Impact of 24/7 Emergency Department Pharmacy Satellite on Emergency Department Operations
Final Report

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# Table of Contents

**Executive Summary** .......................................................................................................................... 1  
Methodology ............................................................................................................................................. 1  
Findings and Conclusions ......................................................................................................................... 2  
Value Added to Nurse ........................................................................................................................... 2  
Value Added to Medical Provider ........................................................................................................... 2  
Nurse and Medical Provider Perceptions of Pharmacy Impact ............................................................. 3  
Value Added to Patient Safety .............................................................................................................. 3  
Recommendations ..................................................................................................................................... 3  
Methods to Measure Impact .................................................................................................................. 4  
Increase Impact ..................................................................................................................................... 4  

**Introduction** .................................................................................................................................... 5  
**Background** .................................................................................................................................... 5  
**Goals and Objectives** ....................................................................................................................... 6  
**Key Issues** ........................................................................................................................................ 6  
**Project Scope** .................................................................................................................................. 7  
**Support Required From Operating Entities** .................................................................................... 7  
**Approach** ........................................................................................................................................ 8  
Observation/Interviews ............................................................................................................................ 8  
Data Collection ....................................................................................................................................... 8  
Complimentary Discharge Medications ................................................................................................. 8  
Order Volume Study ............................................................................................................................... 8  
Literature Search ..................................................................................................................................... 9  
RiskPro Data Regarding Sentinel Events .............................................................................................. 9  
Surveys .................................................................................................................................................... 9  
Task Distribution Analysis .................................................................................................................... 10  
Value Stream Map of Medication Process Flow .................................................................................... 10  
**Findings** ......................................................................................................................................... 10  
Observations .......................................................................................................................................... 10  
Medication Process Flow ...................................................................................................................... 10
Reduction of Waste ........................................................................................................................................................................ 36
Continuous involvement in Patient Therapies .......................................................................................................................... 36
Support for flow of Medications through ED .................................................................................................................. 37
Recommendations ........................................................................................................................................................................ 37
Methods to Measure Impact .......................................................................................................................................................... 37
Benchmark Progress of ED Pharmacy Satellite Impact Over Time ........................................................................................... 37
Format and Track Complimentary Discharge Medication Service Reports .................................................................................. 38
Increase Impact ................................................................................................................................................................................ 38
Tailor Ongoing Medication Updates/Education .......................................................................................................................... 38
Increase Visibility to Medical Providers .................................................................................................................................. 38
Standardize handoff procedure between pharmacists and nurses .................................................................................................. 38
Appendices .................................................................................................................................................................................... 1
Appendix A. Order Volume Study Tick Sheet .......................................................................................................................... A.1
Appendix B. Task Distribution Analysis Tick Sheet .................................................................................................................. A.2
Appendix C. Analysis of Adverse Drug Event Data from RiskRPO Report .................................................................................. A.4
Appendix D. Excel® Macro to Format Discharge Report from MCIT ........................................................................................ A.5
Appendix E. Comparison of Original Pharmacy ROI to Actual Pharmacist Time Spent on Tasks ........................................ A.7
Appendix F. List of Literature Sources ........................................................................................................................................ A.8
Appendix G. Sample Updated Order Volume Tick Sheet for Future Studies ................................................................................ A.9
**Figures and Tables**

Figure 1: Medication Administration Process Flow in the ED………………………………….11

Figure 2: Nurse Consultations by Subject……………………………………………………..12

Figure 3: Medical Provider Consultations by Subject ………………………………………… 13

Figure 4: Basis for Therapy Change……………………………………………………………..14

Figure 5: Therapy Changes by Time Period……………………………………………………15

Figure 6: Pharmacy Utilization by Nurse and Medical Provider …………………………...16

Figure 7: Pharmacy Impact Survey Results (MP and Nurse)………………………………..18

Figure 8: Task Distribution Analysis – Totals…………………………………………………..20

Figure 9: Pharmacist Time Distribution…………………………………………………………21

Figure 10: Task Distribution Analysis – Verification…………………………………………22

Figure 11: Pharmacist Time on Consultations by Reason per 8.5 hour shift………………...23

Figure 12: Task Distribution Analysis – Filling Orders………………………………………..24

Figure 13: Task Distribution Analysis – Trauma/Code………………………………………..25

Figure 14: Task Distribution Analysis – Stock Preparation/ Drug Procurement……………26

Figure 15: Task Distribution Analysis – Delivery of Medications…………………………..27

Figure 16: Box Plot of Incident Reports by Month for 2008 & 2009………………………….28

Figure 17 Various Tracks for Retrieval of Medications from ED Pharmacy…………………..31

Table 1: Reasons for Nurse and Medical Provider Utilization of ED Pharmacy Satellite……. 17

Table 2: Additional Services Prioritized by Medical Providers……………………………...19

Table 3: Adverse Drug Events Reported by Month for 2008 & 2009……………………….28

Table 4: Top Complimentary Discharge Medications……………………………………….29
Executive Summary

Beginning in the fall of 2008, the University of Michigan Health System (UMHS) established a satellite pharmacy in the emergency department (ED) in its Ann Arbor hospital. This was done initially in response to a Joint Commission (JC) (which is a regulatory body for health systems) recommendation requesting prospective reviews of medications administered in EDs throughout the country. Prospective order review is a standard for compliance with the Joint Commission. Prior to the establishment of the ED Satellite Pharmacy, nurses could obtain medications through an automatic dispensing cabinet, called an Omnicell, or by placing an order with the main hospital pharmacy. Medications removed from the Omnicell, which made up the majority of medications in the ED, were not subject to any pharmacist review prior to administration.

The pharmacy, which extended its hours of operation to a full 24/7 schedule in January 2009, helps to satisfy this JC recommendation by having an on-site pharmacist review all medication orders of all controlled and costly medications; the pharmacist’s role is to check for compatibility with respect to patient condition and history. It is thought that by providing this prospective review of the patient’s medical profile that an extra layer of safety would be added to the care that ED patients receive. However, to date, there has not been a way to quantify the impact that the ED Satellite Pharmacy has had on the overall level of patient care in the ED.

In response to this gap in knowledge, an IOE 481 student team was given the task of determining the impact that the 24/7 ED Pharmacy Satellite has had on Emergency Department Operations.

The influence of integrating the pharmacy satellite into ED operations on the unique workflow of the ED and the relative needs of its staff is evident by the feedback of ED staff; however, the exact amount of impact the pharmacy has had is still unknown. To determine the level of impact the ED Pharmacy Satellite has on the University Hospital, it is necessary to quantify the value it has added for nurses, medical providers, patient safety and hospital operations.

Methodology

In order to help quantify the impact that the ED Pharmacy Satellite has had on ED operations and on the overall quality of patient care, the team performed the following tasks:

- Observed ED pharmacist and nurses to create a Process Flow Chart and determine potential data collection techniques, about 20 hours per team member.
- Observed key staff members to determine perception of impact Pharmacy satellite has had on various staff populations.
• Built surveys based on insight from interviews and distributed to all nurses and medical providers. Distributed survey 10-23-2009 to 11-23-2009 to 150 nurses and 138 medical providers.

• Conducted a week long order volume study to determine volumes of consultations and dosage changes performed by pharmacy. Dates: 10-27-2009 to 11-2-2009.

• Conducted a task distribution analysis to determine where pharmacist time is being spent and how these tasks effect ED Operations. Dates: 11-3-2009 to 11-16-2009.

• Obtained historical data about Complimentary Discharge Medication service and RiskPro reports.

• Analyzed study, survey, and historical data to determine areas of ED pharmacy impact.

Findings and Conclusions

The data collected from the Surveys, Order Volume Study, Task Distribution Analysis, Complimentary Discharge Service reports and RiskPro reports was categorized according to the value the data demonstrated to the various aspects of ED operations.

