information technology. Holden et al. (2012) included the variable of *social influence*. In other words, social influence is the individual's perception that "important others" (p. 1051) believe the healthcare information technology should be used. Holden et al. (2012) also added the variable of social influence of patients and families, because the concept of social influence is non-specific, and the influence of patients and families reflects the significance of the healthcare context. Holden et al. retained PU in their research and added the construct of PU for patient care (PU-PT) to represent the perceived usefulness for *improving* patient care.

In the Holden et al. (2012) model all of the predictor constructs relate directly to the outcome variables. Holden et al. found social influence, in general, to significantly

influence behavioral intention to use BCMA (β = .15, $p \leq .01$) and social influence of patients and families to influence satisfaction (β = .16, $p \leq .05$), although the coefficient values were small. The variables of PEoU, social influence in general, and perceived usefulness for patient care were the best subset to predict behavioral intention (R^2=.56). PEoU, PU-PT, and social influence of patient/family were the best model to predict satisfaction (R^2=.76).

*Influence of others on PEoU and PU***.** Similarly, Kowitlawakul (2011) found the constructs of physician support to influence PU (β = .270, $p < .01$) and support from administrators to significantly influence PEoU (β = .242, $p < .01$), but not PU. As discussed previously physician support was part of the model explaining 35% (R^2 = .35) of the variance in PU. Support from administrators explained only 6% (R^2 = .06) of the variance in PEoU.

Likewise, Morton and Wiedenbeck (2009) reported management support to significantly influence PEoU (β = .43, $p < .001$) but not PU. Morton and Wiedenbeck also asked the physician study participants whether the EMR would negatively influence patients' perception of the physician. A significant inverse relationship was found for both PEoU (β = -.23, $p < .001$) and PU (β = -.20, $p < .01$). In other words, as a physician's perception that the EHRs will inhibit the doctor-patient relationship increased, the study participants' perception of PEoU and PU decreased. The model of management support, end-user involvement (β = .20, $p < .05$), and doctor- patient relationship (β = -.23, $p < .001$) were the best model to explain 30% (R^2 = .30) of the variance in PEoU. The doctor-patient relationship (β = -.20, $p < .01$) and PEoU (β = .55, $p < .001$) explained 46% (R^2 = .46) of the variance in PU. Ketikidis et al. (2012) reported that physician

support (β = .196, p < .005), PEoU (β = .513, p < .001), and relevance (β = .208, p < .005) collectively accounted for 67.9% (R^2 = .679) of the variance in acceptance.

Technical support. Several studies included a predictor construct related to technical support. Holden et al. (2012) did not find technical support to significantly influence the outcome variables, but they did suggest that it might still indirectly influence the outcome variables through another construct. They propose that it should be included in the TAM model.

Influence of technical support on PEoU and PU. Lu et al. (2012) hypothesized that service quality, defined as "overall support delivered by the service providers of the healthcare information technology" (p. 261), would be positively associated with both PEoU and PU. These researchers did find that service quality positively influenced both PEoU (γ = .12, p < .001) and PU (γ = .26, p < .001). Service quality along with information quality and system quality explained 69% (R^2 = .69) and 72% (R^2 = .72) of the variance in PEoU and PU respectively.

Moores (2012) included *computing support*, along with *self-efficacy*, in an *enabling factors* construct. Moores' definition of computing support is very similar to the construct of service quality described by Lu et al. (2012). Computing support refers to the perception of the end-user that adequate technical support will be available. Like Lu et al., Moores reported enabling factors to significantly influence both PEoU (β = .55, p < .001) and PU (β = .18, p < .01). However, because self-efficacy was included with computing support in the enabling factors construct, it is difficult to know the influence of computing support as a unique variable. Enabling factors collectively accounted for 42% (R^2 = .42) of the variance in PEoU.

Training. Holden et al. (2012) added the predictor construct of *training received*. This construct was not found to significantly influence the outcome variables, behavioral intention or satisfaction. These researchers suggest that the training constructs may have had an impact on PEoU and/or PU, and thus an indirect impact on the outcome variables. However, this research team, unlike most others, did not measure the influence of the additional constructs on PEoU and/or PU. They suggest that no significant relationship may have been found between training and the outcome variables because training was poorly contextualized. For instance, study participants may have found the formal classroom instruction was not helpful. "Informal" training that occurred on the unit may not have been considered to be part of training. Participants may have considered the latter to be helpful.

Influence of training on PEoU and PU. Escobar-Rodriquez and Romero-Alonso (2013) also hypothesized that training would positively affect both PEoU and PU. These researchers did not provide an additional definition of training. However, both hypotheses were supported with the relationships between training and PEoU (β = -.257, $p < .001$) and training and PU (β = .367, $p < .001$) being significant. Training, healthcare information technology experience, and the perceived risks of the healthcare information technology collectively accounted for 40% (R^2 = .40) of the variance in PEoU as displayed in Table 1. Training and PEoU accounted for 29.5% (R^2 = .295) of the variance in PU.

Morton (2009) also included the construct of adequate training. Unlike Escobar-Rodriquez and Romero-Alonso (2013) but similar to Holden et al. (2012), Morton did not find training to significantly influence either PEoU or PU. Morton

discusses that 67% of the study participants were under 40 years of age and they may have had prior computer experience. Thus, their need for training might have been minimal, and therefore not a significant variable in the users' perception of factors that impact their attitudes about EMR use.

Moores (2012) included the concept of training, along with computing support and self-efficacy, in the enabling factors construct, hypothesized to influence PEoU and PU. As discussed previously, enabling factors were found to influence both PEoU ($\beta = .55$, $p < .001$) and PU ($\beta = .18$, $p < .01$). However, combining concepts into the enabling factors construct does not allow determination of importance of one of the concepts over others.

***Individual characteristics*. S**everal of the TAM-related studies included predictor constructs related to personal characteristics of the study participants. For instance, Holden et al. (2012) added age and experience to the framework. Experience of the user with the technology was added by Escobar-Rodriquez and Romero-Alonso (2013) and Moores (2012), while Kowitlawakul (2011) included the study participants' experience in the hospital. Dunnebeil et al. (2012) and Melas et al. (2011) studied the user's knowledge about healthcare information technology.

Holden et al. (2012) added age and experience to the framework because these two demographic variables were found in other studies to influence healthcare information technology adoption. The concept of experience is also congruent with a model proposed by Courtney, Alexander, and Demiris (2008) utilizing Benner's novice to expert framework (as cited in Courtney et al.). The Courtney et al. model suggests that the novice, competent, proficient, and expert levels of practice align with varying

healthcare information technology implementation needs at each level. This was confirmed in a study by Cho, Staggers, and Park (2010).

While there is theoretical support that age and experience would influence the outcome variables, the results are mixed. Holden et al. (2012) did not find either of these additional predictor variables to significantly influence the outcome variables. However, Escobar-Rodriguez and Romero-Alonso (2013) did find that the participants' healthcare information technology experience significantly impacted PEoU (β = -.215, p < .001) and as noted earlier healthcare information technology experience was part of the model explaining variance in PEoU. In the Escobar-Rodwriquez and Romero-Alonso study, healthcare information technology experience had no influence on PU. Kowitlawakul (2011) found experience in the hospital, measured as years working in the hospital, to significantly impact PU (β = .200, p = .01) and to be a variable in the model explaining the variance in PU.

Moores (2012) divided his participants into two groups, above and below the mean of 2.4 years of healthcare information technology experience, and examined the impact of *enabling factors,* in other words, computing support and self-efficacy, on PEoU and PU. Moores found a significant difference between the two groups for the impact of experience on PU (t = 5.00, p < .001). There was no difference between the two groups in terms of the influence of enabling factors on PEoU. Moores suggests that as individuals begin to accept healthcare information technology, they consider how it will support their work. In other words, they are considering PU. After they have become more experienced in healthcare information technology use, individuals have accepted the value of the system to their work and their attitude is directly influenced only by PEoU. Moores'

findings suggest that the healthcare information technology experience may exceed 2.4 years when this occurs.

Dunnebeil et al. (2012) and Melas et al. (2011) found *perceived knowledge* about the technology to significantly influence PEoU (β = .152, p < .05 and β = .49, p < .001, respectively). However, neither Dunnebeil et al. nor Melas et al. found perceived knowledge to influence PU. Morton and Wiedenbeck (2009) found the construct of *perceived involvement* of the end-used in implementation to be significant only for PEoU (β = .20, p < .05). In the Morton and Wiedenbeck study perceived involvement was a variable in the model explaining variance in PEoU.

Other predictor constructs. Ketikidis et al. (2012) studied the influence of users' perceived *computer anxiety.* These researchers define computer anxiety as feelings of anxiety and nervousness related to computer use. They found this construct did not significantly influence PEoU or PU.

Lu et al. (2012) found system quality to be significant for both PEoU (y = .28, p < .001) and PU (y = .12, p < .05). System quality was defined as inherent features that supported the process of utilizing the healthcare information technology such as performance and the user interface. Likewise, Lu et al. found the *completeness*, *accuracy*, and *timeliness* of the information, collectively referred to as *information quality,* to be significantly related to PEoU (y = .61, p < .001) and PU (y = .57, p < .001). As discussed earlier system and information quality were included in the models that explained the variance in both PEoU and PU. Similar to Lu et al., Moores (2012) found information quality, defined as the accuracy, content, format, and timeliness, to significantly impact PU (β = .45, p < .001) and contribute to the variance in PU. In summary, the results from

all of the studies that included other predictor constructs suggest that these additional constructs influence PEoU, and PU.

Summary of TAM Studies

There are several common themes across the studies in the literature review. All of the studies retained PEoU and PU from the original TAM model, and all found these predictor constructs to significantly influence the outcome variables. Likewise, all of the studies used attitude, behavioral intention, or a synonym, as the outcome variable. Each study also included additional predictor constructs, hypothesized to influence PEoU, PU, attitude, and/or behavioral intention. Several of the studies included the influence of others, identified in general terms or specifically as patients, families, physicians, and administration (Holden et al., 2012; Kowitlawakul, 2011; Morton & Wiedenbeck, 2009). Each of these studies found the influence of others to be a significant predictor variable.

Of the studies that included training as a predictor variable, Escobar-Rodriguez and Romero-Alonso (2013), and Moores (2012) found it to be significant, while Holden et al. (2012) and Morton and Wiedenbeck (2009) did not. Holden et al., did not find technical support to be a significant predictor variable, but Lu et al. (2012) and Moores did find technical support to significantly influence PEoU and PU. Holden et al. also did not find age and experience to be significant, while Escobar-Rodrigues and Romero-Alonson, and Moores did find those variables to be significant. It should be noted that the coefficient values for the additional predictor variables varied in size.

An important consideration is that the Holden et al. (2012) study results in regards to the additional predictor variables consistently differed from the other studies. This may be due in part to the Holden et al. framework positing that all of the predictor variables

directly influence the outcome variables. In the other studies, the additional predictor variables' direct influences on PEoU and PU were measured. Holden et al. acknowledge that some of the additional predictor variables that did not significantly influence the outcome variables in their study, such as training, may influence the outcomes indirectly through other variables such as PEoU and PU.

The studies in this literature review related to the TAM have several limitations. For instance, all the studies used a descriptive survey for the study methodology, which is Level VI on the evidence hierarchy (Melnyk & Fineout-Overholt, 2011). In addition, while the definitions of the outcome and additional predictor constructs are similar, there is some room for variability in interpretation. Strengths of the studies collectively include that all of the studies retained the key predictor variables, PEoU and PU. In addition, each of the studies added one or more predictor variables that is in concert with the socio-technical view. In spite of the limitations of the studies, the findings do support the TAM as a framework and the corresponding published research-based surveys as tools to understand attitude towards and behavioral intention to use healthcare information technology and the EMR.

While the TAM aligns with the socio-technical view, particularly focusing on the perception of the user of the healthcare information technology, it is common for TAM-based studies to add variables in order to further understand the context or social environment (Holden & Karsh, 2010). It should be noted that many of the additional variables correspond to the concepts of the theory of planned behavior. For instance, Holden et al. (2012) added the predictor variable of social influence of patients and families on the nurses' utilization of BCMA. This variable is consistent with the theory of

planned behavior construct of normative beliefs; in other words, it addresses whether users believe that patients and families think BCMA should be used. As discussed, all of the studies in the literature review added variables to the TAM and the corresponding survey used in the research.

Organizational Frames Conceptual Framework

Frames refer to the mental models or maps individuals use to synthesize data and information into patterns (Bolman & Deal, 2013). Frames become assumptions and are used to match what is occurring in a given situation with an established mental model or learned pattern. Frames are efficient and necessary as they support rapid recognition of "clues" in a given situation and thus help individuals navigate and quickly make decisions to keep progressing through the situation. Bolman and Deal (2013) propose four frames, each corresponding to a metaphor. The frames are structural, human resources, political, and symbolic.

