AUTOMATED ORDER ENTRY/RESULT REPORTING:
A Preliminary Analysis

Project Report
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Executive Summary

Introduction

The University of Michigan Hospital is implementing a hospital-wide automated order entry/result reporting (OE/RR) system. The implementation of the system will result in a major hospital transformation. The purpose of an automated OE/RR system is to improve the quality (timeliness, accuracy) of patient orders while presenting the care providers with patient focused access to results from all areas, as opposed to results from individual ancillary departments. This combination will allow integration of the information, and contribute to improved patient service, research, and education.

The study team of six students has done a preliminary analysis identifying potential benefits and problems of such a system.

Purpose of Project

The purpose of this project was to document the current system of order entry and result reporting processes and look for problems in the current system in an effort to find potential areas of improvement with the new system. The primary focus of this project was physician interaction with OE/RR procedures within an inpatient setting.

An additional purpose of this project was to provide a basis for further investigation and study of the current University Hospital system and the automated patient care information system.

Key findings and observations of Internal Medicine inpatient unit 6C

Table 1. Problems Observed with Current OE/RR Process

<table>
<thead>
<tr>
<th>Problem</th>
<th>Comment /Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability of departmental computer terminals</td>
<td>System failed 2-3 times during last six months; this then leads to an abundance of OE/RR by telephone and an overload of calls to and from the labs; this results in difficulty in retrieving results</td>
</tr>
<tr>
<td>Unavailability of computer terminals</td>
<td>All computers occupied; results in wasted physician time walking and looking for available terminals</td>
</tr>
</tbody>
</table>
Legibility

Physician orders are often illegible due to poor penmanship and must be clarified.

Locating medical records

When an inpatient is on the floor, the record is often misplaced or not at one of these locations: just outside the patients room, at the nurses station, or in the conference room.

This requires finding the document, and not giving prompt medical attention to the patient.

Re-work and waste

Re-admitted patients often require orders duplicated from previous visit; all orders must then be written again by hand.

Transporting medical record

Re-admitted patients files can become quite extensive and are required to be carried from the emergency room to the unit floor or patient room.

Distribution of multi-part orders to different locations

Having to press through four carbon copies often results in unreadable orders; this requires that the departments confirm or clarify the orders with the physicians.

House officers and medical students write most of their orders by hand (approximately 90%). Written orders take 1.9 minutes each on average, telephone orders require 2.5 minutes per order, and verbal orders require 1 minute or less per order.

House officers and medical students retrieve most lab results by computer and telephone. Retrieving results by telephone takes 7.2 minutes on average, by computer 1.4 minutes and 7 minutes verbally.

Recommendations for Further Study

Future investigation should involve documentation and quantification of three phases:

1) a further analysis of the current system,
2) an analysis of the automated system, and
3) a large scale comparison between the two.
Studies should begin in units with high volumes of order entry and result reporting (OE/RR) and expand as necessary. The study team recommends the use of charge and billing data in determining which units are high volume units. In addition, the team recommends that further studies include investigation in both medical and surgical units.

The first phase of the analysis should expound on this team's investigation of the University Hospital's current system. Study should concentrate on specific problematic areas of order entry and result reporting as outlined in this report. Specifically, a quantification of these problems, along with other aspects of the system, is necessary so that a comparison can be made at a later date. Areas of interest include:

- Time between order entry and order execution
- Time lost and frequency of occurrence of order clarification or errors
- Time spent retrieving results (looking for charts, waiting for call backs, etc.)
- Time spent co-signing orders (medical students)
- Time spent waiting for computer terminals
- Time lost while computer system is down, and frequency of breakdowns
- Frequency of times orders are illegible on one or more copies of forms

Secondly, similar data must be compiled for an automated system identical or similar to the proposed system which will be implemented at the University Hospital if a valid comparison of the current and proposed system is to be made. A hospital with a similar automated system would be an excellent place to collect this data, as well as investigating problems in implementing their systems, and how they dealt with resistance. This could be accomplished through interviews with those who are familiar with the automated system, including physicians and hospital administrators. Additional hospitals that could be studied include:

- Sacred Heart Hospital, Eau Claire, WI
- El Camino Hospital
- Medical Center of Central Georgia
- Pacific Presbyterian Medical Center
- St. Paul-Ramsey Medical Center, St. Paul, MN
- Methodist Hospital of Indiana, Indianapolis, IN
- Presbyterian Hospital, Charlotte, NC
- Medical College of Virginia Hospitals
- St. John's Hospital and Health Center, Santa Monica, CA
- Rose Medical Center, Denver, CO
- Wishard Memorial Hospital, Indianapolis, IN
In addition, on site observation of an actual system in use could prove beneficial in obtaining quantitative data which can be compared to similar data on the current system.