Value Added to Nurse

In a one week period from 10/27/09 to 11/2/09, the ED pharmacists were consulted by nurses 99 times regarding medication orders. Consultations were primarily made up of questions regarding dosage (25%) and preparation techniques (25%). Approximately 22 minutes of a pharmacist’s 8.5 hour shift are spent on nurse consultations. In addition to the educational value of the ED pharmacy, nurse time is also saved when the ED pharmacy is involved in the medication administration process. The outlined medication filling process shows four distinct methods that a nurse may take in order to obtain a medication from the pharmacy. The processes where after the order has been dropped off to the pharmacy and the pharmacist either delivers the medication directly to the nurse or to their respective nurse station represent the greatest time savings for the nurse.

Value Added to Medical Provider

In the same one week period (10/27/09 – 11/2/09) mentioned earlier, the ED pharmacists were consulted by medical providers 56 times regarding medication orders. Provider consultations focused on dosage (45%) as well as alternative treatments (16%). Approximately 17.5 minutes of a pharmacist’s 8.5 hour shift was spent on medical provider consultations. Medical providers were also surveyed on the relative importance of additional services they would like to see performed by the ED pharmacy in the future. According to survey results, the highest priority
for additional services was given to increased interaction with patients, nurses and providers as well as reviewing medications that patients are currently taking at the time of a visit.

*Nurse and Medical Provider Perceptions of Pharmacy Impact*

The perceived impact of the ED pharmacy from the perspective of nurses and medical providers (MP) was found using survey responses from approximately 40% of both groups. The data show that nurses perceive the pharmacy to have a far more positive impact on ED operations than do medical providers. The nurses also report that they utilize the pharmacy to a greater extent; approximately 4.2 visits per shift in comparison to 1.3 visits per shift by medical providers. A common reason for utilization for both parties is consultations, while 81% of nurses use the pharmacy for preparing IV admixtures as well.

*Value Added to Patient Safety*

In addition to indirect improvements to patient safety through nurse training and consultations, the pharmacy has a more direct impact on patient safety by the increased amount of written order verifications. Approximately 2.3 hours of a pharmacist’s 8.5 hour shift is spent verifying orders. In the past, this verification was done by pharmacies located throughout the hospital, but with the establishment of the ED Pharmacy Satellite its proximity has allowed its pharmacists to have increased exposure to nurses and medical providers. This has allowed the pharmacists to have more contact with the care givers and as such, more continuous involvement in the treatment of patients. In addition, according to pharmacists that were interviewed, approximately 25% of orders verified in the ED are paper orders that would not otherwise be verified by a pharmacist (because nurses would obtain them from Omnicells).

The team collected data on changes in medication orders that were initiated by ED pharmacists. A total of 46 therapy changes primarily on the basis of patient body weight (26%) and hospital protocol (24%) were observed.

Additional pharmacy services that lead to improved patient safety in the ED include dispensing complimentary discharge medications for patients in special circumstances as well as the presence of a pharmacist in all trauma/code situations.

**Recommendations**
Over the course of the study, the team has determined tasks necessary to improve the measurement of the impact the ED pharmacy satellite is having on ED operations as well as tasks necessary to increase the impact itself.

Methods to Measure Impact

- Benchmark Progress of ED Satellite Pharmacy impact over time.
The team recommends repeating the Order Volume Study semiannually in order to track the progress of the ED satellite pharmacy from this point forward. Additionally, a subgroup should be created to design and measure key metrics for the pharmacy which are not currently available due to the lack of electronic data.

- Format and Track Complimentary Discharge Medication Service Reports
Reports for the Complimentary Discharge Medication Service are currently entered in non-standard ways that lead to difficulty in monitoring costs and tracking patient use of the service. By standardizing the input format of the various fields in these reports, Pharmacy Services can better track these metrics.

Increase Impact

- Tailor Ongoing Medication Updates/Education
Data from the Surveys, Order Volume Study and Task Distribution analysis show the needs for education among the staff population based on the number of consultations by reason. Medication updates and training for staff should be tailored to meet these needs in order to increase the impact the pharmacy has on ED operations.

- Increase Visibility to Medical Providers
Survey responses from the medical providers offer insights into additional services that physicians and physician assistants would like to see the pharmacy provide. By increasing dosing recommendations for specialized patient populations as well as recommendations in the resuscitation bay, pharmacists can decrease the gap in utilization between nurses and medical providers.

- Standardize handoff procedure between pharmacists and nurses
The delivery of medications is a key component of the pharmacy impact on time savings for the nurse, however, the process is currently non-standard. As long as the tracks followed by all pharmacists are made consistent, the time savings for nurses can be maximized without compromising the control of medications.
**Introduction**

In the Fall of 2008, The University of Michigan Hospital established a pharmacy satellite in the Emergency Department (ED). The pharmacy was initially established in order to provide an increased amount of prospective order reviews on patient medication orders, to help avoid adverse medication events and increase the level of patient safety in the ED. The presence of the satellite pharmacy located in the Emergency Department facilitates quicker prospective order review than the main hospital pharmacy, located five floors away.

The influence of integrating the pharmacy satellite into ED operations on the unique workflow of the ED and the relative needs of its staff can be witnessed upon observation; however, the exact amount of impact the pharmacy has had is still unknown. To determine the level of impact the ED Pharmacy Satellite has on the University Hospital, the team found that it was necessary to quantify its effects in terms of the value it has added for nurses, medical providers, the University Hospital as well as for patient safety. The purpose of this report is to explain the impact that the team has found the ED Pharmacy Satellite has had on ED Operations. This report will explain our data collection methods, findings, conclusions and will provide recommendations about improving the metrics to measure the ED Pharmacy Satellite’s impact.

**Background**

After submitting an initial proposal (Return on Investment) in support of creating an Emergency Department (ED) Satellite Pharmacy, the University of Michigan’s ED established an onsite, 24-hour pharmacy in January, 2009, becoming one of the few EDs in the U.S. with this resource. The ED staff report that they are not accustomed to utilizing the pharmacy and, as such, the hospital administration is unsure of the level of impact the pharmacy is having on doctors’ and nurses’ workloads and patient safety. The decision to use, or not to use, the ED Pharmacy is ultimately made by the caregiver, and the hospital administrators do not know why some caregivers use the ED Pharmacy more often than others.

Currently, ED staff can obtain medications in one of two ways. Using the first method, the ED staff member can log into a computerized medication dispensing cabinet called an “Omnicell.” These Omnicell terminals are centrally located in each of the areas of the ED: Main, Pediatrics, MedPath, Resuscitation Bay, and West Wing. The Omnicell’s are stocked with medications that are commonly consumed by the patients in those areas. These cabinets allow the nurse to look up the patient’s name, select the appropriate medication and dispense the medication when needed. However, the Omnicell is unable to alert the nurse of potential medication interactions or contraindications. The ED pharmacy now provides caregivers a second way to quickly obtain
medications, with increased patient safety because a pharmacist review of medication orders is an added buffer against ill-effects of medications. Two perceived benefits of the ED pharmacy are the added safety for the patient and the time savings for the ED staff. The extent to which ED staff utilizes the ED pharmacy needs to be quantified in order to validate these perceived benefits.

Additionally, pharmacists in the ED increase patient safety by consulting on medication compatibility, medication alternatives and dosage amounts. A pharmacist also reviews the patient’s medical history and any known allergies, prepares medications in a more sterile environment, and helps evaluate and provide services to critically ill patients in the resuscitation bay. The extent to which these activities and all activities related to medication procurement and administration impact the safety of a patient needs to be quantitatively determined.

Therefore, this project evaluated the impact the ED Satellite Pharmacy has on the value added by nurses and medical providers as well as the safety of patients as they flow through the ED.

**Goals and Objectives**

The IOE 481 team has determined how the impact of the ED Pharmacy Satellite can be appropriately quantified. The quantification includes effects of the pharmacy on:

- Added value for nurses (i.e. additional patient care time and education)
- Added value for medical providers (i.e. pharmaceutical consults)
- Added value to patient safety

The team employed quantitative analysis as well as qualitative information to establish a comprehensive representation of the effect of the ED Pharmacy Satellite on ED operations.

