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An Analysis of Missing Medication Documentation, Processes, and Procedures at the Veterans Hospital (VA Boston Healthcare System - West Roxbury Campus)

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Abstract

Missing medication reports are filed when a nurse cannot locate a medication that should be administered, impacting efficiency and possibly patient safety. At the Veterans Affairs Boston Healthcare System, West Roxbury campus, 2.83% of all administered medications have consistently been associated with missing medication reports. The project team characterized the extent of missing medications, observed medication delivery workflows to identify root causes, and developed recommendations that address new order delivery times, cross-training, and the procedure for filing missing medication reports.

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Kenneth observed on the nursing floors and aided in developing missing medication workflows. Kenneth also performed data analyses of pharmacy finishing times and led a study evaluating missing medications associated with new orders. Additionally, Kenneth was responsible for validating several workflows.

Keith Bishop

Keith was one of the two members responsible for observing on the nursing floors. Through these observations, Keith contributed to structuring the medication pass and missing medication workflows. In addition to this, Keith analyzed the relationship between ward stock items and missing medications.

Anthony Corbo

Anthony served as the main liaison between the IQP group and the pharmacy supervisor and service operations manager. Anthony also observed in the pharmacy and performed an analysis of TUG delivery data and reports of medications dispensed.

Keeon Tabrizi

Keeon observed in the pharmacy and was primarily responsible for the data analyses of the raw data reports and their associated statistical analyses. Additionally, Keeon generated most of the figures including the graphs and workflows presented in the paper. In terms of root causes Keeon largely investigated human based error.

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Chapter 1: Introduction

At the Veterans Affairs (VA) Boston Healthcare System, West Roxbury Campus, a missing medication report is submitted by a nurse when he/she is seeking to administer a medication to a patient and it is not available. This might occur because an incorrect medication is delivered by the pharmacy for that patient, a specific medication for a patient cannot be located, or a new medication order has not been delivered by the pharmacy within an allotted period of time. Missing medication reports have been consistently high, with approximately 650 reports filed per week, representing 2.83% of all orders. This significantly reduces the efficiency of the medical and pharmacy staffs by redirecting a nurse's attention and adding unnecessary orders which need to be filled in the pharmacy. Consequences of missing medication reports primarily include increased processing times for the pharmacy, as they rework orders, and decreased availability of the nursing staff for patient interaction at the bedside as they search for medications and follow up on reports. As a result, the goal of this project was to comprehensively analyze current processes to identify key problems in medication delivery and documentation that lead to missing medication reports.

Missing medications significantly reduce the efficiency of the medical and pharmacy staff at the Veterans Hospital. Missing medications diminish patient quality care due to the interruption of nursing availability and decreased nurse-patient interaction. This is supported by a growing body of literature addressing the importance of nurse availability and patient interaction to overall patient quality care. Because missing medication reports have been consistently high at the West Roxbury campus, it is a focus area for national VA initiatives such as Transforming Care at the Bedside (TCAB) and the efforts of the New England Health Care Engineering Partnership (NEHCEP). In coordination with the efforts of these organizations we sought to characterize the impact that missing medications have had on the West Roxbury campus.

The goal of this project was to identify and explore root causes of missing medication reports by evaluating current medication delivery and documentation processes. Our methodology involved four main steps. First, we assessed the scope of the missing medication problem by studying historical data to identify the percentage of medications reported as missing and what specific medications were commonly reported as missing. Next, we observed and analyzed workflows related to medication delivery. The third step involved examining several root causes, followed by investigating potential solutions in more detail, specifially an examination of the time to fill a new order, returned medications, and workflows variations. Finally, we developed three types of conclusions: areas that should be evaluated in future studies, short-term recommendations, and long-term recommendations.

This project fulfills the Interactive Qualifying Project (IQP) requirement for Worcester Polytechnic Institute (WPI), which is defined as a project that "challenges students to address a problem that lies at the intersection of science or technology with social issues and human needs". Our project directly addresses this intersection by examining how the technologies and processes in place at the VA relate to missing medications, and how this problem is ultimately a concern for patients as well as the individuals involved in their care.[1]

In this project report, relevant background information related to missing medications and associated technologies is provided in Chapter 2. The methodology is outlined in Chapter 3. Results and analyses about missing medications are presented in Chapter 4, and conclusions are presented in Chapter 5.

Chapter 2: Background

We examined the national concern of patient care and how it is impacted by technology. Specifically, we researched the role that technology plays in the area of missing medications. In this chapter, we provide a summary of the VA's participation in the Transforming Care at the Bedside (TCAB) initiative, and the relationship between missing medications and nurse-patient interactions. Later in the chapter, we explain the electronic medical administration system, in the form of Barcode Medication Administration (BMCA), used at the West Roxbury campus, and the role it plays in the subject of missing medications.   Finally, a short literature review on process mapping and analysis is provided.

Transforming Care at the Bedside

The Institute for Healthcare Improvement (IHI's) initiative known as Transforming Care at the Bedside (TCAB) defines a number of new standards for health care procedures and organization. These standards address communication, interpersonal, and interdepartmental issues encountered in American hospitals and health care facilities, including those associated with the Department of Veterans Affairs.[2]

In 2003, the Institute of Medicine (IOM) released a report that identified a number of recommended aims for American health care. These were intended to make health care more "safe, effective, patient centered, timely, efficient, and equitable".[3] This report, which ultimately became the foundation for the TCAB program, was released in order to help national health care organizations cater to a growing American population that is becoming older every year. Furthermore, a number of issues arose because at the time of the report's release, the

United States was experiencing one of the worst nursing shortages in recent history. Therefore, the TCAB program is ultimately targeted toward improving patient care and nurse retention.[4]

Issues associated with missing medications are directly applicable to TCAB's efforts to provide greater nurse-patient interaction time. In an effort to administer medications to patients in a timely and effective manner, nurses file missing medication reports. These reports notify the pharmacy about lost doses or incorrect doses, often due to unnecessary errors and miscommunications between the nursing and pharmacy staffs. The added efforts of filing and monitoring these reports several times a day take nurses away from their patients. This is crucial as nurses are the primary members of the hospital staff who are "close to the patient every hour of the day with the ability to provide continuous professional supervision".[5] This "professional supervision" assures maximized patient care and safety. Several studies have shown that increased nurse availability significantly improves patient safety and quality of care. In one study, increased nursing hours and accessibility were associated with shorter patient stays, and lower rates of infection, bleeding, pneumonia, shock, cardiac arrest, and death.[6] A similar study showed that implementing TCAB, and the resultant increase in nurse retention and availability, yielded a 45% decrease in patient falls, a 30% decrease in cardiac arrests, and a 25% decrease in readmissions.[7] It is evident through the review of these studies that increased staffing and nurse availability has a significant impact on improved patient care.

Overview of the Medication Administration Process in West Roxbury

The medication administration process requires the input of multiple individuals, beginning with the physician who files the original order. After a patient consultation, a physician places an order through the VistA Computerized Patient Record System (CPRS). This order is then sent to the pharmacy where it is finished by a pharmacist. For an order to be considered finished it must be: verified to the patient, checked against patient medical records (to ensure the patient is not allergic to a medication), made BCMA software compatible, and printed. Once printed, the order can then be filled by a technician and sent to its intended ward by one of many possible delivery methods. With the medication on the floor, the nurse then must confirm the medication to the patient by scanning the attached label in the BCMA computer system. Once confirmed, the medication can then be administered.

Medication orders are separated into two types: Continuous and New orders. Continuous orders are those which are regularly administered to patients. These medications are stocked by the pharmacy and are stored in the daily carts for the nurses to administer throughout the day. A new order is a first time medication, which after a patient consultation is requested by a physician. These medications follow the standard finishing process and are then sent to the floor.

Electronic Medication Administration Systems

The West Roxbury campus implements an electronic medication administration system in the form of the VistA Barcode Medication Administration, or BMCA, computer program. To identify the patient, the nurse logs into the BCMA software and scans a bar code of the patient's identification (ID) number on their wristband. The computer then displays the medications that are "Due," based on the time the wristband was scanned in relation to medication administration times and information that is in the patient's active electronic record (**Figure 1**).[8]

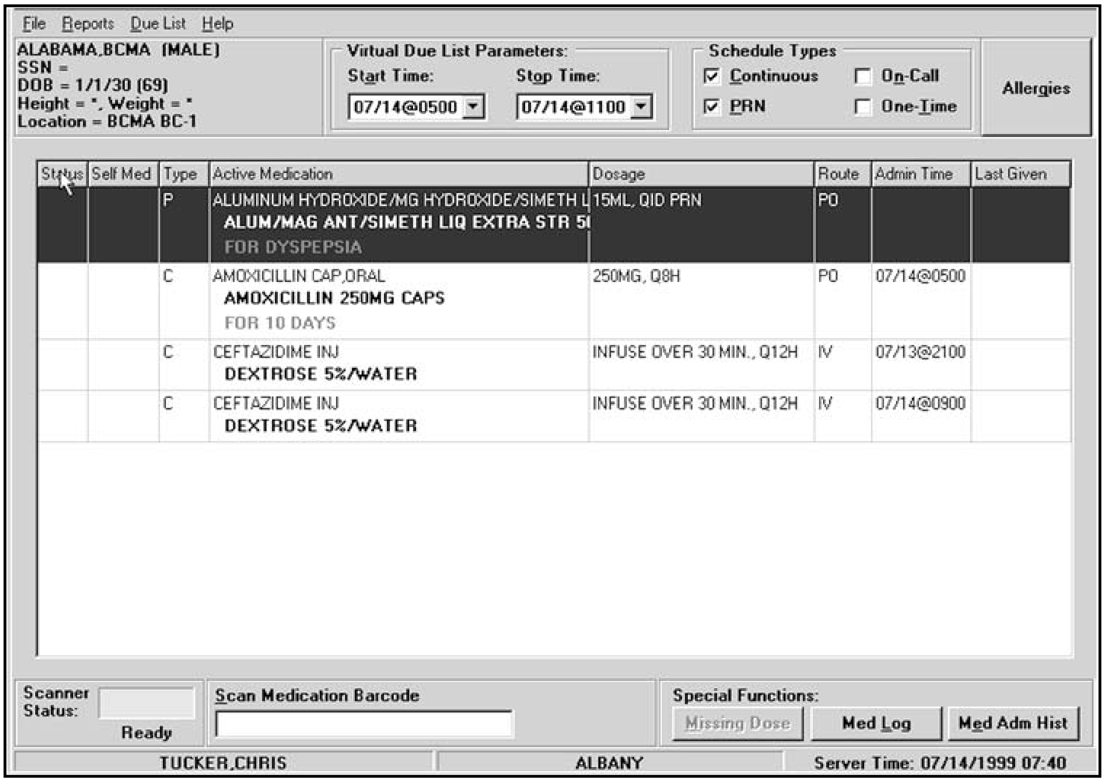

Figure 1: BCMA 'Due' List

Next the bar code of each medication is scanned. If the information about the medication order matches the displayed information, the system automatically records the medication as administered by the nurse at the time of scanning. The scanning of bar coded wristbands is intended to reduce the risk of patients receiving medications not due for the patient. Scanning each medication barcode is intended to verify that the medication, dose, route, and administration time match what was ordered by the physician.

Medication errors are a serious threat to public health. According to the IOM, between 44,000 and 98,000 Americans die annually due to medical mistakes.[9] As part of its ongoing efforts to improve patient safety, the U.S. Food and Drug Administration (FDA) ruled on April 4, 2004, to make barcodes mandatory on the labels of human medications and biological products by the year 2006.[10] As the use of medication barcode technology grows, the health care institutions will need to be mindful of related errors which could ensue with the usage of an electronic monitoring system.

