CONTROLLED SUBSTANCES CHARGING SYSTEM

Industrial and Operations Engineering 481:
Practicum in Hospital Studies
Professor: R. Coffey
Coordinator: L. Cayen
Client: C. Grovenberg
April 27, 1992

Submitted by:
Kelene Jackson
Shaun Stowers
Sherie Williams
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Executive Summary</td>
<td>1</td>
</tr>
<tr>
<td>II. Introduction and Background</td>
<td>3</td>
</tr>
<tr>
<td>III. Alternatives/ Hypotheses</td>
<td>4</td>
</tr>
<tr>
<td>IV. Approach and Methodology</td>
<td>4</td>
</tr>
<tr>
<td>V. Findings</td>
<td>7</td>
</tr>
<tr>
<td>VI. Cost Impact of Converting to Pyxis</td>
<td>11</td>
</tr>
<tr>
<td>VII. Conclusions</td>
<td>12</td>
</tr>
<tr>
<td>IX. Other Issues</td>
<td>13</td>
</tr>
<tr>
<td>X Recommendation</td>
<td>13</td>
</tr>
<tr>
<td>XI. Appendices</td>
<td></td>
</tr>
<tr>
<td>A: Flow Diagram of Pharmacy Billing Process</td>
<td></td>
</tr>
<tr>
<td>B: Sample Time Study Calculations</td>
<td></td>
</tr>
<tr>
<td>C: Sample Legibility Study Calculations</td>
<td></td>
</tr>
<tr>
<td>D: Actual Dollar Charge Comparison/Calculations</td>
<td></td>
</tr>
<tr>
<td>E: Comparison of Medications Not Listed</td>
<td></td>
</tr>
<tr>
<td>F: Cost Savings/Pyxis Justification Calculations</td>
<td></td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

The primary objective of this study was to determine the impact on the current charging system, if an automated charging system is implemented for controlled substances. Aspects studied include financial impact, employee workload and the quality of charging. The automated charging system is called Pyxis. Pyxis is a stand-alone "drug-vending machine". Nurses can use Pyxis by typing an access code, patients registration number and the type of medication that is required. The current billing system is manually driven and dependent on reams of written documentation. The written documentation is sometimes brought into the pharmacy billing area by the pharmacy billing staff and sometimes brought into the area by other hospital personnel, who interface with pharmacy for orders of medications for their particular floor.

Some problems with the current billing system include: MAR's not being sent to billing (at all or within 3 days of patient discharge date), and possible pricing discrepancies. When no record of the times that medications were administered to patients appears on the MAR, it is impossible for billing staff to charge for these items.

In order to evaluate the effectiveness of the current system, several tasks were involved. Employee workload was measured using time study analysis which addressed the three pharmacy components of billing: pricing, totaling, entering. Legibility tests were conducted to show the impact of Medical Administrative Record (MAR) legibility on current system charges. A comparison of net charges from the current system and those that Pyxis would have charged were evaluated for the month of August 1991. Data from 7 patients on the 8th floor in the hospital has been collected and monitored in two forms: 1) the MAR and 2) Pyxis.

For controlled substances, the current billing sequence takes 4.56 hours per day for the one day MAR and 4.95 hours per day for the new one day MAR (which replaces the seven day MAR and the IV Sheets). Narcotics account for 33% of all
medications. Results from the time study analysis suggest that converting to an automated control substance system will have a significant lowering effect on pharmacy billing workload.

The legibility tests illustrated a strong potential for lost charges due to illegible MARs. The definition for illegibility for the purposes of this study, is a condition that arises due to (1) displacement of the carbon that causes the words to overlap, (2) words are too light or (3) partially cutoff. It was found that the average number of one day MARs was 310 and average new one day MARs was 300 per day. An average of 109 and 86 line items are lost or incorrect per day on the old one day MAR and the new one day MAR, respectively. If each of those charges are actually lost and cost only $1.00 each, this would result in a $39,785 estimated annual loss for the one day MAR ($31,390 for the new one day MAR).

