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Knowledge-Based Medication Administration: Program Evaluation and Optimization

Elizabeth Evans
University of New Hampshire, Durham

KNOWLEDGE-BASED MEDICATION ADMINISTRATION: PROGRAM EVALUATION AND OPTIMIZATION

ELIZABETH EVANS

BS, University of New Hampshire, 2003

MS, University of New Hampshire, 2005

DISSERTATION

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This thesis/dissertation has been examined and approved in partial fulfillment of the requirements for the degree of Doctorate of Nursing Practice by:

Pamela DiNapoli RN, PhD, CNL
Associate Professor, Department of Nursing

Gene Harkless DNSc, APRN, FNP, C, CNL
Associate Professor Department of Nursing

Mercedes Fleming MSN, RN
Manager, Nursing Systems and Support

On April 21, 2015

DEDICATION

I would like to dedicate my DNP Dissertation to my family and friends who have provided continuous love and support during this journey; I would not have been successful without them.

To my three sons, Trapper, Colin and Glenn, my daughter in law Sara, my grandson Carson, and my great friend Jamie, guess what, I have my life back.

To my brother Scott for his beautiful soul, warm heart and supportive poetic narratives.

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ABSTRACT

KNOWLEDGE-BASED MEDICATION ADMINISTRATION: PROGRAM EVALUATION AND OPTIMIZATION

By

ELIZABETH EVANS

University of New Hampshire, May 2015

It has been reported by members of The Institute of Medicine that a patient is at risk for one medication administration error per day when hospitalized, thus prevention of medication administration errors is a priority patient safety goal. One recommendation to reduce the prevalence of medication administration errors is the use of barcoded medication administration (BCMA) systems. While there are many benefits to BCMA, there are also issues with existing systems. Suboptimal BCMA design and implementation has resulted in medication administration workarounds. A hospital located in southern New Hampshire, implemented a Knowledge Based Medication Administration (KBMA) system in January 2014. Shortly after implementation, inefficiencies within the system were identified, resulting in KBMA nursing workarounds.

The aim of this program evaluation quality improvement project using mixed methods was to identify the system's issues, and processes resulting in workarounds to find solutions that optimize the KBMA system and ensure patient safety. Override drug scan tracking reports were monitored for specific KBMA nurse workarounds during four phases from January 2014 to December 10, 2014. Simultaneously structured observations of registered nurses using KBMA

(N = 52) were conducted over a three-month period. System process changes and educational interventions were provided during the first three phases and withdrawn during the fourth phase. During the evaluation period, there was an overall decrease in KBMA workaround totals from (N = 12, 231) in Phase 1, to (N = 5,321) in Phase 4.

I: INTRODUCTION

Background

Members of The Institute of Medicine (IOM) have estimated that patients are at risk for one medication administration error per day while hospitalized. The IOM considers improvement in medication administration errors a priority patient-safety intervention. With continued concern for potential medical errors, the IOM released a report in 2006, *Preventing Medication Errors* (IOM, 2006). The report outlined approaches to error-prevention strategies for the healthcare industry in order to help decrease the incidence of medication errors. One recommendation to aid in the reduction of medication administration errors is the use of barcoded medication administration (BCMA) systems (IOM, 2006).

BCMA systems were developed to reduce medication administration errors and related expenses, ultimately in an effort to improve patient safety (Voshall, Piscotty, Lawerence, and Targosz, 2013). By design, BCMA systems facilitate adherence to all aspects of patient medication rights, including right patient, drug, dose, route, and time (Wulff, Cummings, Marck, & Yurtseven, 2011). At the same time, BCMA systems promote patient safety through awareness measures using prompts and alerts (National Patient Safety Foundation, 2013).

Adverse drug events (ADEs) and resultant injuries increase hospital expenses. Depending upon facility size, annual hospital costs for all ADEs are estimated to be as much as $5.6 million per hospital. Patients who experience ADEs have longer, and consequently more expensive hospitalizations than patients who do not suffer ADEs. There is evidence that BCMA systems reduce ADEs, yet technology alone does not ensure the safe administration of

medication (Agency for Healthcare Research and Quality, 2012). In a landmark study by Koppel et al. (2008), the authors developed a typology of 15 workarounds with 31 causes identified that interfere with the processes for the BCMA system. Implementation and use of BCMA technology is solidly on the rise (Miller, Fortier, and Garrison, 2011) as it has become a criterion for achieving Stage 2 Core Measure 16 of Meaningful Use in hospitals starting in 2014 under the American Recovery and Reinvestment Act (Leung, 2012). The American Recovery and Reinvestment Act of 2009 authorized the Centers for Medicare & Medicaid Services to award incentive payments to eligible hospitals who demonstrate Meaningful Use (MU) of a certified electronic health record (EHR). Meaningful use sets specific objectives that hospitals must achieve to qualify for the incentives. Implementation of BCMA technologies was part of Stage 2 MU objectives of advanced clinical processes (Centers for Medicare and Medicaid Services, 2014).

BCMA was first implemented in 1995 at the Veterans Medical Center in Topeka, KS, and was modified to meet the general requirements of all U.S. Veterans Health Administration (VHA) medical centers (Schneider, Bagloy, & Carlson, 2008). Since then, BCMA systems have been implemented in hospitals across the United States in an effort to reduce medication administration errors. Although there are different BCMA systems available, all BCMA systems require a sequence of steps to administer medications. BCMA technology protocols require users to follow a series of procedural steps to administer medication. BCMAs will detect mismatches between patient, medication, and the medication order with alerts and prompts. Users can either modify their actions according to the prompt or override the alert. When an alert is overridden, a workaround has occurred (Koppel et al., 2008). When users fail to use the

BCMA technology as intended through workarounds, medication errors can result (Patient Safety Advisory, 2008).

Review of Evidence

A systematic review of the literature was conducted of qualitative and quantitative, peer reviewed, research studies, and case studies that explored BCMA systems and nurse workarounds, published in English between 2008 through December 2014. The time frame was selected, to include evidence published since the 2008 Koppel et al. review. Reference lists from selected articles were reviewed. Non-English and grey literature was excluded from the search.

Exclusion Criteria

Studies were excluded that researched automated dispensing machines, intravenous medication safety pumps, smart intravenous pumps, medication technicians, or settings outside an acute care hospital.

Search Strategy

The following databases were searched: CINAHL, Cochrane Database of Systematic Reviews, Medline, and ScienceDirect. Key words for this search were: “barcode”, “medication administration technology”, “workarounds”, “nursing”. Boolean Operators (and, or, not) were used to link key words. Studies identified during the database search were retrieved based on information provided in the abstract or title.

Data Extraction

Data were collected and entered into spreadsheet for data management purposes. Study variables included: title, author(s) of study, method, study setting, type of workaround, data analysis, results, recommendations, and level of quality (Appendix A).

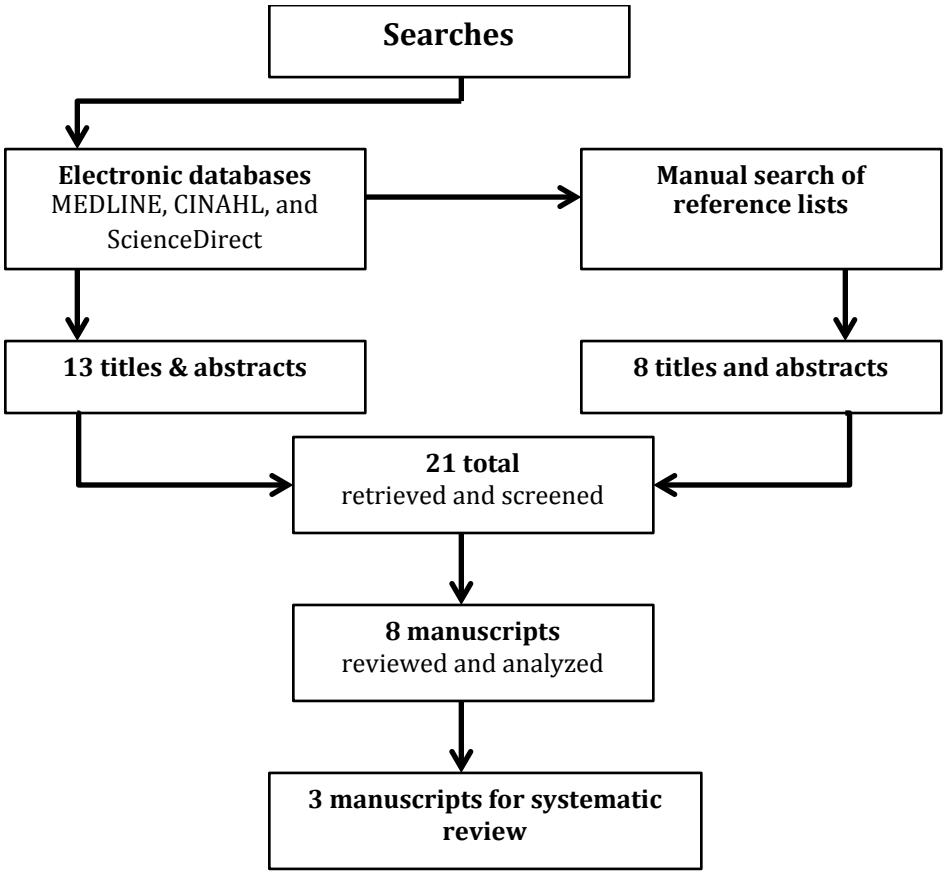
Critical Appraisal

All articles were assessed for methodological quality using the Joanna Briggs Institute's (JBI) Qualitative Assessment and Review Instrument (QARI) (Appendix B). The QARI Instrument is a 10-item checklist that examines components of validity, methodological appropriateness, and ethical conduct of the study (Briggs, 2013).

Results

Based on title or abstract, 21 publications were identified by the initial search strategy. After removal of duplicates, 13 of the publications were excluded with 8 deemed potentially eligible for review. Of the 8 studies, three met inclusion criteria and were included in the review.

Figure 1.1 Literature Search Flow Chart



Synthesis of the Evidence

The three studies reviewed described nurses in the acute care setting and identified workarounds associated with BCMA technologies. The three research studies identified similar types of workarounds: omission of process steps, steps performed out of sequence, unauthorized process steps, technology related, task related, organizational related, patient and environmental related.

Miller, Fortier, and Garrison (2011) conducted an observational study looking specifically at high alert medication triggers and workarounds at a 709 bed academic medical center. Seventeen percent of scanned medications triggered an error alert of which 55% were for high alert medications. However, clinician override reasons for alerts were only documented for 23% of the 55% of administrations. The workarounds were divided into three categories: omission of a process step, performance of an unauthorized step, and performance of steps in improper sequence. Over a 6-hour observation, 121 administration attempts were observed for a total of 468 different workarounds, averaging 3.8 workarounds per medication administration. All of the observed attempts included the workaround of scanning the medication outside of the patient's room. In addition, discrepancies included scanning a patient barcode identification bracelet that was not attached to the patient (90.1%), confirming administration before administration occurred (82.6%), and scanning medications for more than one patient at a time (46.3%).

Rack, Dudjak, and Wolf (2011) used a mixed-method design, which consisted of staff nurse surveys, (n= 220), nurse focus groups (n= 43), and a medication error chart review (n=16) in a 765-bed academic medical center. Staff nurse survey results revealed most staff nurses strongly agreed or agreed that BCMA systems enable them to administer medications safely

(n=199, 90%), medications administered to the right person (n=207, 95%), administered the correct dose (n=194, 88%), and administered the correct medication (n=200, 91%). In addition, nurses were surveyed about their adherence to the medication administration policy. Seventy-eight percent of the nurses indicated that they followed the required process steps in the use of the hospital's BCMA system.

Finally nurses were asked whether they encounter the following clinical situations when administering medications during their last shift: the need to administer medication without scanning the patient identification bracelet; administer medication without scanning the medication barcode; scan a medication package after the medications were administered; and place a patient identification bracelet on another object and scan it. Sixty three percent (n=124) of staff nurses indicated the need to administer medications without scanning the patient identification bracelet, 72 percent (n=139) reported the need to administer the medication without scanning the medication barcode, 43 percent (n=76) reported that there was a need to scan the medication package after the medication was already administered, and 23 percent (n=43) had placed a patient identification bracelet on another object for scanning.