In a 2002 publication entitled, *Improving Patient Safety by Identifying Side Effects from Introducing Bar Coding in Medication Administration*, correlations between medication errors and usage of the BCMA software were analyzed in three unidentified VA hospitals.[11] The publication cites a Harvard Medical Study which found that 19% of medical errors were related to medications, a finding supported by a study of adverse events during hospitalization.[12,13] The process for medication administration used by the hospitals which were studied, were very similar to that of the West Roxbury campus in that they used a system requiring coordination between the physicians who ordered the medications, the pharmacy that finished orders and delivered the medications, and nursing staffs which administered medications to the patients. The report analyzed 334 medication errors from 11 wards, 39% of the problems were found to occur during physician ordering, 12% during transcription and verification, 11% during pharmacy dispensing, and 38% during nursing administration.[14]

After a qualitative analysis of the BCMA software the authors of the 2002 study identified five negative consequences to its usage: (1) nurses confused by automated removal of medications by BCMA, (2) degraded coordination between nurses and physicians, (3) nurses dropping activities to reduce workload during busy periods, (4) increased prioritization of monitored activities during goal conflicts, and (5) decreased ability to deviate from routine sequences.[15]

A side effect of replacing the paper medication administration record (MAR) with BCMA was that the relationship between nurses and physicians was degraded. During the observations, numerous coordination breakdowns occurred between nurses and physicians, some of which might not have occurred with the previous paper-based system. Prior to BCMA, physicians had access to the bedside during medication administration and nurses had immediate access to information about pending and discontinued orders on their paper MAR. Degraded coordination between nurses and physicians can lead to dangerous procedural errors including: failing to detect invalid missing medication reports, failing to renew automatically discontinued medications, failing to prioritize 'stat' medication order over other activities, or failing to explain why laboratory values are unusually high or low for an at-risk patient. Since the BCMA does not require nearly as much nurse-physician interaction any communication errors have a more direct impact on the patient.[16]

The study also found that since the installation of the BCMA software nurses have to abandon certain activities in order to reduce their daily workload. At all three of the hospitals studied, nurses were observed to use strategies to increase efficiency which often evaded the intended use of the BCMA. For example, nurses were observed typing in some of the patients ID number, rather than struggling with the scanning process. When the MAR system was used, nurses felt that there were fewer deviations from routine actions. During this study, nurses uniformly believed that typing a 7-digit ID number took far less time than wheeling a medication cart into a room and scanning the wristband. Finally, several nurses expressed concern that other nurses or physicians would log them out of BCMA if they left the computer console for too long.[17]

Computerized systems, such as BCMA, are often effective at streamlining routine operations, making the system more efficient at anticipating others' actions and detecting errors. A frequent tradeoff from streamlining routine operations is that non-routine sequences of activity become more difficult to perform. The 2002 study cites the example of a taper dose, that prior to

BCMA a physician could enter a description in a text box at the bottom of a single order (e.g., prednisone taper: start at 60 mg decrease 10 milligrams every other day until at 10 mg, then decrease to 5 mg for 2 days). Prior to BCMA, one pharmacist estimated that he would verify a taper dose order in less than 1 minute and pass the note onto the nursing personnel. After the introduction of BCMA, a pharmacist, in order to create the order in a scanning format, was observed to take 17 minutes to break a taper dose order into daily orders at the exact dose, a total of 14 new orders, and discontinue the original order.[18] Although a taper order is a specific example of an issue that can be resolved through software enhancements, it illustrates the decreased flexibility when machine algorithms imitate human actions, because the language used in communicating with a machine is restricted. When the format is not well known to the practitioner, decreased flexibility might lead to the reduced ability to communicate and detect erroneous actions, such as missing medications.

One of the more beneficial features of the BCMA software is the ability to submit a missing medication report. A nurse initiates the missing medication report window and, using automated printouts, the software informs the pharmacy of drugs missing from the 'Due' list (**Figure 2**). The pharmacy then evaluates each request and sends the appropriate dose to the unit or ward during the scheduled medication drops. As identified before, medication errors are detrimental to patient safety. Through software such as BCMA, there can be a greater level of insurance that each patient is receiving their appropriate medication. In hopes of further ensuring patient safety the hospital has examined the application of the Omnicell, an automated dispensing system capable of storing over 200 medications. Omnicell systems aid in the prevention of medication errors, promoting improved workflows, and improving patient care. The product's ability to be customized allows for placement on any ward and once integrated into the BCMA software, the supply management software can improve nursing and pharmacy efficiency as well as augment patient safety.

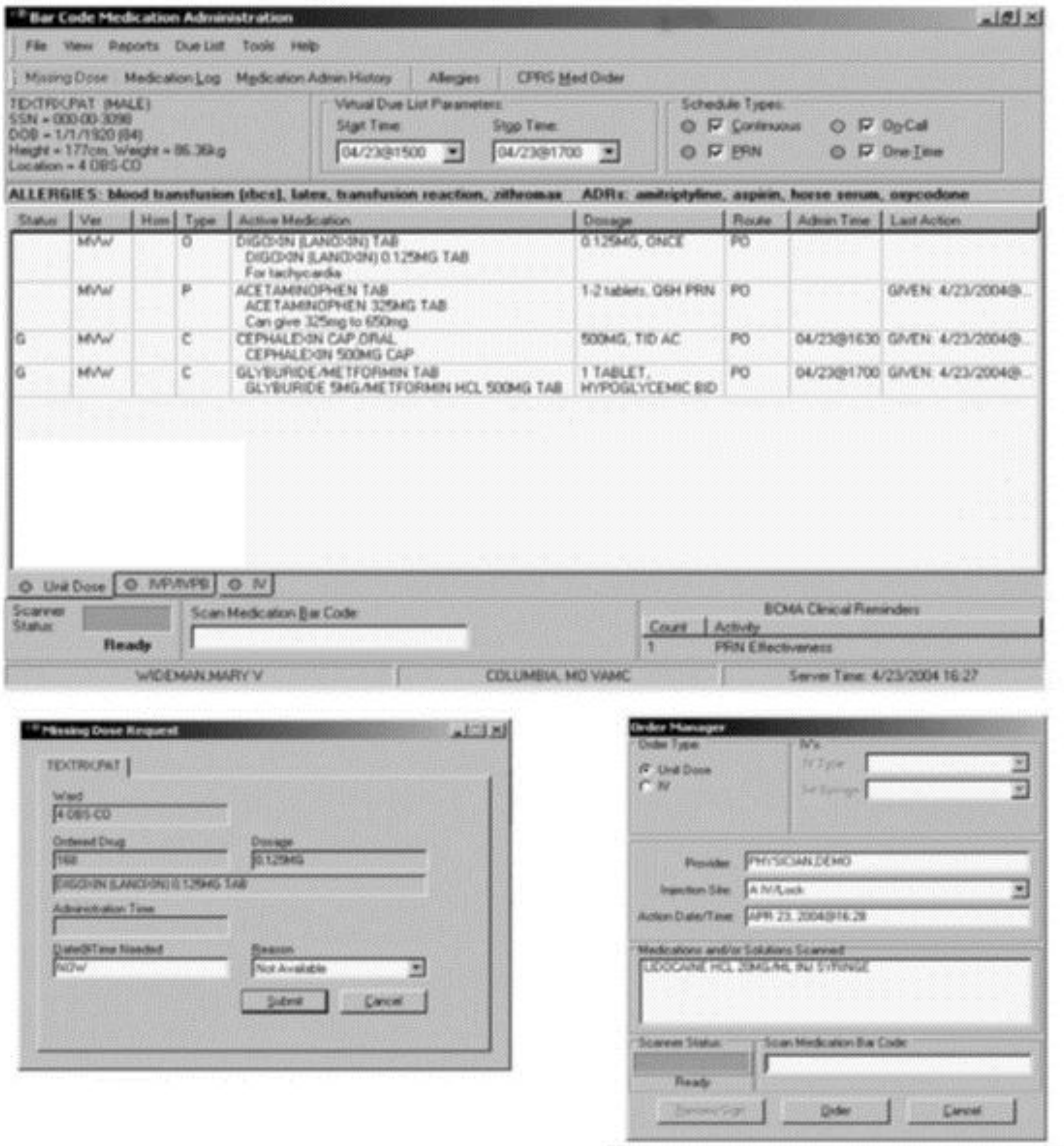

Figure 2: BCMA 'Due List' and Missing Medication Prompt

Process Analysis and Improvement Techniques

Process mapping refers to activities involved in visually defining a specific practice in terms of who is responsible, how a standard a process should be completed and how the success of a current process can be determined. Once this is done, elements which need to be improved are revealed allowing businesses to initiate further process improvement methods. The first structured method for documenting a process is the flow process chart. A flowchart is a common type of diagram that represents an algorithm which shows individual steps as various kinds of boxes, and their order through the connection of arrows. This diagrammatic representation can lead to a step-by-step solution to a given problem through observations and collected data these boxes. Flowcharts are used in analyzing, designing, documenting a process which in turn helps identify areas of a process that need to be improved upon.[19]

After the development of flowcharts, additional tools such as a root cause analysis (RCA) can be applied. RCA is a class of problem solving methods aimed at identifying the root causes of problems or events, or the underlying reasons for why they occur. The practice of RCA is predicated on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms. By directing corrective measures at root causes, it is hoped that the likelihood of problem recurrence will be minimized. However, it is recognized that complete prevention of recurrence by a single intervention is not always possible. Thus, RCA is often considered to be an iterative process, and is frequently viewed as a tool of continuous improvement. Root cause analysis is not a single, sharply defined methodology; there are many different tools, processes, and philosophies of RCA in existence. However, most of these can be classed into five, very-broadly defined "schools" that are named here by their basic fields of origin: safety-based, production-based, process-based, failure-based, and systems-based.[20]

RCA forms the most critical part of successful corrective action, because it directs the corrective action at the heart of the problem. The root cause is secondary to the goal of prevention, but without knowing the root cause, we cannot determine what an effective corrective action for the defined problem will be. In order to reveal the root causes in this project, we followed the method suggested by the Project Management Hut website:[21]

- Define the problem.
- Gather data/evidence.
- Ask why and identify the true root cause associated with the defined problem.
- Identify corrective action(s) that will prevent recurrence of the problem
- Identify effective solutions that prevent recurrence

Through an understanding of RCA and the application of flowcharts, we were able to determine the stages of the medication delivery process that have greatest impact on missing medications.

The New England Health Care Engineering Partnership (NEHCEP) is involved in implementing both short and long term solutions to issues raised as part of the TCAB initiative in VA hospitals. Short term solutions are commonly proposed and discussed in a series of presentation and forum-based meetings known as Rapid Process Improvement Workshops (RPIW).[22]

Hospital employees from all departments attend these three to five day workshops and utilize the 'Lean' improvement methodology to identify the 'valuable' components of healthcare in the VA and eliminate the 'wasteful' components. Improvements are generated by evaluating current processes and eliminating operational barriers and components prone to failure. The solutions that result from the Lean evaluations of the VA's procedures are employed and assessed for ninety days in a 'microsystem' of the hospital, such as the pharmacy or a single ward. This allows the VA to see immediate, real-time results from the RPIW, allowing the VERC to measure the effectiveness of the implemented changes. This testing and evaluation process will ultimately lead to effective long term modifications to the VA's procedures.[23]

The RPIWs provide an efficient structure for NEHCEP and hospital staff to redevelop the VA's healthcare procedures and to meet the standards established by TCAB, therefore capitalizing on nurse-patient interactions and maximizing the quality of patient care. By actively engaging the frontline end-users of patient care to discuss and develop realistic, testable solutions of the hospital's issues, RPIW efforts are expected to be a very promising means for implementing TCAB efforts. The results of this project will be used as input to an RPIW on missing medications that NEHCEP is sponsoring, which will occur after the project is complete.

Chapter 3: Methodology

The goal of this project was to identify and explore root causes of missing medication reports by comprehensively evaluating current medication delivery and documentation processes. To maximize our efforts, we separated the team into two groups. Two team members worked specifically with the pharmacy, while the other two were split between two of the nursing floors, AG and A1. By dividing into the two groups, we were able to document the approaches taken by the pharmacy and nursing departments to deliver medications in a timely manner, provide high-quality patient care, and ensure patient safety.

Our methodology involved four main steps. First, we assessed the extent of the missing medication problem, by studying historical data to identify the percentage of medications reported as missing and what specific medications were commonly reported as missing. Next, we observed and analyzed workflows related to medication delivery. These observations were supported by evaluating the time the pharmacy required to complete an order and to deliver the order via TUG. The third step involved examining several root causes, followed by investigating potential solutions in more detail, including an examination of the time to fill a new order, returned medications, and workflows variations. Finally, we developed three types of conclusions: areas that should be evaluated in future studies, short-term recommendations, and long-term recommendations. These steps are described in more detail in the following sections.

Determining the Impact of Missing Medications

First we analyzed historical data to define the current state of missing medications to support the analysis at the West Roxbury campus, and to help describe its greater impact on the quality of patient care. The informatics department at the hospital provided us with West

Roxbury's desensitized missing medication reports from March 2006 – March 2010, which could be filtered by ward, date and time reported, drug type, and reason reported for the medication being missing. The pharmacy provided data on the number of medications dispensed monthly from January 2007 – March 2010.

Using the filters, we determined how many missing medications were reported per month at the West Roxbury campus. The monthly data was then graphed (number of reports versus time) and a statistical analysis was conducted to show developed trends, or lack thereof, in the data. The data was then filtered again to show the monthly distribution of missing medications in three separate wards, including AG, A1, and SICU. These data sets were also displayed and communicated as graphs. The filtered data was then compared to the total number of medications dispensed by the pharmacy by month. This comparison was used to calculate the percent of dispensed doses that were reported as missing medications on a month-to-month basis. The standard deviation was also calculated for this data set. Next, the data was filtered by medication, and lists of the most common missing medications in AG, A1, and the hospital as a whole were established. The frequencies of the reoccurring medications were evaluated and discussed.

We did not filter the data by 'reason reported' because only four options are available in the BCMA. Of the four options, the selection 'not available' is often used as a default. Therefore the information is very nondescript, and was deemed ineffective in describing the missing medication reports.

