University of Michigan Health System
Program and Operations Analysis

Cost-Benefit Analysis of Medication Reconciliation Pharmacy Technician Pilot
Final Report

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Executive Summary

The University of Michigan Health System’s (UMHS) Medication Reconciliation (MR) process involves updating the medication portion of the Problem Summary List (PSL). Currently, the PSL is usually only updated just before discharge by the patient’s physician. However, the lack of a standard process for MR has resulted in questionable PSL quality. This quality concern is being addressed by the Pharmacy Technician (PT) pilot started in August 2011. The pilot updates a patient’s PSL ideally within 24-48 hours of the patient’s admission to a unit.

UMHS wanted to know the cost-benefit of the PT pilot. The Director of Pharmacy, as a co-chair of the MR committee and the head of the PSL subcommittee, requested this project. An Industrial and Operations Engineering (IOE) student team has determined the cost-benefit of the PT pilot and has found standardization and optimization opportunities in the current MR process.

Background

MR involves updating a patient’s medication list, such as removing or adding medications or adjusting dosage or frequency. Currently, the PSL’s medication list is usually only updated just before discharge by UMHS physicians on the CareWeb system, which is resulting in MR rework and lower PSL quality. High quality medication lists are needed to avoid medication errors that increase workload and decrease patient safety.

To address these rework and quality concerns, the UMHS Pharmacy department has created a MR committee dedicated to improving MR quality. The MR committee has four subcommittees to address (1) the PSL’s medication list, (2) follow up calls to patients, (3) medication list reprogramming in CareWeb, and (4) patient and family centered rounding. A Fall 2011 IOE team recommended the PT pilot as a possible countermeasure for the non-standard update process. The team also recommended a conditional pilot implementation based on the number of medications on a patient’s PSL to utilize PTs more efficiently.

Goals

The primary goal of this project was to determine the cost-benefit of the PT pilot terms of PSL quality, MR workload, decrease in readmissions due to medication error, and implementation cost. The secondary goal was to identify standardization opportunities to optimize the MR processes.

Methods

The team analyzed and compared the MR process in PT pilot units 5B and 7A and control units 6B and 7B. The primary personnel involved in the project included registered nurses, resident and attending physicians, PT’s, and patients.

The following data collection methods were performed:

- Literature search
Five UMHS staff were interviewed and shadowed in order to gain understanding of the current state of the control and piloted MR processes. Three other UMHS staff members were interviewed to explain additional MR projects being performed in different areas. The interviews performed allowed the team to flowchart the piloted MR process which can be viewed in Appendix 4.

Two literature searches were performed. The first search gathered and identified existing justification for implementing PTs for discharge MR. Two slideshows were found that lead the team to gather four reports on the topic. These reports were unable to provide a deeper understanding of the project goals. The second search identified existing reports on MR workload for physicians and nurses; nothing substantial was found. See Appendix 1 for a bibliography of the identified sources.

Two time studies were conducted to record MR workload for inpatient nurses. Time studies were never conducted for physicians. The team discontinued time study efforts after determining MR workload time studies were infeasible within project time limits.

A survey was distributed to nurses and physicians between March 27, 2012 and April 10, 2012, and 27 responses were obtained. The survey assessed opinions of the current state of MR, identified overlap with PT pilot duties, and gathered opinions on the benefits of the PT pilot. The survey can be viewed in Appendix 3.

Two indirect methods were performed. The first, a daily updated PT pilot data sheet, recorded if a PSL change has occurred and the number of medications before and after a PSL change. The PTs collected data on 412 patients from February 23, 2012 until April 2, 2012. The second indirect method, a nurse self-data collection sheet, recorded the number of different types of discrepancies found on a patient’s medication list at discharge. The nurses recorded data for 42 patients from March 27, 2012 to March 31, 2012. The nurse self-collection sheet can be viewed in Appendix 2.

**Findings and Conclusions**

The PT pilot is effective at identifying dose and frequency discrepancies. No dose and frequency discrepancies were identified at discharge in the pilot units while dose and frequency discrepancies were 85.72% of all discrepancies identified at discharge in the control units.

The PT pilot is not currently effective at identifying extra medication discrepancies. The PT pilot did not minimize extra medication discrepancies, which accounted for 93.33% of all pilot unit errors. These extra medication discrepancies may be attributed to PT pilot staff not performing final discharge MR since PTs cannot remove medications that a patient would discontinue after discharge. The Recommendations section suggests a possible countermeasure.
A large variance in PT pilot workload was identified. PT pilot workload was measured in the number of PSL medication lists reconciled per day, with an average of 6.75 and a standard deviation of 5.29. This variance is attributed to the variation in daily admission volume and the non-standard process for supplying information to PTs.

The team determined the PT pilot implementation costs according to different amounts of staffed beds. These costs were based upon 1.6 FTE covering 32 staffed beds, working 8 hours/day for 7 days/week, while being paid a $65,000 salary including benefits and paid time off. Covering all project units, 64 staffed beds, would require 3.2 FTE for a total annual cost of $130,000. Covering all inpatient units, 950 staffed beds, would require 23.75 FTE for a total annual cost of $964,843.75.