Participants from the nurse focus groups in the Rack et al. study were asked to describe scenarios in their practice setting in which any of the four clinical situations previously mentioned would occur: the need to administer medication without scanning the patient identification bracelet; administer medication without scanning the medication barcode; scan a medication package after the medications were administered; and place a patient identification bracelet on another object and scan it. Thirteen scenarios were identified in which there was a need to administer medications without scanning the patient; wristband failure (n=4), scanner failure (n=4), and BCMA use not expected because it was an emergency (n=5). Eighteen

scenarios were described in which there was a need to administer medications without scanning the medication barcode; task too time consuming (n=6), barcode does not scan (n=6), scanner did not work (n=2), and BCMA use not expected because it was an emergency (n=4). Two scenarios indicated the need to scan medication packages after the medications were administered (n=2). Lastly, 10 scenarios were identified related to scanning the patient identification bracelet that had been placed on another object, patient self removal (n=5), and identification bracelet did not fit over patient limbs, casts, or bandages (n=5).

Yang, Kankanhalli, and Yip (2011) used a qualitative case study approach in a large public hospital with over 900 beds. Two researchers conducted interviews with a variety of personnel (n=30), including eleven nurses. Once the workarounds and the issues causing the workarounds were identified, the authors assigned them into categories: technology related (n=5), task related (n=5), organizational related (n=3), and augmented work (n=3). Workarounds specifically performed by nurses included: nurse used a computer on wheels (COW) instead of the required personal digital assistant (PDA) to administer the medication, nurses picked the next administration time slot to administer the medication because the current slot was used (already signed out), nurses used a PDA to scan the patients identification bracelet on a clinical clipboard instead of scanning the patient identification bracelet that was on the patients wrist, nurses administered medication outside of the expected timing, nurses cleared omission for PRN medications in batches, nurses clicked on the medication to be administered in the MAR before administering, nurse did not administer the medication according to the order in Electronic Medication Administration System (EMAS), nurse co-signed for another nurse during medication administration, and nurses administered medications before it was ordered.

Yang et al. identified four workarounds similar to those in the Koppel et al. review. However, five new workarounds were identified: the nurse picked the next time slot to administer the medication, the nurse cleared omission for PRN medications in batches, nurses co-signed for one another during medication administration (entering another nurse's password without the second nurse actually being present), the nurse did not administer the medication according to the order, and nurses administered medications outside of the prescribed time frame.

The first new workaround described occurred when the nurse cleared omission for PRN medications in batches in response to unnecessary alerts for PRN medications. If nurses do not provide a reason why the patient does not need the PRN medication, the order will be reported as an omission and be overdue in the EMAS. Therefore, the nurse clears all the omissions in batches.

The second type of new workaround described the nurse not administering the medication according to the order in the EMAS. Due to different unit practices and stringent EMAS order sets, the nurse selected to omit the administration because the volume of intravenous fluids ordered was too large for the pediatric patient.

Koppel et al. (2008) described a user bypass for a double check. The second nurse would confirm the double check without reviewing the medications. Yang et al. (2012) described the third new workaround: nurses cosigned for another nurse by entering in a colleague's password without the colleague being present. The nurses felt the cosigning process was too cumbersome.

The fourth new workaround described nurses administering medications outside of the prescribed time frame. "Sometimes we have this medicine that should be served before meals

but doctor order says to be served at 8pm. So what we do is that we serve before meal but justify it accordingly as an early serving" (Yang et al. 2012, p. 55). In the fifth new workaround, nurses unfamiliar with the EMAS selected the next prescribed time frame to administer a medication that was overdue. Providers would then have to enter an additional dose to correct the error.

EMAS were developed with the intention of improving patient safety, however new workarounds have been identified in the literature. It is apparent that EMAS/BCMA systems continue to be used incorrectly, limiting their intended patient safety benefits. Solutions for the identified workarounds need to be implemented to eliminate unsafe practices and potential for patient harm.

The many existing BCMA workarounds are well known, yet new forms of BCMA workarounds continue to emerge. A few topics are worthy of further discussion, such as considering whether all workarounds are unsafe or are they inherent systems issues, can these systems issues be truly eradicated, and whether there are acceptable circumstances that justify the workaround. Finally, processes need to be standardized that optimize the use of the system. For example**,** the literature shows that BCMA workarounds can occur due to system-related problems, beyond the control of the initiating nurse. A nurse, who is unable to scan a medication barcode because the battery is low on the scanner, or the barcode is unreadable, is not at fault. The nurse must work around the problem to administer required medication. Sometimes nurses used clinical judgment in effort to avoid harm to their patient, such as in the case in the Yang et al. study, in which the nurse knew that the prescribed intravenous medication would cause harm to the pediatric patient.

There can be circumstances when BCMA workarounds are unavoidable. One situation to consider is that of an emergency. The logistics of the BCMA medication administration protocols during an emergency can be impractical. Finding solutions to correct the system-level problems takes leadership. Solutions require leaders at all levels of the healthcare organization employing BCMA systems, include the end user to understand the nature and frequency of BCMA workaround occurrences, and optimize the system in an effort to ensure that every patient receives the safest possible care. Leading requires taking action while being vigilant about how current processes are failing. For example, in each of the three studies, unreadable, unscannable patient barcode identification bracelets contributed to a workaround. New technologies may provide alternative solutions.

Lanoue and Still (2008) determined that linear barcodes are more difficult to scan than 2-D barcodes. Due to the length of linear barcodes, the curvature of the patient's wristband distorts the spacing of the barcode making it difficult to scan. After several unsuccessful scanning attempts, nurses override the BCMA system, and select 'unreadable barcode' as an option to continue with the medication administration process. It is critical to confirm patient identification, and omission of this step puts patients at greater risk for error.

2-D barcodes offer an alternative solution to the linear barcode design. 2-D barcodes encode more data in a smaller space, are readable from any direction, can be repeated around the length of the wristband, and offer greater read-accuracy (Lanoue & Still, 2008). 2-D barcodes have potential to reduce nurse's omission of identification bracelet scanning.

Global Aim

The global aim of this quality improvement project was to improve medication administration safety through efficiency advancements to optimize the barcode-scanning technologies.

Problem Statement

Knowledge-Based Medication Administration (KBMA) at the hospital was implemented in January 2014. Implementation inefficiencies within the system were identified resulting in KBMA nursing workarounds. The specific aim of this project was to identify the types and causes of the nurse workarounds to help find solutions to optimize the KBMA system to provide and ensure patient safety. The process began with identifying and correcting KBMA related inefficiencies, and ended with a decrease in the overall total of KBMA nursing workarounds from date of implementation through September 30, 2014, and meet Meaningful Use Stage 2 Core Measure 16 during the Attestation period of July 1, 2014 through September 30, 2014.

Conceptual Model

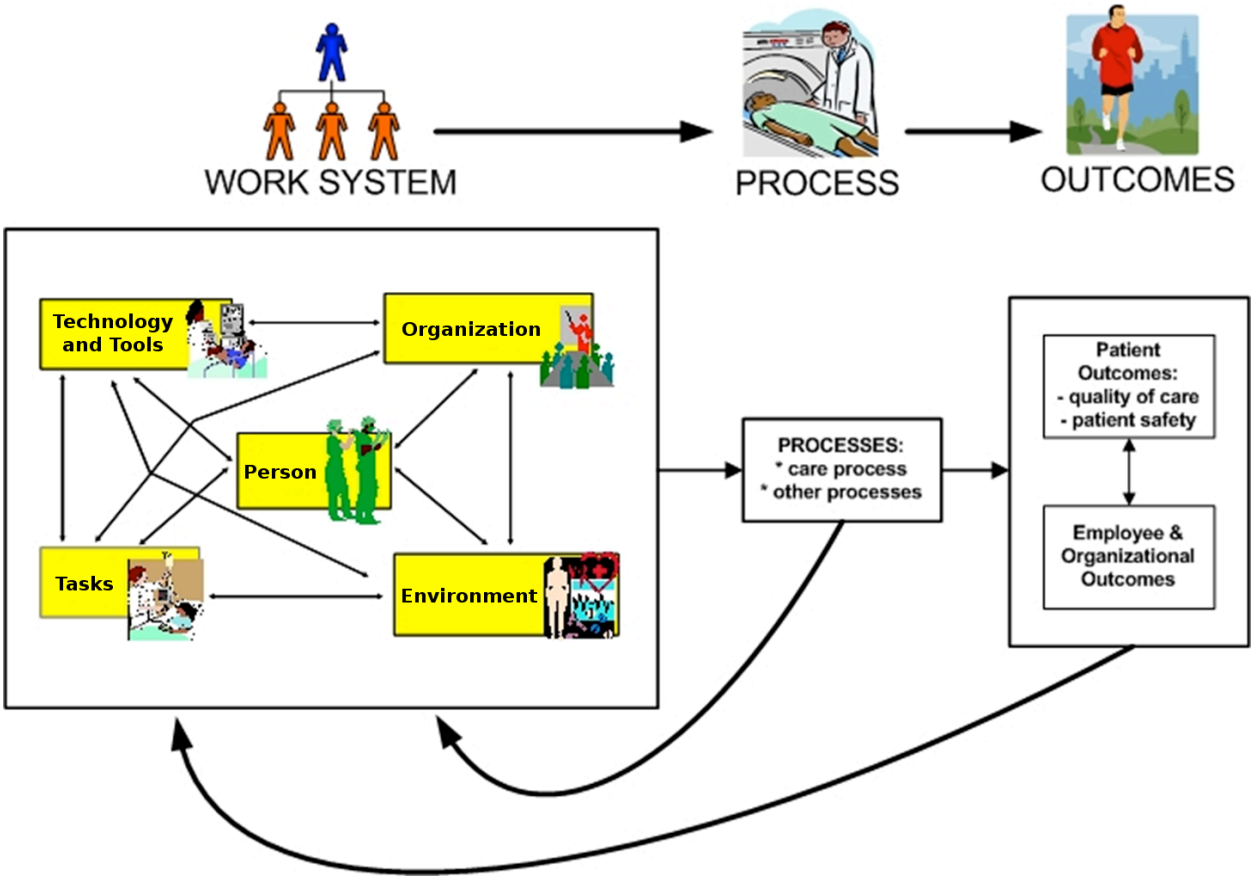
Hospitals are complex adaptive systems consisting of a large number of interactive subsystems. Most errors and inefficiencies in patient care, result from suboptimal systems of which they are a part and with which they interact. To improve the design of these systems, the IOM has proposed the application of engineering concepts and methods in particular, human factors and systems re-engineering (Crayon, Hundt, Karsh, Gurses, Alvarado, Brennan, 2006). Emphasis on system design was recommended in a recent report by the National Academy of Engineering and the IOM: "…it is time to establish a vigorous new partnership between engineering and health care and hasten a transition to a patient-centered 21st century health care

system" (Reid, Compton, Grossman, & Fanning, 2005, p. 15). Patient safety researchers recognize the need for human factor engineering and system approaches to safety research, analysis, and improvement (Crayon et al., 2006).

The Systems Engineering in Patient Safety (SEIPS) model of work system and patient safety (Figure 1.2) provides a framework for understanding relationships among the structures, processes and outcomes in health care. The SEIPS engineering approach to patient safety is anchored within the industrial engineering subspecialty of human factors. The discipline of human factors emphasizes interactions between people and their environment that contribute to performance, safety and health, quality of working life, and the goods or services provided. The SEIPS model explains how the design of the work system can impact not only the safety of patients but also employee and organizational outcomes. It is important to characterize these many interactions between people and their environment in a concise and articulate manner to identify points for improvement or intervention (Carayon, Wetterneck, Rodriguez, Hundt, Hoonakker, Holden, Gurses, 2013).

Work systems need to be well designed for optimal performance. When system designs are suboptimal poor processes and outcomes may occur, triggering an intervention or system redesign. Within the health care system, redesign begins with the identification of the negative work system elements including employee and organizational outcomes that affect quality and safety of care (Carayon et al., 2006).

