Computer Integrated Surgery II Background Reading Report
Group 23
Rahul Swaminathan

Project Summary:

Our project is the "Creation of a Novel Real-time Communication Solution for Timely Sepsis Management". Sepsis is the body's extreme reaction to an infection, and it is a main cause of global morbidity and mortality, with peak mortality occurring in pediatric and elderly patients. Since sepsis attacks the body so quickly, immediate antibiotic administration is of the utmost importance. Children who receive antibiotics within one hour have, on average, a shorter hospital length of stay and shorter in-hospital mortality rate. Though it is known that identifying sepsis early and treating patients within one hour is critical, the Hopkins Hospital does not currently meet this standard. After speaking with Dr. Fackler and other attending physicians at the Johns Hopkins PICU, it is evident there is a communication issue when it comes to treating children with sepsis, with different team members being unaware of when the antibiotics have been delivered to their location.

Our goal is to find a viable solution to this problem and be able to successfully provide IV antibiotics within an hour to children diagnosed with a serious bacterial infection. Our approach to this solution starts with augmenting a process map of the entire sepsis management workflow to identify all the different roles and potential sources of delay. The biggest problem is finding a way to track antibiotic delivery within the hospital from the pharmacy to the patient, for which we initially planned to repurpose an existing IR-based locator system used to track nurses and patients in the PICU. By correlating locations from this live-tracking data with different roles within the sepsis management workflow, we hope to make a platform to display the current delivery status and alert the relevant personnel when it is their turn to act.

Paper Selection:

The paper I selected is "Implementation of a Web-based medication tracking system in a large academic medical center" (Calabrese and Williams 2012). This paper describes the implementation and effect of a live tracking system for the delivery of medication within the Cleveland Clinic. It directly addresses the second phase of our technical approach by suggesting a different method for antibiotic tracking that does not involve any specialized hardware or locator technology. This may be especially useful for tracking the antibiotics in the pharmacy, where IR-based locator technology may not work.

Summary of Goal, Key Results, and Significance:

Medications that require delivery from the pharmacy to a hospital unit are difficult to track except through direct observation. A lack of real-time tracking leads to delayed or lost doses, which in turn leads to nurses needing to call the pharmacy to search for and reorder medications.

This paper suggests that just like traditional package delivery through companies like FedEx, where barcodes are scanned at different locations to provide electronic delivery tracking for vendors and the end-user, pharmacies can also use barcodes on medications to track patient-specific medications during the delivery process in order to decrease medication turnaround time and improve overall workflow efficiencies.

According to this paper, compared to manual observation, electronic tracking of medications allowed the pharmacy to see how much time was spent at each stage of the delivery process and where the largest delays were occurring. The identification of delays and ability to measure pharmacy delivery efficiency also opened the door for other quality-improved initiatives. This is exactly what we aim to do with our process map and gap analysis, as identifying the problem space will help us target our solution to where it is needed most. Moreover, the paper showed that the implementation of a web-based tracking system substantially reduced medication turnaround times by 45% at the central pharmacy and 22% at the satellite locations in the Children's Hospital, heart and vascular institute, and ICU. This substantiates the goal, approach, and significance of our project, since we aim to implement a similar tracking system with the hope of reducing antibiotic delivery times to within one hour of order placement. Although the methods described in this paper have a much broader application than that of our project, we believe that the suggested tracking approach can supplement our technical approach without the need for much additional hardware.

Necessary Background:

Knowledge of prior work is not necessary for this paper, but it may be helpful to know about some of the technology that is already being used by hospitals to improve pharmacy workflow efficiency.

Automated dispensing machines (ADMs) are computerized cabinets for the safe storage and dispensing of drugs. This method of decentralizing the distribution of medication improves patient safety as well as decreases turnaround times by eliminating the delivery process for commonly prescribed drugs.

Computerized prescriber order entry (CPOE) refers to the process of providers sending medication dosage and order details through a standardized computer application rather than manually placing orders over the phone or in person. This is important for preventing communication and prescription errors as it both improves traceability and allows pharmacists to review all order details before starting the delivery process.

Technical Approach:

Baseline data for this study regarding medication turnaround times was collected through manual recording and observation of each medication's order number, label print time, destination unit, medication name, and actual delivery time. Orders delivered through a pneumatic tube were not included in this baseline data collection.