The survey results indicated that 78.75% of physicians and 53.84% of nurses perform 2 or more of the PT pilot tasks. Results also indicated 78.57% of physicians and 61.52% of nurses expect to see a MR workload reduction of at least 30%. All surveyed physicians expected to see a positive effect on patient safety and a decrease in medication list discrepancies. The physicians agreed with expanding the PT pilot to other inpatient units.

**Recommendations**

The team recommends:

- Not implementing the PT pilot until a future IOE 481 student team can obtain sufficient quantitative data for justifying the expansion
- Encouraging collaboration between similar MR initiatives to increase data collection
- Reinforcing the purpose and expectations of the PT pilot to pilot unit staff for a standard delivery of required information to PTs
- Communicating PT verifications to physicians to reduce discharge MR rework
- Standardizing MR process for indicating medications taken at home, but not during a patient’s stay at UMHS
- Investigation of alternative MR processes

**Expected Impact**

No immediate impact is expected. Future PT pilot expansion is expected to increase patient safety and reduce both MR workload and readmissions due to medication error. Collaboration between project teams is expected to lead to more robust conclusions. A standard procedure for delivering patient-edited PSLs to PTs is expected to increase future PT pilot data accuracy and ensure full use of PT pilot potential benefits. Flagged verification of patient medications is expected to reduce physician MR workload and increase confidence of the accuracy of the PSL.
Introduction

The University of Michigan Health System’s (UMHS) Medication Reconciliation (MR) process involves updating the medication portion of the Problem Summary List (PSL). However, the lack of a standard process for MR has resulted in questionable PSL quality. This quality concern is being addressed by the Pharmacy Technician Pilot (PT pilot) started in August 2011. Pharmacy Technicians (PT) in the PT pilot update a patient’s PSL within 24-48 hours of the patient’s admission to a unit. Currently, the PSL is usually only updated just before discharge by the patient’s physician.

A student Industrial and Operations Engineering (IOE) team has determined the cost-benefit of the PT pilot and has found standardization and optimization opportunities in the current MR process. This project was requested by UMHS’s Director of Pharmacy, who is a co-chair of the MR committee and the head of the PSL subcommittee.

Background

MR involves changing a patient’s medication list, such as removing or adding medications or adjusting dosage amount or frequency. Physicians update the medication list digitally in UMHS’ problem summary list (PSL) document on the CareWeb system, when changing a patient’s medications or after finding a medication list discrepancy. Currently the PSL is usually only updated just before discharge when a patient’s final medication list is printed from the PSL. The PSL’s last minute update currently results in significant rework by the patient’s primary physician. The physician must consolidate multiple sources of medication lists due to the non-standard PSL update process.

The non-standard PSL update and MR processes result in medication lists of questionable quality. Medication lists need to be high quality to avoid the occurrence of costly medication errors in terms of both money and physical wellbeing. To mitigate these errors, the UMHS Pharmacy department has created a MR committee in conjunction with the Nursing and Medicine departments. This MR committee is dedicated to improving MR quality by optimizing and standardizing the MR process. Four subcommittees were also created to address more specific areas, such as medication list reprogramming in CareWeb, patient call back, and patient and family centered rounding.

The PSL subcommittee asked a previous IOE team to determine a focus for the PSL quality problem. The Fall 2011 IOE team recommended the PT pilot as a possible countermeasure for the non-standard update process, as illustrated by their value stream map of the MR process.
The PT pilot occurs in the first 24 to 48 hours after admittance to function as a quality check between admission and discharge. The Fall 2011 IOE team recommended that the PT pilot PTs perform a conditional quality check to utilize PTs more efficiently. Figure 2 identifies an upward trend in average MR time as the total number of medications on a patient’s medication list increases. However, the upward trend decreases once the total number of medications on a patient’s medication list is above 10.

2. Average MR time per patient with respect to number of medications (Miles et al. 2011).
Collected by fall 2011 IOE 481 Team 5, November 1-16, N=15

The Fall 2011 IOE team noted more data is needed to determine the number of medications at which the trend reverses. This reversal point could be used to help utilize the PT pilot PT’s more efficiently by having the PT’s check the quality of the PSL most likely to have errors. The PT’s
would then directly obtain verification of absolute changes in the PSL by talking with the patient or the patient’s family, pharmacy, or primary care physician.

The PT pilot is the current proposed method for mitigating the chance of medication errors by developing an efficient standard to improve PSL quality. This project determined the cost-benefit of the pilot and recommends additional optimization and standardization opportunities.

**Key Issues**
The following key issues created the need for this project.

- Unknown efficiency and quality effects of the PT pilot to the PSL update and MR processes are hampering PT pilot’s cost-benefit assessment and implementation
- Non-standard PSL update and MR processes are increasing admission and discharge times of inpatients and rework for UMHS staff
- Multiple medication list sources are creating uncertain PSL quality

**Goals and Objectives**
To determine the cost-benefit of the PT pilot, the student team achieved the following tasks:

- Collect data on the PSL update and MR processes from PT pilot and control units
- Directly compare the PT pilot and control units’ PSL update and MR processes’ efficiency and quality in terms of errors, time, and costs such as employee salary and re-admittance due to medication errors

The team developed standardization and optimization recommendations to:

- Improve PSL update and MR processes’ efficiency and quality in terms of errors, time, and costs such as employee salary and re-admittance due to medication errors
- Increase patient and employee satisfaction with the PSL update and MR processes
- Implement PT pilot through inpatient units efficiently.