Structural Frame

The metaphor for the structural frame is a factory. Key components of this frame include organizational charts, policies, procedures, and established methods of communication. Job descriptions, which provide a structure for some of the human resource processes, are also in the structural frame. In the structural frame job descriptions involve the differentiation of work according to, and integration of the work through communication, reporting structures, and meetings to support the organizational operations. There are problems in the structural frame when the structures are too loosely organized or too rigid, or key structures are missing.

Human Resources Frame

Families are the metaphor for the human resources frame. While the actual job descriptions are in the structural frame, the human resources frame focuses on supporting employees to fulfill their role responsibilities, while also having a sense of accomplishment and satisfaction in their work, and fulfilling their role essentials. This frame includes the traditional human resources concepts such as hiring and performance reviews, and unique concepts such as developing groups and teams. There are issues in the human resources frame when a mismatch occurs between the employees' human needs, such as job satisfaction, and the organizational needs.

Political Frame

The political frame is characterized as a jungle, with the organization being viewed as differences between groups. Politics according to Bolman and Deal (2013) involve making decisions and allocating resources in the context of "scarcity and divergent interests" (p. 183). Competition, a characteristic of the political frame, occurs when there are scarce resources. There is a constructive aspect of the political frame as the skills of an effective organization are also viewed through this frame. The role of a leader in the political frame is that of politician and the organization is viewed as an arena. There are problems in the political areas when the power is concentrated in one place or when the power or influence is too broadly dispersed.

Symbolic Frame

The symbolic frame is rooted in social and cultural anthropology. The metaphors for the symbolic frame are temples and carnivals. This frame involves heroes, stories, rituals, ceremonies, and culture. While the other three frames are described by Bolman

and Deal (2013) as rational, this frame involves the meaning individuals attribute to events. A problem in the symbolic frame arises when the ceremonies or rituals lose their potency.

Rationale for Utilizing Frames

Bolman and Deal (2013) present four frames with which to view and understand organizations. This framework was selected to assess the organization's readiness to implement a TAM survey as it is in alignment with the theoretical framework and area of interest of the scholarly project. The structural frame aligns with the straightforward definition of healthcare information technology, while the human resources, political, and symbolic frames align with the socio-technical view. Collectively the four frames provided a comprehensive organizational assessment.

Organizational Frames Application to BCMA

In this section, a brief description of BCMA is presented. Next, organizational frames are applied to the BCMA process at the community hospital. Finally, frames are used to assess the community hospital's readiness to implement the evidence-based survey.

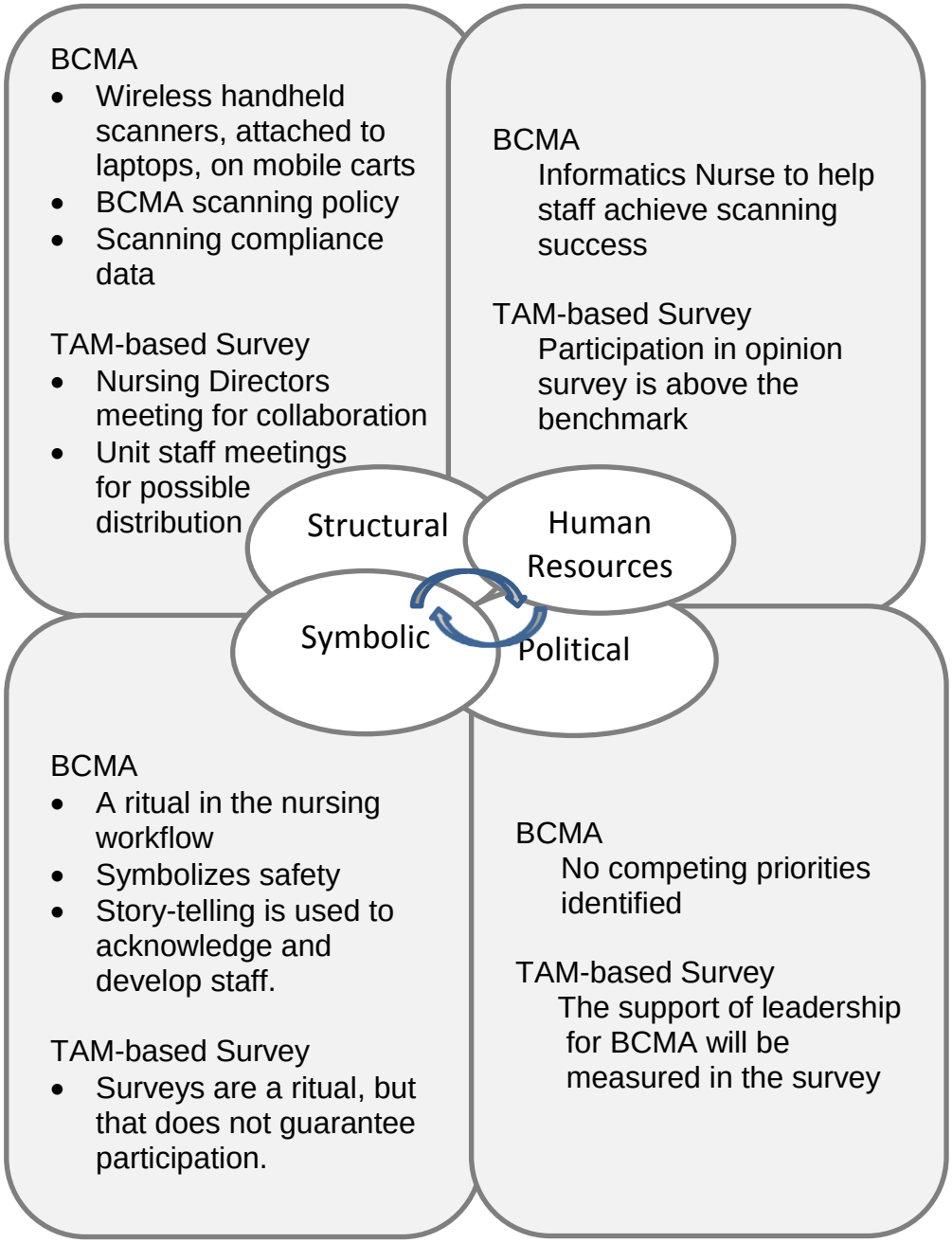
BCMA, a type of healthcare information technology, is an inter-professional process, which begins with computerized provider order entry and includes the administration of the medication to the patient. Alerts related to the patient's allergies and any contraindications for the medications being ordered are presented to the providers (physicians and advanced practice providers), nurses, and pharmacists throughout the ordering and verification process (Poon et al., 2010). In addition, upon scanning the

patient's identification band and medications, BCMA will also alert the nurse if the "rights" of medication administration are not met (Smith et al., 2012).

Application of the frames model to BCMA is depicted in Figure 1. The structural frame assessment includes that the BCMA hardware at the community hospital consisted of a wireless hand-held scanner, attached to a laptop on a mobile cart. The scanner was an input device into the BCMA software application, which interfaced with the eMAR. Information systems technicians were available on site during routine business hours to trouble-shoot any hardware/software issues. A helpdesk was remotely available, at all times, and had the capability to "shadow" the nurse in the BCMA and eMAR software in order to effectively trouble-shoot.

Also from the structural frame viewpoint, there was also an organizational policy related to BCMA at the community hospital. This policy included the statement that BCMA was the standard for practice and was to be utilized. The policy also addressed any exceptions to scanning medications, trouble-shooting and actions for the user when a medication or the patient's wristband would not scan, and an explanation of the BCMA alerts. The BCMA policy supported compliance with use and established BCMA as part of the culture. In addition, there was a structure in place to provide the nursing directors with a report of scanning compliance, so nurses who were not meeting the BCMA scanning compliance benchmark could receive additional support.

Figure 1. Organizational Readiness Assessment Using Frames (Bolman & Deal, 2013)



Note. TAM = Technology acceptance model

Finally, one of the Meaningful Use of the Electronic Health Record Program, Stage 2 requirements is to have a structure implemented to track medications from the order being placed through administration, by an electronic system (U.S. DHHS, CMS, 2013). This requirement can be met using BCMA. The community hospital was in the process of attesting for Meaningful Use Stage 2, and utilizing BCMA to meet the requirement to track medications, which may have contributed to a renewed emphasis on utilizing BCMA.

The human resources frame, as discussed previously, focuses on supports available to employees so they are able to fulfill their role essentials. Related to BCMA, there were several mechanisms by which users were supported. Nurses were educated during orientation to the organization on the process for BCMA and the safety benefits. In addition, an informatics nurse was available for support on the nursing units. Peer-to-peer support was also encouraged by the nursing directors. For instance, if a nurse who was not meeting the benchmark agreed, a peer was asked to spend time with the nurse during scanning to identify any procedural steps being missed, or other barriers that may have contributed to the nurse's lower scanning rate.

From the political frame perspective, no competing priorities or power struggles were identified that influenced BCMA. The organization appeared to have the necessary structures and resources, as described above, to support the utilization of BCMA. In terms of the symbolic frame, BCMA itself signifies and symbolizes the culture of safety that was evident at United Hospital. When fully implemented, BCMA became a ritual in the nurse's workflow at the community hospital. Story-telling, a component of the symbolic frame, was used by the nursing directors to highlight nurses who were

particularly adept at incorporating BCMA into their practice and thus "symbolized" the safety culture.

Organizational Readiness to Implement a Survey

In the following section, the community hospital readiness to implement the TAM survey, from the frames perspective, are discussed. From the structural frame perspective, the nursing, pharmacy, and respiratory therapy directors and the Chief Nursing Officer (CNO) met routinely. It was at these meetings that collaboration with the directors and the Chief Nursing Officer occurred, regarding their support of the project and determining how to engage staff in participation. For instance, a decision point was if the survey should be conducted on paper or if an electronic survey tool should be utilized.

A consideration from the political, human resources and symbolic frame perspectives was the *employee engagement* survey, which employees were invited to participate in every couple of years. The employee engagement survey represented a ritual from the symbolic frame view, it provided information about the perceived support available for employees from the human resources perspective, and reflected staffs' perception about the organizational decision-making process and power base from the political frame view. The last survey was in 2012, with a survey participation rate that was well above the benchmark. While the participation rate was encouraging, it was not assumed that the same level of participation would automatically occur on the BCMA survey. Describing how the information from the BCMA survey would be used and shared with participants was included in the communication to the participants asking for their participation in the BCMA survey.

The evidence-based survey provided the practicum site nursing leadership team with information about socio-technical variables that were measured by the survey. As will be discussed in Chapter Five, some of the variables enhanced the use of BCMA, while other variable constructs identified barriers to using BCMA. Some of these variables on the survey aligned with the political frame of the community hospital, such as the perceived support of the leadership team related to BCMA.

Summary

The theory of planned behavior, which provided the theoretical basis for the development of the original TAM, and the socio-technical view of healthcare information technology were described in this chapter. Collectively, these theories and view provided the theoretical basis for the scholarly project. The frames model (Bolman and Deal, 2013) was utilized to assess the organizational readiness to implement the TAM survey. In the next chapter, the methods to implement the evidence-based survey are discussed, along with further application of the frames model to the readiness of the organization to implement the evidence-based survey.

Chapter Four

Methods

In the preceding chapters, the impact of the electronic medical record (EMR) and health information technology on patient safety, and the concerning problem of lack of adoption of these technologies was discussed. In addition, the purpose of the scholarly project was to understand acceptance and adoption of barcode scanning at medication administration (BCMA) at the practicum site, through an evidence-based assessment utilizing the technology acceptance model (TAM), was presented (Hassink et al., 2012; Hensing et al., 2008; Koppel et al., 2008; McCoy et al., 2012; U.S. DHHS, AHRQ 2009a, 2009b, Zlabek et al., 2011). A literature review of research studies utilizing the TAM was presented. The theory of planned behavior (Ajzen, 2011; Evans et al., 2009), the socio-technical view, and the framing model (Bolman and Deal, 2013) were also discussed. The methods used for the design, implementation, and evaluation of the evidence-based assessment scholarly project are presented in this chapter.

Design Phase

The design phase included the initial organizational assessment to identify which healthcare informatics technology would be the focus of the scholarly project. In addition, the proposed scholarly project was vetted with the community hospital leadership team and their support for the project was confirmed. Finally, implementation and survey instrument considerations were addressed.