Once the two data sets have been compiled, a statistical analysis can be completed showing the attainable results.
I. INTRODUCTION AND BACKGROUND

Introduction

The University of Michigan Hospital is implementing a hospital-wide automated order entry/result reporting (OE/RR) system. The implementation of the system will result in a major hospital transformation. The purpose of an automated OE/RR system is to improve the quality (timeliness, accuracy) of patient orders while presenting the care providers with patient focused access to results from all areas, as opposed to results from individual ancillary departments. This combination will allow integration of the information, and contribute to improved patient service, research, and education.

The study team of six students has done a preliminary analysis identifying potential benefits and problems of such a system.

Purpose of Project

The purpose of this project was to document the current system of order entry and result reporting processes and look for problems in the current system in an effort to find potential areas of improvement with the new system. The primary focus of this project was physician interaction with OE/RR procedures within an in patient setting.

An additional purpose of this project was to provide a basis for further investigation and study of the current University Hospital system and the automated patient care information system.
II. APPROACH AND METHODOLOGY

Through review of literature and personal interviews, the team familiarized itself with the automated system's capabilities and uses. The goal of the literature search was to accumulate articles, data, and hard dollar benefits associated with automated OE/RR systems. The study team submitted a preliminary collection of articles and information associated with TDS and other automated systems. The collection of quantitative notes of this additional literature search are included in Appendix A. Copies of articles have been submitted in a separate document.

In consultation with the client, the team decided the appropriate approach for discovery was to "shadow" critical teams as they perform the OE/RR process.

Two data collection teams then shadowed Dr. Kyle Ruffing, and a team consisting of Dr. Chris Avendaño and medical student Susan Tourner, respectively. Both house officers Ruffing and Avendaño were assigned to University Hospital inpatient unit 6C, which consists of the Internal Medicine Pulmonary and Internal Medicine General units. While shadowing the physicians, the data collection teams (in groups of two) collected information on the type of operation (order entry or result reporting) performed by the physicians, as well as the method of operation used (telephone order, written order, etc.). For each physician activity documented, the starting time and ending time was noted (approximated to the nearest minute), as was the location of and person involved in the activity.

The study team then analyzed the data and information collected.
III. CURRENT SITUATION

General Information

On Wednesday, November 3, 1993, during a preliminary meeting with Dr. William Bria, the current method of order entry and results reporting at the University of Michigan Hospital was discussed. Because the hospital operates as a teaching hospital, most order entry and results reporting is carried out by house officers and medical students. The attending physician's role is one of a teacher, and thus it is understood that they normally do not to write orders, although, under some circumstances it is accepted.

For the medical inpatient unit studied, 6c, the majority of the order entry and results reporting on site is done mostly during three times of the day. They are:

- morning rounds 7:00 to 9:00 am
- noon rounds 12:30 to 1:30 pm
- end of the day 3:30 to 5:00 pm

Although ordering and result reporting occur throughout the day, the times listed above are representative of peak areas of OE/RR.

Four types of order entry are currently in practice at the University Hospital. Figure 1 presents these order types.

Figure 1. Order Types

- **Written**
  This is the most common ordering procedure. The order is written onto a Physician Order Sheet and copies distributed to various affected locations (such as pharmacy).

- **Verbal**
  Orders are given verbally, which must be recorded and signed at a later time. An example is a STAT order.

- **Telephone**
  Used mainly after 5:00 pm or for off-site ordering and reporting. Telephones are often used by auxiliary departments (such as Pharmacy) to confirm or clarify physician orders.
• **Suspended**  Commonly used with pre-admission orders and also in surgery order sets. These orders are written prior to treatment and are signed for as procedures are completed. Also, medical students' orders are suspended orders and must be cosigned by a physician prior to execution of the order.

Similar to orders, there are four types of result reporting methods currently in practice at the University Hospital. They are detailed in Figure 2.

**Figure 2. Results Reporting Methods**

- **Telephone**  Physician may speak to an individual or listen to voice mail such as RtaZ, the electronic voice reporting system in Radiology.

- **Written**  Standard hard copies.

- **Computer**  Physician can obtain results through an on-line computer system. These systems are currently departmental and not hospital wide. The results for a patient are not integrated.

- **Physician interaction**  A specific team member may be in charge of certain patients and will communicate results personally to other medical staff.