**Project Scope**
This project only included the PSL update and MR processes for inpatients admitted to units 5B, 6B, 7A, 6B, and 7B. Though unit 7C was originally in this project’s scope, the unit did not participate. The analyzed processes begin at patient admission to the units, and end at patient discharge and final PSL update in CareWeb. The team only analyzed work related to the medication list portion of the PSL.

Any task not connected to the PSL update and MR processes in units 5B, 6B, 7A, or 7B was not included in this project. Any portion of the PSL outside of medication list was not be analyzed; however, this project’s findings may be extended to other units outside of the project’s scope in the future.

**Methodology**
The project team examined the PSL update and MR processes in PT pilot units 5B and 7A and compared the results to the current, or control, PSL update and MR processes in units 6B and 7B.
The primary personnel involved in the project included registered nurses, resident and attending physicians, PT’s, and patients.

**Literature Search**
The team performed a literature search for potential methods for validating PT usage in MR, and potential MR workload data sources from January 14, 2012 until April 5, 2012. The team reviewed several PowerPoint presentations, in addition to several reports found by the client, from different hospitals using PT’s in MR as well as the previous student IOE team’s report. The reviewed literature sources can be found in the bibliography in Appendix 1.

**Interviews**
The team interviewed 1 of the 2 PTs involved in the PT pilot, 9 nurses during discharge MR and patient medication education, and 2 physicians during discharge MR. The results included developing the PT pilot cost-benefit metrics and indirect data collection methods. The PT pilot cost-benefit metrics developed are detailed in the Findings and Conclusions section of this report.

Additionally, the following parties were interviewed by the team from January 14, 2012 until April 5, 2012:

- Heads of MR Subcommittees at MR Committee Meeting
- Staff Specialist for Nursing Administration
- Clinical Project Manager
- CVC Nursing Director
- PharmD Candidate
- School of Public Health team

These interviews provided the following:

- An increased understanding of the MR process flow
- Differing opinions on the impact of the PT pilot
- New perspectives, references, and advice
- Identification of overlap with other student projects and MR subcommittee pilots
- Potential data sources

**Readmission data analysis**
The team needed to estimate the impact of the PT pilot on readmissions likely due to medication error. Readmissions likely due to medication error are defined as patients included in the High Risk Medication Criteria and are not readmitted due to a procedure. The following data was collected from the PharmD student, the project Client, and the project Coordinator:

- Total number of patients admitted to the project units in January 2012
- A sample of admitted patients from January 2012
- Average cost of readmission for adult patients from 2010

From the gathered data the team determined the following ratios:

- Readmissions per total patients
Readmissions likely due to medication error per readmission

**Indirect Data Methods**

Two indirect data collection methods involving self-data collection sheets were developed when interviews revealed PTs and nurses were willing to collect data. Surveys were determined to be more practical than self-data collection for physicians because they require a smaller physician workload increase.

**Pharmacy Technician Self-data Collection Sheet**

The PTs in the PT pilot updated this self-data collection sheet in an electronic Excel spreadsheet as part of their daily process. The PT self-data collection sheet shown in Table 1 added the following 4 measures to an existing PT pilot self-data collection sheet for PTs.

- Number of medications on the patient’s PSL before changes are made to the PSL
- Number of medications on the patient’s PSL after changes are made to the PSL
- Number of times the patient is visited by a PT to verify needed PSL changes
- Number of calls to a pharmacy by a PT to verify needed PSL changes

<table>
<thead>
<tr>
<th>MRN</th>
<th>DATE</th>
<th>UNIT</th>
<th>PSL Changed</th>
<th># of changes</th>
<th># of Meds before Change</th>
<th># of Meds after Change</th>
<th># of patient visits</th>
<th># of pharmacy calls</th>
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<td>Y</td>
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<td>1</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 1. Example of PT self-data collection sheet**

The PTs collected data on 412 patients from February 23, 2012 until April 2, 2012.

**Nurse Self-data Collection Sheet**

The nurse self-data collection sheet was developed for nurses to note the following, after completing a patient’s discharge MR:

- Date
- Inpatient Unit
- Initials of the patient and the nurse whom performed the discharge
- Number of medications on the patient’s PSL’s medication list
- Number of PSL medication list errors, by type
  - Incorrect frequency for the patient’s medications
  - Incorrect dose for the patient’s medications
  - Medications removed from the PSL’s medication list
  - Medications added to the PSL’s medication list
  - Any other errors, with description

Each unit’s nurse manager informed nurses who discharge patients about the self-data collection sheet in the discharge packets by the unit’s clerk. The nurses collected data on 42 patients from Team 10 Med-List 10
March 27, 2012 to March 31, 2012, and were rewarded with candy. A copy of the Nurse Self-data Collection sheet appears in Appendix 2.