Organizational Assessment

The organizational assessment was utilized to identify the healthcare information technology to be the focus of the evidence-based assessment. As described previously,

the organizational assessment was conducted utilizing the frames model (Bolman & Deal, 2013). As part of the organizational assessment, metrics related to the utilization of healthcare information technology at the community hospital, such as BCMA rates and Meaningful Use of the Electronic Health Record (U.S. DHHS, CMS 2013) measures were reviewed. In addition, rounds with the respective nursing directors occurred on the units that utilize BCMA.

As identified in Chapter Three, the nursing directors monitored BCMA scanning compliance reports. The average for most of the units was above the benchmark established by the nursing directors. However, there was an opportunity for improvement on one unit as a whole, the surgical services/procedural unit, and each unit had some individuals whose scanning compliance could be improved. In addition, as discussed in Chapter Two, research had demonstrated there are opportunities for ongoing improvements on units that have already implemented BCMA (Early et al., 2011; Voshall et al., 2013).

A strength of the community hospitals, found in the organizational assessment, was the strong culture of safety with transparency in reporting errors, daily "check-ins" to review any events that have occurred in the past day, with action plans to address, and leadership rounding on the units. The culture of safety supported high adoption of BCMA, and according to the scanning compliance metrics, BCMA was in general adopted. However, it was anticipated the evidence-based assessment of BCMA would still provide the community hospital leadership team with meaningful and actionable information, such as the impact of their support of BCMA on adoption, and opportunities to improve the workflow. While staff were utilizing BCMA, that did not guarantee staff

perceived it to be useful and/or easy to use. It was anticipated there would be opportunities for improvements in efficiency.

BCMA had been an area of scholarship for the doctor of nursing practice (DNP) student (DeYoung, VanderKooi & Barletta, 2009; Hassink et al., 2012). Implementing an evidence-based assessment related to BCMA adoption and acceptance at a community hospital would contribute to that body of work. This was a secondary reason BCMA was chosen to be the focus of the evidence-based assessment.

Collaborating with the Leadership Team

There were several decisions to be made in collaboration with the appropriate leadership team members, such as confirming which roles and units would be included in the project, and the logistics of distributing the survey instrument. During the overall organizational assessment, it was learned that nurses in the following areas used BCMA: inpatient services (in other words, medical/surgical, pediatrics, and obstetrics); the surgery areas of patient holding, the post-anesthesia care unit, and endoscopy; and the emergency department. In addition, it was discovered that the respiratory therapists also scanned medications.

Due to the widespread implementation of BCMA at the community hospital discovered during the organizational assessment, the key stakeholders for the scholarly project were the nursing, pharmacy, and respiratory therapy directors and the chief nursing officer (CNO), collectively referred to as the Nursing Leadership Team. Another stakeholder was the scholarly project partner at the practicum site who was hospital president, and also the practicum preceptor. Pharmacy is generally an

inter-professional partner in the BCMA process and it was anticipated that director at the community hospital would have insight into the current BCMA process and some of the survey results. Thus, pharmacy was also a key stakeholder.

It was confirmed with the nursing leadership team that all staff at the community hospital who used BCMA routinely, both RNs and respiratory therapists, would be invited to participate in the survey. Staff who had recently been hired would be invited to participate if they had been oriented to BCMA and were at the point in their orientation when they were expected to use it. There is a licensed practical nurse employed at the community hospital; however, that individual did not administer medications, and thus the survey was not applicable to that individual's role. He was not invited to participate.

Another important consideration was determining whether the survey would be on paper or distributed via an electronic tool. Staff members who were not computer literate would perhaps be less likely to take the survey using a computer. Additionally, they may have been the individuals who were less adept at BCMA and less satisfied with it. Their participation in the survey was important. The feedback from the nursing leadership team was to distribute the tool via paper. The directors shared that there are staff members who were less comfortable with computers, particularly in the surgical services area, and recommended that a paper survey be utilized.

The timing of the distribution of the survey, and when in their day the participants would be able to take the survey, were also discussed with the nursing leadership team. As is described in the next section it had been confirmed that the survey took approximately 7 to10 minutes to complete. The leaders agreed that staff could take the survey during the units' shift huddles, and as they had time through-out the day. The

leaders agreed to invite staff to take the survey during the unit huddles, during rounding on the units and at staff meetings, and to have the surveys available in the break rooms. In terms of scheduling the implementation of the survey, the directors advised that there would often be some competing priorities, and due to the relatively short time needed to complete the survey, it could be distributed at any time. It was determined that ten days would be an appropriate time for the survey to be available to the staff. That timeframe would encompass two weekends, and within that timeframe it was likely that staff who were going to accept the invitation to do so would have participated.

Preparing the Survey Tool

In the design phase, the survey was also prepared. Several research studies utilizing the TAM were presented in the literature review. However, the study by Holden et al. (2012) was specifically related to BCMA, and therefore, was the instrument selected for the scholarly project. While the discussions were occurring with the practicum site leadership team regarding how, when, and to whom to distribute the survey, permission was sought from Holden et al. for permission to utilize the tool.

The psychometric properties of the Holden et al. (2012) instrument were acceptable, with all of the subscales having a Cronbach's alpha value of greater than .70. The *technical support* and the *social influence from patients and families* scales attained an alpha of greater than .80. Cronbach's alpha values of greater than .90 were reported for *perceived usefulness, training, perceived usefulness for patient care,* and *satisfaction*.

Of note, several of the questions in the Holden et al. (2012) instrument were validated in other studies. The Holden et al. questions related to perceived usefulness and perceived ease of use were directly taken from Venkatesh, Speier, and Morris (2002).

Likewise, the intention questions regarding the extent to which the participants intended to use BCMA, and predicted they would use it, were from Venkatesh et al. The two questions related to the influence of others in the Holden et al. survey were used in the Venkatesh, Morris, and Askerman (2000) study. The training received and technical support questions were derived from the work of Bailey and Pearson (1983).

Permission was obtained to utilize the survey developed by Holden et al. (2012; Appendix A). In addition, the project proposal was submitted to the Grand Valley State University Kirkhof College of Nursing Associate Dean for Nursing Research and the Institutional Review Board governing the community hospital. In both instances, the project was deemed a quality improvement project with the clarification that the project results could be shared outside of the institutions, but the findings could not be generalized beyond the community hospital.

To confirm readability of the survey instrument and invitation to participate, a draft instrument was completed by three nurses that were from another hospital within the same health system as the community hospital. These individuals were familiar with the process of BMCA and the EMR, and knowledgeable about standard principles for surveying staff in research and quality improvement projects. Two of the individuals were informatics nurses and the third individual was a nurse researcher. It took the individuals between 5 and 10 minutes to complete the survey, depending on whether they carefully read each phrase and considered it, or entered the first response that occurred to them. The individuals provided feedback about spacing and use of borders to increase ease of reading. That feedback was incorporated into the invitation to participate and the survey instrument that was distributed to the staff (Appendices B & C, respectively).

Implementation Phase

The implementation of the scholarly project began on August 7, 2014 when the surveys were distributed to the nursing units and the respiratory therapy director. An ample supply of envelopes containing the survey were placed in the break-rooms, along with a bowl of trail-mix packages and healthy snacks, the "incentive" to take the surveys identified by the nursing leadership team. There was a notecard on the snack bowl thanking people for their interest in the survey.

The doctor of nursing practice (DNP) student rounded on the units approximately every three days, communicated with each of the directors at that time, collected completed surveys, and replenished the supply of unused surveys and "incentive" snacks. The DNP student was also available to the directors via e-mail, although the directors had very few clarifying questions. At the mid-point of the ten-day survey time period, the DNP student sent the directors an e-mail reminding them that the survey time period was half over, and asking them to continue to invite their staff to participate in the survey. The surveys were available until August 17, 2014, but approximately two-thirds of the surveys were submitted within the first few days.

In terms of competing priorities, there was not an unusually high census or unusual staffing challenges during the survey time-period. In addition, there were no hospital-wide issues with the scanning equipment, or the wireless infrastructure on which the BCMA scanners operate. However, the primary EMR documentation used by all nurses was being transitioned from one application to another on August 19, 2014. The educational method was an on-line learning module that took about 30 minutes to complete. As was the case with the BCMA survey, the nurses completed the on-line

learning module whenever they had time throughout their workdays. In addition, the community hospital had been anticipating the Joint Commission for the Accreditation of Hospitals tri-annual visit for several months. While the hospital has a philosophy of always being prepared and have a culture of quality and safety at all times, by August 10, when the surveys were distributed, the nursing leadership team knew the Joint Commission visit would very likely be either the week of August 18, or of August 27. The visit in fact began on August 19, the same day of the EMR changes and two days after the BCMA questionnaire timeframe ended. It is unknown how the competing priorities influenced the survey response rates. However, anecdotally during rounding several staff members commented to the DNP student how "easy" and "quick" it was to complete the survey.

Evaluation Phase

After the surveys were collected, the data were analyzed utilizing descriptive and non-parametric statistics. The results were shared with the nursing leadership team and the preceptor. An action plan to address opportunities for improvement, including recommendations, was developed utilizing a process improvement approach and established staff meetings, huddles and unit rounding. The survey results are discussed in Chapter Five and the recommendations are presented in Chapter Six.

Chapter Five

Results

In the preceding chapter, the methods for the evidence-based assessment of staff member's acceptance and adoption of barcode scanning at medication administration (BCMA) were discussed. In this chapter, the results of the assessment are presented. The results include demographic data for the participants, descriptive data related to the nine Holden et al. (2012) framework variables, an analysis of statistical differences among the five clinical departments/areas, and the correlations between the nine survey variables. The chapter concludes with a discussion of the action plan developed to address the assessment findings.

Participants

A total of 120 nurses and 23 respiratory therapists were invited to participate in the survey, with 44 staff members participating (30% of those invited). The number of nurses and respiratory therapists from each department/area who were invited to participate and the number of actual participants by department are displayed in Table 2. There were only three participants from the intensive care unit. The staff from the intensive care unit and the acute care unit may be assigned to work on either unit due to a higher than usual census or a staffing shortage on one of the units. Therefore, the intensive care unit and the acute care unit responses were combined into an *inpatient* grouping. There were no changes to the department groupings for the emergency department, obstetrics, respiratory therapy, and surgical services/procedural.

Survey Integrity

For the demographic questions one participant did not respond to demographic question five (years of work computer use), one participants did not respond to question six (years of home computer use), and one participant omitted both questions five and six. In addition, two participants did not respond to two of the questionnaire items, and three respondents did not answer four of the items. The items most impacted were the two questions related to technical support, which were answered by 40 of the 44 participants. Of note, the technical support subscale had the second lowest mean score (M = 3.20). It is difficult to know whether the fewer number of responses in any way contributed to the lower score. The items without a response were excluded from the data analyses, consistent with the process utilized by Holden et al. (2012).

Table 2

Number of Staff Member Participants by Department

Staff Members	ED	INPT	OB	RT	SUR	Total
Eligible	28	43	11	23	21	143
Participated	11	11	6	6	10	44
Response percentage (%)	39	26	55	26	48	30

Note. ED = emergency department, INPT = acute inpatient/critical care, OB = obstetrics, RT = respiratory therapy, SUR = surgical services/procedural area.

For five surveys, it was difficult to determine which response option was circled; in other words, it appeared as though two adjoining numbers were circled. On three surveys this occurred for one response each. On another survey it was the case for three questions. For the fifth survey, it occurred for nine of the 32 questions, including each of

the four questions that asked respondents to rate the *perceived usefulness for patient care* items. For each of the total unclear responses, a coin was tossed to determine whether the high number or lower number would be entered into the statistical program. Resulting from the coin toss, eight of the surveys were scored using the higher number, and seven using the lower number. It is reasonable to believe that with the nearly equivalent distribution of higher and lower rating values entered, and the small percentage of the total 1,402 responses that these 15 responses represented (1%), that the use of these procedures did not influence the overall descriptive statistics.

Subscale scores were calculated for each of the dimensions of Holden et al.'s (2012) instrument following the procedures they developed. The cumulative responses for each of the nine survey subscales were utilized in the inferential statistics such as the Kruskal-Wallis and the Mann-Whitney *U* tests. Cronbach's alpha was used to determine internal consistency of the survey subscales (Table 3). IBM SPSS Statistics 20 software was utilized for all data analyses.

Table 3

Cronbach's α for the Survey Subscales

Perceived Ease of Use	Perceived Usefulness	Influence of Others	Beliefs: Patient Perceptions	Perceived Usefulness: Patient Care
.778	.950	.777	.930	.895
Training	**Technical Support Staff**	**Intention to Use**	**Satisfaction**	
.970	.905	.892	.798	

Note. $n = 42$ for the influence of others subscale, $n = 40$ for the technical support subscale, and $n = 44$ for all other subscales

Demographic Data

An ordinal scale was used to determine participants' age, consistent with the method used by Holden et al. (2012). There were six participants (13.6%) in the 18 to 29 years of age category, 18 participants (40.9%) between 30 and 39 years, 10 participants (22.7%) between 40 and 49 years, eight participants (18.2%) between 50 and 59, and two (4.5%) participants were sixty years or greater. Twenty-eight (64%) of the participants were between 30 and 49 years of age and thirty-six (81.8%) of the participants were between 30 and 59 years of age. Of note, the age categories with the smallest number of participants were at the two ends of the scale.