**Study of Internal Medicine Unit 6-C**

From the information collected during the day with Dr. Ruffing and Dr. Avendaño on Thursday, December 2, the study team obtained a general understanding of the current order entry and result reporting process at the University of Michigan Hospital. An example of a typical work day for the Internal Medicine physician teams of inpatient unit 6C is as listed on the following page:

- **7:30 - 8:00 am**  Team meets for the first time in the day. At this point a brief meeting is held, after which the team begins their rounds to patient rooms. The Internal Medicine Pulmonary team consisted of an attending physician, a house officer, four medical students, and a nurse.
• **8:00 - 9:00 am** The team makes rounds to each of their patient's rooms. During these rounds, individual patient's cases are discussed and the attending physician is updated. No orders or results are processed at this time although the attending physician may discuss or recommend orders with the team. Often specific notes are written for later reference when the official order is written.

• **9:00 - 12:00 pm** Around 9:00 am the patient rounds end and the order and result process begins. At this time, the house officer becomes the focus of the order entry and result reporting procedures. The team that participated together in rounds dissolves to take care of their individual patients and responsibilities. Most of the house officer's time is spent between the conference area and the nurses station in the 6C unit. The conference area is where most orders are written by the house officers and medical students. They also check lab results, telephone for orders and results, and verbally exchange information with other members of the staff.

• **12:00 - 1:00 pm** Lunch. (Sometimes used for writing orders)

• **1:00 - 4:00 pm** Again the house officer spends most of the time during this period in the conference center or at the nursing station writing orders and receiving results. If during this time (or any time), a new patient is admitted, it may be necessary to write orders in other locations such as the emergency room.
• 4:00 - 5:00 pm  At this time, activity winds down and the day ends for the physician team. An exception to this would be those members of the staff on call or those that may be working on an ensuing patient case.

Most of the orders and results processed by the house officers took place in the conference area in 6C and much of their time was spent in-between the conference area and the nurses station as they worked on different patient's records throughout the day.

Discussion of Flowcharts

Chart 1 in Appendix B is a flowchart of the ordering process most frequently observed during the data collection session. It illustrates where the key activities occur geographically and where both the order and related documents are generated. It is important to understand that this is not the only way in which orders are created, but does appear to be the most prevalent method on unit 6C. Further data collection is necessary to construct a basis for the less frequent order process flowcharts.

Chart 2 in Appendix B illustrates the distribution of the physician's order after it has been submitted to the ward clerk. Distribution occurs to each location impacted by the order, thus if it was not a medication order a copy will not be sent to the Pharmacy.
Patient Record

Within the Internal Medicine Unit 6C, it is required that each order, regardless of type, eventually be recorded in the patient's medical record. Throughout the day, the record moves throughout the floor a great deal, and thus it is necessary to have an identification system on each record. For the unit on 6C, this system is made up of a rotary dial, as seen in Figure 3, located on the binding to instantly communicate the status of the orders within the record.

Rotary Dial

![Figure 3 - Patient Medical Record with Rotary Dial](image)

Four colors are on the dial as well as a black plate that conceals three of the four colors within the dial. Each of the four colors signals a different type of order situation.
- Black indicates that nothing has been written.
- Green indicates that an order needs to be cosigned.
- Yellow indicates that it is a routine order.
- Red indicates a STAT order, meaning the order is urgent and demands immediate processing.

Written Order Entry

As seen in the frequency data summarized in Table 1 and Figure 4, the majority of the orders processed were written. During the day-long study, the study team came across three different types of written orders: (1) physician order forms, (2) inpatient requisition forms, and (3) inpatient consultation or referral forms. Once
any of these orders has been written, a copy of it is placed within the patient record.

Every written physician's order requires the physician's signature and the date. For example, if the physician orders four medications and a lab test, he or she must sign and date each order, which can be very time consuming. In addition, each written order has many layers. The physician order forms are four (4) layers thick while the inpatient requisition forms are five (5) layers thick. Each of these forms are carbonless (NCR) type forms. When the physician fills them out, they must press down hard as they write, to insure that the order gets copied onto every last layer.
IV. FINDINGS AND CONCLUSIONS

Order entry and result reporting (OE/RR) were documented after following the physicians between 9:15 am and 5:00 pm. Most of the on-site OE/RR took place during this time of the day. Table 1 given below indicates the number of order entries by type of order, average time spent in placing the order (in minutes), and range of order time (in minutes) of the orders entered during the day.