Implementation of a tracking system was conducted in three stages: workflow analysis, equipment selection, and interface development. The workflow analysis consisted of team meetings to create a process-flow diagram for medication distribution. Specific barcode scan points were chosen to capture data for each leg of the delivery process and identify delays during pharmacist review, preparation of the medications, pharmacist verification, preparation for delivery, and technician delivery. Other scan points accounted for interactions between technicians and nurses as well as deliveries through the pneumatic tube system. These sequential scan points can be seen in the workflow shown in Figure 1.

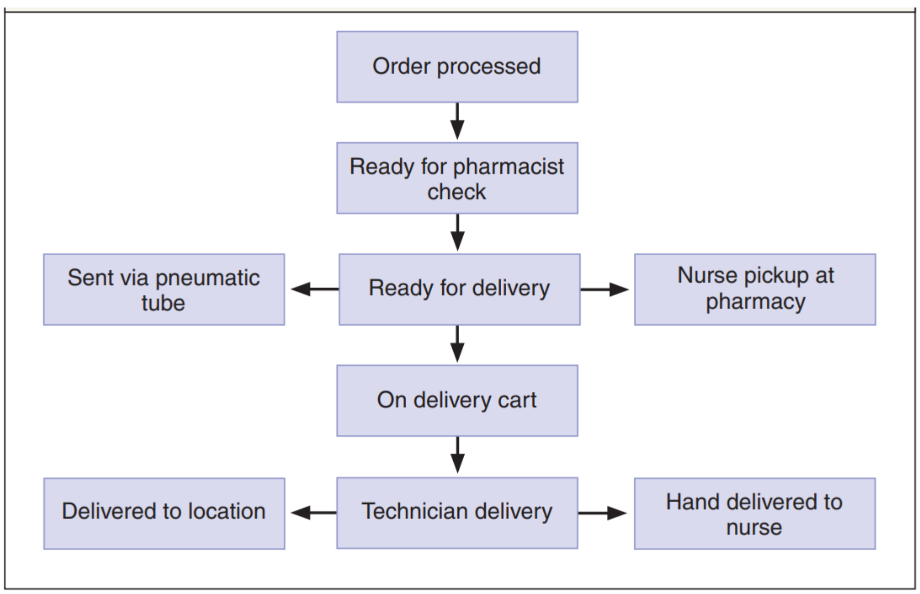

Figure 1: Medication distribution scan points monitored by the Web-based tracking system.

Pharmacy OneSource's MedBoard technology (now called Wolters Kluwer Sentri7) was chosen as the web-based tracking solution for this study. Pharmacy OneSource supplied the pharmacy with unique 2-D barcodes for each scan point and configured a single portal to view each order's destination, delivery status, and time due. This display also included color codes for easier identification of when an order was overdue, approaching overdue, in progress, or delivered/canceled/returned. Each dispensing location was provided with Bluetooth-enabled scanners to capture barcode information, wireless hand-held personal computers, and 42-inch monitors to display the order information and status. The pharmacy informatics team and

Pharmacy OneSource worked together to create a one-way interface between these devices and the automated tracking system.

In addition to deploying these tools in all the pharmacy central and satellite locations, all staff members were instructed and quizzed on how to use the tracking tools in preparation for post-implementation data collection which took place six months later. To ensure the data from this study was representative and reliable, a scan completion rate of 90% was set as the goal, meaning at least 90% of orders scanned by the pharmacy to initiate delivery should have been scanned by the technician to signify the completion of delivery.

Results:

An analysis of the baseline data showed that the original average medication turnaround time was 74 minutes from the central pharmacy and 40 minutes from the satellite pharmacies. It is important to note that this data only includes hand-delivered medications. After implementation of the web-based tracking system, the average turnaround times decreased to 45 minutes from the central pharmacy and 35 minutes from the satellite pharmacies. For the central pharmacy specifically, the turnaround times decreased to 66 minutes for hand deliveries and 17 minutes for pneumatic tube deliveries. For the satellite pharmacies, the turnaround time for hand deliveries actually increased to 45 minutes while the pneumatic tube delivery time decreased to 10 minutes. These results are summarized in Figure 2 and Figure 3.