There was a wide range in the participants' experience in the current role with the minimum being less than a year of experience and the maximum being 40 years (Table 4). Likewise, there was a wide variation in the number of years the participants had worked for the hospital, with the minimum of one year and the maximum of 30 years.

Table 4

Participants' Years of Experience

	M	*SD*	Minimum	Maximum
In current role	10.43	10.67	.8	40
Working for the hospital	7.83	6.81	1	30
In current unit/area	6.73	5.45	.8	24
Computer use at work	9.90	6.77	1	30
Computer use at home	15.27	5.85	5	30

Note. $n = 42$ for computer use items, $n = 44$ for other items

It should be noted that the average number of years of work computer use and home computer use were 9.90 years and 15.27 years, respectively. In other words, the survey participants collectively reported several years of both home and work computer use, although the survey did not measure their comfort or skill level with using a computer in either setting.

The BCMA Questions

The 32 BCMA questions specifically related to the nine subscales were rated by the survey participants using a seven-point response scale (see Appendix E). Measures of central tendency for the 32 individual questions are reported in Appendix F. Two questions were reverse-scaled, *does the bar coding system require a lot of your mental effort?* and, *to what extent are you dissatisfied with the bar coding system?*

Table 5 provides descriptive statistics for the subscales of the BCMA survey. The highest scores among the nine subscales were for the intention to use BCMA (M = 4.96, SD = 1.42) and the influence of others *(*M = 4.74, SD = 1.76). The other outcome variable, satisfaction with barcoding, was also scored relatively highly (M = 4.23, SD = 1.50). The two lowest mean scores were perceptions regarding technical support (M = 3.20, SD = 1.88) and training (M = 3.19, SD = 1.86).

The mean scores of the subscales were not normally distributed and therefore the medians were reviewed to evaluate the relative rankings of the perception scores. Except for satisfaction and perceived usefulness for patient care, the scores of the subscales were ranked similarly whether the mean or median was used. However, the mean for satisfaction *(*M = 4.23) was higher than the mean for perceived usefulness for patient care (M = 4.11). The median for perceived usefulness for patient care (Mdn = 4.63) was

higher than the median of the satisfaction scale (*Mdn = 4.*50). These differences between the medians and the means did not impact the action plans or recommendations derived from these findings.

Table 5

Descriptive Statistics for the Nine Survey Subscales

Variables	*n*	*Mean*	*SD*	*Median*	*Min*	*Max*
Perceived ease of use	44	4.60	1.05	4.75	1.50	6.0
Perceived usefulness (PU)	44	3.96	1.96	4.38	0	6.0
Influence of others	42	4.74	1.76	5.50	0	6.0
Beliefs: Patient perceptions	44	3.87	1.63	4.25	0	6.0
PU: Patient care	44	4.11	1.62	4.63	.25	6.0
Training	44	3.19	1.86	3.13	0	6.0
Technical support	40	3.20	1.88	3.26	0	6.0
Intention to use	44	4.96	1.42	5.50	0.50	6.0
Satisfaction	44	4.23	1.50	4.50	1.0	6.0

A Comparison of the Departments

Table 6 reports the measures of central tendency for each of the subscales by the individual departments. As noted in the table, the lowest mean was reported by the surgical services department for eight of the nine subscales. The lowest mean for *technical support* was reported by the obstetrical department. In general, the small numbers of respondents in each department was a factor in creating non-normal subscale score distributions with large standard deviations for the related range of possible responses. For example, although the ranges of item responses for the subscales

Table 6

Measures of Central Tendency for Subscale Scores by Hospital Department

	Entire Sample		ED (*n* = 11)		INPT (*n* = 11)	
	M (SD)	*Mdn*	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*
Perceived ease of use (PU)	4.60 (1.04)	4.75	4.30 (.83)	4.25	5.18 (.64)	5.50
Perceived usefulness	3.96 (1.93)	4.38	4.37 (1.16)	4.50	5.48 (.90)	6.00
Influence of others	4.74 (1.76)	5.50	5.32 (.87)	5.50	4.80 (2.03)	6.00
Beliefs: Patient perceptions	3.87 (1.63)	4.25	3.36 (1.86)	4.25	4.45 (1.15)	4.86
PU: Patient care	4.10 (1.62)	4.63	4.32 (1.06)	4.75	5.28 (.93)	5.63
Training	3.19 (1.86)	3.13	2.80 (1.47)	3.00	4.82 (1.83)	5.13
Technical support	3.20 (1.88)	3.25	2.68 (1.59)	2.50	4.56 (.82)	4.50
Intention to use	4.96 (1.42)	5.50	5.34 (.77)	5.50	5.77 (.40)	6.00
Satisfaction with BCMA	4.23 (1.50)	4.50	4.43 (1.04)	4.75	5.30 (.92)	5.63

	OB (*n* = 6)		RT (*n* = 6)		SUR (*n* = 10)	
	M (SD)	*Mdn*	*M (SD)*	*Mdn*	*M (SD*	*Mdn*
Perceived ease of use (PU)	4.78 (1.00)	5.00	5.04 (.90)	5.25	3.95 (1.36)	4.13
Perceived usefulness	2.96 (2.09)	4.00	3.58 (2.17)	4.00	2.68 (2.16)	2.38
Influence of others	5.30 (1.10)	6.00	5.58 (.80)	6.00	3.25 (2.2)	4.25
Beliefs: Patient perceptions	4.17 (1.80)	5.26	4.58 (.77)	4.88	3.18 (1.90)	3.13
PU: Patient care	3.42 (2.00)	4.50	4.00 (1.39)	4.00	3.08 (1.95)	3.38
Training	2.67 (2.43)	3.75	3.00 (1.64)	2.75	2.28 (1.82)	2.50
Technical support	2.25 (1.87)	2.75	4.42 (1.50)	4.50	2.44 (2.30)	3.00
Intention to use	4.65 (1.55)	5.75	5.29 (.60)	5.13	3.63 (2.04)	3.86
Satisfaction with BCMA	3.17 (1.85)	4.25	4.79 (1.01)	4.50	3.13 (1.58)	3.13

Note. ED = emergency department, INPT = acute inpatient/critical care, OB = obstetrics, RT = respiratory therapy, SUR = surgical services/procedural area. For the entire sample *n* = 44 except for the influence of others (*n* = 42) and technical support (*n* = 40) subscales.

were 0 to 6, for the six OB department respondents the SD for training was 2.43, nearly the size of the mean (2.67).

Because the data were not normally distributed, the Kruskal-Wallis, a nonparametric test, was utilized to identify statistical differences in the medians of subscale scores across the five departments. The Kruskal-Wallis test identified that there was at least one pairwise difference between departments for all of the subscales ($p < .05$) except the participants' beliefs regarding patients' and families' perceptions of BCMA. Table 7 provides the results of these analyses.

Table 7

Department Differences Using Kruskal-Wallis Test

Subscale	X^2	p
PEoU	9.55	.049
PU	15.17	.004
Influence of others	11.70	.020
Beliefs: Patient perceptions	4.53	.339
PU: Patient care	11.23	.024
Training	11.90	.018
Technical Support Staff	11.06	.026
Intention to Use	10.97	.027
Satisfaction	15.23	.004

Note. df = 4

To ascertain the differences among the departments, pairwise comparisons between the five departments were conducted using the Mann-Whitney *U* test. To protect

against a type I error a Bonferroni correction was also utilized. In other words, the standard level of significance of $p < .05$ was divided by the number of comparisons being made (10). This resulted in a significance level of $p \leq .005$ (Munro, 2005). Consistent with the observed descriptive statistics, when compared to the other four areas, mean rank scores for the subscales were significantly lower in the surgical services department (see Table 8).

Table 8

Pairwise Comparisons of Department Subscale Scores using Mann-Whitney U

	TAM Subscales					
Departments	PU *U* *(p)*	Influence *U* *(p)*	PU: Care *U* *(p)*	Train *U* *(p)*	Inten *U* *(p)*	Satis *U* *(p)*
SUR & ED		15.00 (.004)				
SUR & INPT	14.50 (.004)		15.50 (.005)	13.50 (.003)	14.50 (.003)	11.50 (.002)
OB & INPT	4.50 (.003)					
ED & INPT				14.00 (.002)		

Note. PU = perceived usefulness, Influence = influence of others, PU: Care = perceived usefulness for patient care, Train = training, Inten = intention, Satis = satisfaction, SUR = surgical services/procedural area, ED = emergency department, INPT = acute inpatient/critical care, OB = obstetrics, RT = respiratory therapy. The department listed first had the lowest median score.

Other Group Comparisons of Subscales

There was a large variation in the ages of the survey participants. Holden et al. (2012) theorized that age might influence the outcome variables. The Kruskal-Wallis test was utilized in the scholarly project to determine if age influenced the survey subscale results. However, like the Holden et al. findings, there was no significant difference when the mean ranks for the age categories were compared for the nine survey subscales, and when the mean ranks were compared for the five departments.

Dunnebeil et al. (2012), Escobar-Rodriquez & Romero-Alonso (2013), and Melas et al. (2011) studied the influence of computer experience on the outcome variables. The Kruskal-Wallis test was used to compare the five departments, and the nine survey subscales, in regards to computer experience at work and at home. To facilitate use of the Kruskal-Wallis test, the years of using a computer at home and at work were organized into categories by 5-year increments with 1 to 5 years' experience comprising one group, 6 to 10 years representing the second group and so on. Using 5-year increments resulted in six groups, similar to the number of age categories.

No differences were found in the distributions of the five departments in regards to the number of years of using a computer at home and at work. Subscale scores of the BCMA survey did not differ among those with fewer or greater years of using a computer *at work*. The Kruskal-Wallis test identified that there was at least one pairwise difference among those with fewer or greater years of using a computer *at home* for the technical support subscale ($x^2 = 9.58$, $p = .048$). However, after applying the Bonferroni correction with the Mann-Whitney *U* no significant differences were found.

Subscale Correlations

Spearman's Rho was used to determine if there were any correlations among the nine BCMA subscales. This test was utilized because the data were not normally distributed (Polit and Beck, 2006). The strength and usefulness of a correlational coefficient varies depending on the situation and type of information being studied. However, general guidelines for correlational coefficients are that for $r_s = .00$ to .25 there is little correlation, $r_s = .26$ to .49 a low correlation, $r_s = .50$ to .69 a moderate correlation, $r_s = .70$ to .89 a high correlation, and $r_s = .90$ to 1.00 very high correlation (Munro, 2005).

As displayed in Table 9, perceived usefulness and perceived usefulness for patient care were the only two variables that were *very* highly correlated ($r_s = .91$, $p < .01$). Both of these variables were highly correlated with the two outcome variables, intention to use BCMA and satisfaction with BCMA. The two outcome variables were also highly correlated with each other ($r_s = .86$, $p < .01$).

Training, with a mean of 3.19 for the entire group of participants represented the lowest mean score. Training did not significantly correlate with any other variable, except for low correlations with technical support ($r_s = .43$, $p < .01$) and intention to use ($r_s = .33$, $p < .05$). Technical support had the second lowest score ($M = 3.20$). In addition to being correlated with the two outcome variables, intention to use and satisfaction, technical support was also moderately correlated with perceived usefulness and perceived usefulness for patient care. See Table 9 for correlations for all of the variables.

Table 9

Spearman's rho Correlations between Survey Subscales

	PU	Influence of others	Beliefs	PU: Care	Train	Tech	Inten.	Satis.
Perceived ease of use	.62**	.40**	.52**	.61**	.25	.47**	.56**	.64**
Perceived usefulness (PU)		.40**	.46**	.91**	.28	.50**	.79**	.82**
Influence of others			.29	.48**	.27	.46**	.56**	.50**
Beliefs:Patient perceptions				.49**	.03	.40*	.42**	.40**
PU: Patient care					.28	.54**	.75**	.78**
Training						.43**	.33*	.28
Technical Support							.56**	.60**
Intention to use								.86**

Note. *$p \leq .05$, ** $p \leq .01$

Action Plan to Address the Survey Results

The doctor of nursing practice (DNP) student first discussed the survey results with the president and chief nursing officer (CNO) of the community hospital along with a proposed action plan to address the findings. After confirming support from the president and CNO, the BCMA survey results for all participants were shared individually with each department director. In addition, the specific results for the director's department, and the concepts that contributed to each of the survey variables were discussed. Each department director and the DNP student collaboratively developed

an improvement plan for how the survey results would be shared with the staff and which of the issues were the highest priorities to address. Standard questions to solicit staff input about the survey finding were developed by the DNP student for use by all of the directors when discussing the results with staff.