TABLE 1. ORDER ENTRY DATA

<table>
<thead>
<tr>
<th>Order Entry</th>
<th>Quantity</th>
<th>Average Time (Min.)</th>
<th>Range (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written</td>
<td>70</td>
<td>1.9</td>
<td>1 to 54</td>
</tr>
<tr>
<td>Telephone</td>
<td>4</td>
<td>2.5</td>
<td>1 to 3.5</td>
</tr>
<tr>
<td>Verbal</td>
<td>2</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Verbal Suspended</td>
<td>2</td>
<td>6.0</td>
<td>3 to 9</td>
</tr>
<tr>
<td>Written Suspended</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

(SAMPLE SIZE: N = 78 ORDERS for inpatient unit 6C)

Note: All times measured and rounded to the nearest minute

As shown in Table 1, the 78 orders were issued during the period of observation, and 70 of those 78 orders were written by hand.

One problem noticed was that all written orders must be pressed through four carbon copies. According to Dr. Ruffing the pharmacy calls him at least once a
day to clarify the illegible carbon copies of some orders. Another problem that arises is that a physician may prescribe medications not available in the pharmacy formulary, or may order incorrect dosages (i.e. a physician may prescribe 1000 mg, but the pharmacy only has 500 mg tablets. This is a problem with orders that need to be filled exactly as written for out-patients). That is, before the pharmacy can issue the medication, pharmacy must get the physician's approval to use the alternative.

Table 2 indicates the number of results reported by type of method, average time spent in retrieving the result (in minutes), and range of retrieval time (in minutes) of the results obtained during the day.

<table>
<thead>
<tr>
<th>Result Reporting</th>
<th>Quantity</th>
<th>Average Time (Min.)</th>
<th>Range (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone</td>
<td>5</td>
<td>7.2</td>
<td>2 to 25</td>
</tr>
<tr>
<td>Computer</td>
<td>5</td>
<td>1.4</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Verbal</td>
<td>2</td>
<td>7.0</td>
<td>5 to 9</td>
</tr>
<tr>
<td>Written</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(SAMPLE SIZE: N = 12 RESULTS for inpatient unit 6C)
Note: All times rounded to the nearest minute

Figure 5. Results Reporting Frequency Histogram

They retrieved 5 results by phone and 5 results by computer. The average times to retrieve results were highest when done verbally and by telephone.

Dr. Ruffing spent at least one to two minutes waiting for each result retrieved by telephone. For example, he would have to page the labs and then wait until his
call was returned. There were only four phones and two computers in the conference room on 6C. If a phone was not being used, there was a high probability that another house officer or medical student was waiting for their call to be returned. Consequently, the phone could not be used by anyone else and Dr. Ruffing would have to either wait or go to some other location to place a call.

The computer system in the conference room was observed to not be functional a few times during the day for short periods of time (approximately five to ten minutes). The house officers and medical students also stated that the entire computer system has failed at least two or three times for an entire day in the past six months. When the system fails, the results must be retrieved by phone and the labs have experienced an overload of calls when the computer system fails. Therefore, the house officers and medical students have an extremely difficult time retrieving results whenever the system does fail.

One problem observed with the current system is that physicians can not always locate patient charts when needed. For example, during the morning rounds, the rounding team could not look at a patient's chart because it was in Radiology. The physicians claim that charts are frequently at locations other than the "correct" locations. Theoretically, patient charts should be just outside the patient's room, at the nurses' station, or in the floor conference room.
V. RECOMMENDATIONS

The completion of this project is only a starting point for further study. The study team recommends that two main topics be investigated further: A) Minimizing physician resistance to the automated system, and B) Easing the transition from using the present system to a computer system.

A. Minimizing Physician Resistance to the Automated System

As physician resistance to the installation of the computer system is a primary concern, further in-depth study should concentrate on finding ways to curb this resistance. In order to do so, the following concerns mentioned by the physicians need to be addressed:

1. Documentation of time-saving benefits of the system
2. Availability of computer terminals
3. Reliability of the system

1. Documentation of time-saving benefits of the system

To realize the time-saving benefits of the automated system, documentation and quantification of the following three areas are necessary: 1) a more in-depth analysis of the current system, and all the functions which consume physician time, 2) an analysis of the automated system, and 3) a large scale comparison between the two. Studies should begin in units with high volumes of OE/RR and expand as necessary. The study team recommends the use of charge and billing data in determining which units are high volume units. In addition, the team recommends that further studies include investigation in both medicine and surgical units.