Figure 1.2 SEIPS Model of Work System and Patient Safety



II. Methods

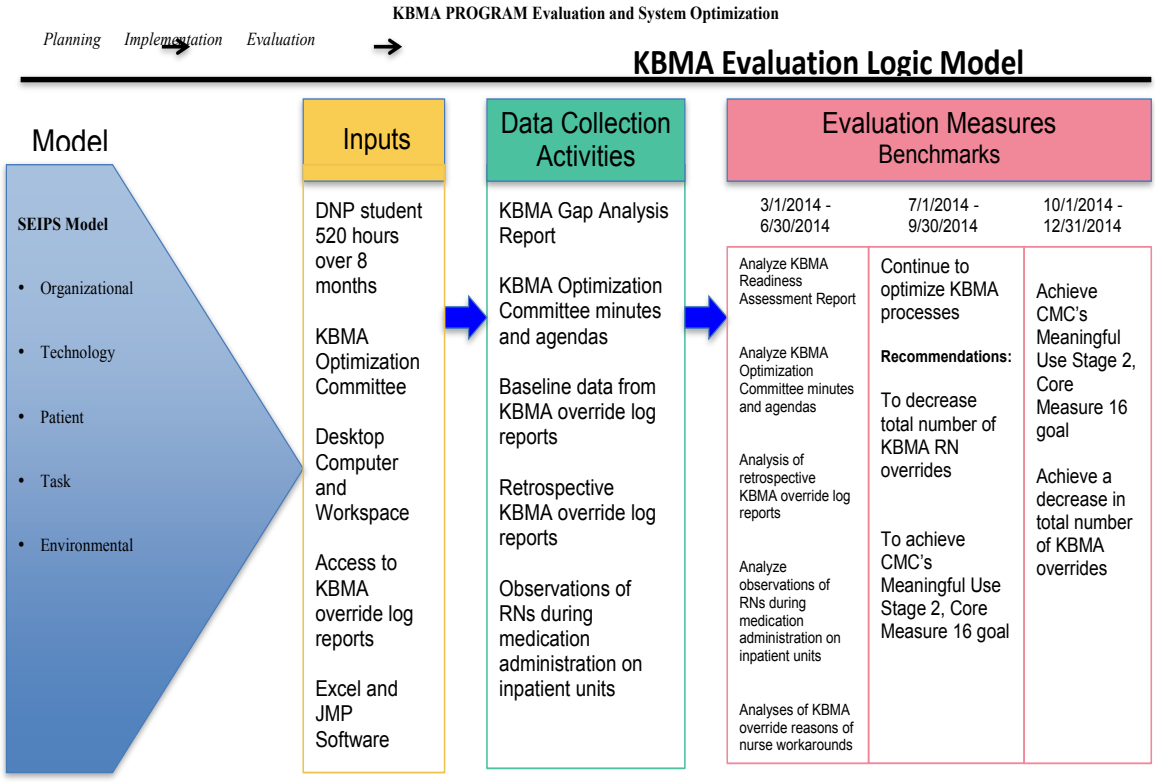
Ethical Considerations

Ethical consideration for the protection of human subjects was submitted to the University of New Hampshire's Institutional Review Board. The application was withdrawn as the proposed program evaluation was deemed quality improvement and not research. (Appendix C).

Project Design

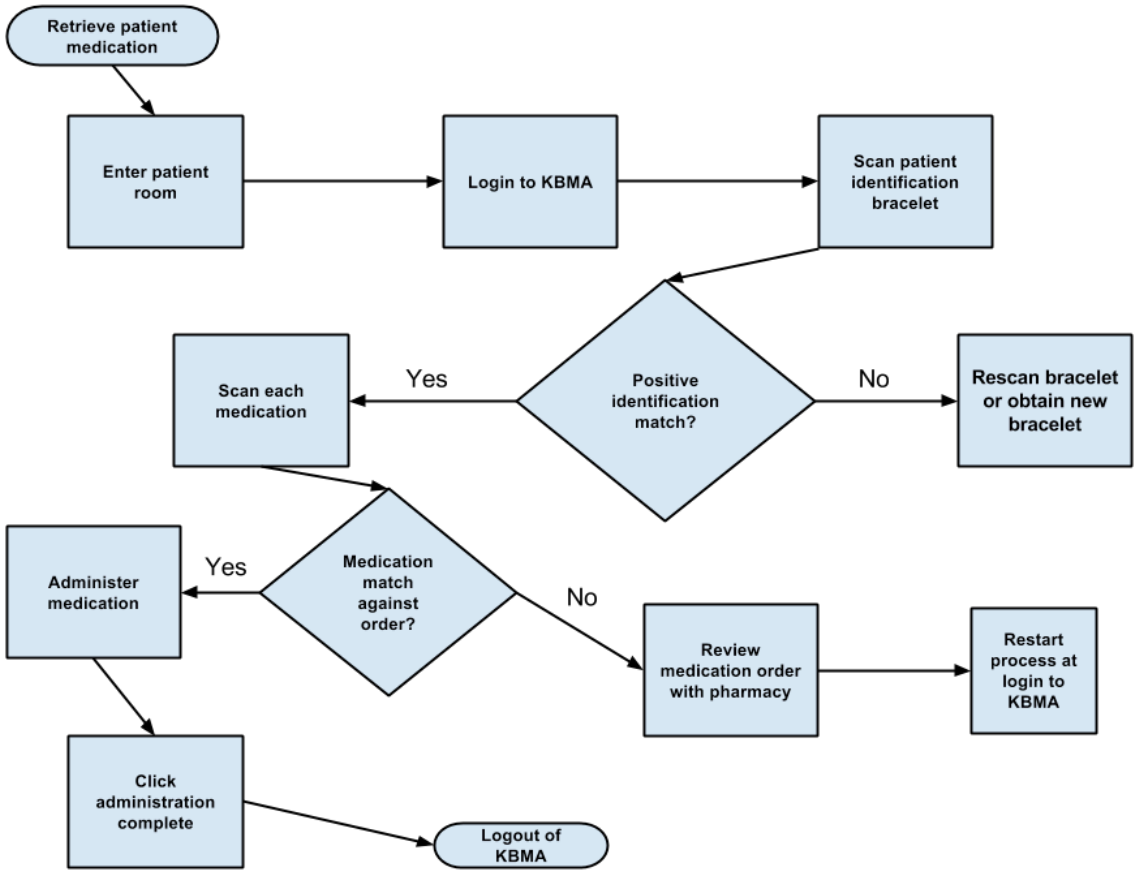
A repeated measures mixed methods program evaluation was conducted to identify the types and causes of KBMA nurse workarounds occurring at the hospital from January 10, 2104 to December 10, 2014. A Logic Model (Figure 2.1) was developed to depict relationships between the activities, outputs, and outcomes used to drive the evaluation (W. K. Kellogg Foundation, 2004).

Figure 2.1 KBMA Evaluation Logic Model



The process begins with understanding the KBMA Process and ends with an optimized system that meets organizational Meaningful Use measures. A nurse is required to follow a sequence of steps in order to ensure safe medication administration. If any step in the process sequence is not met, the nurse should stop the medication administration and correct the error (Figure 2.2).

Figure 2.2 KBMA Process



Phase 1: January 2014 through March 2014

A KBMA Optimization Committee was established which included key stakeholders from the following departments: pharmacy, information technology (IT), respiratory therapy, directors from each inpatient unit, nurse researcher, quality improvement, clinical education specialists, and manager of nursing systems and support. In the preplanning stages of KBMA, the committee completed a KBMA assessment report. The report provided insight into current strengths and weaknesses of all processes involved with medication administration at the hospital (Appendix D). The pharmacy team continued to acclimate themselves to KBMA software by

training in a testing playground. New barcoding and repackaging equipment was tested, and over 1800 formulary medications were entered into the new system. Fine tuning all pharmacy work processes occurred during this phase.

IT worked closely with pharmacy and the manager of system support for nursing. Electronic Administration Record (eMAR) screens were altered based on pharmacy and/or nursing needs. Computer on wheels, scanners, and fixed devices (computers) in patient rooms were installed and tested.

KBMA training for end users and super users continued through Phase 1. End users included: nurses, respiratory therapy, unit directors, IT support, and pharmacy team. Super-users received extra training and provided additional technical support once KBMA implementation went live on each of the units. In March, KBMA was piloted on one medical surgical unit. KBMA related issues that arose on the medical surgical unit during the pilot period were addressed on a moment-to-moment basis when possible. If the problem could not be resolved immediately, the appropriate department was notified. For example, if the problem were technology related, IT would consult with the nurse having process issues, or go directly to the equipment to resolve the issue.

From the onset, nurse workarounds were identified as a potential problem in relation to KBMA compliance. Baseline data for phase 1 was obtained by KBMA tracking reports. The reports informed the work of the KBMA Optimization Committee with a variety of data including nurse drug scan overrides, which are considered unsafe workarounds. All KBMA related problems identified during the pilot implementation were discussed with the KBMA Optimization Committee in the scheduled weekly meetings.

Phase 2: April 2014 through June 2014

Phase 2 began with the implementation of KBMA on ten inpatient units. Not all ten units went live at the same time. Instead, a staged KBMA roll out over a two-month period occurred. Weekly KBMA Optimization Committee meetings continued throughout Phase 2. As more units went live with KBMA, increases in the number of nurse workarounds were identified. Each member of the Optimization Committee reviewed override drug scan reports weekly. Reviewing the reports in detail provided committee members the opportunity to understand unit-specific issues and precisely what types of workarounds were occurring. Data on care processes and organizational outcomes were used to identify problems and provide opportunities to assist with finding solutions to the processes at fault in the work system, this is a key feature of the feedback loops in the SEIPS model.

There were still areas on certain units and patient rooms where the wireless data communication connectivity required for KBMA use was poor. The nurses were either unable to connect to the eMAR or in instances when the nurses were able to connect the signaled dropped during the KBMA process. Nurses also reported problems with the scanners not working. After evaluating the problem, it was revealed that the scanners were not being docked properly after use. In addition, many nurses were unaware of how to reset (reboot) the scanner when the scanner was not working correctly. Reeducation was provided to nurses either 1:1, via postings/alerts in medication rooms, or email updates. .

Nurses described trouble-scanning barcodes on medications that were dispensed in tubes such as ointments or lotions. If the tubes were crimped from squeezing, the barcode would not scan or if the tube had any residual medication on the barcode it would not scan, even after

attempts were made to wipe off the medication. The committee decided to trial placing barcodes near the top of the tubes and off to the side.

Licensed Nursing Assistants (LNA's) are permitted within their scope of practice to apply specific lotions on a patient, i.e. skin barriers. Typically, the application is scheduled and applied during AM care and throughout the day as needed. If the nurse were not available to provide the LNA with the lotion at the time of care, an alert would populate in the eMAR indicating a late administration. Late or early medication administration is considered a workaround. Every patient room was provided a lock-box for LNA type lotions so that the LNA's were not dependent on the nurse for retrieving lotions.

Damaging barcodes when removing specific doses of medication from a sheet of medications was another instance that nurses were struggling with. Certain packaging had a foil component to it, or the packaging was thick, and when the nurse attempted to rip off the required dose, the barcodes were damaged in the process. Every medication room on each unit was supplied with scissors just for this instance.

Phase 3: July 2014 through September 2014

In addition to resolving ongoing workaround issues, primarily IT and pharmacy related, Phase 3 began at the hospital with the MU Attestation period from July 2014 through September 30, 2014. During this time, data was collected on the number of medications from order to administration using the KBMA system. The metric set for The hospital to meet the MU Stage 2 Core Measure 16 specified that more than 10 percent of medication orders created by providers had to be tracked using the eMAR. The attestation requirements were calculated using the following Denominator/Numerator/Threshold/Exclusion criteria:

- Denominator: Number of medication orders created by authorized providers in the eligible Critical Access Hospital (CAH) inpatient departments during the Electronic Health Record (EHR) reporting period.

- Numerator: The number of orders in the denominator for which all doses are tracked using the eMAR.

- Threshold: The resulting percentage must be more than 10 percent in order for an eligible CAH to meet this measure.

- Exclusion: Any eligible CAH with an average daily inpatient census of fewer than 10 patients.

Phase 4: October through December15, 2014

At the end of the attestation period, over sight by the KBMA optimization committee was withdrawn and data collected to evaluate the sustainability of the system changes. The optimization committee continued to collect data but did not meet to review data or make further changes to the system.

Data Sources

1. A review of the KBMA Readiness Assessment Report was conducted to understand the implications associated with the planning process required for implementation of the KBMA system. The 15 page report covered the following topics: eMAR, Nursing, Staffing, Pharmacy Team, Automatic Dispensing Machine, Compounding System, Repackager, Purchasing of Bar Code Medications, Labeling, Formulary Floor Stock

Medications, Route Code Medications, Medication Order Flow, and Test Environment (Appendix E).

2. The KBMA Optimization Committee created the anticipated KBMA Override Reasons (Category 1) built into the system based on the following: discussions with the BCMA vendor and pharmacy directors, problems that were identified during the KBMA educational training sessions, and issues that arose during the KBMA implementation pilot. This category acknowledges system issues that could be tolerated due to the structure of KBMA and could not be corrected by optimization.

   Override drug scan coded reason tracking reports were analyzed from January 10, 2014 to December 10, 2014. The reports provided the total number of override drug scans for each of the KBMA administration override reasons presented in Table 2.1. For example, the week of June 16th there were 83 overrides under the category 'Barcode Damaged When Opening Package', and 50 under the category 'Barcode Missing'. All drug scan coded reason totals were entered into a spreadsheet in weekly increments, and results were presented at the weekly Optimization Committee meetings.

