University of Michigan Health System
Program and Operations Analysis

Analysis of Undeliverable Test Results and Requisition Sheet Data Errors
In the Radiology and Pathology Departments

Final Report
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Executive Summary

A very significant problem in the University of Michigan Health System (UMHS) today is misdirected or undeliverable test results. These can cause delays in patient care and lead to high costs in the hospital. When these results are misdirected or undeliverable, results are not sent to the correct physician, and treatment may be incorrect. A majority of the time these results are incorrect due to blank or illegible fields, or transposed identifiers, such as doctor number. This project team has been asked to analyze requisitions in the Radiology and Pathology departments to determine the proportion that are illegible, incomplete, or incorrectly filled out to measure first time quality. The methodology that the team develops will be used in the future to quantify improvements in the process.

Prior data showed that approximately 3.2 million requisitions are processed each year in the Pathology departments, and 3% of these were undeliverable, for a total of 98,000 each year. The requisitions are qualified as either deliverable, undeliverable, or misdirected in UMHS. Requisitions that are undeliverable sit in a repository and some of the reasons for this include: no UMHS doctor number, the doctor number does not correspond to doctor in UMHS system, or the information on the requisition form may be unreadable. Requisitions that are misdirected are sent to the wrong ordering provider and this may be due to transposed identifiers (mixing up IDX billing with doctor number, as well as incorrectly entered doctor number (transposition of digits).

The goals that were reached in this paper were: to develop a data collection methodology to ensure data is collected and analyzed consistently, collect requisitions, and determine the frequency of undeliverable tests and incorrect requisitions.

Included in the scope of the project were outpatient test requisitions for the Radiology and Pathology departments, excluding the Nuclear Medicine, Angiography, and Cross Section Intervention divisions of the Radiology departments. The team also excluded lab tests sent to external reference labs.

For this project, the team performed the following actions:
- Interviewed staff in Radiology and Pathology departments to determine the consequences of undeliverable test results and poor first time quality and constructed flowcharts for requisitions in each department. The information gathered from these interviews will be discussed in the Findings section of the report.
- Gathered information from requisition sheets, as mentioned previously. The team recorded in an Access database whether the information in the fields was present and legible on the requisition. From these data, the team determined the fraction of requisitions that had illegible, incomplete, or incorrect data fields. A sample size of several thousand requisitions from both Pathology and Radiology was used to obtain statistical significance. The collection methodology will be
discussed in the Methods section of the report and the results of the data analysis will be discussed in the Results and Analysis section of the report.

- Worked with Medical Center Information Technology (MCIT) personnel to query the Clinical Data Repository (CDR) and determine the fraction of results for calendar year 2005 that were classified as either doctor number 99999 (Unknown), 09000 (Illegible Doctor), 00000 (No Doctor Specified), or entered as “free text” (doctor name without a matching number). The results of this analysis will be discussed in the Results and Analysis section of the report.

The team established a very efficient method to collect the legibility and presence of key fields on the requisitions due to the large sample size that was needed for statistical significance. Developing a Visual Basic interface to a Microsoft Access database was determined to be the most efficient manner to collect the requisition data. The requisition collection software has a statistics feature built into it that constantly updated the team on important statistical percentages such as missing doctor name or missing patient registration number. The legibility of the key fields in the requisitions was determined by each team member, all having no prior experience examining requisitions. This was assumed valid because of the high turnover rate of data entry personnel in the hospital.

The team applied this methodology in collecting data from 2,971 requisitions in the Pathology department, and from 2,884 requisitions in the Radiology department. These numbers were determined to be significant in that we are 95% confident the true percentages of the population are ± 1.8% of presented results.

Very significant results were obtained in both the Pathology and Radiology departments. In the Pathology department, it was discovered that the proportion of doctor name or doctor number that was illegible or blank was 31.2% and 32.5%, respectively. This amounts to a number of 998,400 for doctor name being illegible or blank each year, and 1,040,000 illegible or blank doctor numbers. The diagnosis code field is 39.5% illegible or blank in the Pathology department, amounting to 1,264,000 requisitions a year.