**Key Issues**

The project was driven by the need to quantify the ED Pharmacy Satellite’s impact on the following issues:

- Concern for efficient workflow
- Concern for patient safety
Project Scope

This project has included thorough evaluation of activities related to the procurement, preparation and administration of drugs in all five areas of the ED Pharmacy: Main, Children’s Emergency Services, Minor Emergency Care Area, MedPath and West Wing. Nurses, physicians and pharmacists from each of the areas of the ED have been observed and were included in various forms of data collection.

This project pertained only to the ED Pharmacy Satellite. The transfer process for inpatient records and operations of other pharmacies in the hospital were not included in the scope of this project. The project also excluded any optimization of pharmacy satellite processes.

Support Required From Operating Entities

To achieve the goals of this project, the IOE 481 team utilized the resources of the following operating entities:

- Brian Callahan, Pharmacy Assistant Director
  - Provided proper contact information within pharmacy department
  - Conveyed observational study capabilities
  - Attended weekly update meetings
  - Provided background information as well as any historical data

- Sheri Moore, Industrial Engineer Lead and Lean Coach, POA
  - Provided general project guidance
  - Attended weekly update meetings

- Pam Walker, Clinical Coordinator, Emergency Department Pharmacy Services
  - Enlisted pharmacist participation
  - Provided background information as well as any historical data

- Candice Catanzarite, RN Manager
  - Enlisted nurse participation in surveys
  - Assisted in scheduling detailed nurse observation

- Dr. Steven Kronick, Physician Coordinator, Emergency Department
  - Enlisted physician participation in surveys
  - Provided perspective on utilization of pharmacy satellite by practitioners
Jennifer Holmes, Director of Operations, Emergency Department
  • Provided data from ED Software (i.e. Centricity)

Nancy MacDonald, Clinical Coordinator, Henry Ford Hospital – Pharmacy Services
  • Provided information regarding pharmacy performance metrics utilized at HFHS

**Approach**

The team observed the process thoroughly and determined a data collection plan that quantified the impact of the ED Satellite Pharmacy on ED operations. The second part of the approach was to implement that specific data collection plan. The techniques that the team used are outlined below:

**Observation/Interviews**

In approximately 15-20 observation hours in the ED, the team interviewed pharmacists, physicians and nurses, when possible, to determine the educational impact of the pharmacy as well as any impact on their ability to spend more time with patients. Through these interviews, the team ascertained how nurses and pharmacists perceive the pharmacy and the costs and benefits they associate with it.

The team also interviewed the clinical coordinator at the Henry Ford Hospital. The purpose of this interview was to obtain information concerning an established ED pharmacy satellite and what metrics are in place for evaluation.

**Data Collection**

The following data were collected and used throughout this project to aid in evaluating the impact of the ED Pharmacy Satellite:

*Complimentary Discharge Medications*

The team requested a report detailing the medications that the ED Pharmacy Satellite has dispensed without-charge to patients from August 22 to September 19, 2009. The team has created an Excel macro to organize and effectively display the data. The purpose of this was to determine patterns in the discharge medication data and costs of the medications.

*Order Volume Study*

The team created a tick sheet consisting of the various forms of consultations and therapy changes that a pharmacist may face. The sheets were then given to pharmacists at the beginning
of every shift with the expectation that every time a pharmacist provides a consultation to a nurse or medical provider, or initiates a change in therapy, the pharmacist would mark a tick in the corresponding box. Please see Appendix A for a sample Order Volume sheet. The study began October 27 at 8 am and ended November 2, 2009 at 11:59 pm. The purpose of this study was to quantify the number of therapy changes and consultations a pharmacist provided in one week.

**Literature Search**

The team has conducted an extensive literature search and examined past data records to augment observations. The team identified common services and performance metrics other ED Pharmacy satellites provide. A list of the sources for this literature can be found in Appendix F

**RiskPro Data Regarding Sentinel Events**

The team also received a report that listed the Emergency Department Medication Events from January 1 to October 31 for 2008 and 2009. These events are potentially unsafe incidents that have occurred in the ED and were voluntarily reported. The team has compared the data from the year before the ED Pharmacy Satellite opened (2008) to after the ED Pharmacy Satellite was operational 24/7 (2009) and determined the medications that were common in the incident reports. The purpose of obtaining a report of the adverse medication events was to determine how the number of events has changed since the advent of the ED Pharmacy Satellite.

**Surveys**

The team has constructed surveys using Zoomerang® for nurses and medical providers in the ED. The purpose of the surveys was to determine the factors that go into the decision to utilize the ED Pharmacy Satellite and to determine the usage of the variety of services provided by the pharmacy. The survey also evaluated the perception of added benefits the ED pharmacy has had on their work and patient safety overall.

The nurse survey was open for one month beginning October 23 and concluding November 23, 2009. Of the approximate 150 nurses in the ED, the team had 58 responses, corresponding to a response rate of about 39%.

The medical provider survey was distributed to all the physicians and physician assistants in the Emergency Department (138 people). The survey was open for 17 days beginning November 6 and concluding November 23, 2009. Of the approximate 138 medical providers (MPs) working in the ED, the team had 53 responses, corresponding to a response rate of 38.4%. Of the respondents, 50% have 6 or less years experience as a medical provider while 71% have 6 or less years experience as an MP in the UMHS.
Task Distribution Analysis

The team has also conducted another tick sheet study to understand the relative distribution of pharmacist time stratified by task. Task data collected was randomized with the use of beepers. Data was collected for two weeks beginning 2:30 pm on Tuesday November 3 and concluding at 11:59 pm on Monday November 16, 2009. Pharmacists were asked to wear the beepers throughout their entire shift and instructed to place a tick-mark in the box that corresponds to the time of day and task they were performing whenever the beeper vibrated. The beepers were programmed to vibrate randomly 4 times per hour. The beepers allowed the team to collect 1253 ticks in a two-week period for a random sampling of tasks. A sample data collection sheet for this experiment is provided in Appendix B.

Value Stream Map of Medication Process Flow

The team has constructed a high-level value stream map, based on observations and interviews, indicating the process from when a medication order is written until it is administered.

Findings

The findings in this section reflect real-time and historical data collected by the student team over the course of the study.

Observations

Medication Process Flow

Shown in the value stream map of the medication administration process flow in Figure 1 below, a nurse has two primary options for filling medication orders: an Omnicell machine or the ED Pharmacy Satellite. Omnicell machines usually hold common medications specific to the unit of the ED the machine is located. The ED Pharmacy Satellite stores other uncommon medications (as well as an extra supply of common medications) and controlled substances. A nurse who brings an order to the ED Pharmacy Satellite has three distinct options:

- Wait for the order to be filled,
- Leave and allow the pharmacist to deliver the medication or leave, or
- Return to pick-up the medication

Lack of Electronic Data

The team initially hoped to compare medication turnaround time in the ED pre and post the advent of the ED Pharmacy Satellite. Through observations and interviews with key personnel
such as the Director of Operations in the ED, the clients and numerous pharmacists, the team concluded that analysis of this metric would require too much time for the amount of data able to be obtained. Currently, medication orders in the ED are not consistently time-stamped.
Figure 1. Medication Administration Process Flow in the ED
Order Volume Study

Nurse Consultations at ED Pharmacy Satellite

The team has collected data regarding nurse consultations at the ED Pharmacy Satellite for a one-week period beginning October 27 and ending November 2, 2009. During that time frame 1,479 total patients were treated in the Emergency Department. The National Health Statistics Report in 2006 states that while in the ED, a patient receives an average of 1.8 medications. This means that the ED administered roughly 2,600 medication orders during that time frame. As shown in the Figure 1, nurses may either fill medication orders at an Omnicell or at the ED Pharmacy Satellite.