Area 1. Analysis Of Current University Hospital OE/RR System

The first phase of the analysis should expound on this team's investigation of the University Hospital's current system. Study should concentrate on specific problematic areas of order entry and result reporting as outlined in this report. Specifically, a quantification of these problems, along with other aspects of the system, is necessary so that a comparison to the automated system can be made at a later date. Topics of interest within the current system include:

- Time between order entry and order execution
- Time lost and frequency of occurrence of order clarification or errors
- Time spent retrieving results (looking for charts, waiting for call backs)
- Time spent cosigning orders (medical students)
- Time spent waiting for current computer terminals
• Time lost while current computer system is down and frequency of breakdowns

The data collection may take one to two semesters to complete. The OE/RR study should expand from medicine to surgery, the emergency room, Mott’s children hospital and eventually to outpatient clinics. The data can be obtained by shadowing those attending physicians, house officers, and medical students doing the order entry and result reporting in each area. To locate physicians to shadow, this study group recommends the next study group(s) be responsible for arranging appointments. From this study group’s experience in internal medicine, house officers were very cooperative and easily accessible by contacting attending physicians or third year house officers.

Area 2. Analysis Of Proposed OE/RR System

Similar data must be compiled for an automated system similar to the proposed system to be implemented at the University Hospital, so a valid comparison of the two can be made. The Catherine McAuley Medical Center is implementing the same automated system and would be an excellent place to collect this data. Information on the system could be obtained through interviews with those who are familiar with the automated system, including physicians, nurses and hospital administrators. In addition, on site observation of an actual system in use could prove beneficial in obtaining quantitative data which can be compared to similar data on the current system.

The study team recommends that St. Joseph Hospital in Ann Arbor, Michigan, may be a potential hospital to study. The reasons for this choice is that St. Joseph’s implemented a similar automated system in December, 1993, and is geographically close. This will be most worthwhile if their implementation is sufficiently advanced that measurements can be made after physicians have become comfortable with the computerized system. Additional hospitals that could be studied include:

• Sacred Heart Hospital, Eau Claire, WI
• El Camino Hospital
• Medical Center of Central Georgia
• Pacific Presbyterian Medical Center
• St. Paul-Ramsey Medical Center, St. Paul, MN
• Methodist Hospital of Indiana, Indianapolis, IN
• Presbyterian Hospital, Charlotte, NC
• Medical College of Virginia Hospitals
• William Beaumont Hospital, Troy, MI
• St. John’s Hospital and Health Center, Santa Monica, CA
• Rose Medical Center, Denver, CO
• Wishard Memorial Hospital, Indianapolis, IN
Additional hospitals utilizing automated OE/RR systems could be obtained by contacting the system manufacturers, such as:

TDS Healthcare Systems Corporation
200 Ashford Center North
Atlanta, GA 30338
(404) 847-5000

Area 3. Large Scale Comparison Of The Two OE/RR Systems

Once the two data sets have been compiled, a statistical analysis can be completed. Important analysis of the following topics should be addressed:

1. Document improved turnaround time (in hospital w/system)
2. Document reduction of errors, and clarification time

These points are crucial in that they represent information that is pertinent to the physician. Hard data comparing frequency and elapsed times involved in OE/RR may not necessarily prove that the automated system will be faster for OE/RR itself. To curb physician resistance to the system, it may be necessary to show the overall benefit of the system which is likely to be found in overall turn around time. Unfortunately, statistical analysis of such information may be difficult to obtain. However, the study team recommends that turn around time be a primary focus of any further investigation comparing the current and automated systems.

Documentation of errors and clarification time with the current system compared to the automated system is another area which may prove difficult to quantify. The study team recommends, however that this area be researched by conducting interviews with nurses to discuss the times and frequencies involved in clarification of orders due to illegible physician penmanship, undelivered orders, and unfillable prescriptions. Further study in this area will identify and quantify significant benefits to physicians.

2. Availability of Computer Terminals

Physicians have expressed concern that with the new system there may be a lack of accessible computer terminals for retrieval and input of patient information. The concern is that during peak hours of OE/RR there will be significant congestion at the terminals. For example, the study team observed a house officer on University Hospital inpatient unit 6C finding it necessary to walk to inpatient unit 6B to use a computer. Further study could include investigation of other hospitals using the automated system, with an analysis of average number of doctors, or patients, relative to the number of computer terminals available.
Also, the study team recommends that similar studies should be conducted with consideration for the numbers of physicians placing orders at the University Hospital during the peak hours of OE/RR.

3. Reliability of the Current System

House officers have mentioned to the study team that in the past six months departmental computer systems have gone down two or three times. Upon failure of the system, telephones became the primary method for execution of OE/RR that would normally be performed on the computers. This caused problems with congestion on both sides of the phone lines through the respective departments involved with the failed system. One physician indicated great concern about the reliability of the system. Of expressed concern is the reliability of the system in the locations they work, which is a combination of the central computer, ancillary department, unscheduled failures, and scheduled shut downs. He contended that if the system were to fail, the hospital would be in a severe state of confusion until repairs could be made. In an effort to curb physician resistance to this issue, a pilot study should be conducted to quantify the history of the system's uptime at various hospitals where it is currently implemented.