Emergency Department (ED)

The ED department director determined that training received and technical support were high priorities to address. For these two subscales the rankings were significantly lower for the ED compared to inpatient acute care/critical care, and the mean scores were lower (training $M = 2.8$, $SD = 1.47$; technical support $M = 2.68$, $SD = 1.59$). The ED director was also concerned about the lower mean score for the influence of patients/families subscale ($M = 3.36$, $SD = 1.86$) and decided to include that as an emphasis in the staff follow-up. The ED director and DNP student rounded on one occasion to begin to get staff member feedback about the survey findings. Subsequently, the ED director solicited additional input from staff regarding issues during the staff huddles, which occurred at designated times each day.

Inpatient Acute Care/Critical Care/Obstetrics and Respiratory Therapy

The same nursing director is responsible for the inpatient acute care/critical care and obstetrical areas. The inpatient acute care/critical area had the overall highest mean scores, and there were no obvious barriers to BCMA adoption there. The DNP student had also shadowed on the intensive care unit for a day as part of the organizational assessment and no scanning issues were observed. Therefore, the results were shared with staff at a staff meeting but no additional actions were taken. The obstetrical area rated technical support lower than all other departments ($M = 2.25$, $SD = 1.86$). The director

determined this was a priority area. She discussed the results and led a focused discussion on this at a staff meeting. Likewise, the respiratory therapy director decided to follow-up at a staff meeting with his staff regarding the lower score for and training (M = 3.00, SD = 1.64).

Surgical Services/Procedural Department

As discussed previously, the mean scores for surgical services were lower than for the other departments. In addition, there was a statically significant difference between the median rankings for surgical services compared to the highest scoring department for perceived usefulness and perceived usefulness for patient care, training, and technical support. The department director decided to obtain additional staff input regarding problems in these areas.

Surgical services did not have a unit-based shared governance committee and more time was needed than could be accommodated by a routine staff meeting to address the areas of concern. Therefore, the department director decided to schedule an extra 30-minute staff meeting to focus on BCMA. The department director opened the meeting by sharing that the meeting purpose was to provide feedback to the staff regarding the BCMA survey. In addition, this was an opportunity for them to give additional and specific input regarding some of the survey items that were scored lower on the survey.

The director's perception was the lower ratings for the perceived usefulness and perceived usefulness for patient care subscales might relate to the low number of medication errors in the surgical services/procedural area. To address this perception and the lower scores for both of these variables, the DNP student conducted a literature search specific to BCMA use in the surgical services/procedural area. Little information

about BCMA use in surgery and procedural areas was found. However, a recent survey conducted by the Association of Operating Room Nurses (Steelman & Graling, 2013), identified medication safety and confirming the "rights" of medication administration as priorities.

To further explore the issue, the student contacted content experts from the healthcare system (e.g. the medication safety officer) to obtain any system BCMA safety stories that occurred in surgery, and/or procedural areas. A safety story specific to BCMA use, and a potential medication error in a procedural area elsewhere in the healthcare system was uncovered. The surgery director utilized the information from the AORN survey and the system safety story to raise the staff's awareness of the possible usefulness of BCMA in the department.

To address the training received and technical support staff perceptions, the DNP student facilitated a brainstorming activity where participants were asked to identify what technical support problems they were having. The staff were specifically asked what issues there were with getting support, and what issues were requiring assistance. In addition, staff members were asked if they felt like they needed additional training for BCMA, and if so in what specific areas. Brainstorming was used for the staff meeting because this is commonly used in performance improvement activities throughout the community hospital and in the surgical services/procedural department.

Staff Feedback Themes

There were consistent themes identified across the five departments as the survey results were shared with staff. The themes are discussed below, beginning with subscales

having the lowest mean score. The recommendations to address each of the themes are discussed in Chapter Six.

Training

Consistently, staff from the five departments indicated that the training was sufficient, albeit very brief. Staff had predominantly been trained by their preceptors during "on the job training". Staff felt that knowing who to contact if they had training questions would be helpful.

Technical Support

Staff participants did not perceive the BCMA scanners or the laptops to be the cause of problems with BCMA. Consistently, the staff identified the technical support problems as being related to medication label scanning. For the ED and respiratory therapy departments, medications with non-scanning labels had been a problem previously, but it had not been an issue for several months. Surgical services staff identified a few medications that had not been scanning a few months prior, however, those problems were resolved. The obstetrics staff identified some very specific medications that were scanning intermittently, namely ampicillin, rhogam, and the measles, mumps, rubella vaccine. The obstetrics staff stated that they had notified pharmacy of the non-scanning medications; however, they were unsure whether these issues were being addressed.

The surgical services/procedural staff identified two patient groups for whom medications would not scan. Patients cared for in the infusion clinic often brought in their own medications, such as risperidone and allergy medications. There were no barcodes on these medications that were recognized by the BCMA software. In a follow-up

discussion with the pharmacy director, it was learned that the pharmacy could not place a scanable barcode on the medications brought to the clinic by patients, because pharmacy could not definitively identify the medication in the vial.

The second group of patients for whom BCMA was a challenge was the Interventional Radiology patients. Nurses entered the medications for these patients electronically into the EMR based on a paper order set. It was challenging the nurses to ensure they are selecting the correct medication from the orders catalog, and the medications entered by nurses often did not scan.

Perceived Usefulness/Usefulness for Patient Care

The obstetrics, respiratory therapy, and surgical services/procedural departments rated perceived usefulness and perceived usefulness for patient care lower than the emergency and inpatient departments. The obstetrics, respiratory therapy, and surgical services/procedural departments' staff members acknowledged that BCMA influenced patient safety and was useful for patient care. However, fewer medications and medication categories were administered in these areas. Therefore, the staff members perceived there was a diminished risk for medication errors and fewer "opportunities" for BCMA to "catch" a potential medication administration error.

Beliefs about Patient and Family Perceptions

The staff participants believed some patients did not appreciate the scanning of their identification bands and did not understand the safety benefits of BCMA. For instance, some patients had stated they felt like they were at the grocery store. Consistently among the five departments, staff members did not recall receiving any

information during their on-the-job BCMA training about explaining the BCMA purpose and process to patients and families.

Summary

Thirty percent of the eligible staff, 44 people, participated in the survey. The percentage of participants from each department ranged from 25% for inpatient units and respiratory therapy, to 55% for obstetrics. The relatively high scores for the two outcome subscales indicate staff intended to use BCMA and were generally satisfied with it. The primary barriers to acceptance were training and technical support, followed by perceived usefulness/usefulness for patient care, and beliefs about patient and family perceptions. In the next chapter, recommendations to address the issues, the significance of the DNP roles and competencies in implementing the project, and limitations of the project are discussed.

Chapter Six

Discussion

The purpose of the scholarly project was to determine the acceptance and adoption of barcode scanning for medication administration (BCMA) at a community hospital, using an evidence-based assessment, to address scanning barriers. In the preceding chapter, the results of the evidence-based assessment were discussed including demographic data, and descriptive and inferential statistics. In this chapter, the survey findings are considered in the context of the literature review and conceptual framework. In addition, recommendations for the practicum site, the application of the doctor of nursing practice roles and competencies to the project, and the project limitations are discussed.

Project Results and the BCMA Literature Review

There are similarities and differences between the research in the literature review related to BCMA adoption and work-arounds, and the scholarly project results. Issues with medications and patient identification bands scanning were consistent themes in the literature. In addition, readily available and functioning equipment contributed to work-arounds (Early et al., 2011; Patterson et al., 2002, 2006). In the scholarly project, the scanning of patient identification bands and BCMA equipment were not issues. The differences may relate to the differences in the settings. The Patterson et al. studies (2002, 2006) included extended care facilities. The patient bands would have become worn and required periodic replacement, which may account for the patient band scanning issues in that setting. At the community hospital the length of stay was a few days for the inpatients and hours for the emergency department and procedural patients.

The device strategy at the community hospital was very different from what was described in the literature. At the community hospital, there was a scanner and laptop on a workstation on wheels for each patient room or bay in the surgical/procedural area. The exception was the labor and delivery area, where the BCMA scanner was on the fetal monitor cart in each room. Like the other staff participants from the community hospital, the labor and delivery staff did not perceive the BCMA hardware to be an issue. Similar to the literature review, issues with the scanning of medications was a finding in the scholarly project. Several of the recommendations in a following section relate to that finding.

Project Results and the Technology Acceptance Model (TAM) Literature Review

As discussed in Chapter 5, key findings from the BCMA survey at the practicum site were the *intention to use* subscale *(M* = 4.96, *SD* = 1.42) received the highest mean score, while the *influence of others* subscale had the second highest mean score (*M* = 4.74, *SD* = 1.76). The survey subscales with the lowest mean scores were *training* (*M* = 3.19, *SD* = 1.86) and *technical support* (*M* = 3.20, *SD* = 1.88). The *beliefs about patient/family perceptions* and *perceived usefulness* subscales also had lower scores. The surgical services/procedural area consistently had the lowest average scores for the subscales, and was significantly different in ratings compared to the other clinical areas, particularly the inpatient patient/critical care area. There were both similarities and differences when the findings from the research studies in the TAM literature review were compared to the results from the scholarly project, as discussed in the next sections.

Influence of Others

Several of the studies in the TAM literature review included the influence of others as an additional predictor variable, and each of those studies found the influence of others to be a significant predictor of the outcome variables (Holden et al., 2012; Kowitlawakul, 2011; Morton & Wiedenbeck, 2009). In the research by Holden et al. (2012) the mean for this variable was the highest (M = 4.09, SD = 1.66) of all variables in that study. In the scholarly project, the higher rating for the influence of others was not surprising, as this is similar to findings from the organizational assessment conducted as part of the scholarly project. At the practicum site, there was an emphasis on safety practices such as leadership rounding, and holding peers accountable. Likewise, in the Kowitlawakul (2011) study it was identified that administrators would encourage nurses to use BCMA. The implication for practice is clearly that expecting and encouraging staff to use BCMA will influence their perceptions.

Technical Support and Training

The means in the scholarly project for training (M = 3.19, SD = 1.86) and technical support (M = 3.19, SD = 1.88) were the two lowest subscale scores. The results for those subscales obtained by Holden et al. (2012; training M = 2.77, SD = 1.26; technical support M = 3.11, SD = 1.43) were approximately in the middle of all of the subscale results in the Holden study. The results from the studies in the TAM literature review that included training were mixed in regards to the impact of this variable on the outcomes. Escobar-Rodriguez and Romero-Alonso (2013) and Moores (2012) found training to be significant, while Morton and Weidenbeck (2009) did not. Holden et al. did not find technical support to be a significant predictor variable, but Lu et al. (2012) and

Moores did find it to influence the outcome variables. Training in the scholarly project had low correlations with the outcome variables of behavioral intention (r_s = .33, p < .05) and *satisfaction* (r_s = .28, *ns*), while technical support was correlated with behavioral intention (r_s = .56, p < .01) and satisfaction (r_s = .573, p < .01).

Perceived Usefulness/Perceived Usefulness for Patient Care

The highest correlation for the survey variables was between perceived usefulness and *perceived usefulness for patient care* (r_s = .91, p = .01). In the scholarly project perceived usefulness and perceived usefulness for patient care were both highly correlated with satisfaction (r_s = .82, p = .01 and r_s = .78, p = .01) and behavioral intention to use BCMA (r_s = .79, p = .01 and (r_s = .75, p = .01). Holden et al. (2012) added perceived usefulness for patient care to reflect the context of the healthcare environment. It is not surprising that these two variables are closely related, and had similar correlations to the outcome variables, as they are both intended to measure usefulness of the information technology.

The lower mean scores for perceived usefulness and perceived usefulness for patient care in the obstetrics, respiratory therapy, and surgical services/procedural departments may be explained by the numbers and types of medications administered in these areas. It is noteworthy that each of these departments administered fewer medications and fewer types of medications than the emergency department and the inpatient areas. Consequently, there were fewer opportunities for the BCMA process to prevent a medication error.

Perceived Usefulness and Perceived Ease of Use

As indicated in Chapter Two, all of the research studies involving the TAM retained perceived usefulness and perceived ease of use as primary predictor variables. Perceived ease of use and perceived usefulness were moderately correlated with each other (r_s = .62. p <.01) in the scholarly project. Likewise, several of the studies in the literature review found perceived ease of use to have a statistically significant impact on perceived usefulness (Dunnebeil et al., 2012; Kowitlawakul, 2011; Melas et al., 2011; Morton & Weidenbeck, 2009). The implication for the community hospital is that staff's favorable perception of perceived ease of use may also contribute to the relatively high adoption and acceptance. In fact, perceived ease of use had a moderate correlation with five of the variables, including the two outcome variables, in the scholarly project.