In the Radiology department, the proportion of doctor name or doctor number that was illegible or blank was 43.9% and 18.6%, respectively. This amounts to a number of 175,600 for doctor name being illegible or blank each year, and 74,400 illegible or blank doctor numbers each year. The diagnosis code field is 16.9% illegible or blank, amounting to 67,600 requisitions a year.

In the Pathology department, there is not a doctor name or number legible or present on a requisition 16.2% of the time (518,400 requisitions each year). There is no present or legible patient name or number 1.68% (still 53,760 requisitions each year). In the radiology department the numbers are 12.6% for doctor information (50,400 each year) and 0.66% for patient information (2,640 requisitions each year).

To get an idea of the number of undeliverable test results (a measure of final quality) the team worked with MCIT and Pathology Data Systems to determine the number of undeliverable test results that appear in the CDR as a fraction of the number of results that are sent to physician’s CareWeb Inboxes. The results of this study indicate that
around 6% of requisitions are undeliverable due to the doctor name/number being either blank, illegible, or not in the UMHS system. This indicates a significant amount of rework based on our analysis of requisition sheets.

The team has come up with several preliminary recommendations as a result of the above data. These recommendations include: standardization of requisition forms, utilization of typed and legible labels, education of doctors and clerks on required data fields as well as the initiation of the move to computer order entry.

The data collected in this project serves as baseline data for the Clinical Documents Delivery Project (CDDP) to benchmark future improvements made to processes. Second, the improved data collection methodology will result in more accurate and precise data collection. The ultimate result of these improvements will be lower costs associated with test requisition analysis, more efficient patient care, increased patient-staff satisfaction, fewer misdirected and undeliverable requisitions, and improved document and data reliability.
Introduction

Misdirected and undeliverable test results in a hospital environment can cause delays in patient care and can increase costs. A previous study has shown that a significant number of test results in the Radiology and Pathology Departments at the University of Michigan Hospital are undeliverable or misdirected. When results are misdirected or undeliverable, the results are not sent to the patient’s physician and the right treatments cannot be given. Therefore, the Director of Business and Operations Support Services would like to know how frequently this problem arises. The Director of Business and Operations Support Services has asked our team to develop a methodology for collecting data and to gather baseline data that will quantify the number of undeliverable test results in the Radiology and Pathology Departments. The Director has also requested that our team analyze requisitions to determine the fraction of requisitions that are illegible, incomplete or incorrectly filled out to measure first time quality. The methodology that our team produces will be used in the future to quantify improvement in the process. Separate data will be collected for each department to determine the number of requisitions that are illegible, incomplete, or incorrectly filled out. This report details the findings of this study and recommendations for improving the requisition process in the future.

Background

Prior data shows that about 3.2 million requisitions are processed each year for the University of Michigan Hospital Pathology Department with approximately 3% of those requisitions believed to be either undeliverable or misdirected, amounting to around 98,000 requisitions per year that are processed incorrectly.

Test requisitions that are processed by the Radiology and Pathology Departments at the University of Michigan Hospital are classified as either: delivered, undeliverable, or misdirected. Delivered results are correctly sent to the requesting physician through both a paper delivery and a posting on the CareWeb system. The CareWeb system is a comprehensive computer interface that contains demographic and medical information on patients that have been treated in the University of Michigan Health System.

Several situations lead to test results being classified as undeliverable, all of which are related to being unable to identify which doctor ordered the test. Some cases that cause test results to be determined undeliverable are: there is no University of Michigan Health System (UMHS) doctor number on the requisition form, the UMHS doctor number does not correspond to a doctor in the UHMS system, or the information on the requisition form is unreadable. Test results classified as undeliverable are posted on the CareWeb system as either doctor number 99999 (Doctor Unknown), 09000 (Illegible Doctor), or 00000 (No Doctor Specified).