Table 2.1 Knowledge-Based Medication Administration Override Reasons

LNA/RN Not Trained on KBMA
Rate Change/Rate Check/End Shift Total
Barcode Damaged When Opening Package
Patient's Own Medication
Barcode Damaged/Unreadable, No Other Package
Barcode Missing
Product Not Found
PACU Titration
Scanner Inoperable
Pyxis Override
Downtime Recovery
Order Changed. Label Barcode is Old Order Number

KBMA Coded Reason Definitions

1. LNA/RN Not Trained on KBMA

    - Licensed Nursing Assistant/ Registered Nurse not trained on KBMA system

2. Rate Change/Rate Check/End of Shift Total

    - Registered nurse will scan all rate changes (increase/decrease) on all the following intravenous drips: continuous medicated solutions, total parenteral solution, patient-controlled analgesic, epidurals, heparin, and insulin

    - Registered nurse will scan intravenous drip(s) to verify correct rate(s)

    - Registered nurse will scan all intravenous drips at end of shift to obtain total volume infused

3. Barcode Damaged When Opening Package

    - Barcode damaged when opening package (ripped, torn, split, crumpled)

4. Patient's Own Medications

    - A patient own medication will be pharmacy approved and identified only if presented in their original labeled container. Registered nurse will send patient own medications to pharmacy for verification. Pharmacy will place a verification sticker after positive identification. No barcode will be placed on patient own medications to scan through KBMA. However, the registered nurse must go through KBMA, select No Scan and then select 'Patient Own Medication' from drop down menu.

5. Barcode Damaged/Unreadable. No Other Package

    - Barcode on medication packet is damaged and therefore unreadable and unscannable
    - No other medication packet was available to replace damaged medication packet

6. Barcode Missing

    - Barcode missing on medication (auxiliary label missing or is covering up barcode on medication)

7. Product Not Found

    - Registered nurse scanned wrong barcode or pharmacy did not link medication to stock item level in Sunrise

8. PACU Titration

    - Post Anesthesia Care Unit registered nurses will scan intravenous drip medication(s) when first drawn up and or administered to the patient

9. Scanner Inoperable

    - KBMA handheld scanner inoperable

10. Pyxis Override

    - Pharmacy has not yet verified medication and registered nurse overrides Pyxis alert (e.g. STAT medication)

11. Downtime Recovery

- KBMA system down and unavailable thus to update KBMA software

12. Order Changed. Label Barcode is Old Order Number

- Provider changed order and medication scanned is an old order number

3. Override drug scan free text reason tracking reports those workarounds noted by nurses that were not anticipated to be systems issues (category 1). These reports were analyzed from January 10, 2014 to December 10, 2014. This was identified as the second override drug scan category (category 2). The free text reasons that met criteria in this category were coded and assigned to one of the KBMA administration override reasons, i.e. if the nurse wrote " barcode would not scan", the reason was coded under 'Barcode Damaged/Unreadable, No Other Package Available'. When a free text reason could not be assigned a new domain was established (Category 3). In total, 21 domains were established (Table 2.2).

Table 2.2 Free Text Reason Category 3 Domains

Insulin
User Error
Procedural Medications
STAT
Done By Other
Bracelet Not Scanning
No Medication Given
Infusing As Ordered
Computer/Technical Issues
CMO
Medication Was Scanned
Repeat Dose/Partial Dose
Late/Early Administration
Patient Related
Clinical Judgment
Not Verified From Pharmacy
Override Dose
Duplicate
Did Not Carry Over
Task Box Missing
Blood Products

4. Observations of registered nurses (RN's) during medication administrations on inpatient units were conducted to corroborate the data being reported on the KBMA override log reports. Inpatient units included: medical surgical, rehab, cardiac care, intensive care, and post anesthesia care. Observations occurred on a variety of shifts: 7:00am-3:00pm, 3:00pm -11:00pm, 7:00am-7:00pm, 7:00pm-7:00am. The data collected involved unambiguous measurement that did not require subjective judgment. To ensure consistency of observations, the evaluator created an observational tool shown in Table 2.3 that was validated by the KBMA Optimization Committee.

Table 2.3 Observational Tool

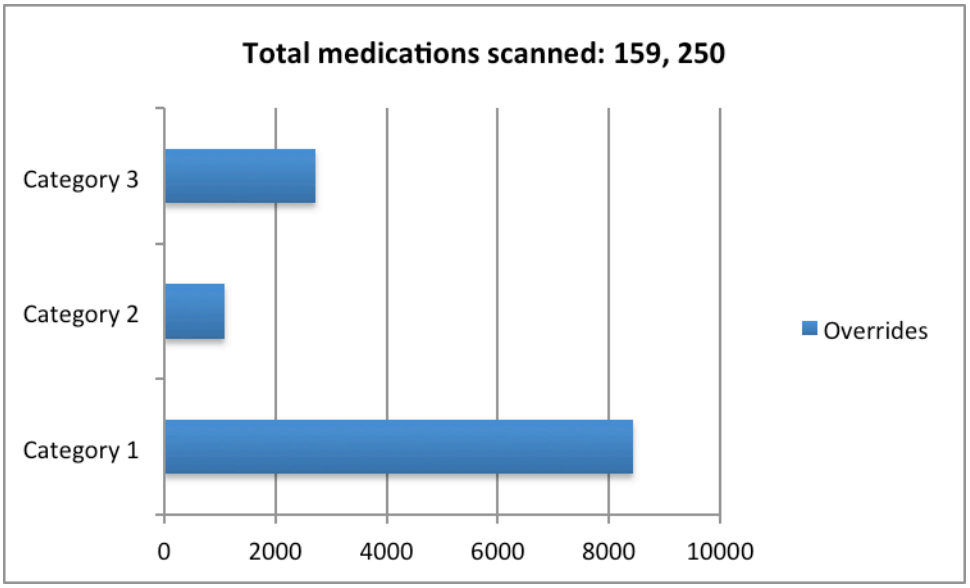
Inpatient Unit Type (e.g. Med-Surg)	
Total # of Medication Administered	
Wait Time for Pyxis (Y/N)	
High Alert Medication 1. Independent Double Verification (Y/N) 2. Syringe labeled (if applicable) (Y/N)	
Type of Workaround	

III: Findings

Override drug scan free text reason tracking reports were analyzed from January 10, 2014 to December 10, 2014. A total of 10,475 free text override reasons were hand-coded. From that total, 2,793 free text reasons were assigned to Category 2, meaning the free text reason the RN provided matched one of the established KBMA administration override reasons established as anticipated systems issues. Category 2 had the same 12 domains as Category 1. By not using the category 1 override reason; the nurses were not using proper processes. The remaining 7,682 free text override reasons were designated to Category 3, which resulted in 21 new domains of KBMA nurse workarounds considered both system and process issues.

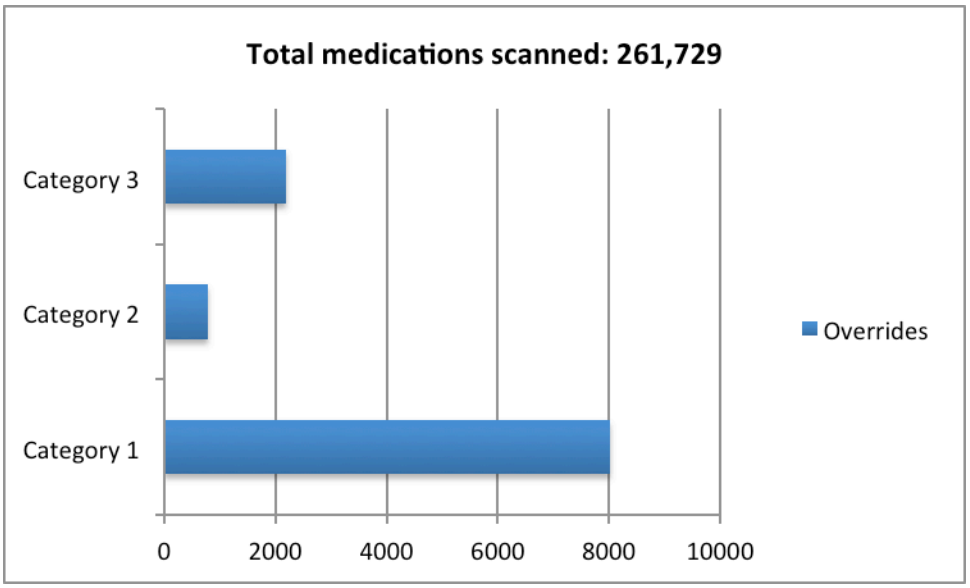
Descriptive Statistics

Table 3.1 Phase 1: January through March



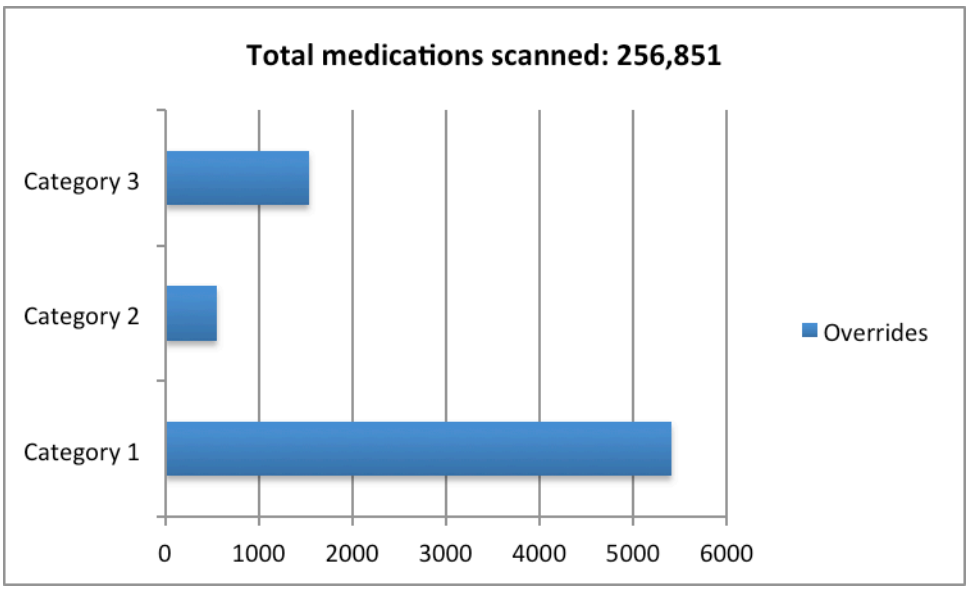
Phase 1 had the fewest medications scanned per that time period (N = 159, 250) however, Category 1 (N = 8,425) had the highest override totals out of Phases 1-4. Total override scans for Phase 1 were (N = 12, 231).

Table 3.2 Phase 2 April through June



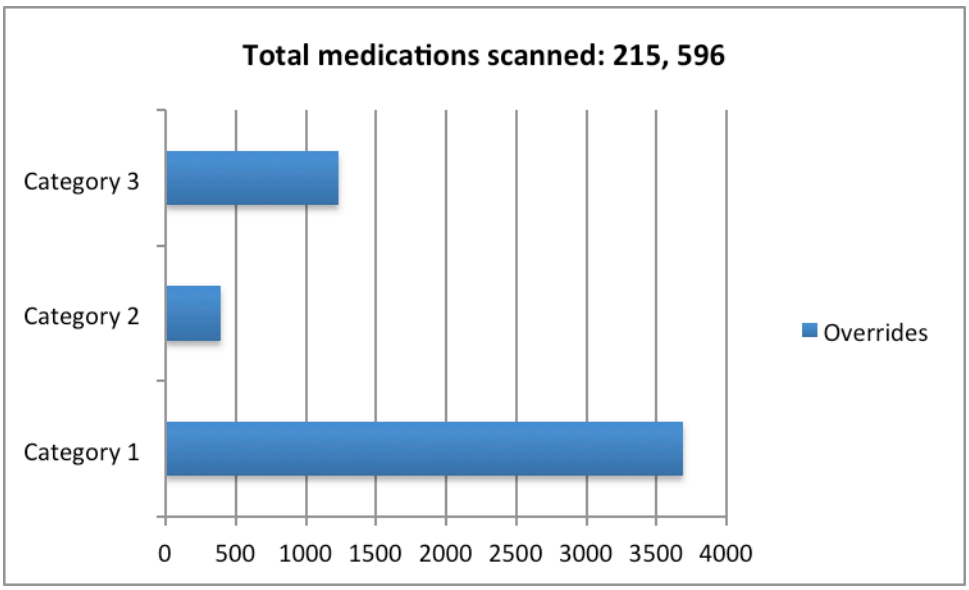
Phase 2 had the most medications (N = 261, 729) though each category had fewer override scan totals when compared to Phase 1. Total override scans for Phase 2 were (N = 10,971) indicating a decrease in override scan workarounds by (N = 1, 260) when compared to Phase 1.