Analyzing Processes

To identify opportunities to reduce missing medications, we described a series of general operating procedures followed by the hospital staff. We shadowed physicians, nurses, and pharmacy staff in order to gain an understanding of the order and verification process for medications. Specifically, we observed teams of physicians and interns tending to patients and submitting orders for new medications. We then followed up on the orders in the pharmacy, and observed the verification process carried out by pharmacists. Pharmacy technicians were observed filling and delivering the orders either by hand on a med run or by loading the orders on a TUG as well as other pharmacy service activities.

Following the medication delivery to the patients, the nurses carry out a medication pass, in which they administer the delivered medications to the patients. We cooperated with the nursing staffs on wards AG and A1 to observe the medication pass and the filing of any missing medication reports. While shadowing the nurses, we observed and recorded the measures taken to locate a missing medication prior to filing a report.

Furthermore, when a nurse filed a missing medication report, we observed the BCMA interface and evaluated its ease-of-use and effectiveness in communicating the circumstances and details of a missing medication to the pharmacy. This, again, helped us to outline the standard operating procedures in the wards and to identify problem areas and develop process improvement strategies.

From these observations, we mapped the processes associated with the completion and delivery of orders, medication administration, and filing missing medication reports, by creating graphical process flow charts. After developing the initial draft of these workflows, we then had the workflows reviewed and confirmed by six members of the pharmacy staff and four members of the nursing staff. After validating the workflow content with the respective end users of the procedures, we defined time frames for certain stages of the processes. Some of the times were determined using numeric data, while others were defined based on the experience and observations of staff members. We obtained data from a member of the pharmacy staff showing how long it takes pharmacists to finish and process new orders. This data, which characterizes the timeframes associated with over 73,000 orders, was used to establish the lead time for a specific stage of the process flows.

Similarly, data was acquired that defines time frames and frequency data for TUG deliveries; the TUGs contain software that records details about the TUG deliveries such as number of deliveries made, how long each delivery takes, and how long it takes for a staff member to access the TUG after it has arrived at its destination. We used these reports to calculate averages for the three pharmacy TUGs' delivery times, thereby allowing us to determine accurate time frames for the delivery process as it was defined in the workflows.

Examining Root Causes and Potential Solutions

Based on the data and process analyses, we then carried out several smaller studies to explore potential causes for missing medication reports in more detail. These were organized into the following categories:

- Missing medication reports filed within the two-hour window
- Other sources
    - Human error
    - Ward stock related
    - Patient transfers
    - Multiple patient drawers
    - Fill on request orders

2 Hour Window

We observed that many missing medication reports were within the pharmacy's two-hour turnaround. In order to better characterize this as root cause of missing medications, we reviewed nurse training documents, assessed department workflows, and evaluated how many missing medications were associated with new orders in the pharmacy's 'two-hour window'. We acquired nurse training assessment documents in order to determine any standard procedures demonstrated and carried out in the nursing wards. We reviewed the training process and nurse assessments, which helped construct the decision-making processes that confirm a medication as 'missing'. This included checking whether or not the medication was a new order, if it was within the 'two-hour window', and if it could be located in various locations throughout the wards. The medication administration and missing medication report workflows were reviewed in a similar manner. Using these documents, we identified some opportunities for improvement and developed recommendations for reform.

Next, we investigated how many missing medications were associated with new orders, and how many of those associated were filed within the 'two-hour window'. Over the course of nine days we compiled copies of all new orders for AG in the pharmacy which was organized by patient and date. For the same dates, all missing medication reports were compiled and organized in the same manner. We manually paired new orders with corresponding missing medication reports and entered the results into a spreadsheet. The missing medication reports that were associated with new orders were then reexamined to evaluate how many of the reports were filed within the two-hour turnaround window that the pharmacy is allotted to process and deliver orders. Finally, a more in-depth statistical analysis of these numbers versus the total number of missing medications was conducted.

Other Sources

We investigated human based error primarily through raw data reports. We noted that when a missing medication is reported in BCMA, there are four options for reason. First, (the default option) is ‘not available’. The other three are related to human error and include ‘dropped medication’, ‘empty packet’, or ‘wrong drug/dose delivered’. We were able to supplement this data with a separate study conducted by a pharmacy technician looking into human error as well.

Additionally, we looked at the ward stock items, which are medications kept in a local supply in the respective ward, of AG and A1.We explored if there was any connection between medication types in the ward stock and missing medications.

Moreover, through our observations we were also able to identify several sources of missing medication reports, but were not able to determine their individual contributions as a percentage to missing medications. These include missing medications due to patient transfers, patients having multiple drawers, and ‘fill on request orders’.

Generating Conclusions: Improvement Opportunities

The final step of the methodology involved identifying potential areas for improvement, which the hospital could follow or explore to revise and improve their missing medication delivery processes on both departmental and interdepartmental levels. Conclusions were organized into three categories, including both (1) short-term solutions, which might be explored in the hospital’s upcoming RPIW, (2) long-term solutions, and (3) prospective areas for additional studies which we believe hold a lot of potential to generate future improvements to the system.

Chapter 4: Results & Discussion

This chapter describes the various data collection and observational studies conducted during the project, with analysis and discussion. As outlined in the methodology, we broke down the project goals into several steps, which are addressed in the subsections in this chapter. s. The ‘scope and impact of missing medications’ subsection includes analysis of historical data to broadly gauge missing medications at the West Roxbury campus as well as show its impact by demonstrating the consistency and scope of the problem. The ‘analysis of medication delivery procedures’ subsection includes both quantitative and qualitative results, and discussion about medication delivery processes in the pharmacy and nursing departments. The ‘exploration of root causes and potential improvements’ subsection further investigates additional causes of missing medications and their relation to the medication delivery process. Lastly, ‘improvement opportunities’ suggests short term and long term recommendations as well as future evaluations based on the data presented and discussed in the previous subsections.

To preface this chapter, it is important to understand the manner in which missing medications are communicated between the drug administration end (nursing) and the drug filling end (pharmacy). When a medication is reported as missing by a nurse, the template shown in **Table 1** prints out in the pharmacy. These reports can be generated for any medication active in the BCMA ‘Due’ list, such as continuous medications or new medications ordered throughout the day.

Table 1: Missing Medication Request form

= =
Report: MISSING DOSE REQUEST
Date Created: MONTH DAY, YEAR@00:00:00 (hr:min:sec)
= =
Request Number:……………….…##-#######-######
Date/Time Entered:……………..Same as Date Created
Entered By:……………………...Nurse Name
Division:…………….………...Hospital (West Roxbury)
Sent to Mailgroup……….……....BCMA Missing Meds (WX)
Printed on Device:…………....…WX_MissingMeds_Prt P16 (Printer Name in Pharmacy)
Patient:…………….………..…Patient Name
SSN (Last 4 Numbers)…………...1234
Ward Location…………………...Ward (A1, AG, etc)
Room/Bed………………………..Room
Drug Requested……………......Drug
Dose Needed……………………...Dosage
Schedule………………….….…Schedule (Daily, BiDaily, etc)
Reason Needed…………………....Not Available
Administration Date/Time……..…Time to be Administered
Needed by Date/Time…………….Same as Date Created

This information is automatically logged and stored within the VA database. We were able to acquire this raw data from the West Roxbury data informatics personnel. These reports were desensitized prior to being accessible to remain HIPPA compliant, as the data was primarily analyzed outside the VA network.

Scope and Impact of Missing Medications

Ward to Ward Missing Medication Distribution

Figure 3 gauges the missing medication distribution on a ward to ward basis over a period of four years**.** This figure demonstrates the relative consistency in missing medications ward to ward and supports the placement of the two team members into AG and A1 as wards in which to observe the processes associated with missing medications.

The frequency of missing medications per ward is related to the type of patients each ward traditionally accommodates, the patients duration of admittance, and the number of medication orders generated.

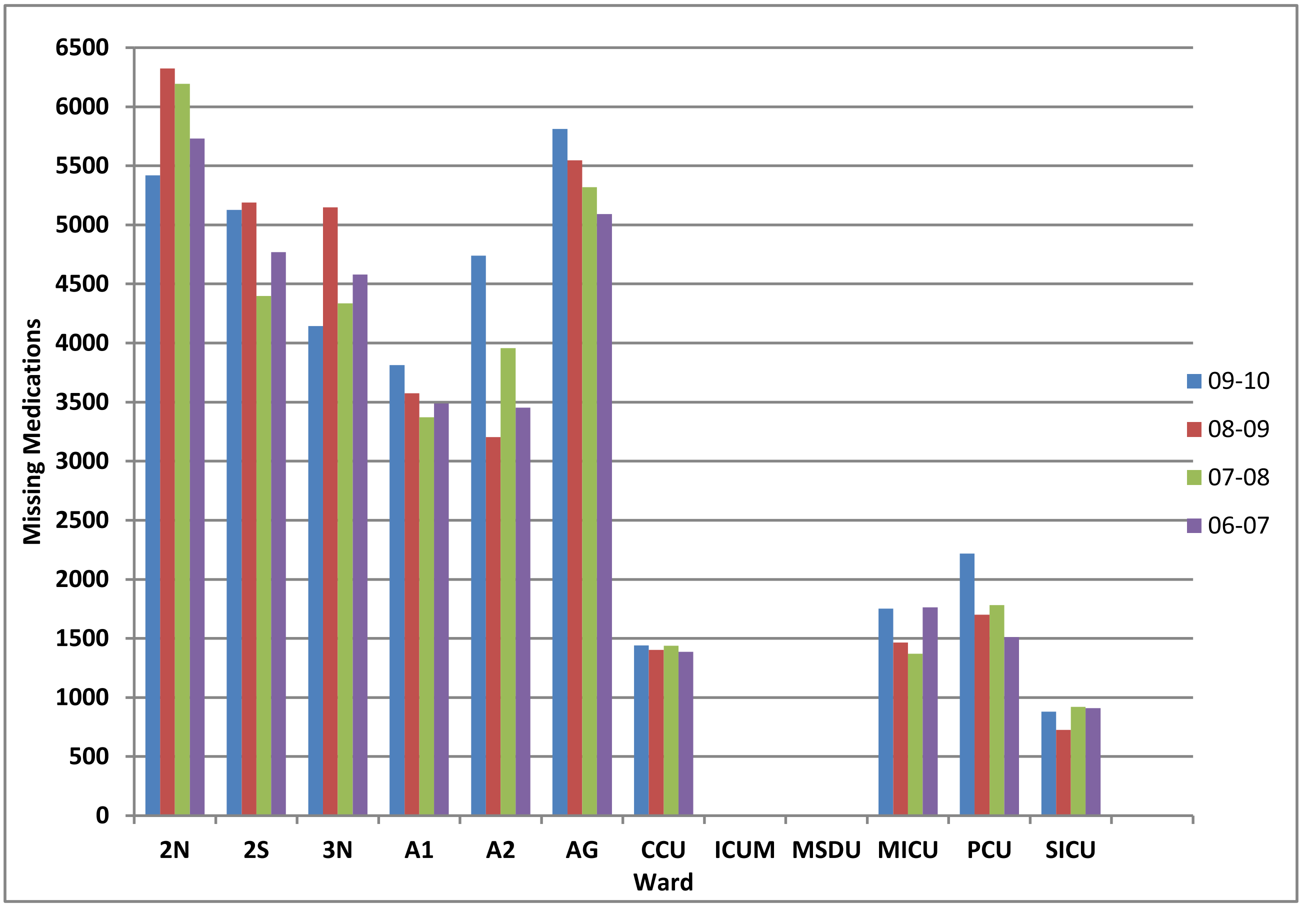

Figure 3: Distribution of Missing Medications Across Wards

Overall Monthly Missing Medications

Figure 4 shows the number of missing medications reported on a month to month basis, providing a historical view of missing medication numbers over four years. The individual raw data files collected run from March to February, therefore cycle (annual) averages are calculated during this time period. The graph shows significant month to month variation in the number of missing medications over the last four years. The monthly average during this time is approximately 2800 missing medication reports per month (approximately 650 per week or 92 per day), with a minimum of 2270 in November 2006, and a maximum of 3564 in March 2010, and an overall standard deviation of approximately 267 reports. Furthermore, cycle averages appear to show an increasing trend in missing medication reports over the last four years, with the cycle average from March 2009 – February 2010 relative to March 2006 – February 2007 approximately 200 missing medication reports or 7.35% more. A two-tailed, paired t-test indicates that the difference between these samples (06/07 and 09/10) is not statistically significant ($p=.0832$, $\alpha=.05$). This suggests that although the West Roxbury campus has been aware of missing medications there has been no significant change (increase or decrease) in missing medications generated despite any previous efforts. It is also interesting to note that March 2010 had the highest recorded monthly missing medications of all the evaluated months.