Results are considered misdirected when the result is sent in error to a provider other than the ordering provider. Redirecting these results to the correct ordering provider increases costs and can delay patient care.
Undeliverable and misdirected tests are problematic for several reasons. First, failed delivery of results causes delayed treatment because the doctor will believe the test has been correctly completed and will wait for test results that will not arrive, which puts the patient’s health at risk. Second, undeliverable and misdirected tests result in additional testing because the results of the original tests were not delivered to the ordering doctor. Third, undeliverable and misdirected tests result in cost increases in the hospital system because additional staff is required to handle these tests and the problems incurred.

The Clinical Documents Delivery Project is a current project in the hospital system that is improving the delivery of test results, discharge summaries, consult letters, and other communications to ordering and referring physicians. The data collected in our team’s project will be used within the Clinical Documents Delivery Project to provide benchmarking for future improvements made to the process.

Goals and Objectives

To obtain data and determine the significance of the problems associated with requisition sheet data entry, the team:

- Developed a data collection methodology.
- Collected and analyzed data to determine a baseline number of test requisitions that are illegible, incomplete, or incorrectly filled out.

To enable accurate collection of similar data in the future, the team:

- Developed a software program (discussed in detail later) to be used in data collection and created a user guide to aid future users of the software.

To quantify how many test results were undeliverable, the team:

- Worked with Medical Center Information Technology (MCIT) and ran a data query on the Clinical Data Repository.

This methodology and resulting information will be used to:

- Provide a benchmark to determine the effectiveness of future improvements to the delivery test results.
- Provide a methodology for the future data collection against these metrics.
- Develop recommendations on how to improve the test requisition process in the future.

Key Issues

Several key issues have led to the necessity of this project:

- Low levels of first time quality lead to increased numbers of undeliverable and misdirected test results.
- A current lack of reliable data about the number of undeliverable and misdirected test results.
- Undeliverable and misdirected tests result in delayed patient care.
• Duplicate tests cause unnecessary cost and inconvenience to the patient, and add extra cost and workload to radiologists and pathologists

Scope of Project

This project analyzed outpatient test requisitions in the Radiology and Pathology Departments of the University of Michigan Hospital. In addition to observing staff and collecting data, the project team visited the East Ann Arbor Clinic to view the process of a Radiology location at an off-campus site. The team collected data at Pathology Data Services, several Radiology locations, and queried data from the Clinical Data Repository. The team determined the fraction of undeliverable test results and measure first time quality for the Pathology and Radiology Departments individually. The team stratified the results by several different areas based on which, if any, identifiers were missing or illegible on the requisition sheets.

Excluded from the project scope was the actual number of misdirected test results. Nuclear Medicine, Angiography, and Cross Section Intervention departments were excluded from the project. Also excluded were any test results outside of the Pathology or Radiology Departments, as well as any lab tests sent to external reference labs.

Approach

For this project, the team performed the following actions:

• Interviewed staff in Radiology and Pathology departments to determine the consequences of undeliverable test results and poor first time quality and constructed flowcharts for requisitions in each department. The information gathered from these interviews will be discussed in the Findings section of the report.

• Gathered information from requisition sheets, as mentioned previously. The team recorded in an Access database whether the information in the fields was present and legible on the requisition. From these data, the team determined the fraction of requisitions that had illegible, incomplete, or incorrect data fields. A sample size of several thousand requisitions from both Pathology and Radiology was used to obtain statistical significance. The collection methodology will be discussed in the Methods section of the report and the results of the data analysis will be discussed in the Results and Analysis section of the report.

• Worked with Medical Center Information Technology (MCIT) personnel to query the Clinical Data Repository (CDR) and determine the fraction of results for calendar year 2005 that were classified as either doctor number 99999 (Unknown), 09000 (Illegible Doctor), 00000 (No Doctor Specified), or entered as “free text” (doctor name without a matching doctor number). The results of this analysis will be discussed in the Results and Analysis section of the report.