Table 3.3 Phase 3 July through September



Phase 3 had fewer medications scanned (N = 256,851) when compared to Phase 2 and each category totals decreased significantly when compared to both Phase 1 and 2 reflecting system optimization. Total override scans for Phase 3 were (N = 7, 494) indicating a significant decrease in override scan workarounds by (N = 4, 737) when compared to Phase 1 and when compared to Phase 2 (N =3, 477).

Table 3.4 Phase 4 October through December



Phase 4 had the second fewest number of medications scanned of all four Phases (N = 215,596) and each category decreased significantly when compared to Phases 1 -3 indicating system optimization. Total override scans for Phase 4 were, (N = 5, 321) demonstrating a significant decrease in override scan workarounds by (N = 6, 910) when compared to Phase 1.

Thematic Analysis

Table 3.5 Category1 Override Scans Comparison-Counts by Month

	Counts by Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Rate change/Rate check/End shift total	335	922	942	752	369	317	242	252	360	311	228	74
Barcode Damaged when opening package	125	553	662	559	327	307	336	242	252	324	313	69
Barcode Damaged/Unreadable. No other package available	58	512	653	431	332	279	236	190	228	260	290	84
LNA/RN not trained on KBMA	42	517	233	277	402	398	383	302	189	156	63	17
Patients Own Medication	3	243	355	337	390	244	126	114	215	131	119	63
Barcode Missing	49	299	406	324	226	157	105	82	153	136	122	35
Scanner inoperable.	49	205	288	192	94	93	76	79	113	86	63	18
Product Not Found	110	199	147	129	96	81	62	85	58	52	58	7
Downtime Recovery	3	182	78	115	76	96	266	5	6	15	10	0
PACU Titration	0	0	32	93	132	108	119	137	166	213	120	61
Pyxis Override	6	80	91	94	92	39	63	52	83	78	56	31
Order changed.Label Barcode is old order number	5	11	30	28	22	7	7	14	12	10	11	8

Rate Change/Rate Check/End Shift Total domain had the highest overall total (N = 5,104). However, over the four Phases the totals dropped significantly. Phase 1 (N = 2,199), Phase 2 (N = 1,438), Phase 3 (N = 854), Phase 4 (N = 613).

Barcode Damaged When Opening domain had the second highest overall totals (N = 4,069). The totals did decrease over the Phases but not as dramatically seen in the Rate Change/Rate Check/End Shift Total domain. Phase 1 (N = 1,340), Phase 2 (N = 1,193), Phase 3 (N = 830), Phase 4 (N = 706).

The third highest over totals were for the Barcode Damaged/Unreadable. No Other Package Available domain (N = 3,553). Totals decreased by half in Phase 3 and 4. Phase 1 (N = 1,223), Phase 2 (N = 1,042), Phase 3 (N = 654), Phase 4 (N = 634).

The following four domains all had totals ranging between 2, 979 – 2, 034: LNA/RN Not Trained On KBMA (N = 2,979), Patient Own Medication (N = 2,340), Barcode Missing (N = 2, 094), and PACU Titration (N = 2,034).

Of the remaining five domains Scanner Inoperable had the highest total (N = 1,356). Label Barcode Is Old Order had the least overall total (N = 165).

Category 2 Override Scans Comparison

Table 3.6 Category 2 Override Scans Comparison-Counts by Month

	Counts by Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1 Rate Check	94	88	40	23	14	25	15	10	21	15	20	1
2 Barcode Damaged when opening package	0	0	0	0	0	0	0	0	0	0	0	0
3 Barcode Damaged/Unreadable. No other package available	78	150	255	152	85	91	84	78	77	83	76	17
4 LNA/RN not trained on KBMA	9	13	3	6	9	7	6	7	3	7	3	0
5 Patients Own Medication	6	26	33	50	21	10	15	8	7	9	4	0
6 Barcode Missing	29	39	33	52	30	18	12	15	20	23	16	1
7 Scanner inoperable	20	22	36	22	10	15	14	4	49	14	20	11
8 Product Not Found	3	15	5	10	4	14	9	1	7	2	2	0
9 Downtime Recovery	0	0	0	0	0	0	0	0	0	0	0	0
10 PACU Titration	0	0	0	0	0	0	0	0	0	0	0	0
11 Pyxis Override	0	0	0	0	0	0	0	0	0	0	0	0
12 Order changed.Label Barcode is old order number	12	33	38	39	38	27	26	26	33	44	20	6

Barcode Damaged/Unreadable, No Other Package domain had the highest overall total for all four Phases (N = 1,226). Phase 1 the largest (N = 483), Phase 2 (N = 328), Phase 3 (N = 239,) and Phase 4 had the least (N = 176). Example free text reasons included, " barcode will not scan", tried 3 times can't scan", "multiple attempts scanning won't scan".

Rate Change/Rate Check/End Shift Total reason was the second highest in regards to total overrides for Category 1 for all four Phases (N = 366). Phase 1 had the most (N = 222), Phase 2 (N = 62), Phase 3 (N = 46) and Phase 4 the least (N = 36). Example of free text reasons for this domain included, "checking end of shift total", and "no rate change", "checking rate".

Barcode Missing domain overall sums were (N = 288). Both Phase 1 and 2 totals were (N = 100), in Phase 3 and 4 the totals dropped by half (N = 47) (N= 40).

LNA/RN Not Trained on KBMA (N = 73) and Product Not Found (N = 72) were close in value for overall totals.

Patient's Own Medication domain totals were (N = 189). Phase 1 (N = 65), Phase totals increased to (N = 81), then decreased in Phase 3 to (N = 30) and ultimately decreased further in Phase 4 to (N = 13). Example free text reasons included, "pt brought meds in from home", " home meds".

Scanner Inoperable domain sums were (N = 237). Phase 1 (N = 78), Phase 2 decreased to (N = 47) then increase in Phase 3 (N =67), then decreased again in Phase 4 (N =45). Example free text reasons included, " scanner won't work", "scanner issues", "IT notified scanner isn't working".

The following domains all had (N = 0) for all four Phases: Barcode Damaged When Opening Package, Downtime Recovery, PACU Titration, and Pyxis Override.

Category 3 Override Scans Comparison

Table 3.7 Category 3 Override Scans Comparison/Counts by Month

	Counts by Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Insulin	220	221	177	114	86	88	60	29	30	26	21	10
User Error	43	271	278	296	164	129	140	110	203	190	202	59
Procedural medications	19	59	49	87	66	44	60	41	51	52	35	9
STAT	7	55	60	58	28	31	33	30	35	30	25	7
Done by other	21	78	68	54	64	58	35	48	52	39	68	10
Bracelet not scanning	25	20	24	9	5	7	4	12	4	4	4	1
No medication given	34	42	54	52	37	32	19	19	21	18	33	14
Infusing as ordered	38	19	8	19	5	4	4	3	3	0	1	0
Computer/technical issues	2	21	25	16	10	45	37	10	25	26	13	2
CMO(comfort measure only)	4	1	23	3	6	13	3	25	7	0	4	1
Medication was scanned	19	42	50	35	21	27	18	29	39	42	39	16
Repeate dose/partial dose	12	38	48	45	25	14	30	12	21	23	19	6
Late adminsitraion/Early administration	22	131	123	73	50	31	26	38	36	48	33	9
Patient related	0	17	22	19	13	9	3	6	6	13	7	0
Clinical judgement	3	15	3	7	0	1	0	3	0	2	0	0
Not verified from pharmacy	3	19	6	7	3	5	3	1	3	2	0	0
Override dose	4	23	35	30	19	8	13	21	12	15	16	2
Duplicate	1	5	7	6	4	1	4	5	1	2	1	1
Did not carry over	5	22	13	34	5	7	1	10	14	5	4	0
Task box Missing	14	20	16	14	10	7	11	6	4	8	4	1
Blood Product	0	2	1	5	5	5	3	3	2	1	5	2
50% dose	1	2	16	6	1	2	0	0	0	3	1	1
Not in a Category	28	70	73	52	48	37	28	39	31	43	40	10

The User Error domain had the highest overall total out of all 21 domains and the highest for all four Phases (N = 2,085) and stayed consistently high over each of the four Phases: Phase 1 (N = 592), Phase 2 (N = 589), Phase 3 (N = 453), and Phase 4 (N = 451). Example free text reasons, “I accidentally forgot to scan”, I forgot to use KBMA process, and “I threw out vial before scanning”.

The second highest overall total domain was Insulin (N = 1, 082). However, unlike the User Error domain the Insulin totals decreased significantly over the four phases: Phase 1 (N = 618), Phase 2 (N = 288), Phase 3 (N = 119), Phase 4 (N = 57). Example free text reasons, “no insulin needed”, and “marked off zero insulin”.

The third highest overall total domain was Done By Other (N = 994). The totals remained relatively consistent for Phases 1-3. Phase 1 (N = 167), Phase 2 (N = 176), Phase 3 (N

= 135) and then decreased slightly for Phase 4 (N = 117). Example free text reasons, " given by Jane on previous shift", "given by MD", and "administered by PA".

Late/Early Administration had the fourth highest overall totals (N = 620) however, by Phase 4 totals decreased significantly. Phase 1 (N = 276), Phase 2 (N = 154), Phase 3 (N = 100), and Phase 4 (N = 90). Example free text reasons, "given late", and "administered early per MD, "given early prior to testing".

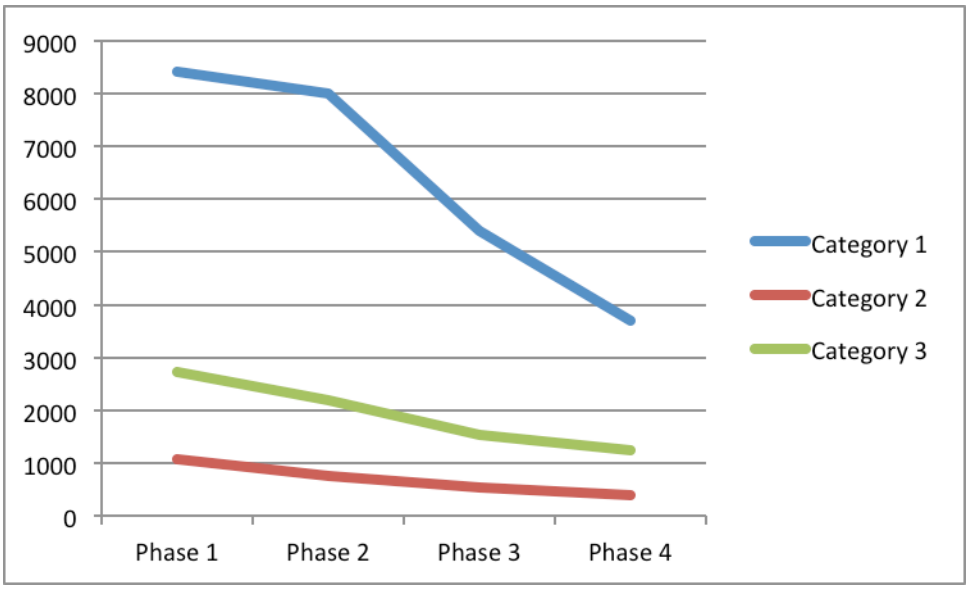
Procedural Medication was fifth highest in overall totals (N =572). Phase 1 (N = 127), Phase 2 had an increase (N = 197), Phase 3 (N = 152), and Phase 4 decreased to (N = 96). Example free text reasons, "given during OR procedure", " procedure med", and "given prior to procedure".

The remaining 16 domains had overall totals ranging from 399 – 33. The domains with the least override totals were Patient Related (N = 34), Task Box Missing (N = 34) and Blood Product (N = 33).

Hypothesis Testing

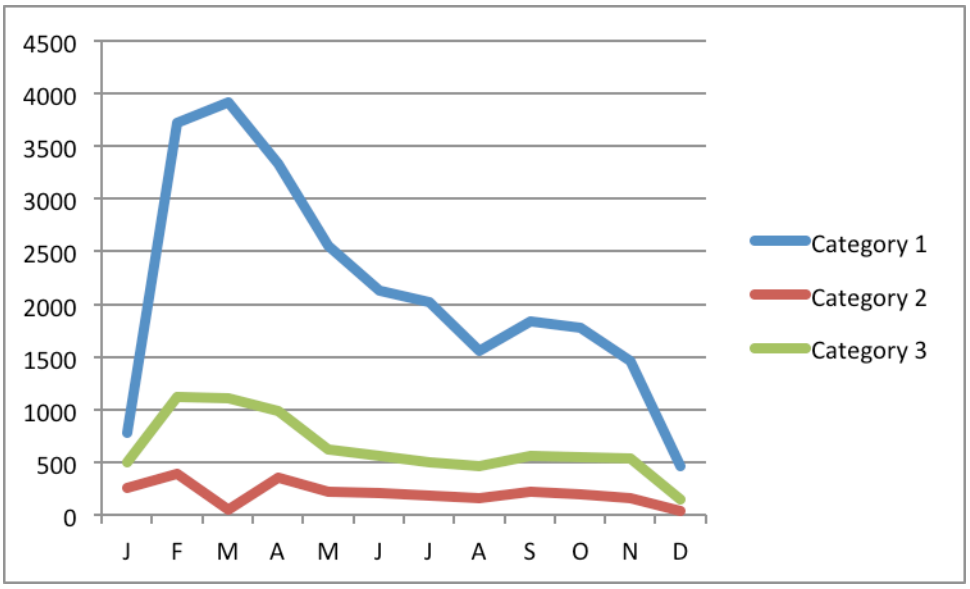
Based on the specific aim of this evaluation, it was hypothesized that by optimizing the KBMA system and correcting process issues there would be a decrease number of workarounds as measured by the override scans.