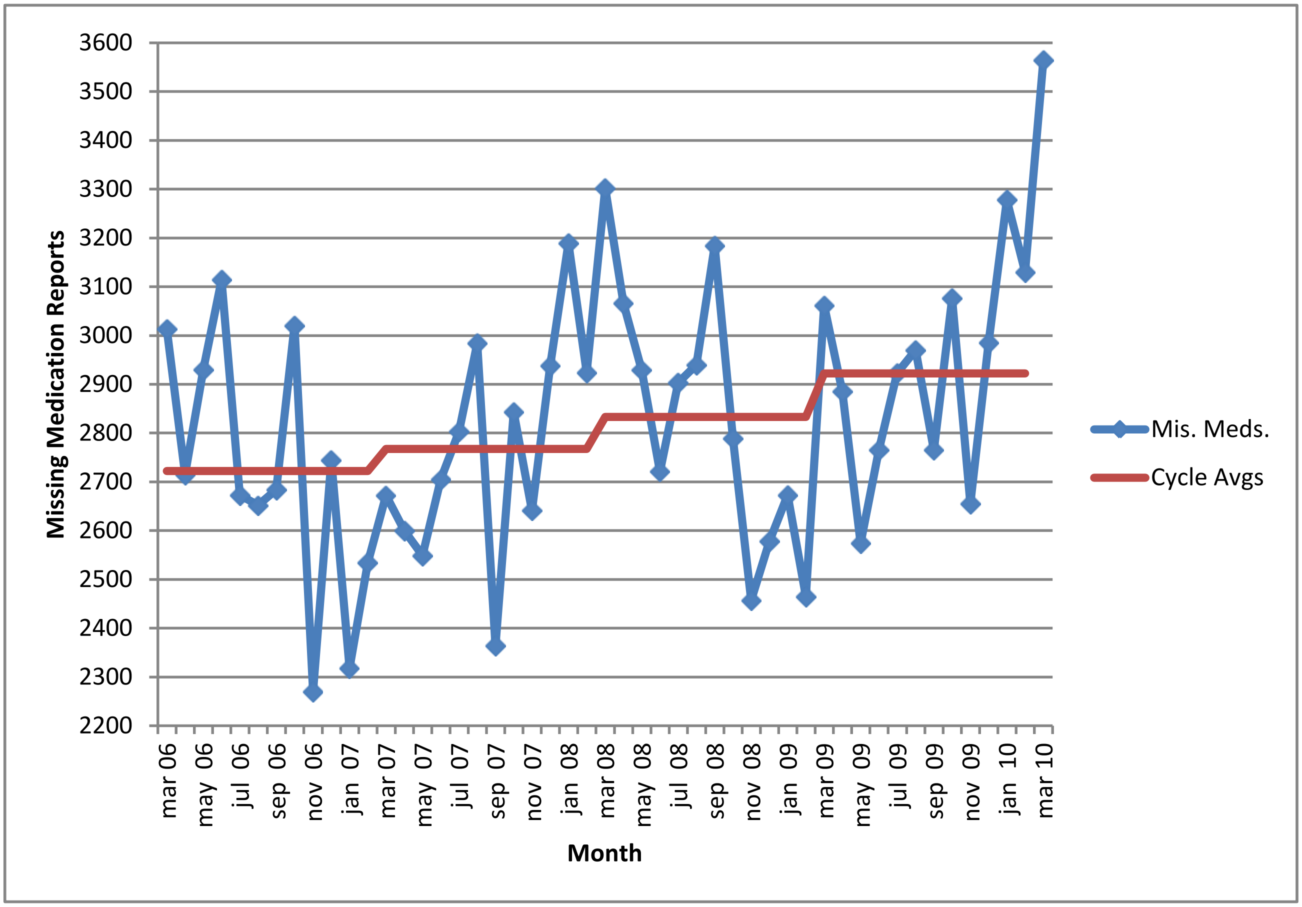

Figure 4: Monthly Missing Medications

Medications Dispensed

To further evaluate missing medications it is also helpful to look at overall medications dispensed. **Figure 5** shows medications dispensed for all wards at the West Roxbury campus on a monthly basis. We were only able access hardcopy of the unit doses dispensed data from January 2007 to March 2010. This was compiled and filtered to generate the figure. An upward trend was noted in this plot (indicated by the linear fit).Additionally, a large variation in the number of doses dispensed monthly was observed. The average monthly medications dispensed during this time was approximately 103,000 units, with a standard deviation of approximately 7721 units.

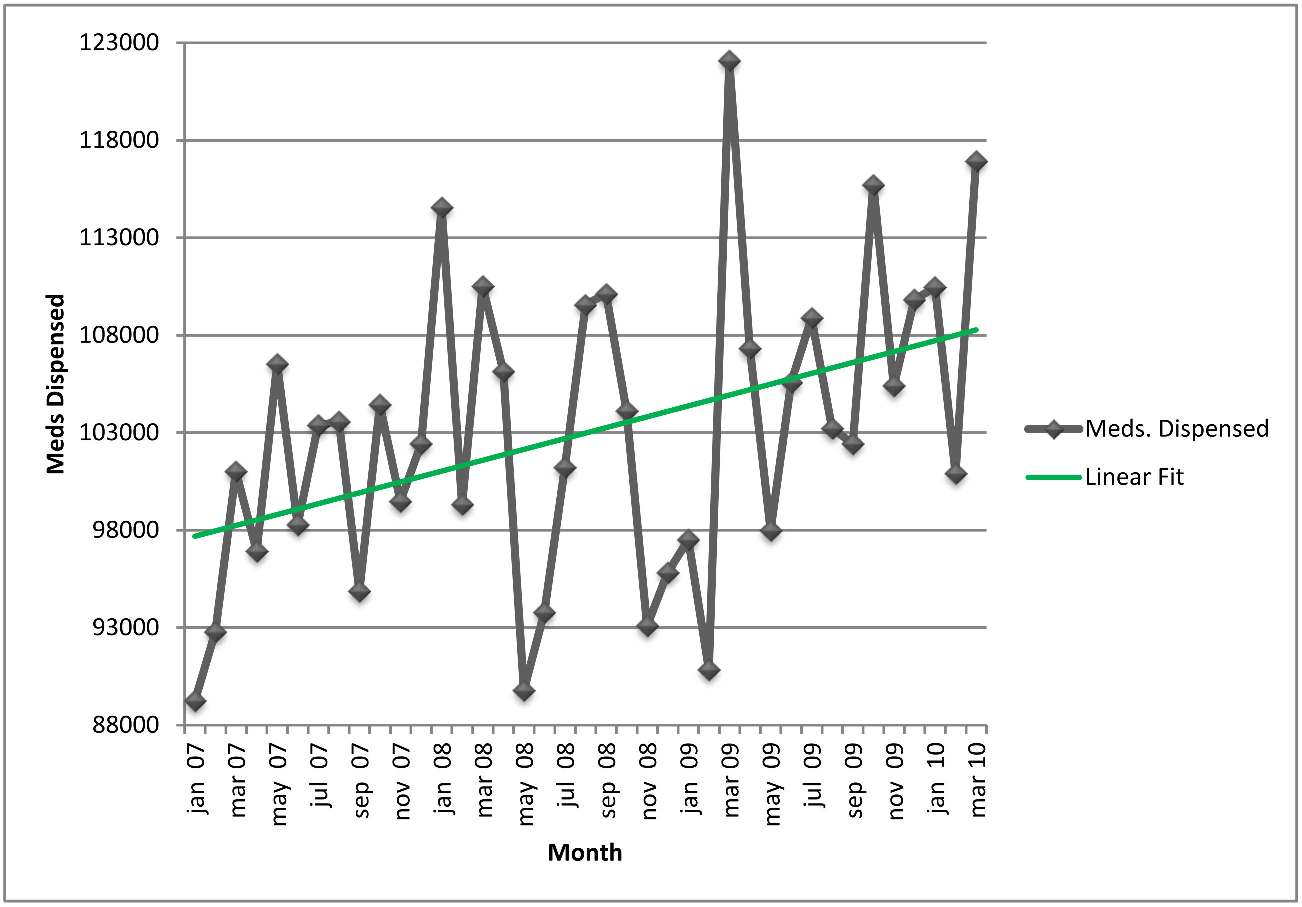

Figure 5: Total Medications Dispensed Jan 2007 - Mar 2010

Percent Missing Medications

With access to both missing medication and medication dispensed data it is of interest to determine the percent missing medications on a monthly basis. This metric is calculated by dividing the monthly missing medications by the units dispensed during the same month. Analysis revealed that the average percent missing medications from January 2007 to March 2010 (limited by the availability of unit dispensed data) has been 2.83% ± 0.37. **Figure 6** shows the percent missing medications during that time period. This figure also shows great variation. Interestingly, the last four months in this data set (Dec 09, Jan –Mar10) show an increase in percent missing medications overall, and also have been above the typical fluctuation range as indicated by the standard deviations.

These results were expected by many individuals in the pharmacy, who have noted that perhaps the increase in percent missing medications relates to recent pharmacy staffing levels being at half capacity. We attempted to investigate if there was any correlation between pharmacy staffing levels and the data presented in **Figure 6**. We were unable to obtain staffing equivalency or management reports for past staffing levels. At this time the observation is speculative and the cause of the increase is otherwise not clear and cannot definitively be attributed to staffing levels.

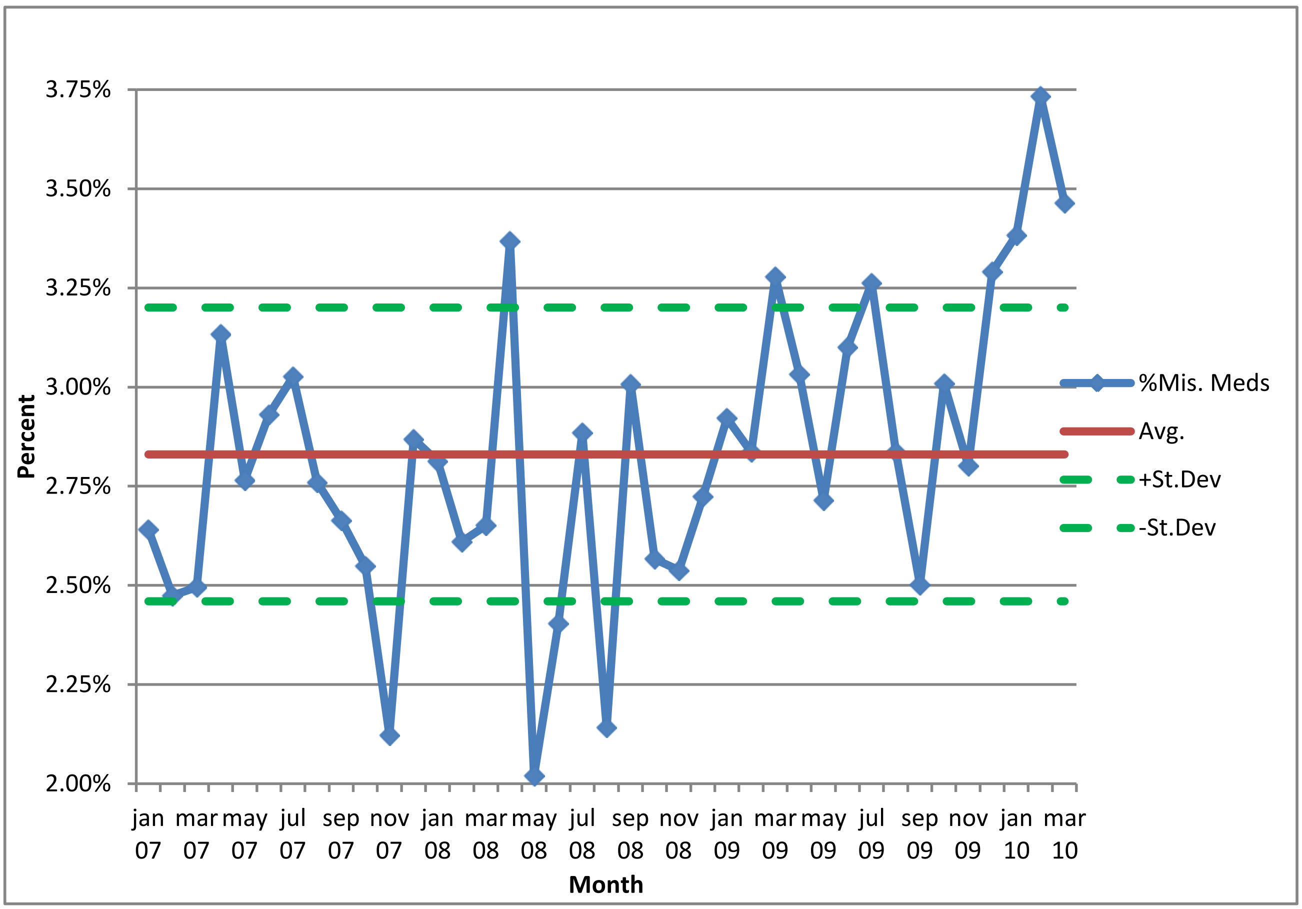

Figure 6: Percent Missing Medications

Common Missing Medications

We looked at commonly occurring missing medications to further assess the scope and impact of missing medications by evaluating the frequency, consistency, and diversity of missing medications at the West Roxbury campus. The top ten commonly reported missing medications per annual cycle (March – February) were compiled for the entire West Roxbury campus as well as the individual wards AG and A1. The calculated impact of the top ten missing medications were deemed significant, based on their percentage of total missing medications. The percent of missing medications contributed beyond a top ten cutoff was noted to gradually decrease. We believe that the top ten can reveal consistencies between commonly occurring missing medications year to year, and the different types of drugs. **Tables, 2, 3, and 4** show the data for AG, A1, and the West Roxbury campus respectively. Note that 'MMs' refer to missing medications in the tables and the highlighted drugs indicate matches in the table across the four years.