From our Order Volume Study data, the team found that the pharmacists in the ED Pharmacy Satellite had 155 consultations during the week of data collection. That represents consultations for approximately 6% of all the medication orders filled in the ED that week. The reasons for consultations (n = 99) from nurses are given in Figure 2 below:

![Figure 2. Nurse Consultations by Subject](image)

Conducted by IOE 481, Team 8 from: 10/27/2009 – 11/02/2009  n = 99 consultations

As shown in Figure 3, the most common reasons for nurse consultations are dosage and preparation technique questions. The large Other category primarily represents nurses consulting pharmacists for a quick answer to drug information question or to identify the cause of a patient overdose.
Medical Provider Consultations at ED Pharmacy Satellite

The volumes of medical provider consultations by ED pharmacists were also gathered in the same study as the nurse consultations. The details of this study are described above, and the tick sheet in Appendix A illustrates how pharmacists distinguished between the consultations they conducted. The results of the categorical breakdown of the medical provider consultations (n = 56) are shown in Figure 3 below.

Figure 3. Medical Provider Consultations by Subject  
Conducted by IOE 481, Team 8 from: 10/27/2009 – 11/02/2009 n = 56 consultations

The primary reason for a medical provider consultation is dosage. Dosage consultations include a wide range of questions regarding the amount or concentration of a medication that will be administered. This is consistent with the perception of medical providers seen in the survey data above. A significant portion of consultations are regarding alternative treatments, which suggests that pharmacists have the opportunity to communicate recommendations for therapy changes based on the emergence of new medications or protocols. In talking to pharmacists, the team discovered that the rather large category of Other is made up of various consults regarding identifying patient overdoses, adverse effects of medication and new medications.
Therapy Changes

During the verification process, if a problem with the medication order has been discovered the pharmacist will then seek a change in therapy for the patient. A change in therapy is defined as a change in the dosage to be given to the patient, frequency of medication to be given, or a change to a similar medication to treat the same symptom(s). The pharmacist could change the current course of therapy due to a number of issues that could arise during the verification process, the most common of which would be due to patient allergies, age, body weight, medical history, or hospital protocol. Figure 4 below demonstrates the basis for therapy changes.

![Figure 4. Basis for Therapy Change](image)

All of the above reasons for therapy change contribute to increased patient safety. Approximately half of therapy changes are a result of recognizing incompatibilities according to previous allergy history and tailoring dosages to the patient’s body weight. In addition, many medication dosages are dependent upon the patient’s body weight. Once the attending medical provider prescribes a medication it is the nurse’s duty to calculate the appropriate dosage. However, with complicated units and conversions, it is very easy to make calculation errors, so to ensure that the wrong dosage is not given, the pharmacist is responsible for rechecking the dosage recommendation to
ensure. Ensuring the calculations are correct and changing the dosage based upon body weight adds to the increased level of patient safety in the UMHS ED.

It is also interesting to note that during the busier times of the day (afternoons and evenings) the number of therapy changes increases. Figure 5 below is a summary of the total number of therapy changes based upon time of day.

![Figure 5. Therapy Changes by Time Period](image)

Conducted by IOE 481, Team 8 from: 10/27/2009 – 11/02/2009 n = 46 therapy changes

**Surveys**

Included in the survey the team administered to nurses and medical providers were questions regarding why and how often they typically utilize the ED Pharmacy Satellite.

**Perceived Utilization**

The team found that on average, a nurse utilizes the ED Pharmacy Satellite approximately 4.2 times per shift, and medical providers utilize it approximately 1.3 times per shift. Figure 6 below illustrates the nurse and medical provider responses for this question.
As shown in Figure 6 above, the number of visits/shift is heavily weighted to 6 or fewer and lower for providers than nurses. The range of responses for nurses is also greater than that of medical providers.

**Perceived Reason for Use**

The team also determined the primary reasons that a nurse or medical provider would utilize the ED Pharmacy Satellite. Survey respondents were instructed to mark as many reasons that apply; therefore, the total number of responses for this question does not sum to our 58 total responses for nurses and 53 total responses for medical providers. Table 1 below indicates these primary reasons.
Table 1. Reasons for Nurse and Medical Provider Utilization of ED Pharmacy Satellite

 Nurse: n = 58, MP: n = 53

<table>
<thead>
<tr>
<th>Reason for Utilization</th>
<th>Nurses</th>
<th>Medical Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Responses</td>
<td>% Responses</td>
</tr>
<tr>
<td>Consult - Dosage</td>
<td>43</td>
<td>75%</td>
</tr>
<tr>
<td>Consult - Drug Compatibility</td>
<td>44</td>
<td>77%</td>
</tr>
<tr>
<td>Prepare an IV admixture</td>
<td>46</td>
<td>81%</td>
</tr>
<tr>
<td>Consult - Allergies</td>
<td>16</td>
<td>28%</td>
</tr>
<tr>
<td>Do Not Use</td>
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<td>0%</td>
</tr>
<tr>
<td>Medication Not In Omnicell</td>
<td>7</td>
<td>12%</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>5%</td>
</tr>
<tr>
<td>CareLink Orders</td>
<td>5</td>
<td>9%</td>
</tr>
</tbody>
</table>

As shown in Table 1 above, nurses utilize the ED Pharmacy Satellite to prepare a mix or IV and consult about drug compatibility and dosage more than any other reason. Twelve percent of the respondents also stated that he or she utilize the ED Pharmacy Satellite when they realize that medication is not in the Omnicell machine. On a related note, the team determined that 82% of nurses do not check Omnicell inventory before pursuing a medication. In comparison, medical providers utilize the pharmacy solely for consultations, if at all. Dosage and compatibility consultations are most common for medical providers; however, a significant amount of respondents that indicated usage for allergy consultations as well.

Perceived Impact of Pharmacy on ED Operations

According to the surveys, both groups felt that the pharmacy has had a positive impact on ED operations (in terms of medication turnaround time, patient safety, convenience, and training), but to varying degrees. A summary of the medical providers and nurses responses are shown in Figure 7 below.
The nurses have a much more positive opinion of the ED Pharmacy than the MPs. The nurses rated each response category at least an 8 while MPs rated each category about one point lower. The weighted averages are provided above each bar. It is important to note that on average, MPs rated Medication Turnaround Time and Education in the high 6 range, corresponding to barely a positive impact.

This perception of the influence of the pharmacy is correlated with the amount levels of utilization between the two groups. Nurses are much more likely to use the pharmacy, 61% of RNs use the pharmacy 4 or more times per day, while just 32% of doctors use the satellite on a daily basis.

Medical Providers were also asked which services they would like to be added to the scope of the pharmacy’s role in the ED. The respondents were instructed to prioritize the additional services he or she deem most helpful that ED pharmacists could provide. The results from this question are provided in Table 2 below.

<table>
<thead>
<tr>
<th>Additional Services That May Be Helpful</th>
<th>Weighted Average Priority Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosing Recommendations for specialized patient populations</td>
<td>2.00</td>
</tr>
<tr>
<td>Increased number of medication recommendations during resuscitation</td>
<td>2.61</td>
</tr>
<tr>
<td>Specific recommendations for choices of discharge medications based on patient need</td>
<td>3.30</td>
</tr>
<tr>
<td>Reviews of current medications issued by primary care providers</td>
<td>3.39</td>
</tr>
<tr>
<td>Increased interactivity with medical providers, nurses and patients</td>
<td>3.61</td>
</tr>
</tbody>
</table>

Of the five suggestions (summarized from interviews with head ED MPs), the MPs suggested that the pharmacists should provide more recommendations for specific/specialized patient populations, and would like the pharmacist to increase the amount of recommendations during traumas/codes. These services can be provided through dialog between the pharmacists and the
medical providers and having the pharmacists respond to more situations in the ED (overdose situations for example).

**Task Distribution Analysis**

A task distribution study was conducted by the student team with the help of the ED Pharmacy staff from November 3, 2009 until November 16, 2009. During this study, pharmacists were asked to carry around a detailed tick sheet outlining all previously observed tasks to be completed by the pharmacist. Pharmacists were instructed to mark a tick on the sheet each time the vibrating beeper they were provided, began to vibrate. Beepers were programmed to alert the pharmacist at 4 random times per hour.

From these observations, a distribution of the tasks the pharmacists performed during a standard 8.5 hour shift was obtained. It was observed that the largest proportion of a pharmacists shift was spent filling orders (29%, or 149 minutes per shift) and verifying orders (27%, or 136 minutes per shift). A graphical summary of these observations is shown in Figure 8 below.