Methods

Methodology Used to Collect Quantitative Data
To be successful in obtaining the large sample sizes necessary, an efficient method for recording legibility data was required. A Visual Basic interface to a Microsoft Access database was determined to be the most efficient manner to collect the requisition data. The software, dubbed Rex, ran on laptops during collection, but can be installed on any computer and the legibility database created by the program can be transferred freely to other computers.

An Access database was chosen over an Excel spreadsheet for several reasons, including: increased data integrity (more entry errors with Excel), reduced entry time with the Visual Basic program, and confidentiality (the databases can be password protected if necessary). Also, if patient sensitive data were to be stored in the database, the program could encode the information in compliance with HIPAA (Health Insurance Portability and Accountability Act). However, since the information the team collected for this project is de-identified, there was not a need to incorporate encryption into the program.

The program starts with an “Open Requisition Database” prompt, which is the stage where the user selects the Access database that the data will be written to. The program is only able to open one database at once, but it is easy to open a different database by clicking on the “SELECT Database” button. The file location of the database currently opened is displayed at the top of the main screen under the program title bar. Figure 1 below shows the main screen of the Visual Basic interface.
Several points were addressed regarding the chosen data entry method. Through discussion with the client, the team determined that the only identifiers necessary to explicitly record were doctor number and location code to stratify the data. All other identifiers will be recorded as either: legible, illegible, or blank according to how they appear on the requisition.

Each requisition will have data entered according to a specific process. Data for each requisition will be added via the “Add Requisition” button on the program. Clicking on the “Add Requisition” button will bring up a data entry screen (see Figure 2 below) formatted to assist in fast data entry. The data entry screen will consist of two text entry boxes and multiple buttons for the other desired fields. The two text entry boxes will be used to enter the doctor number and the clinic location code. All other desired fields (ordering doctor or secondary doctor number and name, visit number, collection date and time, patient regnum, patient name, patient date of birth, and diagnosis) will each have three buttons, as described above. Also, “yes” and “no” buttons were added to track whether the requisition was handwritten.
Legibility status will be stored in integer format with 0 standing for legible, 1 standing for illegible, and 2 standing for field left blank.

The “SEND to MS Access” button will open the requisition database in Access. There is not a need for additional data manipulation features within Rex, such as finding, editing, and deleting records. These tasks can be easily accomplished from within Access, and leaving them out of the Visual Basic interface simplifies the data collection process.

Some important statistics are shown in the interface main screen, as seen in Figure 1. The statistics portion displays whole number totals, such as the number of illegible and
blank entries for specific fields as well as the percentage of requisitions that contain illegible and blank entries.

The software also has a statistics feature built into it that creates detailed reports of important statistics that can be used to constantly update the team on various percentages such as missing doctor name or missing patient registration number. The “SAVE Detailed Statistics” button will prompt the user to name and save an HTML report containing detailed statistics on the currently open database. The report will automatically open in a web browser upon save. For examples of detailed statistics reports, please see Appendices B and C.

A number of sample databases were included with the Rex software package. They are installed to the “databases” subdirectory of the program’s install directory. For more information on using the software, please see the Rex User Guide in Appendix A.

Pathology Methodology

The team examined requisitions from the last two days of every month, starting on December 31, 2005, and working back to June 30, 2005. Data was collected from every fifth requisition and this approach was utilized until approximately 3000 requisitions were collected. An underlying assumption of this methodology was that there were no process changes during the collection period.

Radiology Methodology

The team examined requisitions from each division of Radiology that was included in the scope of the project. A breakdown of volume by division was used to collect a representative sample that was proportionately accurate to the total volume in each division. Data was collected from every second requisition, until the total for each division was complete. The reason that every second requisition was used instead of every fifth requisition as in Pathology was the smaller total sample size of requisitions available from Radiology. However, the requisitions were not organized in any particular method so the randomness of the data should not have been affected. Again, the underlying assumption of this methodology was that there were no process changes during the collection period that we used from June 2005 through March 2006.