Comparison of the charges from Pyxis and the current billing process indicate that Pyxis is cost justifiable since it costs less annually than the predicted annual savings that will be incurred as a result of its implementation. Pyxis would have charged $712.93 for all 7 patients and the current system charged $729.91, based on the assumption (1) that all of the charges on the MARs that arrive in pharmacy billing late (beyond a three-day time period). Pyxis would have charged $712.93 for all 7 patients and the current system charged $356.49, based on the assumption (2) that none of the charges on the MARs that arrive in pharmacy billing late (beyond a three-day time period). Using either Assumption 1 or Assumption 2 will result in a savings of $26,949.99 and $23,004.95 respectively. The calculations can be found in Appendix F. This project group recommends implementing Pyxis as the new billing system.
INTRODUCTION AND BACKGROUND

An interdisciplinary team within The University of Michigan Medical Center has undertaken a project to determine what type of system should be utilized to dispense controlled substances. The team has collected substantial data on the current manual system and an automated system from Pyxis Company. This interdisciplinary team is piloting a second automated system, SureMed. This study is one part of this major project. The primary objective of this study is to determine the impact on the charging system if the team opts for an automated controlled substance system that would have the ability to charge electronically.

Presently, all medications given to patients are to be recorded by a nurse on the patient’s Medical Administrative Record (MAR). This document is used for billing purposes. The patient charging process involves three steps; pricing, totaling, and entering. First, the price of each drug is recorded on the MAR. Second, the total amount is calculated and written at the top of the MAR, and finally the information is entered into a computer under the patients registration number. Although these steps can be completed by one person, this is not necessarily the case. The current system has many potential problems. Of the potential problems, we found the following four:

1. Nurses may forget to record medications on the MAR.
2. Medications may be recorded incorrectly or illegibly.
3. The billing staff rely on their memories to a large extent for prices in order to bill.
4. If the MAR comes down from the floor too late, the patient cannot be charged for the medications listed.

The goal of this project is to determine if an automated system will increase overall efficiency in billing by; saving time, reducing employee workload, and increase charges.
ALTERNATIVES/HYPOTHESES

One of the alternatives that we considered was to redesign the Medical Administrative Record (MAR). An option would be to have a form with specific medications for each diagnosis related group. After some consideration, we considered this to be infeasible because it would be extremely time consuming. Also, it would be very difficult to create a document with the vast number of medications that are used in the hospital that would be practical. However, another group within the hospital has piloted an updated MAR that appears to have fewer legibility problems than the existing MARs (seven day and one day). This pilot has been implemented as a new one day MAR that replaces the seven day MAR and the IV Sheets. Since there was a strong backing from hospital administrative to study the automated system, we did not place much emphasis on developing several alternatives to the automated charging system.

APPROACH AND METHODOLOGY

In order to determine the effectiveness of the current system as it relates to the automated system several steps were taken. Observation and informal interviews of the billing staff provided the team with information on the current (manual) billing system. In addition, impact on workload was measured using a time study of the three phases of the billing process: pricing, totaling and entering. In order to understand all possible bottlenecks of the current system, a flow chart of the billing process was completed. The flow chart can be found in Appendix A. The previous two actions also aided in providing concrete insight into the current charging system. The project team visited pharmacy satellites at the University of Michigan Medical Center, which provided the team with information regarding the interactions of daily pharmacy activity on the nursing unit and the billing process.
Net charges and charges from the manual system and those from Pyxis were compared during a common time period (August, 1991), based on the following criteria:

1. Was the medication recorded?
2. Was the medication recorded correctly?
3. Was the medication billed correctly?

First, the correct acquisition costs were manually inserted into the billing algorithm so that the Pyxis charges would be up to date. Second, the charges recorded by Pyxis were calculated and compared to the narcotics charges recorded on the MAR by the billing staff.

To assess the impact of lost charges due to time delays in billing, each patient's discharge date was compared to the date that the charges were entered into the hospital's billing interface. When time delays are longer than three days, there is a greater probability of losing charges. Finally, The finance staff was interviewed in order to verify actual gains from lost charges and the average dollar amount of narcotics.