**Physician and Nurse Survey**

The team developed a survey to gather an estimated percent reduction in discharge workload. The survey requested expert opinions on the following information:

- Participant’s UMHS title and assigned unit / service
- Frequency of discrepancies on PSL at discharge
- Number of PT pilot tasks performed currently performed by physicians / nurses
- Expected impact on PSL quality, if the PT pilot implemented
- Percent reduction in discharge MR workload, if the PT pilot implemented
- Positive effect on patient survey, if the PT pilot implemented
- Additional tasks for PTs to reduce physician / nurse MR workload
- PT pilot expansion
- Additional MR improvements

The team checked the survey’s readability with 1 physician, 1 nurse, and the staff specialist for nursing administration. The survey was then sent to the client for approval and implementation. The actual survey was conducted through SurveyMonkey, an online survey tool. The survey was open from March 27, 2012 until April 10, 2012. A copy of the survey appears in Appendix 3.

**PT pilot Cost-Benefit Metrics**

PT pilot cost metrics were developed based on PT implementation, from the 2 pilot units to the total number of UMHS staffed beds, stratified by:

- Current PT workload (beds / PT / day)
- Expert opinion estimated maximum PT workload (beds / PT / day)
- Conditional PT implementation based on the number of medications on a patient’s PSL

The information required to quantify the cost metrics included:

- Cost per full time PT / day,
- Total number of staffed beds in 2 pilot units
- Total number of staffed beds in UMHS
- Number of medications (range) for most effective conditional implementation of the PT pilot

The following PT pilot benefit metrics were developed:

- PSL quality, as indicated by PSL errors, by type
  - Incorrect frequency
  - Incorrect dosage
  - Extra medication
  - Missing medication
  - Other error
- Reduction in physician and nurse discharge MR workload based on:
  - Expert opinion gathered through a survey
Literature search results

- Prevented readmission cost due to medication error

**Time Study Data for Discharge MR Times**
The team theorized discharge MR time would not be comparable, even between like subjects, since the multitasking flexibility required by physicians and nurses results in processes that are not standard enough to be compared. Moreover, a large degree of variability is based on both patients to be discharged and the physicians and nurses discharging the patient. The team directly collected preliminary time study data from February 16, 2012 to March 16, 2012. The collected physician and nurse discharge MR times confirmed the team’s theory.

The lack of physician discharge MR time data was counter-measured by physician estimates of percent reduction in discharge MR workload. The lack of nurse discharge MR time data was counter-measured by collecting the number of PSL errors, by type, from nurse self-data collection. The interviewed physicians considered PSL quality to be more valuable than MR time saved.

**Flow Chart of MR Process**
The team developed a swim-lane process flow chart of the MR process to help identify MR process standardization and optimization opportunities. The scope of the process flow chart was the PT’s, nurses, and physicians for both pilot and control units. Since physician and nurse discharge MR processes differ greatly in process specifics, the process flow chart was restricted to high-level processes. See Appendix 4 for the swim-lane process flow chart of the MR process.

**Findings and Conclusions**

*PTs are effective at identifying dose and frequency errors in PSLs*
The PT pilot data sheet was collected for 412 patients. Of these 412 patients, 141 required a PSL change. In total there were 407 discrepancies distributed over three types: extra medications, missing medications, and dose/frequency error. Figure 3 summarizes the distribution of these discrepancies.
Dose and frequency discrepancies accounted for 65.1% of all PT pilot identified changes. Extra and missing medication discrepancies account for the remaining 34.9%. Similarly Figure 4 describes the distribution of error type found among all patients with errors.

Figure 4 displays that the 65.3% of all patients with errors had dose and frequency discrepancies. Extra and missing medication discrepancies made up the remaining 34.7% of patients with errors.
Nurses completed 42 self-collection sheets from units 5B, 6B, 7A, and 7B. Figure 5 describes the discrepancy per unit of the data collected.

Figure 5. Discrepancy per unit, N = 12 discrepancies

The control units encountered a total of 7 discrepancies for the N=26 completed sheets collected and the pilot units encountered 5 discrepancies for the N=16 completed sheets collected. Figure 5 shows the control units had more total errors and fewer errors per completed sheet than the pilot units. Table 2 describes the distribution of the discrepancies by unit.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Dose</th>
<th>Extra medication</th>
<th>Missing medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>42.86%</td>
<td>42.86%</td>
<td>14.29%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Pilot</td>
<td>0.00%</td>
<td>0.00%</td>
<td>93.33%</td>
<td>6.67%</td>
</tr>
</tbody>
</table>

Table 2 Distribution of nurse self-collected sheet by discrepancy type, N = 407

Table 2 indicates the PT pilot is effective in minimizing the amount of dose and frequency discrepancies. No dose and frequency discrepancies were found upon discharge on the identified pilot units. Dose and frequency discrepancies accounted for 85.72% of all discrepancies identified in the control units. The PT pilot did not successfully minimize identified extra medication discrepancies, which accounted for 93.33% of all pilot unit errors. This can be attributed to the fact the PT pilot staff does not perform the final discharge MR and cannot remove medications that a patient would discontinue after discharge.

Large variance in PT workload

The average and standard deviation of the changed MR/day and PSL/day was captured for the workload of PT pilot members is shown in Table 3.
A large variance in a PT pilot staff members’ daily workload occurs. The wide range of the PT pilot MR performed and PSL updates per day can be attributed to a high variance in daily discharges and timing of work.

PT pilot staff stated that pilot unit 7A frequently does not turn in patient edited PSLs before discharge for a PT pilot staff member to perform MR. For instance on any given day PT pilot staff estimate the 0-10% of all 7A patients for whom they receive patient edited PSLs will still be admitted.