![Figure 8. Task Distribution Analysis – Totals](image)

*Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009
8.5 Hour Shift*
Task Analysis Distribution by Shift

The team also analyzed the distribution of tasks over the three daily shifts: mornings (7 am – 3:30 pm), afternoons (2:30 pm – 11:00 pm), and evenings (9 pm – 7:00 am), to determine if certain activities tended to be more prevalent at different parts of the day. The team found that during peak hours of operation (afternoons) that a larger percentage of time was spent filling medication orders as opposed to less busy times (mornings). During these less busy times pharmacists had more time to prepare for the anticipated influx of patients later in the day by preparing IVs and medications for stock and performing research/self-educating themselves on medications. A graphical summary of the pharmacist task distribution, stratified by shift, is shown in Figure 9 below.

![Figure 9. Pharmacist Time Distribution](image)

**Figure 9. Pharmacist Time Distribution**

Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009
8.5 Hour Shift

**Pharmacist Time Spent on Verifying Orders**

The verification process of filling patient medication orders is one of the most prevalent activities performed by the ED Pharmacist, consuming approximately 27% of the pharmacist’s tasks. While the pharmacist is verifying an order, the pharmacist is checking that that particular
medication is the correct dosage, does not conflict with a patient’s allergies (if any exist), is compatible with other medications the patient is currently taking, does not conflict with the patient’s pertinent medical history, and is consistent with the patient’s profile (determining the current course of treatment and how it affects new treatment method). The pharmacist also verifies CareLink orders at a later point, either individually or in a batch. A graphical summary of these tasks is shown in Figure 10 below.

![Figure 10. Task Distribution Analysis – Verification](image)

While all tasks performed during the verification process contributed directly to ensuring that the patient is receiving the appropriate course of treatment, a large proportion (approximately 55%) of the pharmacist’s verification time is consumed by the checking of dosages and reviewing the patient’s profiles. These specific verification processes correspond to approximately 76 minutes of an 8.5 hour shift. Pharmacists ensure that the patient is not receiving too much, nor too little of the prescribed medication to maximize drug effectiveness and safety, and that the medication order will not interfere with a current treatment course when verifying orders.
The team analyzed the amount of time pharmacists spent on consultations, which was then broken down by category and by who was being consulted with, a nurse or medical provider. It was found that a larger proportion of time (22 minutes) was spent consulting nurses than was spent consulting medical providers (17.5 minutes). In comparing the results of the task distribution analysis with the order volume study, the team found that the task distribution study verifies the data that the team has already collected. In comparing the two studies, the team found the same patterns of utilization are consistent and that nurses tend to use the pharmacy more than medical providers. A graphical summary of the amount of pharmacist spent on consultations by subject and by consultee is shown in Figure 11 below.

![Figure 11. Pharmacist Time on Consultations by Reason per 8.5 hour shift](image)

**Figure 11. Pharmacist Time on Consultations by Reason per 8.5 hour shift**

*Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009*

*Nurse: n = 22 minutes/shift MP: n = 17.5 minutes/shift*

**Pharmacist Time Spent Filling Orders**

The task analysis study indicated that an ED pharmacist spends about 2.5 hours a shift filling medication orders. While filling orders, 50% of that time (74.5 minutes per shift) was spent
preparing IV mixtures and 35% time was spent dispensing pills and tablets. Figure 12 illustrates the specific tasks that comprise the 2.5 hours (149 min).

**Figure 12. Task Distribution Analysis – Filling Orders**

Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009

\( n = 149 \text{ minutes/shift} \)

**Pharmacist Time Spent Responding to Trauma Codes**

When the ED has been notified that an incoming patient is extremely urgent and is of code 1, 2, or 3, the pharmacist on duty is paged to help prepare for the patients’ arrival. The page will include the patient’s current condition and the circumstances surrounding the code (trauma, cardiac, potential stroke, etc.) and estimated time of arrival. The information contained in the page is critical to how quickly the a course of medication can be started on an incoming patient; as soon as the page is received the pharmacists begins gathering and identifying potentially prescribed medications that will be available at the patient’s bedside when they enter the ED. The presence of a pharmacist in the resuscitation area greatly reduces the amount of time it takes
for a medication to be turned around in these instances, as there is no time lost in the nurse traveling to the pharmacy and encountering problems with the pharmacy (pharmacist not available, medication not currently available in pharmacy) and having to wait for a medication to be prepared in an instant when time is very critical.

Despite the fact that approximately only 5% of the pharmacists time at work is spent responding to a trauma/code, survey responses from nurses and medical providers reflect that the addition of the pharmacist responding to the code has been extremely beneficial to the speed and effectiveness of care given to the most critical of patients. The pharmacist, in addition to helping the ED to be more prepared for the patients arrival, also serves as “an extra pair of hands” that assists in preparing and administering medications, researching medications, and helping in the physical resuscitation of a patient (administering CPR, assisting patient breathing) among other tasks (evaluating patient condition, receiving/interpreting oral instructions, interpreting test results).

Of the time that a pharmacist spends responding to a code, a large percentage of that time is spent preparing medications (31.7%, or 7.73 minutes per shift) and on other tasks (41.7% or 10.18 minutes per shift) consisting of actively assessing the patient’s condition and receiving orders from the attending medical provider. A graphical breakdown of the tasks performed by the pharmacists during resuscitation is shown in Figure 13 below.

![Figure 13. Task Distribution Analysis – Trauma/Code](Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009)
Pharmacist Time Spent on Stock Preparation and Drug Procurement

The task analysis distribution reveals that ED Pharmacists spend approximately 8% of their time on a given 8.5 hour shift (about 40 minutes) stocking the pharmacy and procuring drugs. Preparation of stock allows the pharmacy to manage the inventory held in the ED Pharmacy Satellite space as well as to prepare common IVs and mixtures to reduce wait times. The team’s observation has revealed some common mixtures, such as the GI cocktail that pharmacists keep prepared due to anticipated demand.

Figure 14 below outlines the distribution of tasks that comprise stock preparation and drug procurement services. These services account for approximately 40 minutes of an ED pharmacist’s 8.5 hour shift.

![Figure 14. Task Distribution Analysis – Stock Preparation/ Drug Procurement](image)

Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009

n = 40 minutes/shift
As the findings in Figure 14 make evident, 40 minutes of a pharmacist shift is spent managing the inventory of the ED Pharmacy Satellite and physically acquiring the medications from the basement (either by walking downstairs or to the tube station).

**Pharmacist Time Spent on Delivery**

Pharmacists are also actively involved in the delivery of medications to the nurses. When not restricted by other tasks, pharmacists routinely deliver the medications to the nurses or appropriate nurses’ station. The amount of time typically spent performing these delivery tasks, usually done in groupings when a number of orders going to the same area have been filled, accounts for 32 minutes of a pharmacist’s shift. Of these 32 minutes spent on delivery, 64.6% (21 minutes per shift) is spent on delivering the medications to the appropriate nurses’ station. A graphical breakdown of the different tasks performed by pharmacists during delivery is shown in Figure 15 below.

![Figure 15. Task Distribution Analysis – Delivery of Medications](image)

*Conducted by IOE 481, Team 8 from: 11/03/2009 – 11/16/2009
n = 32 minutes/shift*

**RiskPro Data**
From 2008 to 2009 the number of reported medical errors has increased from 51 in 2008 to 61 in 2009. While it may appear that the number of errors had increased since the inception of the ED pharmacy, there is perception among ED staff that this may be attributed to an increased culture of reporting. The team conducted a paired t-test to determine if the increase in adverse drug events per month was statistically significant. It was found, with 95% confidence, that the increase was not statistically significant (p = 0.273). Table 3 below shows the number of reported events per month, and Figure 16 illustrates a box-plot with the descriptive statistics for the number of events per month for each year.