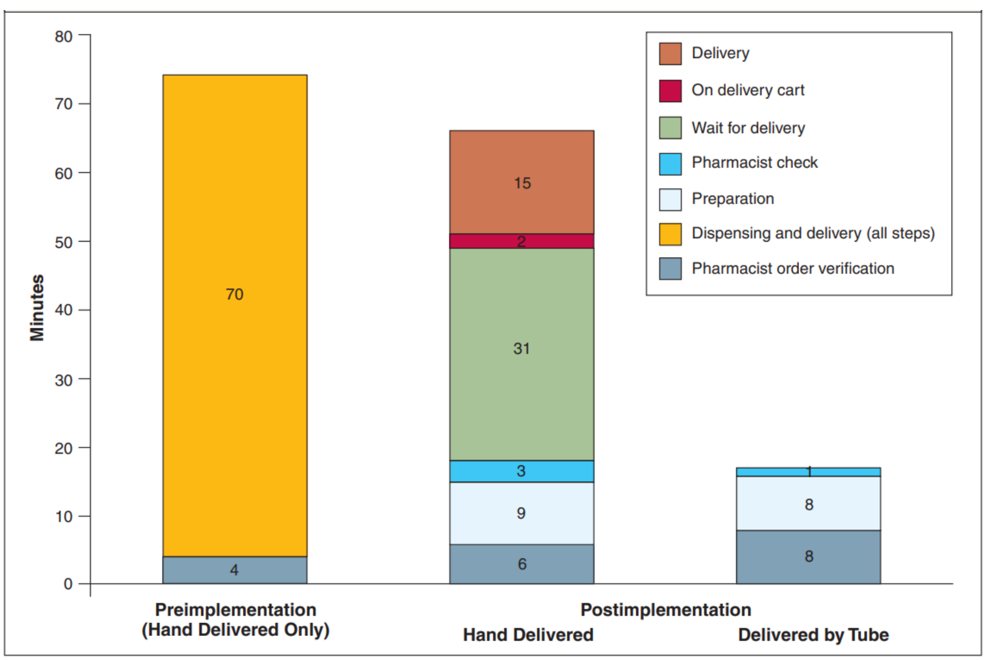

Figure 2: Central pharmacy cycle times and mean turnaround times before and after implementation of the tracking system.

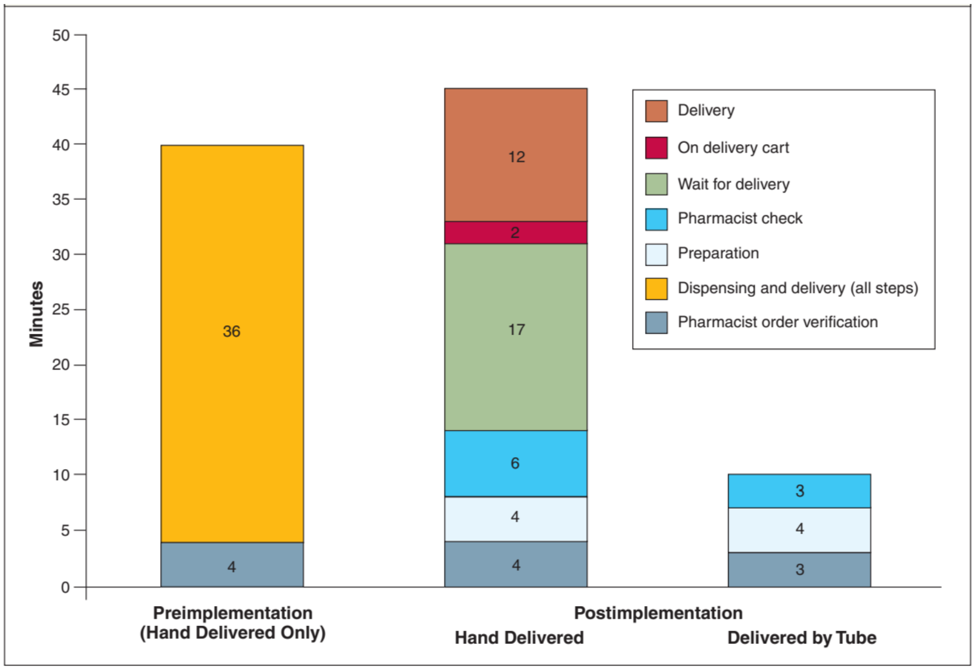

Figure 3: Satellite pharmacy cycle times and mean turnaround times before and after implementation of the tracking system. Values are the means of time values recorded at three satellite locations.