Beliefs about Patient/Family Perceptions

A core value of the community hospital was to create an exceptional experience for patients and families. The survey results for this subscale (M = 3.87, SD = 1.63) were concerning in that context. In the follow-up discussions with staff members, it was learned that the BCMA "on-the-job" training did not include instruction for explaining the purpose of BCMA to patients and families. In addition to BCMA, there were many other items to inform and educate patients about, such as hand washing, and the purpose of medications. The scanning compliance rate of BCMA at this hospital was in general above the benchmark of 90% and the survey results for the satisfaction and intention to use subscales indicated that staff members had generally adopted BMCA. It is possible that BCMA was "second-nature" for the RNs and respiratory therapists and thus they did not explain it to patients and families.

Discussing BCMA with patients and families is also not a prevalent concept in the literature. A literature search in CINAHL and PubMed using the search terms *patients*, *BCMA*, and synonyms returned no results. Similarly, except for Holden et al. (2012), none of the other research studies in the TAM literature review included patients/families in the construct of influence of others. As such, this is an area for additional research. The implication for the practicum site is addressed in the recommendations section.

Additional Predicator Variables

In the scholarly project, demographic data that are often believed to influence healthcare information technology adoption, were not found to be significant. None of the subscales were found to differ among age groups of the survey respondents. This is consistent with the findings by Holden et al. (2012) that age was not a significant predictor of the outcome variables.

In the scholarly project, the mean rankings for the years of using a computer at work and at home did not differ among the nine BCMA variables. Holden et al. (2012) similarly found that healthcare information technology experience did not influence the outcome variables. Escobar-Rodriguez and Romero-Alonso (2013) found that experience influenced one outcome variable, perceived ease of use ($\beta = .215$, $p < .001$), in that study but not perceived usefulness. The implications for the community hospital might be to provide education for each new healthcare information technology initiative, as computer experience alone may not predict adoption of new technology.

Outcome Variables

The outcome variables, satisfaction and intention to use BCMA, were highly correlated ($r_s = 86$, $p = .001$). As discussed previously, behavioral intention to use is a

construct from the original TAM survey (Holden & Karsh, 2010). Holden et al. (2012) added satisfaction as an alternative outcome measure. It is logical these two outcome variables would be closely correlated.

In the scholarly project, the satisfaction and behavioral intention to use BCMA subscales received relatively high mean scores at 4.23 (*SD* = 1.50) and 4.96 (*SD* = 1.42) respectively, with the behavioral intention being the highest mean score in the survey. These scores indicate that staff were *pretty much satisfied* and reported *quite a lot of intent* to use BCMA. These scores were very important as they are intended to measure acceptance, which predicts actual use (Holden et al., 2012). The scores were also consistent with the scanning compliance scores on the organizational quality dashboard.

Although the survey identified scanning barriers to be addressed, the overall scanning compliance for most of the departments was above the benchmark of 90%. Of note, the two outcome variables were both moderately correlated with the influence of significant others subscale, which also had a relatively high mean score for the total group of participants. It is possible that staff intended to use BCMA in part because important others expected them to.

Department Specific Findings

It was not surprising that the surgical services/procedural area had the lowest mean ratings for most of the variables compared to the other departments, and in pairwise comparisons significant differences were obtained for several of the variables. The survey results were consistent with the organizational assessment in that some of the staff from this area did not have individual scanning compliance scores at or above the 90% benchmark. It is challenging to implement BCMA in surgical and procedural areas due to

the use of multi-dose vials, difficulty in accessing the patients' identification bands when covered by sterile draping, and the administration of medications by anesthesia services in addition to nursing. Of note, none of the studies in the BCMA literature review were conducted in these areas. In addition, a search in CINAHL and PubMed of using *surgery*, *procedural areas*, *endoscopy*, and *BCMA*, and a combination of these terms and their synonyms did not return any results.

Role Specific Results

A variation in the scholarly project from published research and other quality improvement projects was the participation of respiratory therapists in the survey and action plan process. The respiratory therapy results were more similar to some of the nursing department results than all of the nursing departments were to each other. For instance, the means for respiratory therapy for perceived usefulness and perceived usefulness for patient care were very similar to the means for the obstetrical and surgical services/procedural department. This was perhaps related to the number and types of medications given. When compared to the emergency department and inpatient units, respiratory therapy, obstetrics, and the surgical services/procedural department all administered fewer medications and medications from fewer classifications. This finding from the survey was consistent with the concept that workflow, process, and context are significant determinants of healthcare information technology use and adoption (Ammenwerth et al., 2006; U. S. DHHS, AHRQ, 2009b).

Summary

This scholarly project used the same survey as Holden et al. (2012). Of note, in general the mean scores for the subscales in the scholarly project were higher than those

obtained by Holden et al. A possible explanation is that in the Holden et al. study BCMA had been implemented three months prior to the research being conducted. In contrast, the community hospital had been using BCMA for over five years. In addition, there was a policy at that hospital indicating the expectation that BCMA was to be used. There were also several other structural, human resource, and symbolic supports for BCMA. In the next section, the recommendations based on the survey results are discussed within the structural, human resource, and symbolic frames.

Framing the Project Results and Recommendations

In the preceding section, the survey results were discussed in the context of the TAM, on which the survey instrument was based. Organization frames (Bolman & Deal, 2013) was the conceptual framework for the organizational assessment. The organizational assessment identified many structural, human resources, and symbolic frame components related to BCMA. These components may relate to the relatively high acceptance of BCMA.

From the results of the evidence-based survey and follow-up with the nursing directors and staff, themes emerged for areas of improvements, as described in Chapter Five. Recommendations to address each of the themes within the context of the corresponding frame follow. Several of the preliminary steps of the recommendations have been implemented. Of note, a strength of the survey and action plan process was the on-going engagement by the clinical directors.

Training

Training represents the amount, sufficiency, and timing of the education for BCMA, and relates to the human resources frame. The training subscale had the lowest

mean score (M = 3.19, SD = 1.86) of any variables in the survey. However, in the subsequent discussions with staff, it was expressed that the training was sufficient but brief.

Recommendation. From the human resources frame/structural perspective the training of BCMA should be standardized. For instance, preceptors should use a checklist to ensure all staff members are receiving the same training. In addition, the resources available for additional help for unique or complex patient scenarios, such as the clinical informatics nurse, should be communicated. An example checklist from the healthcare system that the community hospital was part of was shared with the preceptor and chief nursing officer, and could be modified for the community hospital use.

Technical Support

There was an established structure for technical support including on-site information technology experts. However, the feedback from the staff regarding the rating of technical support was not related to the BCMA hardware. Staff reported anecdotally in the follow-up discussions that there was not sufficient help in problem-solving medications that would not scan.

Recommendations. Several recommendations related primarily to the structural frame. Recommendation One was to re-confirm the structure for returning non-scanning medications to the pharmacy so the scanning issue could be problem-solved. The pharmacy director agreed to be responsible for this action item. A second recommendation was to include the community hospital pharmacy director as a member of the larger healthcare system barcode scanning steering committee. As a member of this group, the pharmacy director would have access to BCMA technical and clinical experts

who could provide support to the pharmacy director for resolving issues, such as non-scanning medications. In addition, the pharmacy director would also bring the unique perspective and challenges from the community hospital to the committee. This recommendation was implemented. The pharmacy director, who also had responsibility for two other community hospitals in the system, has now joined the BCMA steering committee.

The third recommendation related to technical support was to address the scanning issues with the infusion/injection clinic patients. The pharmacy director agreed to lead work with other pharmacy directors throughout the healthcare system to establish a structure, for instance a policy, to address medications brought into the hospital setting by patients that cannot be verified by pharmacy. The policy recommendation may be to not use BCMA to double-check the "rights" of medication administration in this instance, but perhaps use verification by a second nurse.

The fourth recommendation involved the scanning issues related to radiology patients. Based on the staff feedback, the intake of radiology patients was complex, and the entry of orders into the electronic medical record by nurses was at times challenging. The recommendation to the preceptor and the hospital executive team was to include the entire medication process in an appropriate quality or process improvement activity in the radiology department.

Beliefs of Patients' and Families' Perceptions

The subscale related to whether the staff member believed that patients and families perceived BCMA to be important for their safe care, and appreciated being scanned. Staff indicated on the survey that they perceived patients and families only

valued BCMA a moderate amount. In the subsequent discussions with staff it was shared that some patients periodically stated that they felt like they were at the grocery store when their identification band was scanned.

Recommendations. The recommendation, related to the structural frame, was to establish a brief statement for use in interactions with patients and families. The following statement, developed using the Flesch Reading Ease instrument available in Microsoft Office Word® (Wilson, 2009), was shared with the nursing leadership team. This statement is estimated to be written at the 5th grade reading level, and meets the style description of "very easy" based on the Flesch Reading Ease score (Wilson, 2009).

> For safety, I will scan the band on your wrist once and then I will scan the medications to double-check that this is the medication ordered for you at this time.

It was recommended that this statement, or one similar, be shared with the nurses and respiratory therapists, and included in patient information materials. Another recommendation, using the symbolic frame, was to include stories at staff meetings and daily huddles about discussions with patients related to BCMA. These would be similar to the stories that were shared about the impact of BCMA on medication errors. In addition, it was also recommended that discussions occur with nurses, respiratory therapists, and patients/families to determine what factors are contributing to the belief that patients/families only like and appreciate BCMA a moderate amount.

Perceived Usefulness/Perceived Usefulness for Patient Care

Perceived usefulness and usefulness for patient care were not specifically addressed in the organizational assessment. However, it was identified in the

organizational assessment that BCMA symbolized safety in the community hospital, and safety is a key component of usefulness. As discussed in Chapter Five, the clinical areas that had lower mean scores for these measures also reported issues with non-scanning medications. If the scanning does not work for a medication or patient population, BCMA is not useful in that situation, and will not influence patient care.

Recommendations. To address perceptions of usefulness it was recommended that the hospital continue to use the symbolic frame of storytelling at staff meetings and during rounding to communicate the usefulness and impact of BMCA. Specifically, the instances in which BCMA prevented a medication error should be shared, and instances where medication errors increased a patient's length of stay or influenced their outcome should be highlighted. In addition, specialty organization recommendations related to medication safety should also be discussed routinely as occurred in the BCMA-focused surgical services/procedural staff meeting. Finally, resolution of the issues with the process for reporting non-scanning medications and patients whose medications could not be scanned, such as the infusion clinic patients, was recommended.

Perceived ease of use

This subscale related to the structural components already in place at the practicum site, such as a hand held scanner attached to a laptop on a computer cart and the ease of maneuvering the BCMA application in the electronic medical record. The mean score for the all participants was relatively high (M = 4.60, SD = 1.05). Additionally, all of the department means were above 4.00 except for surgical services which was just below that score (M = 3.95, SD = 1.36). There was no additional feedback from staff during the follow-up discussions to indicate that ease of use should be a

priority at this time. Therefore, the recommendation was to continue to provide on-site informatics technology support. The technology upgrades to the software that would include improved navigation tools were routinely taken at the healthcare system level.

Influence of others

The high overall rating for influence of others indicated that staff believed leadership and peers expected them to use BCMA. This was consistent with several structural frame components observed during the organizational assessment. There was a policy that staff members were expected to use BCMA. In addition, the directors received scanning compliance reports from the quality department. Consistent with the human resources frame, the scanning compliance reports were used by the nursing directors to assist individuals who need additional help mastering the skill of scanning, including peer-to-peer coaching. From the symbolic frame perspective, as discussed previously, BCMA stories were shared, which symbolized the value placed on BCMA.

Recommendation. Continued use of support structures, human resource practices, and storytelling, as identified above, was recommended to impact the influence of others. It is reasonable to believe that these structures and practices had an impact on the staff perceptions of leadership and peer support for BCMA. In other words, they interpreted messages as "keep up the good work". Making it a priority to address the barriers identified through implementation of the recommendations would also symbolize leadership support.

Sustainability

The organizational assessment, conducted prior to the initiation of this scholarly project, revealed that the community hospital embraced new practices and innovations,

and adapted to change. As identified in the preceding sections, there were key components from the structural, human resource, and symbolic frames already in place at the practicum site supporting the adoption of BCMA. In addition, some of the recommendations that resulted from the survey had already been acted upon by the time the activities resulting from this project were transitioned from the DNP student to the community hospital.