Additional study should focus on hospitals with excellent as well as poor relative uptimes. For the hospitals with poor uptimes, interviews could be conducted to determine how they respond to system downtime. For the hospitals with excellent uptime performance, the reasons for their success should be found and recommended for the university hospital.

B. Ease of Transition/Implementation

The second set of recommendations the study team has for ISD in continuing this project is to focus on easing the transition from the current OE/RR system to the automated system. Methods of gathering information on such a transition are through interviews with users of the automated system, and by trying to access studies that other hospitals have done internally.

Further research could include resources such as physicians, nurses, and administrators at hospitals with the automated system through on site or telephone interviews. Important aspects which need to be addressed in the interviews include:

- Was there physician resistance to the implementation of the system?
- What were the major difficulties involved in the changeover?
- What methods did the hospital use to overcome these difficulties?
- After having seen the implementation of the system, and the problems encountered, what suggestions do you have to improve the transition between systems?
Through interviews with staff at several of the hospitals who are currently using the TDS system and who previously worked at the hospital before implementation of the system, key problems should become apparent and can be identified before the U-M Hospital implements the system.
VI. ACTION PLAN

The following action plan is provided in an attempt to provide a practical agenda and timetable to permit a comprehensive, successful study of the order entry and result reporting process in the University of Michigan Hospital. Included in the action plan is an overall set of goals for continuing study along with specific recommendations for improving information gathering. The study team recommends that two IOE 481 groups implement this plan.

1. For IOE 481 study groups or persons continuing the study on the present OE/RR process, introduction to the present process should be done immediately (within one to two weeks). The most effective means of gaining an understanding of the OE/RR process is through a short meeting with Dr. William Bria or another physician who can clearly explain the OE/RR process. The importance of this step is great as an understanding of the OE/RR system is the basis of the study.

2. Continue and expand quantification of the university hospital OE/RR system. Within the next 1-2 weeks any study teams should take the initiative by making phone calls directly to attending staff. The attending physicians have been, this team has found, to be quite cooperative in quickly arranging for their medical students or house officers to be shadowed by IOE 481 team members. Shadowing physicians early in the semester will give the students practical and hands on knowledge of the current system, as well as increase the data base of OE/RR information.

3. Gain an understanding of the automated order entry and result reporting system and quantitative differences and impacts it will have. This should be done next by the study group. We recommend visiting a hospital which has the TDS system in use. This will allow the students to have a preliminary and hands on full circle understanding of the situation.

4. After steps 1-3 are carried out by two IOE 481 study teams, it is recommended that the groups split and study separate areas of interest. One study team could continue to expand on the quantification of OE/RR at the University Hospital. After visiting a hospital with the automated system, this study team would have a better understanding of the overall scope of the project and how to approach their collection of data.

It is recommended that the second study team approach the issue of implementation. Through extensive interviews with physicians, nurses and administration at hospitals using the TDS system throughout the country, key problems should become apparent and can be identified before the U-M Hospital implements the system.
5. At points throughout the semester, it is suggested that the two groups, along with Roy More or another client, meet to discuss their finding in joint sessions. This will increase the awareness of the two groups and in doing so, continue to afford the students a wider understanding of the situation. This will in turn help the students to produce coherent and relevant results.
Appendix A -- Literature Notes
"By using the diskette physicians with no prior experience could acquire an understanding of the hospital information system (HIS) in 2-3 hours through simulated exercises." - Healthcare Informatics "How to Prompt Physician Use of the HIS" from TDS Healthcare Systems Corporation information

"Order entry was chosen because physician decisions, by some estimates, determine more than 80 percent of hospital costs."
"A 50-percent increase in personal order sets (POS) use could reduce errors in order entry from 5,821 to about 2,956 a year."