Table 3. Adverse Drug Events Reported by Month for 2008 & 2009

*Obtained from RiskPro Report, pulled 12/01/2009*

<table>
<thead>
<tr>
<th>Month</th>
<th>2008 Reports</th>
<th>2009 Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>February</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
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<tr>
<td>April</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>May</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>June</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>July</td>
<td>8</td>
<td>4</td>
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<td>August</td>
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<td>7</td>
</tr>
<tr>
<td>September</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>October</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>51</strong></td>
<td><strong>61</strong></td>
</tr>
</tbody>
</table>
Complimentary Discharge Medication Service Data

As a courtesy to patients discharged by the ED, the pharmacy will often provide a small package of complementary medications to the patient, at no additional cost to the patient. This package generally consists of a few dosages (approximately 24-48 hours’ worth) of the prescribed medication giving the patient time to travel back to their home and allowing them to fill their medication order at their own convenience. The pharmacy will provide this service as deemed appropriate; from August 22, 2009 to September 19, 2009, 75 complimentary dosages were provided to discharged patients. Among the 44 different medications (with the number of times dispensed in parentheses) the most popular among them were Lorazepam (7), Hydrocodone (4), and Invega (4) with a number of others dispensed 3 times or fewer, as shown in Table 4 below.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Times Prescribed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorazepam</td>
<td>7</td>
</tr>
<tr>
<td>Hydrocodone</td>
<td>4</td>
</tr>
<tr>
<td>Invega</td>
<td>4</td>
</tr>
<tr>
<td>Acetylcysteine</td>
<td>3</td>
</tr>
</tbody>
</table>
The team created an Excel® macro to format the data in the report received from MCIT so that it could be sorted by relevant categories. Such categories include: date ordered, medication given, prescriber and National Drug Code (NDC) number. The team had hoped to determine the costs associated with these medications; however, the format of the data (especially NDC code) was non-standard. Therefore, the team was unable to determine the costs of these medications.

**Evaluation of Pharmacy Against Original ED Satellite Pharmacy ROI**

The proposal for the creation of the ED Satellite Pharmacy quoted the benefits of specific ED Pharmacy services. Appendix E shows each of these services as well as the amount of time Pharmacists spend on each of these tasks in a given shift. The table in Appendix E shows that all the goals of the proposal for the ED Pharmacy are in some way being fulfilled by the tasks that the pharmacists perform throughout the day.

The table in Appendix E illustrates that the majority of the goals relate to forms of consultation that the pharmacist provides while in the emergency department. The degree to which these consultations impact the staff of the emergency department is evident in the various goals that are achieved, both in patient safety and in education.

**Conclusions**

The findings above provide a basic understanding of the services performed by pharmacists in the Emergency Department as well as the perception of these services among ED staff. To evaluate the impact that these services are having on ED operations, it is necessary to define the value added by each of the functions of the pharmacy. The aspects of ED operations to which value is added by the ED Satellite Pharmacy include Nurses, Medical Providers, Patient Safety and the University Hospital as a whole.

**Value Add to Nurses**

The value added to nurses by the ED Pharmacy Satellite can be seen in the educational value provided in consultations as well as the time savings provided by the functions that pharmacists have taken over from nurses.

*Consultations*
Nurse consultations account for a majority of the consultations the pharmacists perform, and are often regarding dosage or preparation techniques. The value of these consultations is primarily in the enhanced education and training of the nurse in the use or effects of a specific medication. The consultations may have widespread effects when conducted on common medications that are used frequently in the Emergency Department. Therefore, although only 99 consultations were observed over the course of the week, the number of orders that were affected by the consultations is larger.

**Time Savings**

The value stream map created as a result of the team’s observations defines four tracks by which a nurse can obtain a medication from the ED Pharmacy. Figure 17 below illustrates the possible tracks. The red dotted-circle denotes track 4 with the least time savings, in which the nurse brings an order to the pharmacy and waits at the window while it is filled. The green circle denotes the other three tracks which allow the nurse to drop the medication order at the ED Pharmacy and return to patient care while the order is being filled.

![Figure 17. Various Tracks for Retrieval of Medications from ED Pharmacy](image)

Track 1 illustrates the case in which the nurse returns to the window to retrieve the filled medication, track 2 illustrates the case in which the pharmacist delivers the filled medication to the nurse directly and, finally, track 3 illustrates the case in which the pharmacist delivers the filled medication to the RN station. Tracks 2 and 3 seem to offer the most time savings for the
nurses, because they are allowed to return to patient care during the filling and delivery of the medication order.

**Value Add to Medical Providers**

The impact of the ED satellite pharmacy on medical providers is far less than the impact it has had on nurses. This is seen in the survey responses of each group regarding their perceived utilization, the number of consultations done with each group and the pharmacist time spent on consultations with each group. Based on a phone interview with the ED Pharmacist at Henry Ford Hospital, the team determined that a higher utilization rate is often observed among nurses than medical providers in ED pharmacies.

**Consultations**

Medical Provider consultations were primarily regarding dosage and alternative treatments, and made up 17.5 minutes of a pharmacists 8.5 hour shift. The consultations regarding alternative treatments and therapy changes due to hospital protocol may suggest that the ED pharmacist is communicating valuable medication updates to medical providers. This form of communication can alter future therapies and help them better align with the protocols and medications the hospital would like to see used.

**Value Add to Patient Safety**

Of the studies conducted, our team was able to identify a number of practices and policies in the ED that have contributed positively to overall patient safety. The pharmacists themselves are involved in a broad number of activities outside of filling orders handed to them by nurses and medical care providers. Examples of activities performed by pharmacists that contribute to patient safety include:

- Verifying prescribed medication and patient history
- Responding to urgent, incoming trauma codes
- Preparing IV medications
- Preparing a package of complimentary discharge medications

**Therapy Changes**

The therapy changes observed in the Order Volume Study were primarily due to body weight and hospital protocol. These changes may reflect complex calculations for children’s mixtures, or new protocol the hospital has recently implemented. An important note about the therapy changes is that the majority of the orders that were changed were via an electronic CareLink
system that would previously (before the creation of the ED Pharmacy satellite) have been sent to the main hospital pharmacy. There are, however, a smaller number of therapy changes for paper orders that would not have otherwise been prospectively reviewed.

*Trauma Code Participation*

The majority of the 24 minutes that the pharmacist spends in the Resuscitation Bay is spent anticipating patient needs. However, the presence of the pharmacist at every code is instrumental to patient safety as it is mentioned by the Joint Commission, the American Society of Health Professionals and the proposal for the creation of the ED satellite pharmacy at UMHS. All of these sources cite the pharmacist’s presence in the ED as contributing to the accurate preparation and administration of medication without the risk of interactions or contraindications.

*Preparing IV Admixtures*

With the addition of the ED Pharmacy Satellite and the installation of its laminar flow hood, IV medications are prepared by the pharmacist in a more sterile environment. The pharmacy’s laminar flow hood (which was not available to the nurses before the inception of the satellite) creates an area free of airborne contaminants which allows for the extended expiration dating of the IV medication (saving the pharmacy money by not having to remake expired medications, and allowing for the use of partial dosages). With the risk of contamination reduced because of the more sterile environment, the chances for infection due to an IV or the potential ill-effects of the usage of an expired medication have increased the overall level of patient safety in the ED.

*Complimentary Discharge Medication Service*

The complimentary discharge policy gives the patient ease of mind, as the sense of filling an urgent medication is reduced and gives them time to adjust to their current situation. This practice, while not free to the pharmacy, helps ensure that there are no relapses in the treatment of the patient’s condition (and potential revisit to the ED). If complementary medications were not provided, the patient would be stressed to fill a medication and in the event that commercial pharmacy services were not available, a reoccurrence of symptoms with their potential complications could result. This event may jeopardize the patient’s overall health and reduce the effectiveness of the care provided in the ED. This practice is beneficial to the patient and helps identify the UMHS ED as a source of excellent and thorough patient care.

*Value Add to University Hospital*

ED pharmacist provide the hospital with benefits such as:

- Reduction of waste
• Continuous involvement in patient therapies

• Support for flow of medications through the Emergency Department.