The following section gives more information on the time study analysis of the three components of the billing system:

**Time Study Analysis**

**Test Participant**

An average test participant was studied, who had been in the pharmacy billing department for 2 years and 5 months. Average, in this context, means that the test participant was neither the fastest nor the slowest member of the billing staff, but her skills were in the middle of these two extremes.

**Pricing**

The test participant was given a total of 200 MARs to price. Two types of MARs were timed: 1) 100 one day and 2) 100 new one day. The participant was timed
pricing all of the MARs, then the line items were counted for both types of MARs. The amount of time in seconds was computed per line item.

**Totaling**

The same stacks of one-day and new one day Mars were used as in the pricing portion of the test. The test participant was timed totaling the same two stacks of MARs.

**Entering**

Another test participant, a part time data entry clerk, completed the entering sequence of billing. She was timed entering fifty MARs into the hospital's billing data base. More detail on time study calculations can be seen in Appendix B.

During the time study, the test participant indicated that she was having difficulty reading some of the line items on the MARs. This difficulty was a direct result of words that were too light to read. This prompted an inquiry into the legibility of the MARs.

**MAR Legibility Analysis**

Testing of MAR legibility was used to discern whether or not this is a factor in the accuracy of the current system. The criteria for legibility in this study are as follows:

1. Were the words too light to read?
2. Did the words overlap (due to misplaced carbon paper)?
3. Were partial or whole words missing?

Neatness of the handwriting on the MAR was not a criteria because this does not appear to create any problems for the billing staff.

MARs from one week were collected by the billing staff to allow calculation of an average number of MARs per day. Two legibility tests were carried out. The first test had a sample size of 50 MARs, while the second test had a sample size of 100. The total number of line items and the number of illegible line items were
counted. This resulted in the number of lost line items per day which translates into lost charges. More detail on the legibility test can be found in Appendix C.

FINDINGS

Time Study Analysis

One Day MAR

The average pricing time for a one day MAR is 16.7 sec/line item, while the average totaling time was .65 sec/line item. The average entering time was 1.03 sec/MAR item. This translates to 4.56 hours per day of the billing staff’s workload.

New One Day MAR

The average pricing, totaling and entering times were 18.7 sec/line item, .75 sec/line item and 1.03 sec/MAR, respectively. This translates to a total of 4.95 hours per day of the billing staff’s workload.

In both the pricing and totaling sequences, the new one day MAR takes a slightly longer time period to complete than the one day MAR. The layout of the new day MAR contributes to this increase in task time, there are two columns of medications instead of one. There is no significant difference in the entering sequence time because in both cases, the same amount of information is entered per MAR.

MAR Legibility Analysis

A one week sample of MARs was counted in order to determine the number of MARs that are processed per day and the average number of narcotics that appear on each MAR. The average number of one day MARs that are processed per day was 310. The average number of narcotics line items per MAR was 3, on both one day MARs and new one day MARs. The average number of line items for all medications is 9 for the one day MARs. In the one day test, 11.8% of the line items
were illegible. This resulted in 109 lost or incorrect charges. The average number of new one day MARs that are processed per day was 300. In the new one day test, 9.6% of the line items were illegible. This resulted in 86 lost or incorrect charges. This would have a negative impact on the hospital's charge. For instance, if each of these charges were lost, and only cost $1.00 each, then average annual losses would be estimated as $39,765.00 for the one day and $31,390 for the new one day. These losses are in narcotics only, which are only about 33% of the total pharmacy charges.

**Charge Comparison**

In order to calculate the differences in charges (from the MAR and from Pyxis), two different assumptions were made. Assumption 1 is based on the idea that all late MARs will be charged on the patient's bill. Assumption 2 is based on the idea that none of the late MARs will be charged on the patient's bill. See Appendix D for complete detail on calculations.

**Charges**

**Assumption 1:**

In 6 out of 7 cases, the current billing method charged more than Pyxis would have charged. Overall, the current system charged $729.91, while Pyxis would have charged $712.93 for all of the 7 patients. This is a difference of $16.98 during the one month period in which the study was conducted. Refer to Figure 1, below, for an individual analysis. The difference in the amount of charges between Pyxis and the current billing method can be attributed to the difference in the number of medications listed on each document (MAR and Pyxis Printout). In 5 out of 7 cases Pyxis was missing more dosages of medications than the MAR.
Assumption 2:

In 3 out of 7 cases, the current billing method charged less than Pyxis would have charged. The current billing method charged $356.49, as opposed to the $712.93 that Pyxis would have charged. This is an estimated loss of $356.44 during the one month period of this study (See Figure 2).
Figure 2. Comparison of Charges: Pyxis vs. MAR, Assumption 2.