Table 3.8 KBMA Phase Total Overrides by Category



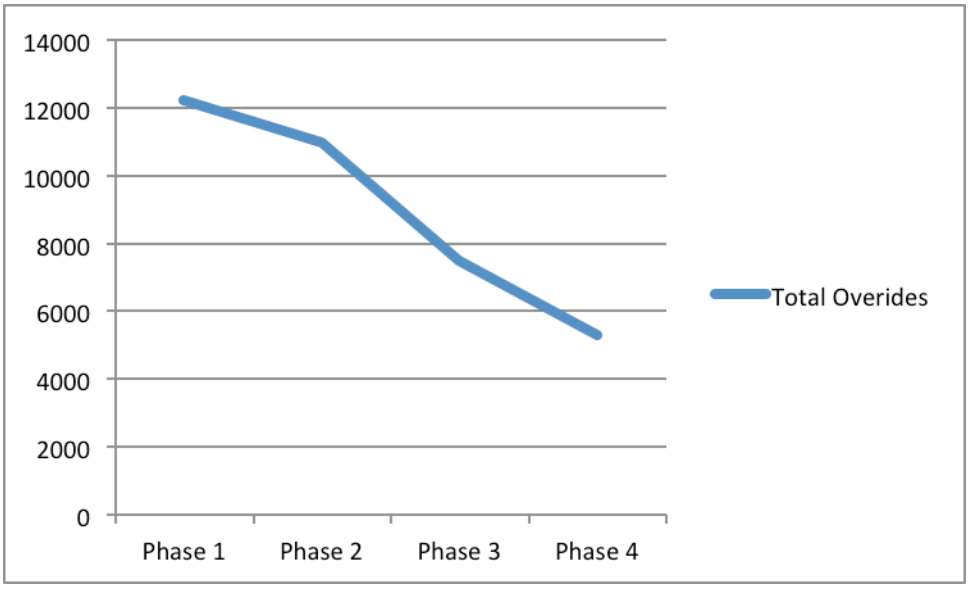
Phase 1 and Phase 3 are significantly different as are Phase 1 and Phase 4. This would indicate that optimizations and education in Phase 1 improved the systems and processes of KBMA for Phase 3 and 4, but there were no significant changes in workarounds based on changes made in Phase 2.

Table 3.9 KBMA Categorical Total Overrides for 2014



Category 1 override workarounds decreased significantly from April through June and again in mid November through December. The increase seen in August through mid November indicates optimization and education was not effective during this time period. Category 2 override workarounds did not decrease until May and then increased slightly in September through October. The trends in this category are very similar to those found in Category 1. Category 3 had similar trends as seen in both Category 1 and 2 except for the significant decrease in March, indicating education and optimization during the KBMA pilot period was effective.

Table 3.10 KBMA Total Overrides for all Categories Combined



Total override workarounds for all combined categories decreased significantly from Phase 1 to Phase 4, indicating education and optimization ultimately improved systems and processes of KBMA.

MU KBMA Compliance Monthly Averages

Table 3.11 July through September Meaningful Use KBMA Compliance Percentage Averages

	July	August	September
MU KBMA Compliance % Averages	37.05%	37.52%	39.74%
MU KBMA % Compliance Goal	10%	10%	10%

Table 3.16 shows MU KBMA compliance goals were met each month during the MU attestation period.

Structured Observations

Structured observations of RN's using KBMA were conducted over a three-month period on the following inpatient units: medical surgical, rehabilitation, cardiac care, intensive care, and post anesthesia care (N = 52). Observations were conducted on a variety of shifts: 7:00 a.m. - 3:00 p.m., 3:00 p.m. -11:00 p.m., 7:00 a.m.- 7:00 p.m., 7:00 p.m. -7:00 a.m. A total of (N = 191) medications were administered during the observational period. The total number of workarounds (N = 22) occurred during the structured observations.

Patient Identifiers

The largest number of workarounds fell in patient identification. Twelve RN's did not ask their patient's to state their name and date of birth prior to scanning their patient identification bracelet. All of the patients were alert and oriented and would have been able to answer the questions if asked.

Two different patient identification bracelets would not scan during the administration process. The correct procedure is to identify the patient's name, date of birth, and medical record number against the patient's eMAR. In both instances, the RN did not follow the correct process as defined by policy.

Insulin Administration

Administering insulin requires an independent double verification that requires the RN to pull up the correct amount of insulin into an insulin syringe based upon the patient's blood glucose and medication order. There is an insulin sliding scale order that the RN verifies how much insulin to administer. For example, if the patient's blood glucose were 160 the insulin sliding scale order would state to administer two units of insulin for blood glucose of 150-170. The second RN verifying the insulin dose should independently look at the patient's blood glucose, independently check the insulin sliding scale order, and then verify the amount of insulin drawn into the syringe. The administering RN places a barcode sticker on the insulin syringe for the barcode scanning process.

In one observation the RN administered insulin without any verification from another RN, and during another observation the second RN did not perform any independent verification. Instead the second RN glanced at the insulin syringe and nodded her head suggesting it was safe to administer.

Non-formulary Medications

In three different observations the RN was unsure of the KBMA process for administering non-formulary medications. In all three instances the patient brought in their own medications. The medications were verified by pharmacy however; the pharmacy's policy does

not require a barcode to be placed on the patient's medication container. The proper process is to go through KBMA and select No Scan and then select 'Patient Own Medication' from the drop down menu. Instead all three RN's omitted the KBMA process altogether and administer it through the eMAR.

Early Medication administration

Four observations exposed RN's administering medications early. One occurrence was per patient request. The patient regularly took the medication at 5:00 p.m. at home; it was prescribed to be administered at 7:00 p.m. per the medication order. The correct process would have been for the RN to notify the pharmacy to change the time on the order to 5:00 p.m.; however, the RN did not follow through with pharmacy. The remaining three early administrations involved a nasal spray, an ointment, and an eye drop. All were scheduled to be administered at 10:00 a.m. however all three RN's administered the medications during their 8:00 a.m. medication pass.

Medication Packaging

Some oral medications are not packaged separately but instead are attached together in a multi-dose packet. The RN tears off however many pills is needed per the medication order. Most often the RN will leave the pill packaging attached if more then one is selected. For example, the medication order is for Tylenol 650 mg. The Tylenol is packaged in 325 mg tablets; the RN tore off two tablets, however the packages remain attached. The correct process is to scan each tablet (package) separately, yet during three different observations the RN scanned the same tablet twice.

IV: DISCUSSION

The results of this program evaluation revealed that the hospital met MU Stage 2, and KBMA overall workaround totals decreased from Phase 1 to Phase 4. The cause and types of the KBMA workarounds discovered were similar to those found in the literature. Understanding why the workarounds occurred could be explained by variables identified in the SEIPS Model: technology and tools, organization (KBMA policy and procedures, person (nurse), tasks (medication administration), and environment (medication rooms, workstations, and patient rooms). Given the complexity of healthcare it is crucial for organizations to understand their work systems and the impact (workarounds) it has on patient safety.

Nurses developed workaround strategies when faced with obstacles using KBMA. Resolutions that do not consider issues across the whole system, including organizational factors are unlikely to have significant or sustainable impact. Although the attributes are described separately, it is important to emphasize the importance of the interactions between all work system elements.

As mentioned previously, the hospital met MU stage 2. The hospital not only met the 10 percent compliance requirement during the attestation period, but also continued to meet the requirements post attestation. If the MU compliance percentage requirements increase over time, as suspected, the KBMA Optimization will need to reevaluate the current KBMA- overrides reasons, practices, and policies that were deemed acceptable at the beginning of the project. Currently, MU requires that 10 percent of medication orders created by providers be tracked using the eMAR. It is expected that the percentage requirements increase i.e. 50 percent, and if this happens, current Wildcat MU compliance measures would fall short. Post attestation MU

compliance percentage averages were almost identical to those found during the attestation period. Therefore, minimal improvement was made in decreasing workarounds.

To increase MU compliance percentages, workarounds must decrease. If any medication order is not scanned, the order becomes ineligible, as it did not meet MU requirements, regardless of the patient's length of stay. For example, if a patient had a length of stay of four days and received a scheduled medication each day, that medication must be scanned each time it is administered. If one instance occurs when the medication is not scanned, the medication order becomes ineligible even if not scanning is correctly attributed to a work system issue and not considered a workaround.

The User Error domain (Category 3) has the highest overall total workarounds of the 21 domains; has the highest for all four Phases, and the totals did not decrease over time. It is unclear why this occurred. One would surmise that over time individuals would become acclimated with the technology and User Error reasons would begin to decrease. However the opposite occurred, User Error totals doubled from Phase 1 to Phase 4. The introduction of a new process can commonly disrupt workflows until that new process becomes routine. Experienced nurses can have more difficulty changing methodology to the BCMA processes when compared to new graduates, who know of no other medication administration process. There can be a number of reasons why the total number of workarounds may have increased, such as: time pressure, increased census, under-staffing, increased patient acuity, number of medications per patient. Regardless further investigation is required.

The Patient's Own Medication (Category 1) domain totals were significant enough to warrant attention. Optimization committee members from pharmacy were initially undecided

about whether or not to affix barcodes after verification to medications patient's brought in from home. A survey of policy at eight local hospitals in the Seacoast and southern New Hampshire related to verifying how barcoding was conducted when patient's brought in their own medications from home. The results were presented to the KBMA committee and although seven of the eight surveyed hospitals were affixing barcodes to patients own medications the pharmacy committee members decided they would not affix barcodes to patient's own medication/s. The members stated it was too time consuming, especially if patient's only stayed for 24 hours. Many patients' are on numerous medications and the process to create individual barcodes for each medication was considered too laborious. This continues to be a system issue resulting in nurse workarounds.

Barcode Damaged/Unreadable/No Other Package Available domains in Categories 1 and 2, had significantly high totals overall. Although the totals decreased over time, this domain remains remarkable in relation to the following discussion. Anecdotally, several unit Directors mentioned two major reasons why nurses selected this override reason during their medication administrations. First, the nurses indicated that they would scan a medication no more than twice. If the medication would not scan, they would select the Barcode Damaged/Unreadable/No Other Package Available override reason. The nurses reported they do not have time to straighten out barcodes or place packaging on a flat surface in attempt to flatten out or straighten the barcode. Second, nurses reported that when they were too busy they would select this reason because it is conveniently one of the first choices in the drop menu.

Both reasons provided have important implications and can be viewed as latent failures of the KBMA system design. However the response from the optimization committee was, "well, we won't be able to fix that" and "they're being honest but there is nothing we can do

about that, so let's move on to next agenda item". This was a lost opportunity for process improvement.

At least nine of the 21-workaround domains identified during this evaluation were directly related to constraints found within certain eMAR screens that force nurses to free-text override reasons. Ideally, these eMAR limitations would have been identified during the pilot implementation period and corrected. However, some eMAR screens cannot be modified to conform to KBMA desired results. Unfortunately, BCMA system constraints are not unique and a major contributor to workarounds.

By Phase 4 several domain issues improved with the system optimization. For instance, the LNA/RN not trained on KBMA domain was resolved by training all of the LNAs during phases 2 and 3. During Phase 4 all new RN and LNA employees received KBMA training in their hospital orientation. Technical issues were resolved as they were identified over time, decreasing overall totals in computer, scanner, and patient identification bracelet related problems.

Some workarounds were clearly intentional tradeoffs, such as overriding the system for STAT medications, patient behavioral issues, and administering medications for a dying patient. Considering these situations, achieving 100 percent barcode scanning compliance is unlikely. However, by optimizing KBMA work system process issues workarounds should continue to decrease.