Reduction of Waste

The transfer of intravenous (IV) medications preparation from the nurse station to the ED Pharmacy could potentially reduce the amount of waste in the hospital’s Emergency Department. The reduction in waste can primarily occur two ways:

• Preparing IVs under a laminar flow hood

• Reusing multi-dose vials

The laminar flow hood is a device in the ED Pharmacy that ensures the atmosphere in which the IV is prepared is sterile, which allows the IV expiration time to be extended. This may result in savings in cases where the IVs are not used immediately following their preparation and may otherwise need to be discarded.

Also, because of the relatively small degree of control for medications in the Omnicell, it is ED policy to discard multi-dose vials obtained from the Omnicell even if medication remains in them. However, the ED Pharmacy Satellite can hold and reuse multi-dose vials with a greater degree of control.

A negative consequence has been the perception among some nurses that the transfer of responsibility for IV preparation to the pharmacy has diminished a skill set that all nurses should possess. Some nurses have expressed concern that newer nurses are not as well-equipped to prepare IVs themselves because of the increased usage of pharmacy services.

Continuous involvement in Patient Therapies

Orders for inpatients, or patients that have already been admitted into the hospital, are entered electronically in a system known as CareLink. All orders submitted through CareLink must be verified by a pharmacist before they can be filled, and historically, the responsibility for this verification fell on the other pharmacies in the hospital. Many of these orders, however, are for patients whose treatment began in the Emergency Department.

The pharmacists in the ED Satellite may now participate in the verification of CareLink orders, resulting in time savings for other pharmacies, due to the reduction in volume of orders. The ED Pharmacist’s participation in this process is also advantageous because of their continuous involvement in a patient’s care from the time they enter the Emergency Department. The pharmacist’s presence in the ED and exposure to the patients early in the process makes them
better suited to verify these orders, and ensure that the patient gets on the right drug therapy earlier in their visit.

Support for flow of Medications through ED

The service of procuring drugs for the Emergency Department is valuable because it places creates a channel through which demand can be communicated to the pharmacy storage in the basement of the hospital. Our observations reveal that the time-consuming tasks of procuring drugs from the basement pharmacy or tube station are performed in the case of an urgent need for an unusual medication that the pharmacy may not regularly keep in inventory.

Recommendations

Based on the data collection described above, the team has derived a list of recommendations that would allow the ED Satellite Pharmacy to 1) better measure their impact or 2) increase their impact on ED operations.

Methods to Measure Impact

Benchmark Progress of ED Pharmacy Satellite Impact Over Time

The ability of the pharmacy to benchmark its progress in key performance metrics over time is crucial in quantifying impact. The team recommends two main ways to further benchmark the progress of the ED Pharmacy Satellite:

- Perform Order Volume studies twice a year
- Create a sub-group to determine what metrics to continuously measure

The team recommends conducting a study similar to the Order Volume Study internally twice a year for approximately one week. This will enable the ED Pharmacy Satellite to compare the number of therapy changes and consultations from year to year. The team has provided a sample tick sheet for this study in Appendix G.

The team also recommends forming a sub-group comprised of key ED personnel to determine which performance metrics are most useful to the ED and how data for these metrics can be obtained. The team recommends considering the quantity of medications moved from an Omnicell to the ED Pharmacy Satellite, as well as the proportion of total orders written in the ED that are verified by a pharmacist. This proportion is 100% for all electronic orders, however,
there are great deals of paper orders in the emergency department that are retrieved by nurses from Omnicells and are not verified by pharmacists.

*Format and Track Complimentary Discharge Medication Service Reports*

The database of complimentary discharge medications dispensed by the ED should be placed in a given spreadsheet that allows simple queries to determine if patients are abusing the complimentary service, or if certain medical providers tend to prescribe these medications too often.

The team recommends that pharmacists standardize the input fields when entering the complimentary discharge medication into the computer. With the aid of the Excel® macro the team created, this will enable pharmacy management to easily sort and summarize the data contained in the report. Currently the data is too non-standard to usefully display the information in the report.

*Increase Impact*

*Tailor Ongoing Medication Updates/Education*

The common forms of consultations from nurses and medical providers can provide key insights into the needs of the staff population. Medication updates regarding the specific concerns of nurses and providers will increase the impact the pharmacy has on education of medical staff and ultimately increase patient safety.

The process of transferring medications from the Omnicell to the ED Pharmacy can be based on the medications that are commonly found in RiskPro incident reports. The medications that are more common in errors should be transferred to areas of greater control, such as the pharmacy.

*Increase Visibility to Medical Providers*

To increase visibility of pharmacists and the ED Satellite Pharmacy to medical providers, the team recommends that ED pharmacists attempt to perform the services requested by medical providers. These services may include being more proactive when assisting in resuscitation area and increasing the number of dosing recommendations a pharmacist provided to a medical provider before the medication order is written.

*Standardize handoff procedure between pharmacists and nurses*

The four tracks in the process flow diagram in Figure 17 illustrate the possible handoff of medication between a pharmacist and a nurse. Tracks 2 and 3 represent the greatest time savings for nurses because they eliminate any waiting time for the medication. The handoff method in Track 2 is preferable to that of Track 3 because it provides greater control of the medication. If
for some reason the nurse is not available for a direct handoff, there should be a standardized delivery system by which pharmacists can deliver medication to RN stations. The system should involve a specific location for the medication as well as a procedure for the unit clerk to page the nurse and alert them that the drug is available.
Appendices

Appendix A. Order Volume Study Tick Sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
<th>Task</th>
<th>Due to AEP</th>
<th>Due to Body Weight</th>
<th>Due to Hospital Protocol</th>
<th>Due to Non-Medical Treatment</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>07:00-10:00</td>
<td>11:00-14:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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</table>

<table>
<thead>
<tr>
<th>Change Orders</th>
<th>Consulation</th>
<th>Diagnosis</th>
<th>Preparation</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

A. 1
Appendix B. Task Distribution Analysis Tick Sheet

This was double sided. The flip side is exactly the same except the hours include the rest of the day
<table>
<thead>
<tr>
<th>Tasks</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>07:00-10:59</td>
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<tr>
<td>Filling Orders</td>
<td></td>
</tr>
<tr>
<td>Preparing IV</td>
<td></td>
</tr>
<tr>
<td>Preparing Mixture</td>
<td></td>
</tr>
<tr>
<td>Dispensing Pills/Tablets</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Dosage</td>
<td>NURSE</td>
</tr>
<tr>
<td>Consultation</td>
<td></td>
</tr>
<tr>
<td>Compatibility</td>
<td></td>
</tr>
<tr>
<td>Preparation techniques</td>
<td></td>
</tr>
<tr>
<td>Alternative treatment</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Dosage</td>
<td></td>
</tr>
<tr>
<td>Allergies</td>
<td></td>
</tr>
<tr>
<td>Compatibility with other meds</td>
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</tr>
<tr>
<td>Pertinent Medical History</td>
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<tr>
<td>Other</td>
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<tr>
<td>Administer Medication</td>
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<tr>
<td>Preparing Medication</td>
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<tr>
<td>Research (i.e. interactions,</td>
<td></td>
</tr>
<tr>
<td>allergies)</td>
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</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>IVs, Mixtures, other</td>
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</tr>
<tr>
<td>Stock Prep</td>
<td></td>
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<tr>
<td>To RN Station</td>
<td></td>
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<tr>
<td>To Patient Room</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Delivery</td>
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</tr>
<tr>
<td>Walking to Basement</td>
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</tr>
<tr>
<td>Pharmacy</td>
<td></td>
</tr>
<tr>
<td>Tube Station</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Drug Procurement</td>
<td></td>
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<tr>
<td>Checking Email</td>
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<tr>
<td>Taking a Break</td>
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<tr>
<td>Using Restroom</td>
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<tr>
<td>Other</td>
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</tbody>
</table>

A. 3
Appendix C. Analysis of Adverse Drug Event Data from RiskRPO Report

Paired T-Test and CI: 2009 events, 2008 events

Paired T for 2009 events - 2008 events

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 events</td>
<td>10</td>
<td>6.100</td>
<td>1.792</td>
<td>0.567</td>
</tr>
<tr>
<td>2008 events</td>
<td>10</td>
<td>5.100</td>
<td>2.470</td>
<td>0.781</td>
</tr>
<tr>
<td>Difference</td>
<td>10</td>
<td>1.000</td>
<td>2.708</td>
<td>0.856</td>
</tr>
</tbody>
</table>