Medications

Figure 3 shows the individual differences in the number of dosages of medications that are missing for each individual patient on the Pyxis print out and the MAR, under Assumption 2. Assumption 2 is based on the idea that none of the late charges will appear on the patient’s bill. This provided a vehicle for comparing the current billing method to the Pyxis (automated) billing method in terms of medications listed as being administered to patients. For example, there were 7 dosages of medications listed on the MAR that did not appear on Pyxis for patient 1. Similarly, there were 3 dosages of medications listed on Pyxis that did not appear on the MAR, for patient 1. These are ten separate instances of medications. See Appendix E for a complete listing of missing medications for both billing methods. Possible reasons for the discrepancies include stealing, lack of standardized storage methods for narcotics.
and human error. The storage method for certain narcotics varies from floor to floor. For example, Tylenol #3 is locked up on some floors but not on others.

Figure 2. Comparison of Medications: Pyxis vs. MAR

**COST IMPACT OF CONVERTING TO PYXIS**

Pyxis is cost justifiable because its cost is estimated to be significantly less than the savings that will be incurred as a result of its implementation. The lease/maintenance cost for Pyxis is approximately $700.00/month. Another cost associated with Pyxis is the computer paper that is used to print out patient medication/billing information. The Pyxis pilot program utilized 50 pages of this paper per month. At this utilization rate, the annual cost for paper would be $30.47. This cost information is based on the prices quoted in the University Stores Catalog. The
annual time savings is $35,172.70. The charge comparison, under Assumption 1, will save an additional $415.08 per year. The charge comparison, under Assumption 2, will yield a loss of $3,957.96 annually. Using either Assumption 1 or Assumption 2 will result in a savings of $26,945.99 and $23,004.95 respectively. The calculations can be found in Appendix F.

CONCLUSIONS

Results from the Time Study Analysis show that converting to an automated controlled substance system would significantly impact billing workload. Narcotics account for one third of all medications. A total of 9.51 hours per day will be eliminated by removing the narcotics billing portion. If the program was expanded to include all medications then implementation of the automated system would be more effective because there would be only one method for administering and billing medications. The legibility tests illustrates potential lost charges using the current billing system. An automated system would increase charges because the billing system would no longer be dependent upon handwritten documents, thereby reducing the amount of human error incurred due to illegibility. Comparison of the charges from Pyxis and the current billing process indicates that the current method charged more than the automated method would have charged, based on Assumption 1. Based on Assumption 2, Pyxis would have charged twice as much as the current method. Comparison of the medications listed on both the MAR and the Pyxis printout, shows that the current method lists more medications than the automated method. The discrepancies in the number of medications missing on Pyxis may be due to pre-listing medications on the MAR that are never administered to the patient. When this occurs, the medications may be returned to the Pyxis machine, but not listed as being returned on the MAR. Although there may be other causes for the discrepancies, they are unknown.
OTHER ISSUES

The impact of implementing an automated narcotics billing system includes many important issues. One is the standardization of narcotics storage by all the nursing units. Another important issue that comes into play is breakdown of the automated system. If this occurs, an alternate billing procedure must be planned to act as a back-up.

RECOMMENDATION

Converting to Pyxis will result in an annual savings that is greater than the annual implementation cost. Therefore, the project team recommends converting to the automated billing system.
APPENDIX A: PHARMACY BILLING PROCESS

PRICING

DOES EMPLOYEE KNOW PRICE?

NO → LOOK UP PRICE

YES → RECORD PRICE

IS PRICE CORRECT?