The lack of standard procedure for PTs to collect patient edited PSLs limits the PT pilot from operating at peak performance. The PT pilot misses the opportunity to beneficially influence the physicians’ MR workload if PTs do not receive a patient edited PSL before discharge.

**Decrease in Total Readmission Costs**

By extrapolating of the available data the team determined conservative (10%) and aggressive (25%) estimated reductions in total readmissions for the project units. These estimates were provided by the project coordinator and client because of the lack of quantifiable data to link PT impact to a decrease in readmissions likely due to medication error. The sample gained from the PharmD student contained N=45 patients.

The following formula was used for the analysis of each project unit:

\[
\text{(Number of patients)} \times \text{(Percentage of readmissions)} \times \text{(Percentage of readmission likely due to medication error)} \times \text{(Average cost of readmission: $22,336)} = \text{Total cost of readmission likely due to medication error for a project unit}
\]

Table 4 shows the total cost and dollars saved in pilot and control units based on the conservative and aggressive reductions.

<table>
<thead>
<tr>
<th>Reduction in readmissions</th>
<th>10%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pilot units</em></td>
<td>$6,778,529</td>
<td>$5,648,774</td>
</tr>
<tr>
<td><em>Control units</em></td>
<td>$2,729,332</td>
<td>$2,274,443</td>
</tr>
<tr>
<td><strong>Dollars saved</strong></td>
<td></td>
<td></td>
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<tr>
<td><em>Pilot units</em></td>
<td>$753,170</td>
<td>$1,882,925</td>
</tr>
<tr>
<td><em>Control units</em></td>
<td>$303,259</td>
<td>$758,148</td>
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Table 4. Yearly costs of readmissions by estimated reductions
Using the conservative estimate the Pilot units will save $753,170 a year. The aggressive estimate will save $1,882,925 a year.

**Implementation Costs of the PT pilot**

A key objective is to determine the implementation cost of the PT pilot across different amounts of staffed beds. This is to understand the scalability of the PT pilot in inpatient units. The costing information below was given by the Pharmacy Business Manager.

1.6 FTE for 8 hours/day, 7 days/week = $65,000 total cost/year

Implementation costs have been developed for four different states.

- PT pilot covers all patients working at the average 6.754 MR per day
- Conditional use of the PT pilot for patients with 9 or more medications according to a High Risk Medication Use Criteria
- PT pilot staff operating at the estimated maximum workload of 8 MR per day
- Conditional use of the PT pilot operating at the estimated maximum workload

From the 42 nurse self-data collection sheets 54% had medications greater than or equal to 9 resulting in 0.86 FTE necessary for conditional use in the pilot units. The estimated maximum workload was provided to the team by the PharmD student who was knowledgeable of the responsibilities of PT pilot staff. Table 5 shows the implementation costs of the four states stratified by the number of staffed beds.
Table 5. PT pilot Implementation costs stratified by total number of staffed beds

<table>
<thead>
<tr>
<th>Future State 1: Conditional Use &gt;=9</th>
<th># FTE</th>
<th>Total Cost/Year</th>
<th>Average MR/Day</th>
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<td>0.86</td>
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<td>$521,015.63</td>
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<table>
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<tr>
<th>Future State 2: Estimated Maximum PT workload</th>
<th># FTE</th>
<th>Total Cost/Year</th>
<th>Maximum MR/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.35</td>
<td>$54,876.25</td>
<td>8</td>
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<tr>
<td></td>
<td>2.7</td>
<td>$109,752.50</td>
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<tr>
<td></td>
<td>20.05</td>
<td>$814,569.34</td>
<td>8</td>
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</tbody>
</table>

<table>
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<tr>
<th>Future State 3: Conditional use + Estimated Maximum workload</th>
<th># FTE</th>
<th>Total Cost/Year</th>
<th>Maximum MR/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.73</td>
<td>$29,633.18</td>
<td>8</td>
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<tr>
<td></td>
<td>1.46</td>
<td>$59,266.35</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>10.83</td>
<td>$439,867.44</td>
<td>8</td>
</tr>
</tbody>
</table>

Costs of implementation increase as the number of staffed beds increase. The costs of implementation decrease if the PTs perform maximum workload.

Survey to Nurses and Physicians
A total of 13 nurses and 14 physicians completed surveys between March 28 and April 10, 2012. Figures 6 and 7 illustrate the results of the PT pilot task overlap with physicians and nurses respectively.
The majority of PT pilot task overlap occurs with 78.57% of physicians performing 2 or more of the PT pilot tasks. Similarly 53.84% of nurses perform 2 or more of the PT pilot tasks. This indicates that the redundant work performed by the PT pilot is more impactful of physician MR.
workload than nurse MR workload. Figures 8 and 9 illustrate the estimated percent reduction of physician and nurse MR workload if the PT pilot were implemented.

**Figure 8. Physician results for estimated MR workload reduction**

**Figure 9.5 Nurse results for estimated MR workload reduction**
Figures 8 and 9 indicate that 78.57% of physicians and 61.52% of nurses expect to see a MR workload reduction of at least 30%. Data indicates that more of a reduction in MR workload for physicians will occur as they perform the majority of PT pilot task overlap.