"Admission orders are frequently repetitive listings of routine orders, sometimes specific for a particular illness or disease and often modified for a particular patient. However, physicians write almost identical orders 90 percent of the time."
"Postoperative orders are similar to admission orders, and I find the timesaving to be tremendous. I can enter two pages of typewritten orders in 30 to 45 seconds. Once these orders are entered, they are immediately transmitted electronically to all concerned departments and organized into a nursing care plan."
Physicians and Computers, "The Electronic Medical Record: A tool for change" Harriman H Jett, M.D. from TDS Healthcare Systems Corporation information

"At Harvard Community Health Plan's (HCHP's) Burlington clinic, a physician turns on the computer and sees a screen with a "to-do" list of lab results that haven't been read and patients who need to be called or seen."
From Donna de Angelis, director of IPS project for HCHP, says "More than 10% of tests are reordered because the results of the initial test come back too slowly or a physician forgets to check for them"
"A recent study of computer use at Wishard Memorial Hospital in Indianapolis showed a savings of almost $900 in charges per case, or 13%, when residents entered orders in a computer that reminded them about drug costs, drug interactions, recommended frequency of lab tests and other factors that affect cost and quality."
"Because these systems are so new, overall estimates of potential savings are notoriously mushy...But the Bush administration claimed the healthcare system could save $113 billion over eight years just by computerizing registration and billing, and experts say those numbers just scratch the surface."
"Physician's two biggest objections to the computer system are that it's out of commission too often and it's too slow, Mr. Gardner said. That shows how picky physicians can be, because special "fault-tolerant" hardware gives the system 99.6% uptime, and a recent hardware upgrade also cut the response time from six seconds to three."
"Dr. Abrams of Rose Medical Center in Denver is working with the Shared Medical Systems Corp to develop a clinician workstation. He said he can shave as much as 15 minutes from the time it takes to visit each patient in the hospital because he doesn't have to search for their charts." 

Modern Healthcare, "Get the computers right, and physicians will get with the program", Elizabeth Gardner, March 1, 1993, p35-50.

"Explains John Fleming (HPMS Inc. president): 'If a hospital wants to reduce admitting time from 30 minutes to under 15 minutes, we can integrate a Benefits Realization Program (BRP) methodology that plans for the change, tracks the progress and works to solve problems.'

(Matt Hubler, executive vice president of Sacred Heart Hospital) reports that Sacred Heart saved approximately $375,000 in the first 12 months of the program. 'We expect to save another $950,000 in the next year, and when the final phase of the computer system comes on-line, projected savings jump to $1.7 million every year,' reports Hubler. 'And these are funds that end up on the bottom line.'"

Patient Care "Quality Care Through Benefits Program", Jack Todaro.

"If your hospital is running about 100,000 patient days a year, you can save between $2.5 million and $3.5 million every year in labor reductions, according to John Fleming, president of Hospital Productivity Management Services (HPMS)."

"At El Camino Hospital, (they) can provide insurance to (their) physicians at approximately 70 percent of the normal rates. due to 90% of their physicians routinely using the patient care system and BRP.

"At Sacred Heart Hospital in Eau Claire, Wisconsin, Matt Hubler, executive VP, reported excellent first year results. We originally projected annualized savings in labor of $800,000 to $1 million this first year. We now have surpassed that goal. We expect annualized savings in labor of $1,021,013 against a payroll budget of roughly $18 million.


"The permanent patient record (PPR), according to sources at TDS, can accommodate up to 16 million distinct patient records referencing up to 65,000 separate inpatient or outpatient episodes of care and still maintain subsecond response time."


"The display of specific information about the patient on the computer screen has reduced the number of outpatient tests ordered and the resulting charges by 8 to 18 percent; the reductions occurred primarily in the ordering of tests with a low yield of abnormal results"

A study was done which: "During the intervention sessions, however, when a physician had completed ordering a test, the computer opened a "window" on the screen and displayed the charge the patient (or the insurer) would pay for the
current test and the total charges for all tests ordered for that patient on that
day." "The study included all patients and all visits to physicians, whether
scheduled or unscheduled."
The results of the test: During the intervention, physicians ordered 14.3% fewer
tests per patient than the control group and the intervention patients were
charged 12.9% less per visit. For residents, the numbers were 15.3% and 13.4%,
respectively. For faculty members, the numbers were 7.9% and 11.2%,
respectively.
"The physicians in the intervention group spent an average of 11.5 seconds
ordering each test, as compared with 10.0 seconds per test for the physicians in
the control group. Although this 1.5 second difference was small, it was
statistically significant given the large total number of tests ordered (P<0.01)."
"We found that physicians ordered fewer diagnostic tests when they were given
information about the charges for tests during the test-ordering process. The
resulting reduction in charges to the patient or insurer was almost $7 per patient
visit; if extrapolated to our entire primary care practice, this change would
reduce total charges by more than $250,000 annually."
The New England Journal of Medicine "The effect on test ordering of informing
physicians of the charges for outpatient diagnostic tests", Tierney et al., Vol 322
No. 21, May 24, 1990, pp1499-1504.