(COULD LEAD TO LOST REVENUE)

TOTALLING

ENTERING
HOURS PER DAY:
OLD ONE DAY MARs

Pricing

\[(16.7 \text{ sec/line item}) \times (3 \text{ line items/MAR}) \times (310 \text{ MARs/day}) \times (1 \text{ hr/60 sec})\]

\[= 4.3 \text{ hrs/day}\]

Totalling

\[\left(0.65 \text{ sec/line item}\right) \times (3 \text{ line items/MAR}) \times (310 \text{ MARs/day}) \times (1 \text{ hr/60 sec})\]

\[= 0.168 \text{ hrs/day}\]

Entering

\[\left(1.03 \text{ sec/line item}\right) \times (310 \text{ MARs/day}) = 0.089 \text{ hrs/day}\]

TOTAL TIME TO PROCESS:

\[= 4.56 \text{ hrs/day}\]

NOTE: The same calculations were applied to the new one day MARs
APPENDIX C

LEGIBILITY CALCULATIONS

PERCENT ILLEGIBLE:

\[
\text{PERCENT ILLEGIBLE:} = \frac{\text{NUMBER OF ILLEGIBLE LINE ITEMS}}{\text{TOTAL # OF LINE ITEMS}}
\]

\[
= \frac{88}{748} \quad (\text{SAMPLE SIZE} = 50)
\]

\[
= 11.8 \%
\]

TOTAL NUMBER OF ONE DAY MARS/DAY = 310

AVERAGE NUMBER OF NARCOTICS LINE ITEMS/MAR = 3

LOST / INCORRECT NARCOTICS LINE ITEMS PER DAY:

\[
(3 \text{ LINE ITEMS/MAR}) \times (310 \text{ MARS/DY}) \times (0.118) = 109 \text{ LINE ITEMS/DY}
\]

NOTE: The same calculations were applied to the new one day MARs
<table>
<thead>
<tr>
<th>PATIENT</th>
<th>PYXXS</th>
<th>MAR-ASSU 1</th>
<th>MAR-ASSU 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>269.39</td>
<td>289.45</td>
<td>28.49</td>
</tr>
<tr>
<td>2</td>
<td>35.37</td>
<td>55.14</td>
<td>34.30</td>
</tr>
<tr>
<td>3</td>
<td>186.30</td>
<td>88.90</td>
<td>33.32</td>
</tr>
<tr>
<td>4</td>
<td>75.35</td>
<td>81.63</td>
<td>81.63</td>
</tr>
<tr>
<td>5</td>
<td>18.96</td>
<td>36.04</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>98.09</td>
<td>104.88</td>
<td>104.88</td>
</tr>
<tr>
<td>7</td>
<td>29.47</td>
<td>73.87</td>
<td>73.87</td>
</tr>
<tr>
<td>TOTAL</td>
<td>712.93</td>
<td>729.91</td>
<td>356.49</td>
</tr>
</tbody>
</table>
APPENDIX D

CHARGE COMPARISON

DIFFERENCE BETWEEN PYXIS AND MAR - ASSUMPTION 1:

MAR- PYXIS:

$729.91/MO - $712.93/MO = $16.98/MO

ANNUAL DIFFERENCE IN DOLLARS:

$203.76/YR

DIFFERENCE BETWEEN PYXIS AND MAR - ASSUMPTION 2:

MAR- PYXIS:

$356.49/MO - $712.93/MO = $-356.44/MO

PREDICTED ANNUAL LOSS:

$-4277.28/YR

ASSUMPTION 1: LATE CHARGES IN THE CURRENT METHOD ARE ON THE PATIENT'S BILL.