Also, the survey shows that all physicians expect to see a positive effect on patient safety, a decrease in medication list errors, and desire PT pilot expansion to other inpatient units. The most common responses regarding MR improvements include:

- More reliable admission MR
- Better Transition of Care (TOC) communication between the ED and inpatient units
- Including an additional medication list check before patient education at discharge to PT pilot duties

**Recommendations**

The PT pilot should not be expanded into other inpatient areas. This project should be continued at the current state for future IOE 481 student teams. The conclusions made in this report would be much more substantial given a significant sample size. The primary focus of the follow up team should be to determine direct data collection methods to quantify the PT pilot impact. An example of a direct method would be daily observation of physicians in control and pilot units to compare MR workload.

The follow up team needs to contact UMHS staff, see Appendix 5, immediately to begin working relationships and begin interviews to develop a deeper understanding of the subject. Direct observation methods can only start after the team begins relations with UMHS staff.

The follow up team should collect the following data points from the PT pilot and control units:

- Number of medication for each reviewed PSL
- Extra medication discrepancies
- Missing medication discrepancies
- Medication dose discrepancies
- Medication frequency discrepancies

By recording the number of medications for each PSL the follow up team will have a more accurate distribution of patients included in the High Risk medication category. Recording specific discrepancy types will allow direct comparison to nurse self-collected data. These changes can easily be made to the existing PT pilot data sheet.

The follow-up team should have CareWeb access in order to independently research readmissions. The ability to manually pull data from CareWeb would allow identification of readmissions due to medication error. This data would allow the assessment of readmission costs and comparison of rates from pilot and control units.

Project teams should be informed of similar initiatives from other divisions in the University. Similar initiatives include: projects that analyze MR at admission, the effect of PTs on
readmission costs, and patient education at discharge. Increased collaboration and communication between teams could yield mutually beneficial results.

The purpose and expectations of the PT pilot should be reinforced to inpatient staff. Pilot units 5B and 7A do not follow a standard process in returning information to the PTs. PTs do not typically receive patient edited PSLs from unit 7A before a patient’s discharge. Therefore 7A is not receiving the benefits of the PT pilot such as increased PSL quality before discharge MR. Unit 5B currently does not have this issue.

Physicians suggest that MR workload could be further reduced if PT pilot verified medications were flagged on discharge navigator. These verified medications would instill confidence in the quality of the PSL. If the software cannot be changed, physicians should receive a hardcopy document indicating verified medications before discharge MR.

The Medication Reconciliation committee should continue to investigate alternative methods of medication reconciliation. Examples of alternatives are: performing MR during patient family centered care rounds, improving admission MR, and increased TOC communication between the ED and inpatient units.

**Expected Impact**

As there is no recommendation to expand the PT pilot to other inpatient areas there is no expected impact upon the control units. Future significant samples of various data will lead to concrete conclusions that will justify the expansion of the PT pilot. Expansion of the PT pilot is expected to increase patient safety and PSL quality while reducing MR workload for inpatient staff and readmissions due to medication error.

Collaboration between teams with MR project overlap can lead to more robust conclusions. Similar to a literature search, collaboration exposes follow up teams to existing data and the opportunity to expand data collection methods.

A standard procedure for PTs to collect patient edited PSLs is expected to create an identical impact on MR for pilot units. Analysis of the pilot performance will also be simpler due to the homogeneous nature of the collected data. The current analysis of the pilot performance cannot fully account for the maximum benefit of the PT pilot because of the missed opportunities for MR before discharge.

Flagged verification of patient medications is expected to reduce physician MR workload and increase confidence of the accuracy of the PSL.
Appendix 1: Bibliography


Miles, T., Patterson C., and Young, M (2011). Analysis of Problem Summary List and Medication Reconciliation. IOE 481 Fall 2011.


Appendix 2: Nurse Self-data collection sheet

Data Collection by Nurses for U-M Engineering Students

Discrepancies Found on Discharge Medication List

Please collect the following information about discrepancies found on the discharge medication list as you discharge your patient, and then return the sheet to your unit’s clerk.

REWARD: There should be candy in your unit’s breakroom for those who complete this data collection sheet and/or the survey on SurveyMonkey. Please contact us at EngineeringMedList@umich.edu if you have any questions, comments, or concerns. THANK YOU!

Day of Week (please circle): Tuesday / Wednesday / Thursday / Friday
Unit (please circle): 5B / 6B / 7A / 7B / 7C
Nurse’s Initials: ____________________
Patient’s Initials: ____________________
Number of Medications: ____________________
(on discharge medication list before changes)

Number of discrepancies found on the discharge medication list, by type:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong Frequency</td>
<td>For example, prescribed 2 x day instead of 3 x day.</td>
</tr>
<tr>
<td>Wrong Dosage</td>
<td>For example, prescribed 5 mg instead of 10 mg.</td>
</tr>
<tr>
<td>Extra Medication</td>
<td>For example, medications the physician discontinued, but were not removed from Discharge Navigator.</td>
</tr>
<tr>
<td>Missing Medication</td>
<td>For example, medications the physician intended to start the patient on at home, but were not added to Discharge Navigator.</td>
</tr>
<tr>
<td>Other Discrepancies</td>
<td>Any discrepancies that do not fall under the other 4 types. Please include a brief description. For example, patient clarifies they only take brand name medications after generic medications were prescribed.</td>
</tr>
</tbody>
</table>
Appendix 3: Survey for Physicians and Nurses

Medication reconciliation is the process of identifying the most complete and accurate list of medications a patient is taking and comparing that list against the medication list found in the medical record. A Pharmacy Technician Pilot (PTP) has been used in units 5B and 7A since August 2011. The PTP allows Pharmacy Technicians to compare an inpatient’s medication list to the medications found on their medical record. A small team of Industrial and Operations Engineering (IOE) students have been pulled together to assess the effectiveness of the PTP.