Table 2: AG Common Missing Medications

AG MMs: #	Mar 2006 - Feb 2007 (MMs: 5091) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	140
2	DOCUSATE NA 100MG CAP	116
3	HEPARIN 5,000 UNITS/1 ML INJ	77
4	SENNOSIDES 8.6MG TAB	67
5	METOPROLOL TARTRATE 25MG TAB	66
6	ASPIRIN 81MG EC TAB	54
7	IPRATROPIUM BROMIDE 0.02% INH	51
8	ASPIRIN 325MG EC TAB	49
9	MULTIVITAMIN CAP/TAB	47
10	FERROUS SO4 325MG TAB UD	45
	Total	712
	%	13.99%

AG MMs: #	Mar 2007 - Feb 2008 (MMs: 5294) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	108
2	DOCUSATE NA 100MG CAP	101
3	FUROSEMIDE 40MG TAB	76
4	METOPROLOL TARTRATE 25MG TAB	69
5	HEPARIN 5,000 UNITS/1 ML INJ	64
6	SENNOSIDES 8.6MG TAB	64
7	MOMETASONE 220MCG/INHL INHL,OR	64
8	ASPIRIN 81MG EC TAB	61
9	METOPROLOL 12.5MG(HALF OF 25MG	60
10	METOPROLOL TARTRATE 50MG TAB	55
	Total	722
	%	13.64%

AG MMs: #	Mar 2008 - Feb 2009 (MMs: 5198) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	145
2	DOCUSATE NA 100MG CAP	83
3	METOPROLOL TARTRATE 25MG TAB	72
4	FORMOTEROL FUMARATE 12MCG INHL	67
5	SENNOSIDES 8.6MG TAB	60
6	FUROSEMIDE 40MG TAB	60
7	ASPIRIN 81MG EC TAB	59
8	HEPARIN 5,000 UNITS/1 ML INJ	58
9	METOPROLOL 12.5MG(HALF OF 25MG	54
10	MOMETASONE 220MCG/INHL INHL,OR	52
	Total	710
	%	13.66%

AG MMs: #	Mar 2009 - Feb 2010 (MMs: 5182) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	171
2	HEPARIN 5,000 UNITS/1 ML INJ	90
3	MOMETASONE 220MCG/INHL INHL,OR	87
4	DOCUSATE NA 100MG CAP	84
5	FUROSEMIDE 40MG TAB	76
6	ASPIRIN 81MG EC TAB	75
7	MULTIVITAMIN CAP/TAB	75
8	FORMOTEROL FUMARATE 12MCG INHL	67
9	IPRATROPIUM BROMIDE 0.02% INH	62
10	SENNOSIDES 8.6MG TAB	60
	Total	847
	%	14.57%

Table 3: A1 Common Missing Medications

A1	**Mar 2006 - Feb 2007** (MMs: 3489)	
MMs:		
#	Drug/Dose	
1	DOCUSATE NA 100MG CAP	94
2	FERROUS SO4 325MG TAB UD	94
3	OMEPRAZOLE 20MG EC CAP	69
4	HEPARIN 5,000 UNITS/1 ML INJ	59
5	RANITIDINE HCL 150MG TAB	57
6	MULTIVITAMIN CAP/TAB	57
7	METOPROLOL TARTRATE 25MG TAB	47
8	SENNOSIDES 8.6MG TAB	40
9	FOLIC ACID 1MG TAB	39
10	ALBUTEROL 90/IPRATROP 18MCG 20	38
	Total	594
	%	17.02%

A1	**Mar 2007 - Feb 2008** (MMs: 3372)	
MMs:		
#	Drug/Dose	
1	RANITIDINE HCL 150MG TAB	83
2	FERROUS SO4 325MG TAB UD	79
3	DOCUSATE NA 100MG CAP	71
4	HEPARIN 5,000 UNITS/1 ML INJ	63
5	OMEPRAZOLE 20MG EC CAP	61
6	ENOXAPARIN SODIUM INJ 30MG	61
7	MULTIVITAMIN CAP/TAB	51
8	FORMOTEROL FUMARATE 12MCG INHL	43
9	FOLIC ACID 1MG TAB	38
10	ALBUTEROL 90/IPRATROP 18MCG 20	37
	Total	587
	%	17.41%

A1	**Mar 2008 - Feb 2009** (MMs: 3574)	
MMs:		
#	Drug/Dose	
1	DOCUSATE NA 100MG CAP	92
2	OMEPRAZOLE 20MG EC CAP	91
3	FERROUS SO4 325MG TAB UD	87
4	RANITIDINE HCL 150MG TAB	73
5	ENOXAPARIN SODIUM INJ 30MG	69
6	MULTIVITAMIN CAP/TAB	59
7	SENNOSIDES 8.6MG TAB	53
8	FORMOTEROL FUMARATE 12MCG INHL	50
9	HEPARIN 5,000 UNITS/1 ML INJ	45
10	TRAMADOL HCL 50MG TAB	44
	Total	663
	%	18.55%

A1	**Mar 2009 - Feb 2010** (MMs: 3814)	
MMs:		
#	Drug/Dose	
1	DOCUSATE NA 100MG CAP	130
2	OMEPRAZOLE 20MG EC CAP	85
3	MULTIVITAMIN CAP/TAB	79
4	HEPARIN 5,000 UNITS/1 ML INJ	74
5	FERROUS SO4 325MG TAB UD	67
6	TRAMADOL HCL 50MG TAB	61
7	RANITIDINE HCL 150MG TAB	56
8	ENOXAPARIN SODIUM INJ 40MG	53
9	FOLIC ACID 1MG TAB	53
10	ACETAMINOPHEN 500MG TAB	46
	Total	704
	%	18.46%

Table 4: West Roxbury Campus Common Missing Medications

WX MMs: #	**Mar 2006 - Feb 2007** (MMs: 32667) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	693
2	DOCUSATE NA 100MG CAP	613
3	METOPROLOL TARTRATE 25MG TAB	380
4	HEPARIN 5,000 UNITS/1 ML INJ	368
5	FERROUS SO4 325MG TAB UD	358
6	SENNOSIDES 8.6MG TAB	330
7	MULTIVITAMIN CAP/TAB	304
8	ASPIRIN 81MG EC TAB	281
9	ALBUTEROL 90/IPRATROP 18MCG 20	280
10	NYSTATIN 100000 UNT/GM TOP PWD	269
	Total	3876
	%	11.87%

WX MMs: #	**Mar 2007 - Feb 2008** (MMs: 33212) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	603
2	DOCUSATE NA 100MG CAP	567
3	FORMOTEROL FUMARATE 12MCG INHL	455
4	METOPROLOL TARTRATE 25MG TAB	362
5	MOMETASONE 220MCG/INHL INHL,OR	327
6	HEPARIN 5,000 UNITS/1 ML INJ	322
7	SENNOSIDES 8.6MG TAB	320
8	FUROSEMIDE 40MG TAB	311
9	FERROUS SO4 325MG TAB UD	305
10	METOPROLOL 12.5MG(HALF OF 25MG	297
	Total	3869
	%	11.65%

WX MMs: #	**Mar 2008 - Feb 2009** (MMs: 34007) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	756
2	DOCUSATE NA 100MG CAP	642
3	FORMOTEROL FUMARATE 12MCG INHL	494
4	METOPROLOL TARTRATE 25MG TAB	402
5	MOMETASONE 220MCG/INHL INHL,OR	397
6	SENNOSIDES 8.6MG TAB	367
7	MULTIVITAMIN CAP/TAB	357
8	ASPIRIN 81MG EC TAB	357
9	METOPROLOL 12.5MG(HALF OF 25MG	319
10	HEPARIN 5,000 UNITS/1 ML INJ	314
	Total	4405
	%	12.95%

WX MMs: #	**Mar 2009 - Feb 2010** (MMs: 35068) Drug/Dose	
1	OMEPRAZOLE 20MG EC CAP	767
2	DOCUSATE NA 100MG CAP	635
3	MOMETASONE 220MCG/INHL INHL,OR	421
4	FORMOTEROL FUMARATE 12MCG INHL	409
5	ASPIRIN 81MG EC TAB	389
6	MULTIVITAMIN CAP/TAB	368
7	SENNOSIDES 8.6MG TAB	358
8	HEPARIN 5,000 UNITS/1 ML INJ	355
9	METOPROLOL 12.5MG(HALF OF 25MG	355
10	FERROUS SO4 325MG TAB UD	322
	Total	4379
	%	12.49%

These tables show consistency in the common missing medications, particularly on a ward to basis. For example, in A1 the same 6 medications were found in the top ten missing medications in that ward. Moreover, this data shows the range of medication types. Ultimately, this is a concern for patient safety and efforts of TCAB as important medications such as Heparin or Enoxaparin are frequently reported as missing, as well as less critical medications such as Multivitamins or Ferrous SO_4 which reduce nurse – patient interaction.

Table 5 shows the distribution of the common missing medications in A1 over the four years (March – February). Note that across the four years there were only 15 unique drugs for that made up the top ten missing medications. Also included in this distribution is the cumulative number of missing medication requests per drug (through the four years) and which year the drug appeared in the top ten. Overall 6 drugs appeared all four years, 1 drug appeared in 3 separate years, 5 drugs appeared in 2 separate years, and 3 drugs appeared in 1 year.

Table 5: A1 Common Missing Medications Distribution

	Drug	MMs	06-07	07-08	08-09	09-10
1	DOCUSATE NA 100MG CAP	387	x	x	x	x
2	FERROUS SO4 325MG TAB UD	327	x	x	x	x
3	HEPARIN 5,000 UNITS/1 ML INJ	241	x	x	x	x
4	OMEPRAZOLE 20MG EC CAP	306	x	x	x	x
5	RANITIDINE HCL 150MG TAB	269	x	x	x	x
6	MULTIVITAMIN CAP/TAB	246	x	x	x	x
7	FOLIC ACID 1MG TAB	130	x	x		x
8	ENOXAPARIN SODIUM INJ 30MG	130		x	x	
9	TRAMADOL HCL 50MG TAB	105			x	x
10	FORMOTEROL FUMARATE 12MCG INHL	93		x	x	
11	SENNOSIDES 8.6MG TAB	93	x		x	
12	ALBUTEROL 90/IPRATROP 18MCG 20	75	x	x		
13	ENOXAPARIN SODIUM INJ 40MG	53				x
14	METOPROLOL TARTRATE 25MG TAB	47	x			
15	ACETAMINOPHEN 500MG TAB	46				x

As illustrated in the previous data, including the historical data analysis and the look at common missing medications, it is clearly seen that missing medications should be considered an area of concern for the VA. Missing medications reports occurred at a consistent level in this hospital despite discussion and mindfulness for several years.

Analysis of Medication Delivery Procedures

The following section both presents observed processes in the pharmacy for the medication delivery procedure of new orders, and a general process for medication administration by nurses. In addition to the process flows, a general description of the process is provided, as well as discussion about specific areas of particular importance to missing medications.

Pharmacy Process Flow

Figure 7 depicts the pharmacy process flow. We were unable to obtain any existing standard operating procedures and thus depended on observations in the pharmacy, followed by revision and validation from the pharmacy staff to generate the process flow. Note the blue boxes indicate timeframes for certain steps.