By the time the BCMA support activities were fully transitioned, the pharmacy director had joined the healthcare system barcode scanning steering committee. The chief nursing officer (CNO) and nursing leadership team were planning to collect additional information regarding the patient perceptions of BCMA. The pharmacy director was collaborating with other pharmacists in the healthcare system on improvements for the process of addressing non-scanning medications, including the communication feedback loop to the clinical departments. Based on the organizational assessment, the fact that supports for BCMA had previously been implemented, and some recommendations based on the survey were already being implemented, it is highly likely that the recommendations were seriously considered and implemented as appropriate within the organizational context.

Doctor of Nursing Practice Roles and Competencies

The doctor of nursing practice (DNP) roles (Dreher & Glasgow, 2011) and eight essential competencies (American Association of Colleges of Nursing [AACN], 2006) were the foundational guidance for the scholarly project. In alignment with DNP Essential I, *Scientific underpinnings for practice*, the researched technology acceptance model (TAM), was the foundation on which the survey was built. Use of an

evidence-based framework and survey instrument was essential to lay the foundation for the project.

It was appropriate for the results of the scholarly project, a quality improvement initiative, to be shared within the organizational culture and context. Of note, there is evidence that the forums used to share the survey results are an important foundation for developing a safety culture (U. S. DHHS, AHRQ, 2008). In addition, the directors and the DNP student developed the talking points to share with staff. However, no "protocol" was strictly adhered to, and the discussions with staff likely took on the "personality" of that department. However, because an evidence-based survey with reliability and validity was utilized, staff consistently interpreted the survey questions similarly, and consistent themes for improvements were evident across all of the departments. Correspondingly, the evidence-based survey results have been utilized to describe the healthcare phenomenon of BCMA at one community hospital, resulting in recommendations for improvements.

Consistent with DNP Essential II, *Organizational and systems leadership for quality improvement and systems thinking* (AACN, 2006), and the DNP role of *leader* (Dreher & Glasgow, 2011) organization and systems leadership skills were used throughout the scholarly project. For instance, advanced communication skills were utilized when collaborating with the nursing leadership team during the implementation of the project and the development of the corresponding action plan. In addition, a comprehensive organizational assessment, utilizing a conceptual framework, was the foundation for the project.

The literature was appraised at the beginning of the project to confirm the patient safety benefits of BCMA, and to identify an appropriate framework and instrument for the survey. In addition, key components of the selected evidence-based instrument developed by Holden et al. (2012) were identified in order to maintain the fidelity of the measure throughout the implementation process. Additional literature searches were conducted during the implementation and evaluation phases of the project related to BCMA in surgical/procedural areas, and patient/family perceptions of BCMA. These actions demonstrate competency in *Clinical scholarship and analytical methods* (DNP Essential III), the DNP role of *scholar* (Dreher & Glasgow, 2011), and relate to DNP Essential IV, *Information system/technology* (AACN, 2006). In regards to DNP Essential V, *Health care policy for advocacy in health care* (AACN, 2006), the recommendations for the project will influence the policies at the community hospital and potentially the healthcare system of which the community hospital is a member. For instance, a key recommendation was to establish a policy for the use of BCMA when the patient medications cannot be scanned.

Throughout the project, there was a significant amount of intra- and inter-professional collaboration, in alignment with DNP Essential VI, *Interprofessional collaboration for improving patient and population health outcomes* (AACN, 2006). The preceptor, the CNO, the nursing, respiratory therapy and pharmacy directors, staff nurses, and respiratory therapists were all key stakeholders in this project. Including respiratory therapy and pharmacy in the project also demonstrated the DNP role of *innovator* as none of the studies in the literature review included respiratory therapy, and only some involved pharmacy.

DNP Essential VII, *Clinical prevention and population health for improving the nation's health (*AACN, 2006), was the impetus for the scholarly project. The purpose of the project was to assess the acceptance and adoption of BCMA, in order to address barriers and concerns. The goal is that BCMA supports the key strategy of the community hospital to provide quality care and improve the health of the community. In addition, DNP Essential VII and the DNP *advocate* role (Dreher & Glasgow, 2011) were evident in the recommendations. For instance, one of the recommendations was to incorporate a plain language statement in the BCMA process to effectively communicate with patients and families.

Advanced nursing practice, Essential VIII (AACN, 2006), and the roles of *clinician* and *advocate for nurses* (Dreher & Glasgow, 2011) were ingrained in the project. As discussed above, the purpose of the project was to evaluate acceptance of an evidence-based intervention previously implemented, BCMA, using an evidence-based instrument. The goal of the project was to support patient safety through supporting nurses and respiratory therapists to achieve excellence in their practice. With intention, the survey process and the process for developing the action plan were conducted in such a way as to create an environment in which staff could feel comfortable expressing their honest views. Minimal demographic data were collected to avoid breach of anonymity, and processes that were familiar to staff, such as rounding and brainstorming, were used to collect anecdotal follow-up information.

Limitations

There were several limitations in this scholarly project. One of the most obvious was the small number of participants. There was a 30% response rate for the entire group

of eligible participants, with greater participation from obstetrics (55%) and surgical services (48%). With this level of participation, the respondents may not have represented the perceptions of the majority of the staff members. In addition, the total number of staff eligible for inclusion was relatively small (n = 143) as this scholarly project was conducted at a rural community hospital and even the larger percentage of participation from obstetrics and respiratory therapy equated to relatively few staff. Consequently, the recommendations were based on the input from a small number of people.

Another limitation was the methods used for the follow-up and action plan development. Staff members who participated in the survey may not have been the same staff members who were involved in the follow-up events. Finally, the project was not intended to be research and this was affirmed by the internal review boards associated with the university and the practice setting to be a quality improvement project. As a result, and due to the small number of participants, the findings of the survey are unique and cannot be generalized beyond the community hospital.

Implications

As described previously, specific recommendations for the community hospital were developed based on the evidence-based survey results and the themes that emerged from the subsequent discussions with the nursing directors and staff members. There were also implications for the community hospital leaders, as well as health system leaders in general, that are not specific to BMCA. While the political frame assessment identified few issues related to the BCMA process and the organizational readiness to implement the scholarly project, one of the themes and associated recommendations related to a macro-system issue within the political frame. The recommendation to invite the community hospital pharmacy director to join the larger healthcare system barcode

scanning steering committee was discussed previously as part of an intervention within the structural frame. In addition, this recommendation addressed the disconnection that may occur between a community hospital and the larger health care system of which the community hospital is a part. From the political frame perspective (Bolman and Deal, 2013) the overall organizational assessment for the community hospital identified that the larger health care system would at times make decisions that impacted the community hospital without community hospital input. For instance, while the system barcode scanning steering committee had been meeting for several years, the community hospital did not have formal representation on the committee. It was through the scholarly project journey that the DNP student, a co-chair of the system barcode scanning steering committee, identified the benefit to the community hospital pharmacy director of being a member and the benefit to the committee of having the community hospital perspective. In work with community hospitals in general, community hospital representation at the macro-level should be assessed.

Secondly, there are many factors related to the use and intention to use technology that involve the actual technology, but the processes that surround the technology are also important. Staff usage of technology does not guarantee there are not opportunities for process improvements. While the staff scanning compliance rates for most departments at the community hospital were acceptable, there were still several opportunities for improvements and compliance rates alone did not convey the whole situation. Through the scholarly project some processes were identified as needing improvement, such as the process of notifying pharmacy of non-scanning medications. In addition, new processes were identified to address some of the staff perceptions and attitudes, such as the process

for discussing BCMA with patients and families. The community hospital had a culture of continuous process improvement and the concept of focusing on processes aligned with that culture.

Another implication is to identify key stakeholders for any project from the organizational level. In the scholarly project, unlike any of the investigations or improvement projects in the literature review, respiratory therapists were included. Throughout the survey results analysis and follow-up discussions, it was clear that the respiratory therapy processes and issues were very similar to those of some of the nursing areas. In on-going discussions with the nursing directors the patient access, (i.e., registration) staff members were identified as key stakeholders to communicate the safety benefits of the patient identification bands. At the community hospital, the patient access staff placed the identification bands on most patients. At the completion of the scholarly project, discussions were on-going with the patient access leadership about a standardized safety benefits statement for the patient access staff to communicate to patients and families when applying the wristband.

Finally, the organizational assessment using the framing organizations model (Bolman & Deal, 2013) was the critical foundation for the scholarly project and the entire practicum. It was through the organizational assessment, within the context of the frames, that the structural, human resources, and symbolic supports for BCMA currently in place at the community hospital were identified. The organizational readiness to implement the survey and ways to communication with key stakeholders were identified through the organizational assessment. In addition, the frames provided the framework for the discussion of the recommendations related to the survey results.

Summary

The purpose of this scholarly project was to conduct an evidence-based assessment of the acceptance and adoption of BCMA, an evidence-based technology intervention, by nurses and respiratory therapists at a community hospital. The purpose was achieved through the distribution of a reliable and valid survey, analysis of the survey results, and development of an action plan with appropriate stakeholders. Based on the organizational assessment is it likely the recommendations will be implemented and sustained. If the recommendations were implemented, along with the structural, human resource and symbolic supports already in place, it is likely that nurses and respiratory therapists will continue to practice in an environment where the BCMA process is optimized, resulting in increased patient safety.

APPENDICES

Appendix A

Models Explaining Variance in Outcomes

Researchers and Models	Outcome Variable	Variance Explained by the Model
Dunnebeil et al. (2012)		
PEoU (β = .492, p < .001)	PU	R^2 = .676
Importance of data security (β = .172, p < .05)		
Importance of documentation (β = .187, p < .05)		
Intensity of HIT utilization (β = .204, p < .001)		
PEoU (β = .235, p < .01)	BI	R^2 = .556
PU (β = .557, p < .001)		
Escobar-Rodriguez and Romero-Alonso (2013)		
HIT experience (β = -.215, p < .001)	PEoU	R^2 = 0.40
Perceived risks (β = -.215, p < .001)		
Training (β = .257, p < .001)		
PEoU (β = .257, p < .001)	PU	R^2 = .295
Training (β = -.257, p < .001)		
PEoU (β = - .256, p < .001)	ATT	R^2 = .501
PU (β = .563, p < .001)		
Holden et al. (2012)		
PEoU (β =.25, $p \leq$ .01)	BI	R^2 = .56
PU for patient care (β =.39, $p \leq$ .01)		
Social influence in general (β =.15, $p \leq$ .01)		
PEoU (β = .38, $p \leq$ .01)	SATIS	R^2 = .76
PU for patient care (β = .16, $p \leq$ .05		
Social influence of patients and families (β = .16, $p \leq$ .05)		
Ketikidis et al. (2012)		
PEoU (β = .513, p < .001)	ACC	R^2 = .679
Physician support (β = .196, p < .005)		
Relevance (β = .208, p < .005)		
Kowitlawakul (2011)		
PEoU (β = .420, p <.01)	PU	R^2 = .35
Physician support (β = .270, p <.01)		
Years working in the hospital (β = .200, $p \leq$.01)		

PEoU (β = .466, p <.01) PU (β = .297, p <.01)	ATT	R^2 = .44
Lu et al. (2012)		
Information quality (γ = .61, p < .001) Service quality (γ = .12, p < .001) System quality (γ = .28, p < .001)	PEoU	R^2 = .69
Information quality (γ = .57, p < .001) Service quality (γ = .26, p < .001) System quality (γ = .12, p < .05)	PU	R^2 = .72
PEoU (β = .29, p <.001) PU (β = .61, p <.001)	ACC	R^2 = .75
Melas et al. (2011)		
PEoU (β = .52, p < .01) Clinicians expectations for HIT sophistication (β = -.43, p < .01)	PU	R^2 = .29
PEoU (β = .23, p < .01) PU (β = .52, p < .01)	ATT	R^2 = .70
Moores (2012)		
Enabling factors (computing support, training, & self-efficacy; β = .55, p < .001)	PEoU	R^2=.42
Information quality (accuracy, content, format, timeliness; β = .45, p < .001)	PU	R^2 = .35
PEoU (β = .23, p < .001) PU (β = .35, p < .001)	ATT	R^2 = .23
Morton and Wiedenbeck (2009)		
Involvement of the end-user in implementation (β = .20, p < .05) Management support (β = .43, p < .001) Patients' perception of the physician (β = -.23, $p \leq$ .001)	PEoU	R^2 = 0.30
PEoU (β = .55, p < .001) Patients' perception of the physician (β = -.20, p < .01)	PU	R^2 = 0.46

Note. ACC = acceptance, ATT = attitude, BI = behavioral intention, PEoU = perceived ease of use, PU = perceived usefulness, SATIS = satisfaction. The *B* and *y* values indicate

whether that variable contributed significantly to the regression models (represented by R^2) explaining the variance in the outcome.