Another study was done which during an intervention period, a window opened
which displayed the last three results of the same test for the same person.
"During the intervention period, the mean patient charge for study tests was 13%
lower for scheduled intervention visits than for control visits. This reflected 8.5%
fewer study tests being ordered during intervention visits than during control
visits."
"It took time for the computer to find, format, and display previous test results
and have the physician respond to them—an average of 4 seconds per test. This
small time penalty may have persuaded physicians not to order tests for patients
with marginal indications."
"The physicians may also have anticipated greater scrutiny of their testing of
patients for whom they received the display for one test and thus avoided
ordering subsequent tests. The present design kid not allow us to test this
hypothesis."
"We believe the major explanation for the reduction in test-ordering was that
physicians were able to make better decisions when presented with concise
displays of patient information relevant to a specific test at the time it was being
ordered."
Annals of Internal Medicine "Computerized Display of Past Test Results",

Another study was done which during an intervention displayed the probability
that the test would show the abnormality that the physician had selected as the
main one of interest.
“For all physicians, intervention patients’ charges for study tests were 8.8% less than control patients’ charges per patient visit.”

“Estimating the likelihood that a laboratory test will have abnormal results requires that one must first obtain patient-specific data and then weigh them appropriately. Neither of these efforts is easy.”

“Computers can help by retrieving the necessary data and then applying the appropriate weights.”


“The time required to enter orders was significantly longer for interns using the computer (p<0.001). Cumulative time was 80% longer for admission orders and 200% longer for daily orders. There was no significant difference between interns. Less time was spent by physicians using the computer system to maintain personal note cards with patient information.”

Abstract from JM Overhage “Computer assisted order entry: Impact on intern time use” Tierney, McDonald, and Pickett, Regenstrief Institute and Indiana University School of Medicine, Indianapolis, IN.

Another study was done concerning intern time including times of activities interns partake in during their work day: “The majority of time was devoted to information gathering and documentation.”

Abstract from JM Overhage “How do interns spend their days: A time-motion study of internal medicine interns.”, Tierney, McDonald, and Pickett, Regenstrief Institute and Indiana University School of Medicine, Indianapolis, IN.

“Physicians say the systems enable them to cut down on paperwork and eliminate trips to the hospital to retrieve tests, results, and other records.”

“Physicians who are computer literate are more likely to use the systems, according to experts, but those with little computer knowledge say that ease of use is a prime selling point.”

Hospitals “A Doctor in the Network - Physician links improve access to critical data.”, Rhonda Bergman, May 5, 1993, p24-26

“In at least one teaching hospital, diagnostic studies accounted for 25 percent of the average patient’s bill.”

“In many large medical institutions, a 15- to 30-minute delay between the request and the delivery of a patient’s paper medical record is common.”

American Journal of Public Health “The Effect of Immediate Access to a Computerized Medical Record on Physician Test Ordering: A Controlled Clinical Trial in the Emergency Room.”, Gregory A. Wilson, MD; Clement J. McDonald, MD; and George P. McCabe, Jr., July 1982, Vol. 72, No. 7, p698-702

“A study that reviewed every pharmacy order for a seven-day period indicated that, during the first year of computerization, physician use of the computerized
direct-order entry system was more than 70%. A subsequent review of every medication order for a seven-day period in October 1983 indicated that slightly more than 98% of 2500 orders received each day at the pharmacy were made by physicians through computer terminals.

*American Journal of Hospital Pharmacy* "Direct order entry by physicians in a computerized hospital information system.", Carole G. Schroeder and Paul G. Pierpaoli, Feb 1986, Vol. 43, p355-359
Appendix B -- FlowCharts
Chart 1.
Model For Order Construction and Flow

**Hallway**
- Physician and Team discuss patient care plan (pre-visit)

**Patient Room**
- Physician and Team visit and examine patient

**Conference Room**
- Physician prepares orders for patient from S.C.U.T. list entries

**Nurse's Station**
- Physician delivers completed Order Forms to Unit Clerk
- Order Forms generated (4 copies)
- S.C.U.T. List entries generated for later use in writing the official Order Form

**Done**
- To Ward Clerk
Chart 2.
Order Form Distribution

Nurse's Station

To Unit Clerk

Ward Clerk Separates and Distributes Order Form Copies

MEDICAL RECORD COPY
Placed in patient chart.

Finished Order Form (4 Copies)

Ward Clerk Files
UNIT COPY
Used by unit for scheduling and by floor pharmacy for med requests.

Nurse's Station

NURSING COPY
Used by nurses for filling the order. Goes into Patient Care Plan.

Main Pharmacy

PHARMACY COPY
Goes to main Pharmacy to fill medication requests.