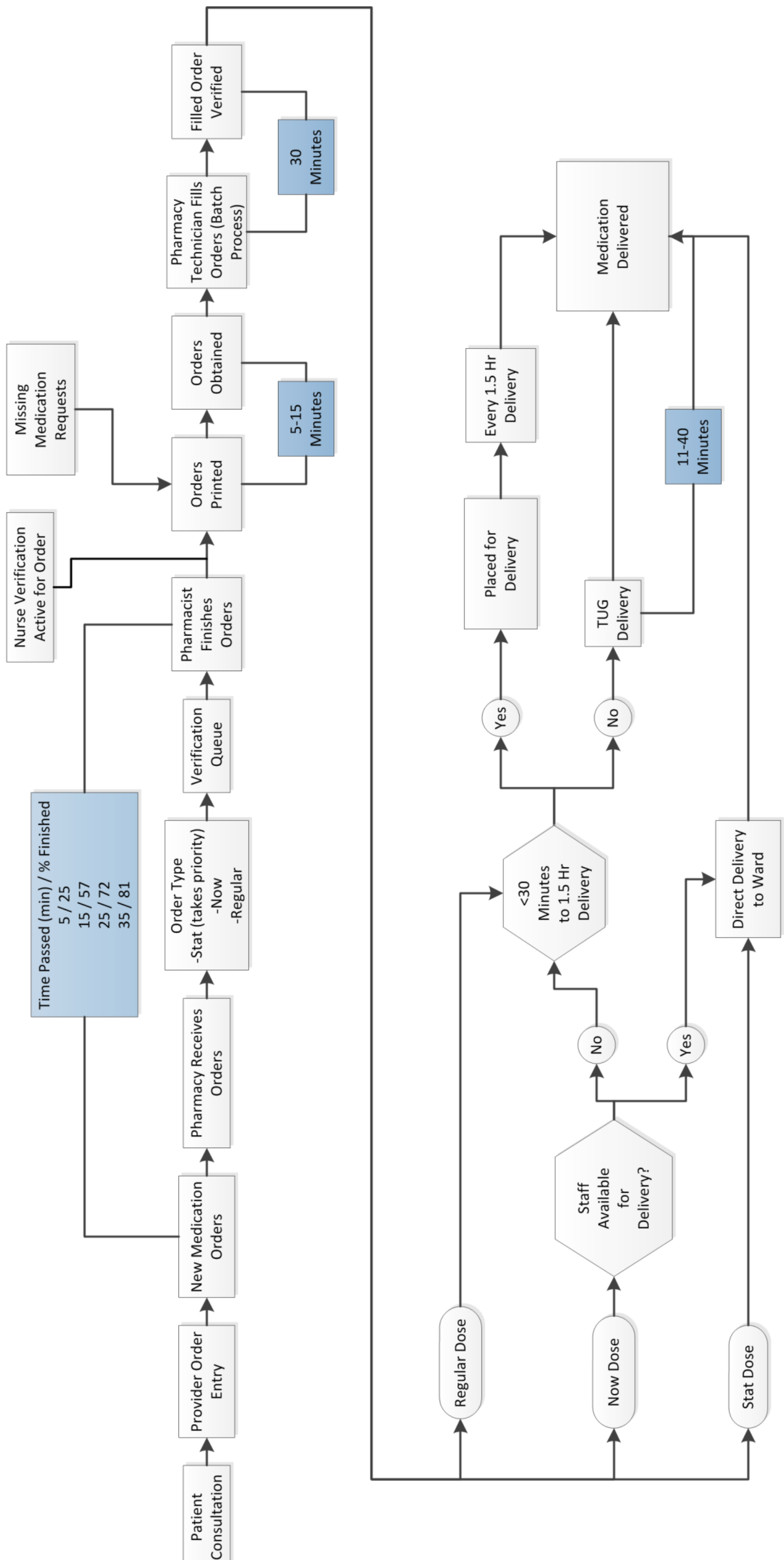

Figure 7: Pharmacy Process Flow

Figure 8 and **Table 6** support the timeframes used in the flow chart in **Figure 7** for pharmacist finishing time, and TUG delivery time respectively. Other timeframes used in the process flow were determined through the revision and validation process used to develop the flowcharts.

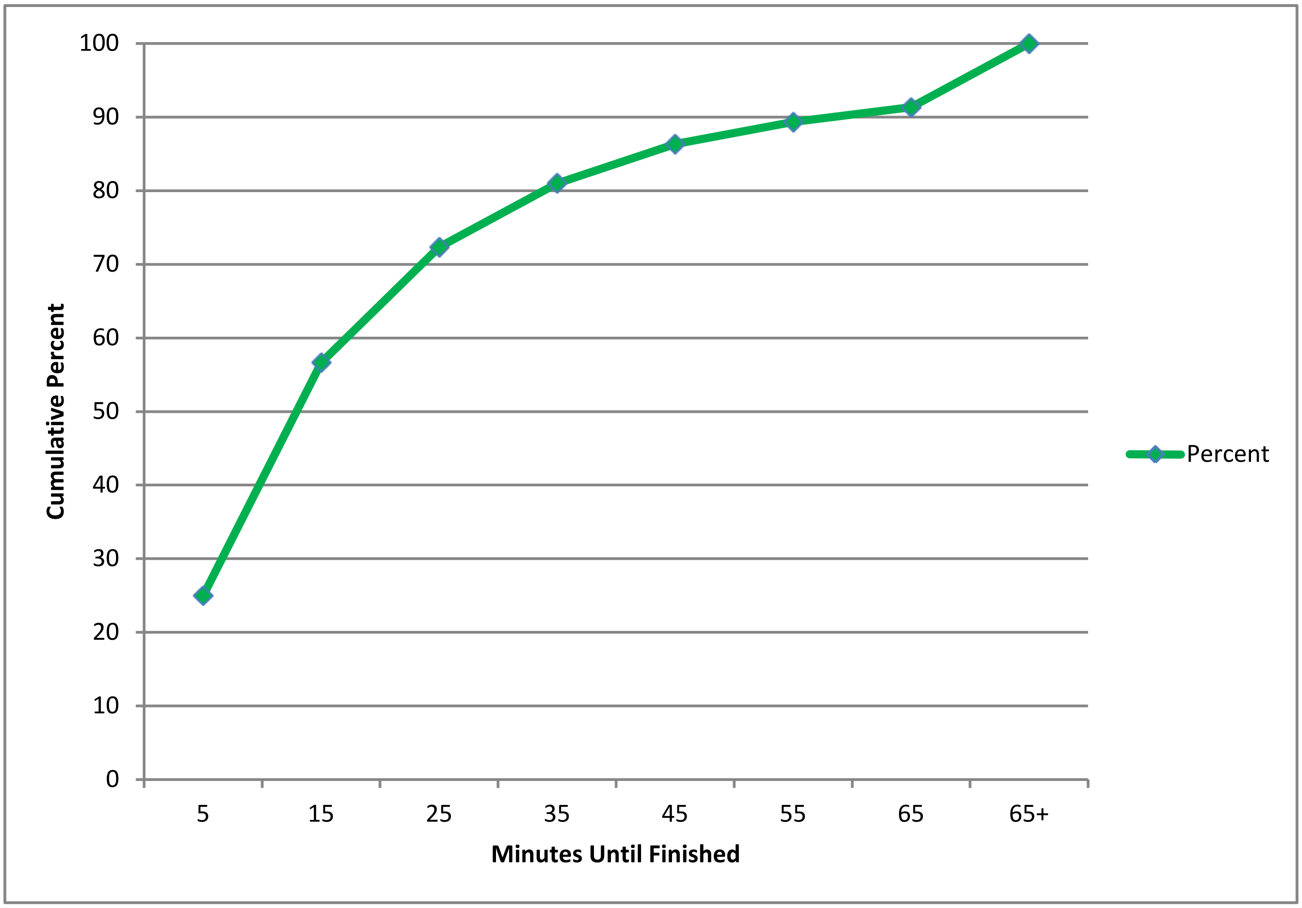

Figure 8: Pharmacist Order Finishing Times

Figure 8 shows pharmacist finish ordering times, which was used to determine the window of time it takes for new orders to be processed. The finishing time distribution is based on over 73,000 orders over a three month period. Finishing an order means the pharmacist has confirmed the drug ordered, by for example, evaluating the patient's lab results, previous history, allergies, etc. Frequently, the pharmacist must modify the order to make it BCMA compliant for administration. Orders that require extensive time for finishing are deemed as 'problematic orders' by the pharmacist. These orders require the pharmacist to directly contact the ordering physician and can cause delays in the finishing of these orders. The graph is interpreted as follows: after 5 minutes, there is a 25% chance that a new order has been verified by the pharmacist, by 15 minutes there is a 57% chance that a new order has been finished. However, there is a 10% chance that the verification may take more than one hour.

TUG data was referenced to indicate the average time it takes medications to reach their respective wards once sent by the pharmacy. Initially, we asked both pharmacy and nursing staff for their opinions on TUG speed which revealed varying perceptions of the TUG's performance. Overall 10 individuals between nursing and pharmacy were questioned. In both departments there were individuals who felt the TUG delivered at an adequate speed, inadequate speed, and several individuals had no opinion. Ultimately, we were also able to obtain automated reports generated by the TUGs since their implementation in March 2008. The data from the reports was compiled in **Table 6**.The information used to support the pharmacy new medication order workflows consists of the average round trip time, average delivery time to first ward, and average number of stops per trip.

Table 6: TUG Report Data

TUG	Year	Avg. Trips per Day	Avg. Round Trip Time (h:m:s)	Avg. Stops per Day	Avg. Delivery Time (to 1st Ward)	Avg. Wait Time (at ward)	Average # of Stops (per trip)
TUG-77-1	2008	3.2	0:51:41	7.6	0:13:12	0:01:25	2.4
	2009	6.2	0:43:12	14.4	0:09:57	0:01:17	2.3
	2010	4.7	0:52:14	13.9	0:10:59	0:01:10	3
TUG-77-2	2008	4.9	0:50:25	12	0:12:10	0:01:18	2.5
	2009	8	0:46:32	18.8	0:10:33	0:01:12	2.4
	2010	6.2	0:48:28	16	0:11:03	0:01:16	2.6
TUG-77-3	2008	5.8	0:53:13	14.4	0:12:17	0:01:15	2.5
	2009	10.5	0:44:22	24.7	0:09:26	0:01:25	2.4
	2010	8.4	0:47:06	22.4	0:09:52	0:01:21	2.7
Averages		**6.4**	**0:48:35**	**16.2**	**0:11:03**	**0:01:18**	**2.5**

The pharmacy process flow (**Figure 7**) shows how new medication orders are handled. First, a patient consultation results in new medication orders sent electronically to the pharmacy via the CPRS. Once received by the pharmacy, a pharmacist assigned to the ward(s) where the new order was sent from finishes the order. As noted in the process flow figure, and also indicated in **Figure 8**, there is a certain timeframe for the order to be finished. Most of the orders are adjusted by the pharmacist to be BCMA compatible as discussed. When the order is finished it is sent to a printer. At this printer both the new orders and missing medications requests are received. When a pharmacy technician proceeds to fill the orders it is done in a batch-like process with both missing medications and new orders being filled at the same time. Ultimately, the medication is delivered to the ward. Therefore, the general process for a new order is the provider order entry, pharmacist order finishing, pharmacy tech order filling, and delivery to the ward.

This generalized order processing process has an associated timeframe, labeled the '2 hour window', to deliver a medication to a ward. These 2 hours primarily apply to regular priority new orders. However, this window is loosely defined. In fact, its understanding within the pharmacy varies, and its understanding on the nursing end was effectively non-existent, indicating a clear interdepartmental communication gap. Within the pharmacy there were two noted definitions of the 2 hour window, one starting at the time of the order entry (i.e. from when the order was placed) and the other starting from the time the order is printed in the pharmacy (i.e. pharmacist order finishing time). The majority of pharmacy technicians felt the '2 hour window' was the turnaround time allowed to fill and deliver the medication to the ward after the order printed out. The great majority of nurses, including the nurse managers of the wards, were generally unaware of any existing 2 hour window aside from how it may even be defined. However, there were a few nurses, notably who had been recently hired and had spent time shadowing in the pharmacy, knew there was notion of some 2 hour window. These nurses felt the window began with the time the medication was ordered.

Ideally, the '2 hour window', or any other established timeframe, should begin at the time the physician orders a medication. However, the existing computer systems in the West Roxbury campus make it difficult to clearly communicate the times that would be associated with the 2 hour window. After a medication is ordered, an order sheet prints out on the nursing floor indicating the physician order time, and other pertinent information. The order is concurrently sent to the pharmacy. After the order is finished by the pharmacist, the medication appears on the BCMA 'Due' list, and at this point the missing medications can be filed. The nurse is unable to see the pharmacist finish time in the 'Due' list, but can on a single medication to medication basis, query the original order time. On the pharmacy end, when the order prints out for the technician to fill, the only time that prints out is pharmacist order finish time. The technician is not easily able to see the original order time. As a result, communication of ordering time and finishing time is not readily communicated between nursing, pharmacy technicians, and pharmacists.

Additionally, another critical time in this process is when the ordering physician wanted the medication to be administered to the patient. For example, consider an order that is to be administered twice daily (typically at 9 am and 9 pm) and is ordered by the physician at 8:50 am. It is unrealistic for the pharmacy to deliver the medication on time for the scheduled administration, and no standard exists as to how nurses should handle such events. Furthermore, consider if the ordering physician makes the order for the twice daily medication at 9:15 am. Within CPRS the physician has the option to ‘send an additional dose now’ (not to be confused with the order priority now). This indicates that though it is after the scheduled administration time the physician has requested that an additional dose be sent. However, should a physician not make this distinction, the pharmacist finishing the order will more often than not ‘roll back’ the order time (i.e. prior to 9:00 am) to allow the additional dose to be sent up.

In **Figure 7** new orders are broken into three categories on priority: stat, now, regular. Now doses represent drugs that should be administered in a shorter time period than a regular dose. Stat drugs are generally not a concern as they are given priority for the pharmacist to finish, and often the electronic order is also called down directly to the pharmacy.

Two important insights can be gained by looking at the class of drug and the manner in which it is handled in the process flow. Now doses and regular doses are essentially treated the same way in the pharmacy. While there is a decision in the process flow for a now dose to be delivered by hand immediately after the order is filled, it is rarely the case, in part due to staffing.

A clear procedure in the pharmacy does not exist to differentiate between now and regular dose delivery. Based on observations and discussion in the pharmacy opinion varies on this priority differentiation. Some individuals noted that now doses are treated similarly to stat doses, others noted that if possible, now doses will be exclusively sent by TUG, and finally several individuals stated that there is a no real difference in the way the pharmacy handles now and regular doses.