Appendix B

Predictor Variables

Researchers and Specific Predictor Variables	Outcome Variable Impacted	Research Finding
Influence of Others		
Holden et al. (2012)		
Social influence in general	BI	$\beta = .15$, $p \leq .01$
Social influence of patients and families	BI	$\beta = .16$, $p \leq .05$
Kowitlawakul (2011)		
Physician support	PU	$\beta = .270$, $p < .01$
Administration support	PEoU	$\beta = .242$, $p < .01$
Morton and Wiedenbeck (2009)		
Management support	PEoU	$\beta = .43$, $p < .001$
Patients' perception of the physician	PEoU	$\beta = -.23$, $p < .001$
	PU	$\beta = -.20$, $p < .01$
Technical Support		
Lu et al. (2012)		
Service quality	PEoU	$\beta = .55$, $p < .01$
	PU	$\beta = .18$, $p < .001$
Moores (2012)		
Enabling factors: computing support, self-efficacy, training	PEoU	$\beta = .55$, $p < .001$
	PU	$\beta = .18$, $p < .01$
Training		
Escobar-Rodriquez and Romero-Alonso (2013)		
Training	PEoU	$\beta = -.257$, $p < .001$
	PU	$\beta = .367$, $p < .001$
Individual Characteristics		
Escobar-Rodriguez and Romero-Alonso (2013)		
HIT experience	PEoU	$\beta = -.215$, $p < .001$
Kowitlawakul (2011)		
Years working in the hospital	PU	$\beta = .200$, $p = .01$
Dunnebeil et al. (2012)		
Knowledge about technology	PEoU	$\beta = .152$, $p < .05$
Melas et al. (2011)		
Knowledge about technology	PEoU	$\beta = .49$, $p < .001$
Morton and Wiedenbeck (2009)		
Involvement of the end-user in implementation	PEoU	$\beta = .20$, $p < .05$

Other Predictor Constructs		
Lu et al. (2012)		
System quality	PEoU	$y = .28$, $p < .001$
	PU	$y = .12$, $p < .05$
Information quality	PEoU	$y = .61$, $p < .001$
	PU	$y = .57$, $p < .001$
Moores (2012)	PU	$B = .45$, $p < .001$
Information quality		

Note. This table displays the predictor constructs or variables, which were found to significantly influence BI, PEoU, and/or PU. BI = behavioral intention, PEoU = perceived ease of use, PU = perceived usefulness. The *B* and *y* values indicate whether that variable contributed significantly to the regression model (represented by R^2) explaining the variance in the outcome.

Appendix C

Permission from Holden to Use TAM-based BCMA Instrument

Marie Vanderkooi <vanderm5@mail.gvsu.edu>

May 3

to richard.holden

Dear Dr. Holden:

I am writing to request a copy of the instrument used in your study Modeling Nurses' Acceptance of Bar Coded Medication Administration Technology at a Pediatric Hospital (2012). I want to review the instrument for potential use in my clinical project for my Doctor of Nursing Practice degree.

If the instrument addresses my project's aims, I plan to administer it to a group of approximately 100 nurses at a community hospital in rural Michigan. I anticipate administering the instrument during this summer, and completing the statistical analysis and defense of my project by December 2014. Like your study, the instrument will be administered via a paper survey.

If I use your instrument, I would intend to include it as an appendix to my final project document. May I reproduce the instrument and if that is acceptable, how should the copyright information be referenced? Thank you for your consideration of my request.

Sincerely,

Marie VanderKooi, MSN, RN-BC

Grand Valley State University

DNP Student

Holden, Richard J

May 6

to me

Hi Marie,

Please see attached. The response scale is described in the paper, but if you can't find it, let me know.

You are free to use and reproduce the instruments for scholarly work, as long as you cite our original paper appropriately. The instruments should not be used for commercial or other not purely scholarly purposes without further discussion.

Good luck on your project!

Rich

Marie Vanderkooi <vanderm5@mail.gvsu.edu>

May 26

to Richard

Rich,

Thank you for permission to use the instrument for my scholarly project.

A few follow-up questions:

On the survey in your study were the questions in the same order as on the attachment, in other words, grouped by construct?

For question Tech 75, (If it were up to you, to what extent would you want to use the new bar coding system), is it acceptable delete "new" as the staff at the community hospital have been using barcode scanning?

Holden, Richard J <richard.holden@vanderbilt.edu>

May 26

to me

Hi Marie,

The section of the survey with questions about technology had about 80-90 items, of which the ones I sent are a subset. All the items were grouped in sets of about 10-12 and presented in the order indicated by the number after "tech" (i.e., tech10 is followed by tech11, tech12, etc). Yes, deleting "new" makes sense in this case.

Rich

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Appendix D

Invitation to Participate in the Survey

Medication Barcode Scanning Survey

You are invited to take a survey about barcode scanning during medication administration (BCMA). The results of the survey will be used to improve the BCMA process at United Hospital.

Participation in the survey is voluntary. It takes about 10 minutes to complete the survey. Put the survey back in this envelope when you are finished, seal the envelope, and place it into the "Completed Surveys" collection envelope on your unit. Please do not place your name on the survey.

This survey is part of a Doctor of Nursing Practice project, *An Evidence Based Evaluation of Medication Barcode Scanning Acceptance in a Community Hospital*. As stated above, this survey will identify ways to improve BCMA at United and Kelsey Hospitals. If you have questions about this survey please contact Marie Vanderkooi, DNP Student, at vanderm5.mail@gvsu.edu, or Dr. Cynthia Coviak, GVSU faculty advisor, at 616-331-7170,

Thank you for participating in this survey.

Appendix E

BCMA Survey Tool

By completing and submitting this survey, you are consenting to participate in this quality improvement project. Please do not place your name on the survey. Thank you for your time.

Barcode Scanning for Medication Administration Survey

Demographic Information
(Please check appropriate boxes or fill in the line)

Age (in years)

☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ ≥ 60

Years of Experience:

In current role _____ (years)

Working for United Hospital _____ (years)

In current unit/area _____ (years)

Using a computer at work _____ (years)

Using a computer at home _____ (years)

Unit/Area worked most often:

☐ Critical Care

☐ Emergency Department

☐ Inpatient Acute Care

☐ Obstetrics

☐ Surgical Services/Procedural

Scale:

0	1	2	3	4	5	6
Not at all	**A little**	**Some**	**Moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**

In actual practice, to what extent: (circle number)

Is the bar coding system clear and understandable?
0 1 2 3 4 5 6

Does using the bar coding system improve your performance in your job? 0 1 2 3 4 5 6

Do you find the bar coding system to be easy to use?
0 1 2 3 4 5 6

Does using the bar coding system increase your productivity?
0 1 2 3 4 5 6

Does interacting with the bar coding system require a lot of your mental effort? 0 1 2 3 4 5 6

Do you find it easy to get the bar coding system to do what you want it to do? 0 1 2 3 4 5 6

Does using the bar coding system enhance your effectiveness on the job? 0 1 2 3 4 5 6

Do you find the bar coding system to be useful in your job?
0 1 2 3 4 5 6

To what extent do people who:

Influence your behavior think that you should use the bar coding system? 0 1 2 3 4 5 6

Are important to you think that you should use the bar coding system? 0 1 2 3 4 5 6

Scale:

0	1	2	3	4	5	6
Not at all	**A little**	**Some**	**Moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**

To what extent do you think patients (or their families):

Like the bar coding system? 0 1 2 3 4 5 6

Believe the bar coding system reduces the chances of medication errors? 0 1 2 3 4 5 6

Believe the bar coding system is good for quality patient care? 0 1 2 3 4 5 6

Appreciate being scanned before medication administrations? 0 1 2 3 4 5 6

In actual practice, to what extent has the bar coding system:

Improved patient care? 0 1 2 3 4 5 6

Reduced the likelihood of medication errors? 0 1 2 3 4 5 6

Facilitated better patient care decision-making? 0 1 2 3 4 5 6

Made caring for patients easier? 0 1 2 3 4 5 6

To what extent do you intend to use the bar coding system, assuming you have access to it? 0 1 2 3 4 5 6

To what extent are you satisfied with the bar coding system? 0 1 2 3 4 5 6

To what extent do you predict that you will use the bar coding system, assuming you have access to it? 0 1 2 3 4 5 6

(continued →)

Scale:						
0	**1**	**2**	**3**	**4**	**5**	**6**
Not at all	**A little**	**Some**	**Moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**

How much better do you like this method of administering medications compared to the old way? 0 1 2 3 4 5 6

If it were up to you, to what extent would you want to use the bar coding system? 0 1 2 3 4 5 6

To what extent are you dissatisfied with the bar coding system? 0 1 2 3 4 5 6

How much do you want to use the bar coding system? 0 1 2 3 4 5 6

To what extent would you recommend the bar coding system to a friend at another hospital? 0 1 2 3 4 5 6

How much skills training did you receive for the bar coding system? 0 1 2 3 4 5 6

How useful was the skills training that you received for the bar coding system? 0 1 2 3 4 5 6

How complete was the skills training that you received for the bar coding system? 0 1 2 3 4 5 6

How well timed was the skills training you received for the bar coding system? 0 1 2 3 4 5 6

In actual practice:

How quickly does technical support respond to issues concerning the bar coding system? 0 1 2 3 4 5 6

How helpful is the technical support staff in dealing with the bar coding system? 0 1 2 3 4 5 6

Thank you for your time.

Appendix F

Measures of Central Tendency for the Subscale Questions

Question	*M*	*SD*	*Mdn*
PEoU	**4.60**	**1.05**	**4.75**
Is the bar coding system clear and understandable?	5.07	1.12	5.00
Do you find the bar coding system to be easy to use?	4.82	1.33	5.00
Does interacting with the bar coding system require a lot of your mental effort?	1.61	1.51	1.00
Do you find it easy to get the bar coding system to do what you want it to do?	4.14	1.50	4.00
PU	**3.96**	**1.93**	**4.38**
Does the bar coding system improve your performance in your job?	4.43	1.91	5.00
Does using the bar coding system increase your productivity?	3.34	2.27	4.00
Does the bar coding system enhance your effectiveness on the job?	3.86	2.14	5.00
Do you find the bar coding system to be useful in your job?	4.20	1.91	5.00
Influence of Others	**4.74**	**1.76**	**5.50**
Do people who influence your behavior think that you should use the bar coding system?	4.64	2.11	6.00
Do people who are important to you think that you should use the bar coding system?	4.95	1.53	5.00
Beliefs: Patient Perceptions	**3.87**	**1.63**	**4.25**
Do you think patients or their families like the bar coding system?	3.48	1.80	4.00

Question	*M*	*SD*	*Mdn*
Do you think patients or their families believe the bar coding system reduces the chances of a medication error?	4.30	1.72	4.50
Do you think patients or their families believe the bar coding system is good for quality patient care?	4.36	1.77	5.00
Do you think patients or their families appreciate being scanned before medication administration?	3.34	1.89	3.00
PU: Patient Care	**4.10**	**1.62**	**4.63**
Has the bar coding system improved patient care?	4.30	1.70	5.00
Has the bar coding system reduced the likelihood of medication errors?	5.02	1.39	6.00
Has the bar coding system facilitated better patient care decision-making?	3.61	1.98	4.00
Has the bar coding system made caring for patients easier?	3.50	2.24	4.00
Training	**3.19**	**1.86**	**3.13**
How much skills training did you receive for the bar coding system?	2.95	1.75	3.00
How useful was the skills training that you received for the bar coding system?	3.34	2.12	3.00
How complete was the skills training that you received for the bar coding system?	3.30	1.85	3.00
How well timed was the skills training you received for the bar coding system?	3.18	2.04	3.00
Technical Support	**3.20**	**1.88**	**3.25**
How quickly does technical support respond to issues concerning the bar coding system?	3.10	1.95	3.00
How helpful is the technical support staff is dealing with the bar coding system?	3.30	1.99	3.00

Question	*M*	*SD*	*Mdn*
To what extent do you intend to use the bar coding system?	5.29	1.37	6.00
To what extent do you predict that you will use the bar coding system?	5.34	1.26	6.00
If it were up to you, to what extent would you want to use the bar coding system?	4.68	1.91	6.00
How much do you want to use the bar coding system?	4.52	1.97	5.00
Satisfaction	**4.23**	**1.51**	**4.50**
To what extent are you satisfied with the bar coding system?	4.48	1.59	5.00
How much better do you like this method of administering medications compared to the old way?	4.00	2.25	5.00
To what extent are you dissatisfied with the bar coding system?	2.07	1.77	2.00
To what extent would you recommend the bar doing system to a friend at another hospital?	4.50	1.96	5.00

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