This survey should take no more than 3 minutes.

#1. Are you a Nurse or a Physician?

#2. Which unit or service are you assigned to?

#3. How often are discrepancies noticed on the patient medication discharge sheet?

#4. The pharmacy technician pilot in units 7A and 5B currently perform the following tasks within 24-48 hrs of inpatient stay:

1. Collect a hardcopy medication list with edits from a patient
2. Check for discrepancies between the official medication list, patient edited medication list, and admit H&P
3. Confirm correct medications for the medication list by checking with patient and family at bedside or contact a 3rd party (primary care provider, patient’s pharmacy, family not at bedside)
4. Make verified changes to medication list on CareWeb

Do you currently perform any of these tasks? How many?

#5. Given that the pharmacy technicians perform the aforementioned tasks would you expect to see an impact on the amount of errors in a medication list?

#6. Would you see your own medication reconciliation workload being reduced if a pharmacy technician performed these tasks? By how much?

#7. Do you think the pharmacy technician pilot would have a positive effect on patient safety?

☐ Yes
☐ No

8. Are there any other tasks that a pharmacy technician could perform to reduce your medication reconciliation workload?

#9. In your opinion should the pharmacy technician pilot be expanded?

☐ Yes
☐ No

10. Are there any other improvements that would assist you in medication reconciliation?

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Appendix 4: Flowchart of PT pilot Process

PTP (Pharmacy Technician Pilot) within 24-48 hours of Patient’s Admission to Unit

<table>
<thead>
<tr>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
</tr>
<tr>
<td>Give patient current PSL medication list</td>
</tr>
<tr>
<td>Pick up patient edited PSL medication lists, and give stack to PT 1/day</td>
</tr>
<tr>
<td>Patient (or Family)</td>
</tr>
<tr>
<td>Edit PSL medication list to best of knowledge</td>
</tr>
<tr>
<td>Pharmacy Technician</td>
</tr>
<tr>
<td>Receive stack of patient edited PSL medication lists, then identify and try to visit patients with possible, but unverified, changes</td>
</tr>
<tr>
<td>Patient (or family) available?</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>Try to visit patient later in the day</td>
</tr>
<tr>
<td>Able to verify possible changes?</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
</tr>
<tr>
<td>Make verified changes to PSL medication list on CareWeb</td>
</tr>
<tr>
<td>Contact third party (i.e., patient’s Pharmacy, PCP, family, etc.)</td>
</tr>
</tbody>
</table>
# Appendix 5: Contact List