Waiting for delivery and delivery were identified as the most time-consuming steps in processing a medication order. Based on these bottlenecks, the authors of the study identified that the sole use of scheduled delivery rounds prevented faster deliveries as some orders would be sent for delivery right after the end of a delivery round, so they would not be seen until the next round an hour later. To fix this, technicians were instructed to conduct unscheduled delivery rounds for orders that were "overdue" or "approaching overdue" in addition to the scheduled hourly delivery rounds.

The pediatrics and heart institute satellites met the goal of having a scan percentage rate greater than 90%, but the central pharmacy and ICU pharmacy had scan percentage rates of 85% and 82%, respectively, likely due to additional training needs for the larger number of staff in the central pharmacy and urgent delivery needs in the ICU that were prioritized over remembering to scan the medications.

Assessment:

This paper provides a well-structured and easily comprehensible summary of an approach implemented in the Cleveland Clinic to track medications and reduce turnaround times. The importance of the work is clearly explained, and it is obvious from the results that the goal of the study was successful in at least one pharmacy location. The technical approach of the study involving the scanning of barcodes at various identified locations is also explained in detail, which provides a good foundation for future studies attempting a similar approach. Furthermore, the concept of a scan completion rate offers a great insight into both the reliability of this study as well as potential problems with implementing barcode-based tracking in large pharmacies or those with urgent delivery needs.

However, this paper also has several limitations. It would have been useful if the authors had explained why they believe hand-delivery turnaround times increased in the satellite pharmacies, as this result was mentioned in Figure 3 but never discussed despite its importance, and my immediate assumption was that the scanning and tracking added additional time-consuming steps to the delivery process. Additionally, the paper briefly mentioned a prior study involving a web-based tracking system, but it would have been better if they explained what this study has done differently and how exactly they are expanding on the previous work. Also, the lack of baseline data regarding pneumatic tube deliveries detracted from the accuracy of the paper's conclusions. This limitation was briefly mentioned at the end of the paper, admitting that sometimes over 50% of deliveries come through the pneumatic tube system. But, the graphs included pneumatic tube deliveries in the pre and post implementation turnaround times even though these were not calculated in the baseline data, giving the appearance of a larger decrease in turnaround time than actually observed. If this study is repeated at a different location, measuring baseline pneumatic tube delivery times is crucial for confirming the overall validity and necessity of any tracking technology.

Relevance and Next Steps:

While our initial tracking plan required specialized hardware for IR-based tracking technology, the method suggested in this paper could be accomplished just through QR-codes and modern cell phone cameras. Due to the limitations identified in this paper with regards to the time needed for each scanning step and the potential for scanning to be overlooked when delivery needs are urgent, the suggested method may not actually work that well throughout the PICU. Consequently, based on these findings, we may implement the IR-based tracking in the PICU since every room is already configured with the necessary IR-sensing hardware, and we will reserve the web-based tracking approach for the pharmacy and pneumatic tube rooms where IR-based tracking may not work. The time and effort needed to train all PICU and pharmacy personnel to consistently scan barcodes also outweighs the benefits of switching from IR tracking to barcode tracking, since IR tracking would require much less training, whereas the barcode training process would be more manageable if it was limited to just the pharmacists and pharmacy technicians.

Conclusions:

Overall, this paper provides a great suggestion for a new way to track antibiotics that we had not yet considered. The technology described in the paper is simple yet effective, requiring very little hardware that is not already available in the hospital. However, the paper does lack an explanation of some of the results as well as sufficient baseline data to confirm the benefit of tracking technology in all pharmacy locations. Future steps will include investigating the barcode scanning technology further, interviewing pharmacy staff to see if anything like this has been tried before, and creating a proof-of-concept prototype to verify that we can implement a smaller-scale version of this system on our own without going through a third-party provider.

References:

Sam V. Calabrese, B.S.Pharm., M.B.A., Jonathan P. Williams, Pharm.D., M.S., Implementation of a Web-based medication tracking system in a large academic medical center, *American Journal of Health-System Pharmacy*, Volume 69, Issue 19, 1 October 2012, Pages 1651–1658, https://doi.org/10.2146/ajhp110527