The structured observations corroborate the type of workarounds that were being reported in the weekly override scan reports. One concern that emerged during observation was the process of nurses scanning the patient's identification bracelet. Many nurses did not identify

their patient according to hospital policy. A serious potential negative consequence of the use of technology is when the nurse becomes reliant on the system itself. Computer entry errors lead to system errors, and nurses must understand they are the last line of defense in the medication administration process.

Observations occurred on a variety of shifts, times, and units. Several units were alerted that there would be a visiting evaluator observing KBMA system medication administrations, and some units were not notified. There were RN's who were more relaxed during observation than others. Several RN's were very welcoming; a few seemed annoyed; while others took time explaining exactly what they were doing step by step. It must be stated that it is possible not all workarounds were identified during the structured observations, due to the Hawthorne effect. This can occur when an individual improves an aspect of their behavior in response to their awareness of being observed.

BCMA systems have been developed with the intention of improving patient safety by facilitating adherence to all aspects of patient medication rights. It is apparent from both the results of this program evaluation and existing literature that BCMA systems continue to be used incorrectly, consequently failing to provide intended patient safety benefits. It should be unacceptable for organizations to implement BCMA systems with accepted workarounds in place, or at best only having a minimum reserved for particular circumstances. Each defensive layer built into BCMA systems is intended to reduce variation at the point of care, and thus prevent errors from reaching the patient, yet in reality these systems are imperfect.

V: CONCLUSION

Accurate medication administration is required to improve quality and ensure patient safety. However, results from this review confirm that nurses continue to develop new workarounds while using BCMA systems. BCMA systems have the potential to prevent medication errors, although workarounds can eliminate the intended benefits. Efforts to correct workarounds should focus on identifying work system process issues that are barriers for nurses using BCMA systems as designed. Often, BCMA workarounds are system-level problems that in turn lead to unavoidable nurse workarounds. Ideally, nurses, the significant user of BCMA systems, should be more directly involved, beginning to end, with new BCMA implementation. Nurse input in system selection and design may be beneficial and potentially reduce the need for most workarounds.

Leaders, such as the DNP in an organization can continue to identify workarounds resulting from work system process issues. The DNP with advanced education and leadership skills are able to evaluate organizational practice policies and procedures for quality improvement using systems thinking. The DNP can provide leadership in the evaluation and resolution of systems and process issues as they analyze and communicate critical elements necessary to resolve and sustain change.

The SEIPS model of work system and patient safety provides healthcare leaders a model that has the ability to highlight the social and technical system elements and their interactions that can influence processes and patient safety outcomes. The framework recognizes that change at the microsystem-level begins with changes at the macrosystem level.

Limitations

One limitation of this program evaluation was the inability to obtain the KBMA Optimization Committee minutes and agendas from January through May and again from September through December. As a result it was difficult to accurately track all problems, particularly those initially identified at the beginning of the KBMA implementation process, and later, issues were being addressed in Phase 2 and 3. Follow up conversations did take place with several KBMA committee members to help answer questions; however there would be more confidence in the results had the minutes been available.

A second limitation occurred when the evaluator was hand coding the 10, 974 free text reasons. When a free text reason potentially fit more then one category, a judgment was made for the category reason assignment. This could have resulted in bias, potentially; another evaluator to provide inter-rater reliability would have been preferred.

Finally, it is possible that the 21 free text override domains could have been further combined. However, recommendations were made to the KBMA Optimization Committee for reexamining these domains.

Recommendations

It is important for organizational leaders and key stakeholders to acknowledge BCMA workarounds and understand the processes that result in such workarounds. Efforts to address KBMA workarounds should systematically investigate processes through the lens of the SEIPS framework. Once identified leaders can then address each type, determine the causes, and working with the interdisciplinary team, identify and implement solutions to avoid incidence of such workarounds.

The nurse manager for nursing systems and support should continue to monitor and report KBMA Override Reason tracking reports on a quarterly basis to the KBMA Optimization Committee. With the potential for MU compliance percentages to increase within the next few years, such review of reports allows key stakeholders the opportunity to provide ongoing updates and reminders of KBMA policies.

If the Barcode Damaged/Unreadable domain remains a primary problem, investigating a change to a 2-D barcode for the medication packages is worthy. Currently, the hospital uses linear barcodes. 2-D barcodes offer an alternative solution to the linear barcode design which pharmacy currently uses. It has been identified that nurses will often not take the time to straighten linear barcodes, thus 2-D barcodes have potential to reduce these workarounds.

Implications for Practice

A number of important implications for nursing practice arise from the findings of this program evaluation. This evaluation has yielded information that supports the growing body of evidence related to nurse workarounds when using BCMA systems. It is important for organizational leaders and key stakeholders to recognize the barriers nurses encounter while using BCMA systems in an effort to promote safer and more efficient patient care. Nurses should be encouraged to report BCMA workarounds to better enable patient safety and the ongoing pursuit of practical solutions to emerging issues. Technology in itself is not sufficient to prevent medication administration errors. Technological patient safety protocols, processes, and procedures must be regularly revisited and revised to ensure that BCMA systems are being used correctly. Understanding the design and implementation of a work system can improve patient safety, as it requires assessments of specific aspects of the work system in conjunction of work

system interactions. These system interactions should be recognized as core attributes when trying to find resolutions to quality improvement program implementation problems.

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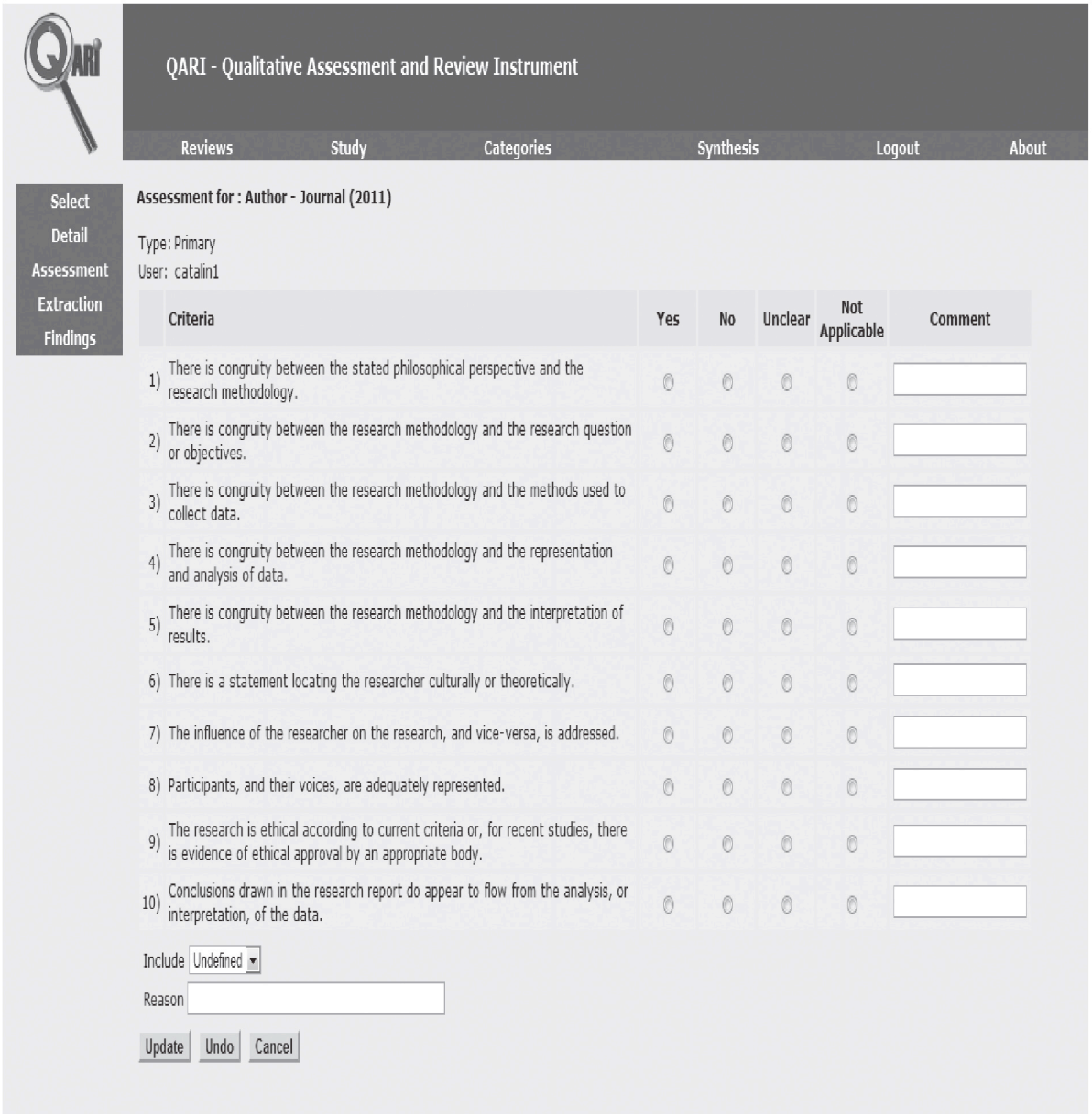
Appendix A

Author(s) of study being extracted	Study Setting	Workaround type	Quality Assessment Score	Data analysis	Results	Recommendations
Miller, Fortier, & Garrison	Medical University of South Carolina Medical Center, Medical surgical units	Omission of process step (N=30) Performance of unauthorized step (N=258) Performance of steps in improper sequence (N=156)	9	Retrospective-mediation scanning reports 1/1/2008-11/30/2008 Observation of nurses	Observation revealed a median of 3 clinician workarounds per administration Clinician override reason alerts were documented in 23% of administrations	Workflow processes must be continually analyzed and restructured to yield the intended full benefits of BCMA technology
Yang, Ng, Kankanhalli, & Yip	900 bed hospital	Technology related (N=11) Task related (N=7) Organizational related (N=9)	9	Interviews Training sessions Triangulation	Workarounds that appear after BCMA implementation may lower the efficiency and effectiveness of these systems	It is essential for management to formulate regular audits or review of systems for delivering quality healthcare services.
Rack, Dudjak, & Wolf	765 bed academic medical center	Omission of process steps (N=76) Steps performed out of sequence (N=124) Unauthorized BCMA process (N=43) Technology (N=16)	8	Survey Focus groups	More than half of the nurses surveyed indicated that they administered medications without scanning the patient or medications during last shift worked.	Hospital leaders should ensure that vendors design systems that enhance nurse efficiency and do not compromise nurse workflow.

Appendix B

APPENDIX C



Elizabeth & Pam,

The purpose of this email is in writing to close the loop on this study. In the telephone conversation last week involving Pam, Neil, and me, we agreed that this application will be withdrawn from further consideration by the UNH IRB as the activity is quality improvement, not research.

Thank you.

Julie

Julie F. Simpson, Ph.D.

Director, Research Integrity Services

Affiliate Assistant Professor of College Teaching

University of New Hampshire

Service Building, Room 103

51 College Road

Durham, NH 03824-3585

Phone: 603/862-2003 * Fax: 603/862-3564

Email: julie.simpson@unh.edu

Visit the UNH Research Blog: http://www.unh.edu/research/blog

Appendix D

KBMA Readiness Assessment Results

eMAR		
Pre-Visit Questions	**Assessment**	**Post KBMA Implementation**
Outline how your organization is currently using the eMAR for medication documentation.	The following care units at CMC use the eMAR: RMU, Mom's Place, Special Care Nursery, E100, E200, D100, D200, C100, ICU, PACU. This includes all medication administration documentation including medications given as an override. It is not used in the ED.	No change.
Describe how your organization uses bedside devices in the medication administration process.	Nurses and respiratory care practitioners utilize a combination of rolling carts and devices that are hardwired in the patient rooms. Due to the freezing, latency, and loss of connection problems, staff members have begun to develop the habit of documenting medication administration at the Nurses' Station rather than at the patient's bedside. This is a serious safety concern. The nurses and respiratory care practitioners cannot perform the required 2-identifier checks without logging on to a device at the patient's bedside. For the fixed devices in the patient's rooms, the two major problems are: devices being unplugged due to the lack of adequate outlets in the rooms (in many cases, the patient or visitor unplugs the CMC computer to plug in their own personal computer), and either the patient's body or another piece of equipment is obstructing access to the fixed device. A frequent complaint with the rolling carts has been the slowness of their performance. Staff members report that the rolling carts are significantly slower and less reliable than the fixed devices at the Nurse's Station. Special Care Nursery (SCN) has one rolling cart in their stabilization room. There are no rolling carts in the nursery.	New computers and computer on wheels were purchased. Connectivity issues were resolved.