95% CI for mean difference: (-0.937, 2.937)
T-Test of mean difference = 0 (vs not = 0): T-Value = 1.17  P-Value = 0.273
Appendix D. Excel® Macro to Format Discharge Report from MCIT

Sub organize()

' Adds new sheet after the original  
ActiveWorkbook.Sheets.Add After:=Sheets(1)

' Formats new sheet  
Sheets(2).Cells(1, 1) = "RX #"  
Sheets(2).Cells(1, 2) = "Prescription Quantity"  
Sheets(2).Cells(1, 3) = "Time Entered"  
Sheets(2).Cells(1, 4) = "Patient Name"  
Sheets(2).Cells(1, 5) = "Drug Description"  
Sheets(2).Cells(1, 6) = "Medication Quantity"  
Sheets(2).Cells(1, 7) = "Instructions"  
Sheets(2).Cells(1, 8) = "Prescriber"  
Sheets(2).Cells(1, 9) = "NDC/Item #"  
Sheets(2).Cells(1, 10) = "Manufacturer"  
Sheets(2).Cells(1, 11) = "Date Filled"  
Sheets(2).Cells(1, 12) = "Refills"  
Sheets(2).Cells(1, 13) = "Pharmacist"

' Bolds and freezes top line  
Range("A1:M1").Select  
Selection.Font.Bold = True  
With ActiveWindow  
.SplitColumn = 0  
.SplitRow = 1  
End With  
ActiveWindow.FreezePanes = True

Dim RX As Double ' Declares variable for prescription number

RX = Sheets(1).Cells(2, 1) ' Sets RX number as first number in spreadsheet

Dim i As Integer  
Dim j As Integer  
i = 2 ' Counter for next row on data sheet  
j = 2 ' Row counter on NEW data sheet
While RX <> 0

    Sheets(2).Cells(j, 13) = Sheets(1).Cells(i, 7) ' pharmacist cell
    Sheets(2).Cells(j, 1) = RX ' RX cells
    Sheets(2).Cells(j, 2) = Sheets(1).Cells(i, 3) ' Prescription Quantity
    Sheets(2).Cells(j, 3) = Sheets(1).Cells(i, 4) ' Time Entered
    Sheets(2).Cells(j, 3).Select
    Selection.NumberFormat = "m/d/yyyy h:mm"
    Sheets(2).Cells(j, 4) = Sheets(1).Cells(i, 6) ' Patient Name
    Sheets(2).Cells(j, 5) = Sheets(1).Cells(i + 1, 6) ' Drug Description
    Sheets(2).Cells(j, 6) = Sheets(1).Cells(i + 2, 6) ' Medication Quantity
    Sheets(2).Cells(j, 7) = Sheets(1).Cells(i + 3, 6) ' Instructions
    Sheets(2).Cells(j, 8) = Sheets(1).Cells(i + 4, 6) ' Prescriber
    Sheets(2).Cells(j, 9) = Sheets(1).Cells(i + 5, 6) ' NDC
    Sheets(2).Cells(j, 10) = Sheets(1).Cells(i + 6, 6) ' Manufacturer
    Sheets(2).Cells(j, 11) = Sheets(1).Cells(i + 7, 6) ' Date Filled
    Sheets(2).Cells(j, 12) = Sheets(1).Cells(i + 8, 6) ' Refills

    i = i + 9
    RX = Sheets(1).Cells(i, 1)
    j = j + 1

Wend

End Sub
<table>
<thead>
<tr>
<th>Pharmacy Functions defined in ED Pharmacy Proposal</th>
<th>Related Tasks</th>
<th>% of Pharmacist Time Spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform review of medication orders prior to administration of the first dose. The pharmacist would circulate</td>
<td>Verifying Orders</td>
<td>29%</td>
</tr>
<tr>
<td>routinely through the various areas where medication orders are written to review them prior to administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the first dose. For patients admitted to the observation unit and those scheduled for admission, medication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>orders will be entered into the pharmacy computer system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify severity of allergic reactions and document in medical record</td>
<td>Document Intervention</td>
<td>1%</td>
</tr>
<tr>
<td>Participate on medical and trauma code response teams</td>
<td>Trauma/Code</td>
<td>5%</td>
</tr>
<tr>
<td>Suggest appropriate, cost-effective medication alternatives</td>
<td>Consultations - Alternative</td>
<td>1%</td>
</tr>
<tr>
<td>Suggest patient-specific medication doses</td>
<td>Treatment</td>
<td></td>
</tr>
<tr>
<td>Perform pharmacokinetic dose checks, monitor patient therapy, and provide dosing/monitoring</td>
<td>Consultations - Dosage</td>
<td>3%</td>
</tr>
<tr>
<td>recommendations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check for and provide information on drug-drug, drug-disease, drug-lab interactions</td>
<td>Consultations - Compatibility</td>
<td>8%</td>
</tr>
<tr>
<td>Use laboratory data to evaluate effectiveness of drug therapy</td>
<td>Research</td>
<td>3%</td>
</tr>
<tr>
<td>Identify unknown medications</td>
<td>Consultations</td>
<td>8%</td>
</tr>
<tr>
<td>Provide information on overdose or poisoning management</td>
<td>Consultations</td>
<td>8%</td>
</tr>
<tr>
<td>Evaluate and report adverse drug events</td>
<td>Document Intervention</td>
<td>1%</td>
</tr>
<tr>
<td>Provide drug information support to medical and nursing staffs</td>
<td>Consultations</td>
<td>8%</td>
</tr>
<tr>
<td>Perform formal/informal consultations as needed to other health professionals</td>
<td>Consultations</td>
<td>8%</td>
</tr>
<tr>
<td>Conduct drug use evaluations</td>
<td>Stock Prep/ Drug Procurement</td>
<td>8%</td>
</tr>
<tr>
<td>Provide education to medical and nursing staffs</td>
<td>Medication Updates</td>
<td></td>
</tr>
<tr>
<td>Assist with treatment protocol development, implementation, and monitoring</td>
<td>Medication Updates</td>
<td></td>
</tr>
<tr>
<td>Perform liaison function between ED and inpatient services regarding pharmaceutical care to ensure</td>
<td>Verifying Orders</td>
<td>29%</td>
</tr>
<tr>
<td>consistency in treatment protocols, etc.</td>
<td>Admit Hold Services</td>
<td></td>
</tr>
<tr>
<td>Precept pharmacy students</td>
<td>Discussion/Instruction</td>
<td>2%</td>
</tr>
<tr>
<td>Document clinical and cost-savings interventions</td>
<td>Document Intervention</td>
<td>1%</td>
</tr>
<tr>
<td>Participate in and/or facilitate research involving drug therapy</td>
<td>Research</td>
<td>3%</td>
</tr>
</tbody>
</table>
Appendix F. List of Literature Sources


"Questions Regarding ED Satellite Pharmacy at Henry Ford Hospital." Telephone interview. 20 Nov. 2009.

* Please tick in groups of 5 every time you change a dosage or provide consultation

<table>
<thead>
<tr>
<th>Change Dosage</th>
<th>07:00-10:59</th>
<th>11:00-14:59</th>
<th>16:00-19:59</th>
<th>23:00-02:59</th>
<th>03:00-06:59</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to Age</td>
<td>Electronic</td>
<td>Paper</td>
<td>Electronic</td>
<td>Paper</td>
<td>Electronic</td>
</tr>
<tr>
<td>Due to Allergies</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Due to Body Weight</td>
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<tr>
<td>Due to Hospital Protocol (i.e. Alternative Treatments)</td>
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<tr>
<td>Due to Medical History (i.e. renal/hepatic function)</td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Dosage</td>
<td>NURSE</td>
<td>MD</td>
<td>NURSE</td>
<td>MD</td>
<td>NURSE</td>
</tr>
<tr>
<td>Consultation</td>
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