Legibility Criteria

Legibility was determined by each team member, all having no prior experience examining requisitions. This was assumed valid because of the high turnover rate of data entry personnel in the hospital. The team restricted all data fields to be in a designated area, except for patient information when a stamp or sticker may be out of place. For the decision of whether or not the patient information was handwritten, if one of the three main identifiers (name, registration number, or date of birth) was handwritten, all of the information was classified as handwritten. Additionally, for the Pathology department, the diagnosis field applied strictly to whether or not an ICD-9 code was present in the
designated field, whereas in the Radiology department, the diagnosis applied to the "clinical conditions" section. As the team had no training in the comprehension of medical diagnoses or procedures, if the information contained in the "clinical conditions" was legible, even if we could not comprehend it, the information was recorded as legible. In general, the team was fairly lenient in determining legibility characteristics. For example, if there was doubt as to whether a number was a "4" or a "9", the number was recorded as legible.

Findings

Interview Results

The following is a list of interviews, and the contribution of each interview to the project, that our team conducted during tours of various locations within the University of Michigan Health System.

- Teresa, Clinic Coordinator (Taubman Clinic) –
  Activity: Provided the team with blank copies of several kinds of requisitions to demonstrate the range of requisition types. Showed us an exam room and explained the information that goes on each requisition.
  Findings: A clerk at the clinic explained that the clerks fill in missing information on a requisition and then file or send the requisition to the appropriate people.

- Heather, MRI Clerk (MRI) –
  Activity: Explained the MRI area’s system of handling and storing requisitions. Requisitions come into the MRI office and are analyzed by staff in order to ensure completeness.
  Findings: Complete requisitions are stored in a filing cabinet based on the time of the appointment. Incomplete requisitions are analyzed by staff members who use various computer interfaces, including CareWeb, to complete the requisitions. Incomplete requisitions that can be completed are stored in the filing cabinet according to appointment time. Incomplete requisitions that cannot be completed are stored in a separate folder and wait for further action.

- Harry Neusius, Administrative Manager Healthcare (Pathology) –
  Activity: Provided the team with several examples of requisitions that had data field entry errors that caused them to be misdirected or undeliverable (poor first time quality). We then went to Central Distribution as well as another clinic in Taubman to see their data entry systems. Mr. Neusius also took us to the Cancer/Geriatric center where we saw the EWS system and how information was entered into the computer database.
  Findings: A few reasons the requisitions were misdirected or undelivered were: missing doctor number, missing attending physician, illegible doctor number, and missing patient information.

- Judy Nyhuis, Allied Health Associate Supervisor (Pathology Central Distribution)
  Activity: Showed us around Central Distribution and explained the process of entering data for requisitions that come in with blood samples from blood draw
Judy also explained different consequences of requisitions missing certain pieces of information.

Findings: After being entered into the computer system, paper requisition sheets are filed in a cabinet by day of arrival. The paper requisition sheets are stored on site at Central Distribution for one week then sent to Iron Mountain.

- Marsha, Clinical Nurse (East Ann Arbor Clinic, Pathology) –
  Activity: We were shown an exam room as well as a blood draw station. Once the blood was drawn, the blood sample and the requisition sheet were taken to the analysis lab at East Ann Arbor.
  Findings: If the analysis lab could not perform a required test, the blood sample (along with an identification label and the paper requisition sheet) would be stored in a fridge before being sent by courier to Central Distribution. A copy of every requisition is sent to Central Distribution, even for the tests that can be completed at the East Ann Arbor analysis lab.

- Brett, MRI clerk and Kaye, MRI Technician (East Ann Arbor Clinic, Radiology) -
  Activity: The team was shown around the MRI imaging area and discussed the process with two staff members: Brett, a member of the office staff, and Kaye, an MRI technician.
  Findings: Brett discussed the process of dealing with the ordering clinic to correct any illegible or missing data on a requisition. Kaye stated that nearly all of the requisitions she received were correctly completed as a result of his work.