Is your current device selection meeting your needs? Do you anticipate additional device purchases?	We need to explore rolling carts that take up less space, have faster performance, do not experience a loss of connection, and do not freeze. It may also be time to reevaluate other portable devices that could meet the need of bedside access for medication administration 2-identifier checks and all other aspects of safe bedside medication administration.	New computer on wheels were purchased.
Describe the current level of electronic clinical documentation for your organization.	Nurses, nursing assistants, respiratory care providers, dietitians, speech language pathologists, occupational therapists, physical therapists, pastoral care, IV therapists, social workers, and RN case managers record 99% of all clinical documentation in our EMR (Sunrise). Radiology nurses, preadmission testing (PAT) nurses, and admission nurses complete the patient profile and historical medications.	No change.
Is the eMAR currently used in any location where the pharmacy does NOT verify orders? If so, please describe the workflow and your plans for use of KBMA in these areas.	The Pharmacy is not open from 11:00 pm until 7:00 am. For this reason, medications cannot be verified during this period of time. As a safety mechanism, nurses confirm appropriate medication, dose and indication with a second nurse when override meds need to be administered. The name of the verifying nurse I entered on the medication administration form and displays on the verifying nurse's Signature Manager. Within the limits of out override policy, medications can be administered without pharmacy verification.	Pharmacy is open and staffed 24/7.
Is the eMAR currently used in any location where the visit number may change during the patient's stay?	When the patient is in an outpatient status, and is later converted to an inpatient or OIB status, it is possible for their account number to change. For this reason, we currently do not allow orders to be entered on any patient prior to the patient actually being placed in a bed on a patient care unit.	No change.
Are flushes documented on the eMAR?	Flushes are not documented on the eMAR. Nurses do have flexibility to add flushes as reminder tasks.	No change.

Are patch removals documented on the eMAR? If yes, describe the process.	Lidoderm patches are built as an order set with tasks for both the application and removal of the patch. We need to ensure that this type of order set has been built for each medication that has the transdermal patch route.	Order sets were built to ensure application and removal of transdermal patches.
Nursing		
Are all medications brought to the bedside in unit dose packaging? If not, please describe the medication and associated process.	No, Insulin doses are drawn up and double-checked while the nurses are still in the medication room. (See insulin preparation and administration description below). Insulin requires a co-signature. Some oral liquids such as Vancomycin come in a bottle from which the nurse pours the prescribed dose. Silver nitrate sticks come in a container with several sticks that are not unit dose.	No change.
Are ½ tabs administered? If yes, how/where are they prepared?	Half and even quarter tabs may need to be administered. There is no information in the body of the order or in the Instructions section guiding the nurse to administer a half or quarter tablet. The nurse is expected to calculate when a half or quarter tablet is needed as the dose to be administered. The organization has adopted a new policy that when a newly ordered medication requires more than three pills to give the prescribed dose, the nurse is required to check the calculation with the peer and note whether the pharmacist has included a message in the dispensing instructions section of the task description that confirms the number of pills/tablets required.	
Are there any medications that require a co-signature? If yes, for what meds? Describe the process.	Our policy is to have high-risk medications require a co-signature. This co-signature creates a flag and displays on the nurse's signature manager. Our high-risk medications include: Heparin, Insulin< Chemotherapy, and medications administered via the epidural, intrathecal, and PCA routes of administration. Epidural and PCA solutions and pump settings must be double-checked by the nurses, and a co-signature is required.	No change.

Describe the process for administering insulin. • How is it dispensed? • Where is it prepared?	The various types of insulin are available in vials in the medication refrigerator in the medication rooms on the inpatient care units. The nurse logs onto the medication room computer, pulls up the patient's eMAR, reads the type of insulin to be administered, calculates the amount of physiologic insulin to be administered, goes to the refrigerator, obtains the correct vial that is not patient specific, and withdrawals the correct number of ordered units. At this point, the insulin calculations, correct type of insulin, and the number of units they observe to be in the syringe are all verified by a second nurse. No information is given to the second nurse. In many cases, for the sake of convenience, the verifying nurse is given the patient's CBG result and the number of carbohydrates ingested. Some verifying nurses will check the most recent CBG result themselves. The verifying nurse is required to calculate the dose from the information on the eMAR, and then handed the vial and syringe for their confirmation that the correct type of insulin is being given and the correct dose has been calculated in the syringe. The vial of insulin is then returned to the refrigerator. There is some variation, as some nurse will start their documentation on the Diabetes Flowsheet in the medication room.	No change.
When do nurses document medication administration? • At the bedside? • Workstation in hall? • Workstation at nursing desk? • Other?	Due to recent system performance issues, both the nurse and respiratory care practitioners are less consistent in documenting medication administration at the patient's bedside. The reason staff members cite for not documenting medication administration at the bedside include: fixed device not plugged in, fixed device not working, lack of availability of a rolling cart, rolling carts are slow, the rolling cart losses internet connection, and the image freezes on the screen of the rolling carts. In these instances staff members state that they do not have time to go find another cart, plug it in, or explore what is wrong with the cart/fixed device, and then login and/or reboot the device.	All medications are administered at the bedside.

Describe the process when a medication is administered from a bulk container: • Ointment/creams from tubes or jars • Eye drops from bottles • One dose from large/stock bottle • Other?	There are limited numbers of medications that are administered from a bulk container. These medications include spirits of peppermint and hurricane spray. The pharmacy compounds several products including: Butt Balm, Vancomycin and Gentamicin eye drops for the newborns, and Magic Mouthwash.	No change.
Does your organization use standard administration times? For all clinical areas?	Yes we use and have a policy for standard administration times. There are exceptions to standard medication administration times. For example, the first dose of an antibiotic will be given within two hours of the time of the order. Subsequent doses will automatically be scheduled based on the time the first dose is marked as done and the frequency. SCIP postoperative antibiotics and postpartum antibiotics will be administered based on the administration time of the last dose in the OR. Enoxaparin (Lovenox) and Fondapariux (Atrixtra) will be scheduled based of the administration time of the first dose. We employ the 50% rule. The 50% rule refers to half of the length of time between doses. When less than 50% of the scheduled interval has passed, the medication may be administered to the patient and the next dose will be administered according to the standard medication administration times. When greater than 50% of the interval has passed, the medication should not be administered until the next scheduled standard medication administration time. Exception to the 50% rule for IV antibiotics: when less than 50% of the scheduled interval has passed, the IV antibiotics may be administered to the patient in the next dose will be administered to the standard medication administration times. When greater than the 50% of the medication interval has passed, the IV antibiotics may be administered to the patient, then reschedule subsequent doses.	No change.

Is there a defined process for changing standard administration times? If so, please describe.	As described above with the 50% rule.	No change.
How are physician administered medication documented?	Providers do not have access to the eMAR. If a provider administers a medication, the nurse marks the medication as done by other, inserts the providers name in the order form, which automatically goes to the provider's signature manager for signing.	No change.
Are there any other projects ongoing that may interfere from nursing staff availability during implementation of KBMA?	While there are numerous other projects that will be competing with the KBMA implementation, staff understands the seriousness of this project and will be required to attend 2 to 3 hours of required education. Education must be completed in order to administer medications in KBMA.	NA
Staffing and Hours		
Is the pharmacy open 24 hours? If no, what are the pharmacy hours?	Not currently but should be by the time KBMA is implemented. 7:00 am to 11:00 pm	Pharmacy is open and staffed 24/7.
Are the pharmacists on the nursing units? If yes, do pharmacists enter/verify orders from the floors?	Only two Pharmacists cover the hospital Monday thru Friday from 7:00 am to 3:30 pm. They do verify orders while on the floor.	Pharmacy is open and staffed 24/7.
Do you outsource any of your pharmacy services? If yes, Please describe in detail functions that are outsourced. If yes, are you	Yes High volume IVPB and Drips (Vancomycin, Cefazolin 2gm, Phenylephrine 100mg/250NS, Norepinephrine and Dexmedtomidine. Some of the out sourced products will be needed to	No change No change.

planning for clinicians to use outsourced barcode labels or pharmacy generated bar code labels?	use the Barcode on the item, as they are floor stock items. Others such as some of the IVPB will be dispensed from the pharmacy with a specific label with a barcode.	
Is there a pharmacy staff member dedicated to pharmacy information systems maintenance and implementation?	Yes	No Change
Is there a pharmacy staff member dedicated to pharmacy purchasing?	Yes	No Change
Pharmacy Implementation Team		
Will there be a person (s) responsible for	Yes	No change.

process redesign within the pharmacy? Who will be responsible for system maintenance, i.e. formulary, new item configuration? Who will be responsible for barcode maintenance for KBMA?	Pierre LaBrie Pierre LaBrie	

Are there any other projects ongoing that may deter from staff availability during implementation of KBMA?	No	NA
Floor stock/Automatic Dispensing Machine		
Is the automated dispensing system a profile system?	Yes	No change.
Can the nurse obtain medications without pharmacy entering the order first? If yes, is this an override function?	Yes Yes	No change.
Are there floor stock medications on the floor that are not stocked in the automated dispensing machine?	Yes but very limited	No change.

Are there floor stock medication/IV fluids stocked by other departments, i.e. central supply? If yes, what are they?	Yes All plain IV fluids, Heparin and NS flushes.	No change.
Are the items stocked in the automated dispensing machine and on the floor as floor stock recognized as such by the pharmacy information system during order entry? If yes, how is this maintained?	Yes The Clinical System Analyst has this responsibility by updating SMM.	No change.
Compounding System		
In the case of items such as TPN, does the order entry of these compounds occur within the compounding system, the pharmacy order entry system or both?	Both	No change.

How are the labels for these items generated and do they contain a bar code?	The labels are produced through the compounding system (Abacus Software), which contains a bar code. There is also a label produced from Sunrise that has a bar code.	No change.
Repackager		
What system(s) do you currently use to repackage? Manual? Automated? Please specify repackage method for each dosage form.	Both Manual and Automated Manual for all liquid products and syringes. Automated for any oral tablets and capsules.	No change.
What percentage of your total medication volume is repackaged?	Less than 1%	No change.
What percentage of your liquid medication volume is repackaged?	Less than 20%	No change.
What percentage of this volume is repackaged for pediatrics?	90%	No change.
What percentage of this volume are adult medications?	10%	No change.

Is the pharmacy's repackager currently able to generate bar codes on packages? If yes, can it generate these bar codes for all package types?	No. Barbara Case is in the process of looking at newer repackagers and software that will have the abilities to generate a bar code. . Yes, for the new repackager.	New software and repackager were purchased.
Purchasing of Bar Coded Medications		
What percentage of medications is currently purchased that is bar coded by the manufacturer?	98%	No change.
Is there currently an opportunity to use a company or wholesaler to repackage and/or bar code medications? If yes, would this be an option for your organization?	CMC is currently using a company that repackages out high volume oral medications that are bought in bulk. The packages that we receive have bar codes on them.	No change.

Labeling		
Does the pharmacy system currently allow for bar codes to be printed on the IV Fluid/IV Piggyback labels?	Yes	No change.
Do your current medication labels contain a bar code? If not, is there room on the label for a bar code?	Yes	No change.
Formulary/Floor stock/Frequency/Route Code Maintenance		
How many medication formulary items are in the pharmacy system?	1800	Unable to obtain.
What type of non-medication formulary items currently generates tasks on the eMAR?	RN INR Check, Medication Verification Order, Vaccine Assessments.	No change.
What is your current process for maintaining formulary items in the pharmacy system after a new item is purchased?	The new item that is brought in by the buyer gives the information to the Clinical system Analyst to update SMM.	No change.

If an item on contract is not available, is another brand purchased?	Yes	No change.
Are you up to date on your Multum updates? If not, when was the last update run?	Yes	No change.
If a patient is discharged, are all the medication orders automatically discontinued? Is there a delay (please specify)?	All medications are discontinued after 1 hour in Sunrise by the system.	No change.
If the patient's discharge is canceled, is the pharmacy required to reenter all the medication orders?	Only if it is past the 1 hour time frame.	No change.

Medication Order Flow		
Are any medication orders entered by the pharmacy department? If yes, what types of orders are entered, i.e. chemo, TPN, one-time orders, etc.?	Yes Some providers are currently on paper, TPN, Chemo, and CPOE TORB given to a pharmacist.	No change.
When a patient is transferred, do all orders get discontinued and then new orders are entered or do the existing orders remain on profile and only new orders entered and non-reordered meds DC'D?	Existing orders remain on the profile and only new orders entered and non-reordered meds discontinued.	No change.
How are time changes for medications handled?	By Nursing.	No change.
Are there any other projects ongoing that may deter from pharmacy staff availability during the implementation of KBMA?	No.	NA

Test Environment		
Can test patients be entered into the live pharmacy system?	We have a TEST environment. There are TEST patients in PROD but they have no eMAR.	NA
Is the test environment and the live system completely synchronized? If no, when was the last synchronization?	SCM - Yes SMM – No New TEST will be made prior to KBMA testing in 6.1	NA