<table>
<thead>
<tr>
<th>Name, Title, Dept.</th>
<th>Email, Phone</th>
<th>Relevance to project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>John Clark</strong></td>
<td></td>
<td>Project client and head of the Transitions of Care PSL subcommittee.</td>
</tr>
<tr>
<td>Director of Pharmacy</td>
<td><a href="mailto:johnclar@umich.edu">johnclar@umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Pharmacy Administration 734.232.4882</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cathy Clough</strong></td>
<td></td>
<td>Schedules meeting times with John Clark.</td>
</tr>
<tr>
<td>Pharmacy Secretary</td>
<td><a href="mailto:cclough@umich.edu">cclough@umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Pharmacy Administration 734.232.4882</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mary Duck</strong></td>
<td></td>
<td>Project coordinator and UMH Liaison.</td>
</tr>
<tr>
<td>Industrial Engineer</td>
<td><a href="mailto:mgduck@umich.edu">mgduck@umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Expert Program &amp; Operations Analysis (POA) 734.764.9431</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mary Hatfield</strong></td>
<td></td>
<td>Schedules meeting times with Mary Duck.</td>
</tr>
<tr>
<td>POA Secretary</td>
<td><a href="mailto:missno@med.umich.edu">missno@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>POA 724.936.2477</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Katie Barwig</strong></td>
<td></td>
<td>Liaison to nursing staff. Coordinates communication and data collection with nursing staff.</td>
</tr>
<tr>
<td>Staff Specialist</td>
<td><a href="mailto:kcoldren@med.umich.edu">kcoldren@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Nursing Administration 734.232.4124</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dr. Chris Kim</strong></td>
<td></td>
<td>Co-physician lead for Transitions of Care initiatives. Connected us with Tammy Ellies, Brendon Weil and MFH teams.</td>
</tr>
<tr>
<td>Clinical Assistant</td>
<td><a href="mailto:seoungk@med.umich.edu">seoungk@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Professor, Assistant Medical Director</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department of Internal Medicine, Faculty Group Practice 734.647.2892</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chereen Mroz</strong></td>
<td></td>
<td>Liaison to physician staff. Scheduled times to meet with physicians and MFH doctors.</td>
</tr>
<tr>
<td>Liaison with Physicians</td>
<td><a href="mailto:chereen@med.umich.edu">chereen@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Department of Internal Medicine</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dr. Robert Chang</strong></td>
<td></td>
<td>Willing to be observed/interviewed while working within Discharge Navigator.</td>
</tr>
<tr>
<td>Medical Family Hospitalist (MFH)</td>
<td><a href="mailto:robcchang@med.umich.edu">robcchang@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Attending Physician Department of Internal Medicine 734.647.2892</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Staci Barber</strong></td>
<td></td>
<td>Part of the Pharmacy Technician Pilot (PTP). Provided data that included if and why the PSL was changed.</td>
</tr>
<tr>
<td>Pharmacy Technician Ambulatory Care Pharmacy</td>
<td><a href="mailto:serinbar@med.umich.edu">serinbar@med.umich.edu</a></td>
<td></td>
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Team 10 Med-List 26
<table>
<thead>
<tr>
<th>Name, Title, Dept.</th>
<th>Email, Phone</th>
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<tr>
<td>Charity Thompson</td>
<td><a href="mailto:charitye@med.umich.edu">charitye@med.umich.edu</a></td>
<td>Part of the Pharmacy Technician Pilot (PTP). Provided data that included if and why the PSL was changed.</td>
</tr>
<tr>
<td>Charles Berklich</td>
<td><a href="mailto:charles.berklich@gmail.com">charles.berklich@gmail.com</a></td>
<td>Working on his PhD with readmission costs from medication problems after discharge. Provided readmission data and medication error definitions.</td>
</tr>
<tr>
<td>Dr. Benjamin Singer</td>
<td><a href="mailto:singerb@med.umich.edu">singerb@med.umich.edu</a></td>
<td>Willing to be observed and interviewed about role in medication reconciliation.</td>
</tr>
<tr>
<td>Cecilia Sauter</td>
<td><a href="mailto:csauter@med.umich.edu">csauter@med.umich.edu</a></td>
<td>Provided Charles Berklich data to evaluate the impact of PTs. Has access to reports that include patients that were discharged and received a follow-up call by nurses and the gaps identified from the call. It does not show if readmission occurred.</td>
</tr>
<tr>
<td>Alice Schuman</td>
<td><a href="mailto:aschuman@med.umich.edu">aschuman@med.umich.edu</a></td>
<td>Provided costs of Pharmacy Technicians and FTE information.</td>
</tr>
<tr>
<td>Dr. Nate Houchens</td>
<td><a href="mailto:nathanho@med.umich.edu">nathanho@med.umich.edu</a></td>
<td>Part of Transitions of Care committee with a focus on medication reconciliation and discharge summary. Connected team with Dr. Chris Kim and Dr. Robert Chang.</td>
</tr>
<tr>
<td>Dr. Jeff Smith</td>
<td><a href="mailto:sdjeffre@med.umich.edu">sdjeffre@med.umich.edu</a></td>
<td>734.936.5582</td>
</tr>
<tr>
<td>Dr. Vikas Parekh</td>
<td><a href="mailto:viparekh@med.umich.edu">viparekh@med.umich.edu</a></td>
<td>Willing to be observed and interviewed about role in medication reconciliation.</td>
</tr>
<tr>
<td>Tammy Ellis</td>
<td><a href="mailto:tmrice@med.umich.edu">tmrice@med.umich.edu</a></td>
<td>Supplied contact information and brief project descriptions of other (non-IOE) relevant student projects.</td>
</tr>
<tr>
<td>Brendan Weil</td>
<td><a href="mailto:bweil@med.umich.edu">bweil@med.umich.edu</a></td>
<td>Secondary contact to Tammy Ellis.</td>
</tr>
</tbody>
</table>

Team 10 Med-List 27
<table>
<thead>
<tr>
<th>Name, Title, Dept.</th>
<th>Email, Phone</th>
<th>Relevance to project</th>
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<tbody>
<tr>
<td><strong>Mary Beth Reed</strong></td>
<td></td>
<td><strong>Part of student team analyzing medication reconciliation upon admission.</strong></td>
</tr>
<tr>
<td><em>Graduate Student</em></td>
<td><a href="mailto:reedmarybeth@gmail.com">reedmarybeth@gmail.com</a></td>
<td></td>
</tr>
<tr>
<td>UM School of Public Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>573.424.2983</td>
<td></td>
</tr>
<tr>
<td><strong>Camille Johnson</strong></td>
<td></td>
<td><strong>Part of student team analyzing patient education around discharge.</strong></td>
</tr>
<tr>
<td><em>MD/MBA candidate</em></td>
<td><a href="mailto:cij@umich.edu">cij@umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>UM Medical School and Ross School of Business</td>
<td>617.460.0165</td>
<td></td>
</tr>
<tr>
<td><strong>Joan McNeice</strong></td>
<td></td>
<td><strong>Provided overview of a pilot program that involved performing medication reconciliation during patient-family centered rounds.</strong></td>
</tr>
<tr>
<td><em>Clinical Nurse Manager</em></td>
<td><a href="mailto:jmeneice@med.umich.edu">jmeneice@med.umich.edu</a></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular Center - 5 (CVC-5)</td>
<td></td>
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