Both the now and regular orders feed into the step labeled "<30 minutes to 1.5 Hr Delivery". This notes that if it is less than 30 minutes to the next scheduled human delivery (that occurs every 1.5 hours as established by the pharmacy) then the medication will go by human delivery; otherwise it will go by TUG. However, this step is very much at the discretion of the pharmacy technician. The time of day, volume of orders, and time until the next 1.5 hour delivery, all determine the path a medication takes. The idea of "<30 minutes to 1.5 Hr Delivery" is used as an open-ended guideline for the process flow, and is a step where significant decision making exists.

As shown with the pharmacy process flow there exist several communication gaps internally within pharmacy and also between pharmacy and nursing. First, the '2 hour window' is unclear as discussed and needs to be defined if it is ever to be recognized. Second, after the establishment of a '2 hour window', it should become part of nursing standard operating procedures to check the order time for new orders. It is currently inefficient for nurses to reference order times to assess the status of pending new orders. The project team is aware of a nurse verification step (noted in **Figure 7**) that becomes active after a pharmacist finishes an order, which must be completed prior to administering a medication. The team feels that this step could be potentially utilized to look at order times. The project team thinks that taking steps to address these issues will have a direct effect on the number of missing medication reports generated at the West Roxbury campus.

Medication Passes in Nursing

Figure 9 provides a workflow of the medication pass which a nurse generally follows for each patient; this workflow is summary for how a medication is administered and includes steps from the delivery of the medication to medication administration. We were unable to develop a workflow in greater detail due to the variations in nursing techniques. Two types of nursing styles were observed at the hospital, the first being primary nursing and the other team nursing; each style follows a different method for caring of patients. For example, primary nursing utilizes one nurse who is in charge of a range of patients. This single nurse follows a similar procedure to that outlined in **Figure 9,** whereas team nursing consists of a small group of nurses (usually 2-3) who conduct the medication pass in more of an assembly line fashion where the nurses divide the steps between them. Both primary and team nursing may deviate from the workflow depending on the preferences of the individual nurses; however both styles must follow the outlined steps to some degree before a medication is administered.

Medication administration occurs throughout the day at scheduled intervals. Each scheduled medication pass is allotted a window of completion time. This window permits for nurses to begin the pass an hour before it is called to start, and finish and hour after the start time, allowing for medications to be administered in a timely manner, while accounting for unexpected interruptions that often are encountered during the work day.

Even though there are scheduled passes, often medications require a nurse to administer doses at other points of the day. For example, some orders call for medications to be administered with meals, before bed, etcetera, forcing nurses to structure their day around only one aspect of patient care. This can also lead to missing medications especially when nurses attempt to administer orders outside the known administration time.

At any point during the provided workflow a nurse can encounter a missing medication. When this occurs, the nurse must exit the current BCMA window and initiate the electronic report window to file a missing medication.

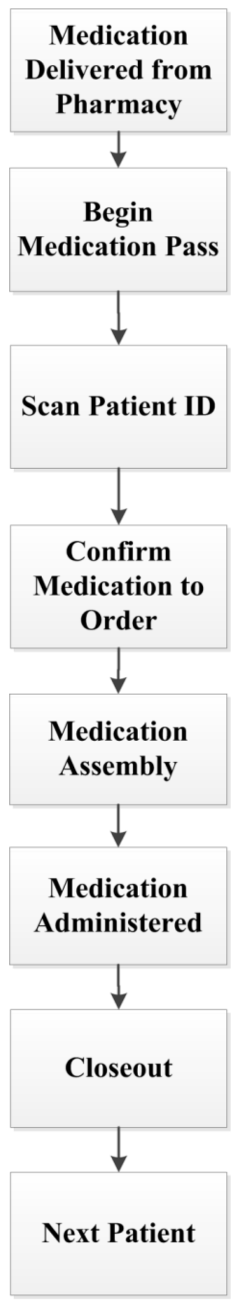

Figure 9: Medication Pass Workflow

Exploration of Root Causes and Potential Improvements

We categorized our RCA into two main groupings: missing medications associated with the '2 hour window' and other sources. As shown in the section below, the '2 hour window' was found to be an area with a measurable impact on missing medications. We found that the other sources were more difficult to statistically measure due to complications which are elaborated on in this chapter.

2 Hour Window

Our process analysis and observations in the hospital helped to initially identify new orders as particularly problematic when considering missing medications. Moreover, we suspected that the pharmacy's two-hour turnaround for medication order processing and delivery was at the root of a significant number of missing medication reports.

The pharmacy provided us with all the new orders and missing medication reports from AG over a nine-day period. We then manually sorted the new orders and missing medications by date and patient then matched them in order to examine how many missing medications were associated with new orders. **Figure 10** shows the results of the study.

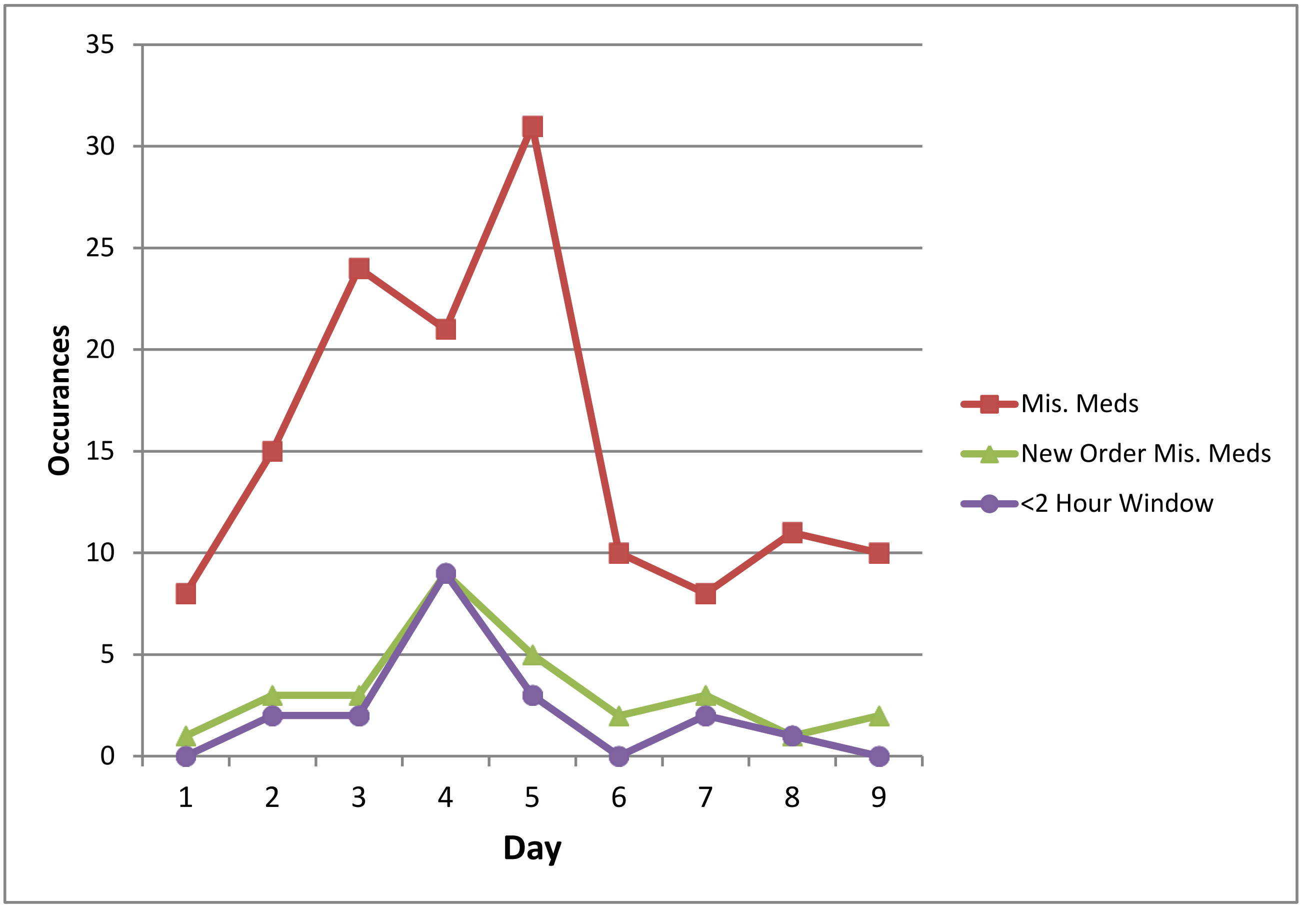

Figure 10: Missing Medications Associated With New Orders (AG)

The study showed that of the 109 missing medication reports filed over the course of these nine days, 23 reports, or 21% of the total, were associated with new orders. West Roxbury's pharmacy supervisor predicts that an examination of the entire hospital would reveal that closer to 30% of all missing medications are associated with new orders. After associating times with each of the new order missing medications, we calculated that 70% of the reports were made within the '2 hour window' which made up 15% of the total missing medications during this nine-day snap shot.

We found that the '2 hour window' is not clearly defined and it is not communicated to the entirety of the hospital staff as previously discussed. For example, in our study an order for calcium gluconate was finished by the pharmacy on April 6, 2010 at 12:39 AM, and reported missing at 12:42 AM. In the study, we had to use the pharmacy's finishing time to define the '2 hour window' as we did not have access to the time that the medication was ordered by a physician. While it is unclear whether the '2 hour window' begins when a physician orders a medication or when the pharmacy finishes processing the order, the data associated with pharmacy finishing times show that there is an 82% chance that the order was finished within 35 minutes of the physician submitting the order (**Figure 8)**. In this case, the missing medication report was likely filed within the '2 hour window', either 3 minutes or 38 minutes after the medication was ordered. Either way, this particular missing medication report was likely made significantly earlier than the two-hour turnaround time. However, it is clear that this lack of definition creates a communication barrier between the individuals and departments that contribute to the significant 15% of all missing medications that are associated with new orders in the window.

Other Sources

We also investigated any remaining root causes and attempted to determine their impact by calculating their corresponding percentages. The first source identified was that of missing medications associated with human based error. An analysis of the BCMA generated raw data of missing medications reports revealed several points of interest. When a missing medication is filed a default reason is applied as 'not available'. However, three other options are available as reasons to file a missing medication. These include 'dropped', 'empty package', and 'wrong dose/drug delivered'. Any medication filed with these reasons other than 'Not available' would indicate a human error. From the pharmacy's perspective, empty packets, wrong doses, or wrong medications should be caught before being delivered to the wards. 'Dropped' refers to a medication that was dropped during handling. **Table 7** shows the percentage of missing medications documented as human error as a function of these categories over four separate annual cycles.

Table 7: Missing Medications Due to Human Error

Annual Cycle	% Human Error
06-07	6.97%
07-08	5.95%
08-09	6.75%
09-10	8.34%
AVG	**7.00%**

We believe that these figures are deflated because not all missing medications are filed with the appropriate reason, as most are generically filed as ‘not available’ (the default option). Additionally, we were unable to determine the overlap between human error as a function of new and continuous orders. This type of information is not available in the raw data reports and would require a manual approach similar to the missing medications versus new order study conducted on AG.

A separate component of human error is the filing of missing medications that may not actually be missing and could have been found in the ward. Although we did not investigate this directly, we obtained a two day study from 2008 conducted by a pharmacy technician. In the study the technician, over a six hour period of time for two days, followed up on missing medication requests after they were made to the pharmacy. In total the technician looked into 75 missing medication reports. The technician noted that 9 of the missing medications requested were located in the patients’ drawers, 10 were located in the medication inbox, 3 were found stored in refrigerators, and 9 could not be located but were personally delivered by the pharmacy technician conducting the study. Thus, in this 2 day study perhaps over 40% of the missing medication requests were erroneous, in that the medication could be found in the ward.

Beyond human error and new orders there still remains a significant percentage of missing medications. First, we sought to determine what percentage of missing medications on a particular ward involved medications found in the ward stock. Analysis over a year cycle revealed that this is not an area of concern. In AG, 0.5% of missing medications were medications that could be found in the ward stock, and in A1 1.5% could be found in the ward stock over the 2009-2010 cycle. This suggests the potential to transition to the Omnicell or a reevaluation of the ward stock.

Patient transfers are another potential root cause of missing medications. If a patient is transferred from one ward to another there is a possibility that the patient's continuous medications may not follow the patient, and that a daily cart exchange of medications will occur in the wrong ward, or that any new orders will be sent to the wrong ward. In all these cases missing medication reports can be filed. In the pharmacy, reports can be printed to indicate new patient admits, transfers, and discharges. However, because this information is not communicated between the wards and pharmacy in real time, it leaves room for error. There was no efficient way of attributing a certain percentage of missing medications as a result of patient transfers. Such an analysis would require a manual study that we did not undertake. Missing medications as a result of patient transfers associated with continuous medications can result in a series of missing medication requests for each continuous order while a new order would result in a single missing medication report.