ASSUMPTION 2: LATE CHARGES IN THE CURRENT METHOD ARE NOT ON THE PATIENT'S BILL.
ALSO INCORPORATES CHARGES THAT NEVER ARRIVE IN PHARMACY BILLING.
<table>
<thead>
<tr>
<th>Date</th>
<th>Codeine</th>
<th>Morphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/7</td>
<td>1-30 mg</td>
<td></td>
</tr>
<tr>
<td>8/10</td>
<td>2-30 mg</td>
<td></td>
</tr>
<tr>
<td>8/11</td>
<td>3-30 mg</td>
<td></td>
</tr>
<tr>
<td>8/16</td>
<td>1-30 mg</td>
<td></td>
</tr>
<tr>
<td>MAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/19</td>
<td>2-60 mg</td>
<td></td>
</tr>
<tr>
<td>8/19</td>
<td>1-30 mg</td>
<td></td>
</tr>
<tr>
<td>MAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/22</td>
<td></td>
<td>1-4 mg</td>
</tr>
<tr>
<td>8/23</td>
<td></td>
<td>1-4 mg</td>
</tr>
<tr>
<td>Date</td>
<td>Name</td>
<td>Medication</td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>8/9</td>
<td>Linda W.</td>
<td>1-30 mg codeine</td>
</tr>
<tr>
<td>8/11</td>
<td>Linda W.</td>
<td>1-50 mg meperidine</td>
</tr>
<tr>
<td>8/14</td>
<td>Linda W.</td>
<td>1-25 mg meperidine</td>
</tr>
<tr>
<td>MAR</td>
<td>Linda W.</td>
<td>2-25 mg meperidine</td>
</tr>
<tr>
<td>8/8</td>
<td>Linda W.</td>
<td>1-25 mg meperidine</td>
</tr>
<tr>
<td>8/13</td>
<td>Jesse F.</td>
<td>1-30 mg morphine</td>
</tr>
<tr>
<td>8/17</td>
<td>Jesse F.</td>
<td>1-30 mg morphine</td>
</tr>
<tr>
<td>MAR</td>
<td>Jesse F.</td>
<td>1-60 mg morphine</td>
</tr>
<tr>
<td>8/15</td>
<td>Jesse F.</td>
<td>1-4 mg Dilaudid</td>
</tr>
<tr>
<td>8/19</td>
<td>Jesse F.</td>
<td>1-30 mg morphine</td>
</tr>
</tbody>
</table>

There was no information for the following dates: 8/4, 8/5, 8/6, 8/9, 8/10, 8/11.
| Dorothy Y.       |  
| Pyxis           |  
| 8/10 1-30mg morphine sulf |  
| 8/10 2-2 mg morphine IV inj. |  
| There was no information for the following date: |  
| 9-Aug          |  


APPENDIX F

COST SAVINGS CALCULATIONS

HOURS/YEAR:

(8 HRS/DAY)*(5 DYS/WK)*(52 WK/S/YR) + (4 HRS/DAY)*(1 DY/WK)*(52 WK/S/YR) = 2288 HRS/YR

AVG. ANNUAL SALARY PLUS BENEFITS:

($16,000/YR)*(1.15)*(1.26) = $23,184/YR

AVG. HOURLY SALARY PLUS BENEFITS:

($23,184/YR) / (2288 HRS/YR) = $10.13/HR

CALCULATED ANNUAL TIME SAVINGS:

(9.51 HRS/DY)*(365 DYS/YR)*(10.13/HR) = $35,172.70/YR
PYXIS COST CALCULATIONS

ANNUAL LEASE/MAINTENANCE FEES:

\( \text{($700/MOS) \times (12 \text{ MOS/YR}) = \$8400 / \text{YR}} \)

ANNUAL COST OF PAPER SUPPLIES:

\( \text{(50 PAGES/MO) \times (12 \text{ MO/YR}) \times ($83.79 /1650 \text{ PAGES}) = \$30.47/\text{YR}} \)

TOTAL COST/YR:

\( \text{$8430.47} \)
CALCULATED ANNUAL TIME SAVINGS:

(9.51 HRS/DY) * (365 DYS/yr) * ($10.13/HR) = $35,172.70/YR

ANNUAL LEASE/MAINTENANCE FEES:

($700/MOS) * (12 MOS/yr) = $8400 / yr

ANNUAL COST OF PAPER SUPPLIES:

(50 PAGES/MO) * (12 MO/yr) * ($83.79 / 1650 PAGES) = $30.47/yr

TOTAL COST/YR: $8430.47/YR

PREDICTED SAVINGS - ANNUAL COST:

$35,172.70 - $8430.47 = $26,742.23

ASSUMPTION 1: $35,172.70 + 203.76 - $8430.47 = $26,157.99

ASSUMPTION 2: $35,172.70 - $8430.47 - 4277.28 = $23,004.95