Additional causes include multiple patient drawers and 'fill on request orders'. While observing on the floors, we noticed that some patients had more than one medication drawer in the daily cart. This did lead to missing medication reports, since occasionally a nurse could not locate the medication during administration times, but we were unable to determine the frequency of these occurrences. Similarly, certain medications such as creams and eye drops can only be refilled by filing a missing medication report. This is done by filing a report with the generic ‘Not Available’ option from the drop down menu in the BCMA. We were unable to determine how often these erroneous reports were made since there was no way of identifying them from the other legitimate reports.

Improvement Opportunities

The following section outlines short and long term recommendations as well as future evaluations.

Short Term Recommendations

As previously mentioned one of the goals for this project was to identify areas of improvement which, if addressed, could result in a decrease of the number of missing medication reports filed within the hospital, therefore increasing staff efficiency and patient care. Through investigation, we were able to produce two sets of considerations. The first set of considerations was designed around the RPIW planned for West Roxbury shortly after we completed the project. As is evident through the new order data, the ‘2 hour window’ concept needs to be clearly defined. If at the RPIW meetings the participants were able to agree upon an acceptable delivery standard, which was enforced in the pharmacy and communicated throughout the nursing wards, 20% of all missing medications reports could potentially be removed.

Process analyses revealed that several variables were associated with methods for medication delivery and handling, and missing medication report filing. We realized that there were too many steps in both procedures which required a staff member's judgment. Therefore, a lot of deviations from the determined workflows occur on an individual-to-individual basis. Members of the pharmacy and nursing staffs would not know what to expect from each other, resulting in variations in delivery methods, medication storage, and so on. These variations ultimately lead to medications being missing – or at least perceived to be missing – and increase the number of missing medications reported each day and a decrease in the efficiency of the hospital staff. We suggest that members of the RPIW utilize our proposed ideal workflows to establish applicable standardized methods to aid in reducing communication gaps between nursing and pharmacy.

Another approach to reducing communication barriers is through the use of formal interdepartmental cross training. Nurses who had experience in the pharmacy, either through schooling or shadowing, were less likely to file a missing medication within the '2 hour window' because they were aware of the finishing process and the pharmacy's two-hour turnaround time. By establishing cross training methods, we think that the number of prematurely filed reports will be reduced.

After an analysis of the current method for handling a missing medication, we felt that it was important for the nurses to follow a simple procedure for locating medications before submitting a potentially erroneous report. There was some question to whether or not adding these steps is counterproductive to TCAB efforts, since this would add to the nurses' responsibilities and potentially reduce their time at the bedside. However, we feel that the lack of a standard operating procedure has a greater impact on their ability to properly administer medications, and in the long run will reduce wait times for new, now, and stat orders. Therefore, it may be helpful to establish a standard missing medication filing procedure. **Figure 11** shows the proposed ideal approach to handling of a missing medication and was adopted after minor modifications for testing through the RPIW. The first step that should be taken is to determine whether or not the medication in question can be found in the ward stock (in the future this step could also include the Omnicell). If the medication is available in the floors' ward stock, then a medication report should not be filed and the medication should be administered. If not located in the ward stock, then we suggest looking in the following areas: patient bedside, inbox, and any other possible patient specific drawers. These three locations have been noted as common storage sites for medications. Again, if the medication is located in any of these sites then the medication should be administered. However, if the medication cannot be located then the nurse should check the order type. If the medication is a continuous order, then a report should be filed since continuous medications should always be found in the daily cart. If the medication is a new order, then an additional step is required prior to filing a missing report. By accessing the medication history in another window, the nurse can tell when the medication was ordered by the physician. At this point the nurse can determine whether the medication should be on the floor or not. As previously mentioned, the '2 hour window' is not currently defined or effectively communicated between the departments. This flow chart would be ideally used under circumstances where the '2 hour window' has been defined and nurse accessibility to order time data is improved.

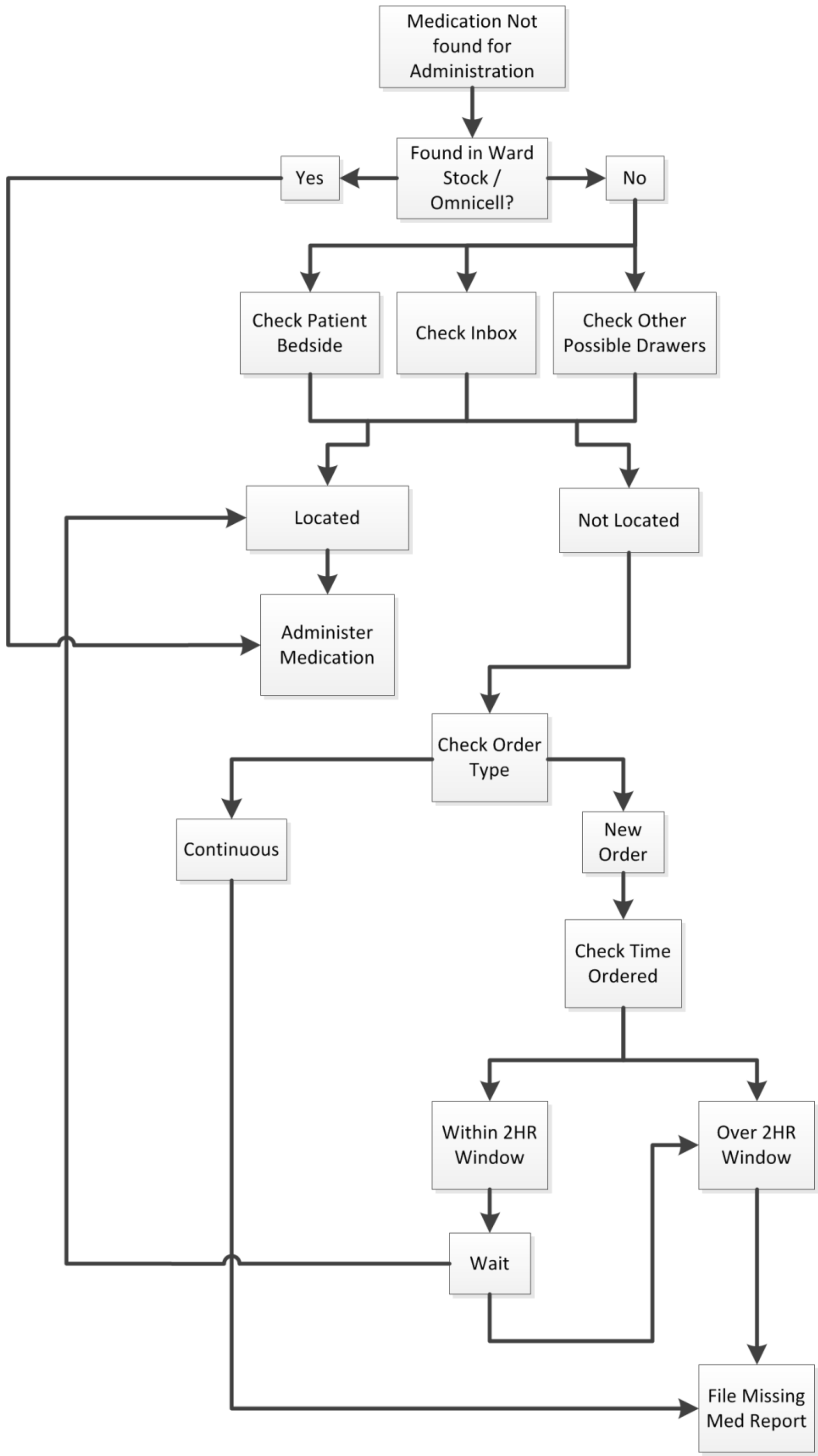

Figure 11: Proposed Missing Medication Filing Procedure

Long Term Considerations

In addition to short term considerations, we also have developed several long term recommendations. A major change that is scheduled for installation is the Omnicell. The Omnicell is an automated medication dispensing unit, capable of storing medications on the nursing floors, and making over 200 drugs immediately available to the nursing staff. The consistency of the common missing medication frequencies (Tables 2, 3, and 4) shows the potential benefits of the Omnicell and provides a preliminary outline of the classes of medications which may be appropriate for each ward's stock.

Medications are often reported missing when they are being processed or when they are in transit from the pharmacy to the nursing wards. A possible long-term solution would be to install a real-time medication tracking system so that nurses can see a medication's processing and delivery status. This solution is feasible, as there are developed medication-tracking technologies that are being used at private hospitals in America. One such technology is the MedBoard, a "barcode-driven" system that "tracks the medications that nurses are waiting for just like FedEx tracks a package" using display screens located in the nursing wards. [24] One case study shows that the Riverside Methodist Hospital in Ohio reduced their missing medications by 50% and reduced their waste costs by 32% in just the first six months of implementing the MedBoard. [25] By simply communicating the status of orders, medication delivery becomes much more controlled thereby reducing the number of missing medications filed and increasing the availability and efficiency of the hospital staff.

Finally, we considered a reevaluation of medication storage on the nursing floors. While conducting the process analyses and determining the root causes of missing medications, we observed that a number of missing medications were due to relocated and misplaced missing medications. Nurses relocate medications to satellite carts or alternative patient drawers, and pharmacy technicians deliver medications to several non-standardized medication rooms and medication inboxes. These issues suggest the potential benefits of standardizing and centralizing medication storage and delivery sites on the nursing floors. This consideration for reform of the medication storage and ward structure would reduce clutter on the nursing floors and limit the number of possible locations that a medication could be found.

Future Evaluations

Due to our limited time at the West Roxbury campus, several possible root causes of missing medications were not examined. However, we believe that future evaluations of these root causes could reveal some potential areas for improvement.

An assessment of the Omnicell following its eventual implementation would be beneficial in determining its impact on missing medications. Some members of the hospital staff believe that the addition of a new technology interface will complicate the medication administration process, and others believe that the Omnicell avoids addressing the actual root causes of missing medications and masks the problem rather than addressing it. On the other hand, many believe that the Omnicell will prove to be the ultimate solution to missing medications. An assessment of the Omnicell's impact on missing medications would give valuable insight to the effectiveness of the staff's interaction with the new technology, its effect on the number of missing medication reports, and the resultant effect on the efficiency of the hospital staff.

As part of the evaluation, we examined the most common missing medications at West Roxbury. However, there is undoubtedly an underlying correlation between the frequency of a medication administered and the reoccurrence of missing medication reports filed for that particular drug. For example, the fact that omeprazole is consistently the top missing medication reported at the West Roxbury campus from 2006 to 2010 may be related to the frequency of this drug being administered. Therefore, we think that further evaluation is needed in this area.

We identified a number of possible root causes of missing medications that make up the 80% of reports that are not attributed to new orders. These potential root causes include complications with patient transfers as briefly discussed, and 'fill on request' medications that are reported missing because they need to be refilled. These are certain medications, primarily ointments, inhalers, creams, eye drops, etc. that can only be refilled via a missing medication request. We believe that a way to differentiate these requests from other missing medication reports is to add a reason within BCMA (i.e. 'refill request'). Lastly, we believe that the West Roxbury campus should look into the order priorities 'regular' and 'now'. As seen in the pharmacy process flow and its relevant discussion, these two classifications of drug priority are essentially treated the same.

Finally, while not directly attributed as a root cause, we believe that the returned medications at the daily cart exchange could be looked examined in a future study. In a brief one day study, 349 medications were returned to the pharmacy during one cart exchange for only ward AG. We did not investigate the relation of these returned medications to missing medication reports, patient discharges, or patient transfers, and this may be an additional item for the future.

Chapter 5: Conclusion

The goal of this project was to examine missing medication reports at the VA Boston Healthcare System West Roxbury campus, to characterize their overall rate of occurrence, to evaluate their impact as a barrier to transforming care at the bedside (TCAB), to identify root causes, and to identify possible opportunities for improvement for consideration at the hospital's upcoming Rapid Process Improvement Workshop. We assessed the current state of missing medications by observing and analyzing current procedures in medication order processing, delivery and administration, as well as through analysis of missing medication figures from March 2006 to March 2010.

We found that historically, missing medication reports have been consistently high at the West Roxbury campus. Our analysis of current data and processes in the hospital identified missing medications as an inherent part of the hospital staff's current operating procedures and a primary contributing factor to decreased efficiency of the pharmacy and nursing staffs. Literature reviews regarding TCAB and the quality of patient care suggest that an increase in nurse availability and efficiency significantly improve patient safety and care. Therefore, missing medications were viewed as detrimental to the quality of patient care.

We then identified improvement areas, categorized into two classes First, we brainstormed several approaches that the hospital staff can use to explore realistic and effective improvements during the upcoming RPIW, such as awareness and review of the '2 hour window' for delivery of new medication orders, consideration of interdepartmental (pharmacy, nursing) cross-training, and a proposed missing medication standard operating procedure. These recommendations address the approximately 15% of missing medication reports related to new orders. Next we examined several additional potential causes of missing medications and found that human error, patient transfers, and daily cart organization also exacerbated the problem. These remaining causes should be studied in the future for continued process improvement.

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