- Catherine Williams, Applications Systems Analyst/ Programmer Senior (MCIT) –
  Activity: She stated she would extract data from the CDR using queries to obtain the number of requisitions that were filed under the different undeliverable codes (00000, 09000, and 09999 for example).
  Findings: The data will be delivered to the team in the form of an Access database for further analysis.

- Susan Fisher, Administrative Specialist (Radiology) –
  Activity: Provided the group with a tour of several different Radiology imaging areas and access to requisition sheets from those imaging areas.
  Findings: Susan is assisting the group with gathering Radiology requisitions and providing an area for the group to perform data analysis on those requisitions.

- Kathy Davis, IT Management Level 3 (Pathology Data Systems) –
  Activity: Showed the group where pdf files of requisitions are stored on Pathology computers and how the requisitions were organized.
  Findings: Kathy has provided the group with access to pdf files of requisitions on Pathology Data Systems computers as well as an area to analyze the requisitions.
**Flowcharts**

Below are two flowcharts that show the path the requisitions follow through the Pathology and Radiology Departments, respectively, based on interviews with department personnel.

![Flowchart](image)

**Figure 3. Pathology Requisition Flowchart.**
Sample Size and Confidence Interval Values

The team collected data from 2971 Pathology requisitions and 2884 Radiology requisitions. All of the following graphs and figures, unless otherwise noted, represent these sample values. This number of requisitions provided a confidence interval of 95% certainty that the percentages for Pathology and Radiology are both about ±1.8% from the reported values.
Results and Analysis

Figure 5. Illegible or Blank Fields in the Pathology Department

Figure 5, above, displays the percentage of analyzed data fields that were illegible or blank on the requisitions collected in Pathology. Two important statistics are the percentages of doctor name (31.2%) or doctor number (32.5%) that were illegible or blank. This amounts to 998,400 requisitions per year with the doctor name being illegible or blank, and 1,040,000 requisitions per year with the doctor number being illegible or blank (based on about 3,200,000 requisitions each year in the Pathology department, source: Matt Plachta). The diagnosis code field is illegible or blank on 39.5% of requisitions, amounting to 1,264,000 requisitions a year. The field with the smallest proportion of illegible or blank entries, patient name, amounts to 92,800 requisitions each year.
Figure 6, above, displays the percentage of analyzed data fields that were illegible or blank from collected Radiology requisitions. Important statistics from this figure are the proportions of doctor name (43.9%) and doctor number (18.6%) that were illegible or blank. This amounts to 175,600 requisitions per year having a doctor name that is illegible or blank, and 74,400 requisitions per year with the doctor number that is illegible or blank (based on approximately 400,000 requisitions each year in the Radiology department, source: Matt Plachta). The diagnosis code field is illegible or blank on 16.9% of requisitions, amounting to 67,600 per year. The field with the smallest proportion of illegible or blank fields, patient registration number, amounts to 11,200 requisitions each year.
Figure 7, above, displays a breakdown, by field, of the percentage of Pathology requisitions that had an illegible or blank entry in that field. As shown on the figure, over 27% of the requisitions had a blank entry in the doctor number field and the doctor name field was blank on almost 22% of requisitions. Diagnosis code was blank on almost 37% of requisitions. These proportions amount to 870,400, 691,200, and 1,174,400 requisitions with blank entries in these respective fields each year.


Figure 7. Further Breakdown of Key Fields in Pathology Department
Figure 8. Further Breakdown of Key Fields in Radiology Department

Figure 8, above, displays a breakdown, by field, of the percentage of entries that were illegible or blank on requisitions collected from the Radiology department. The field with the highest proportion of illegible entries is doctor name with almost 42%. A possible explanation for this is that the most commonly used radiology requisition form says that a signature is required by the physician initiating the order and signatures are generally less legible than a person’s printed name. This problem will be discussed in more detail in the “Recommendations” section of the report.
Figure 9, above, highlights the necessity for quality improvements in requisition data entry. In the pathology department, 16.2% of requisitions had both doctor name and number fields that were illegible or blank, amounting to 518,400 requisitions each year. There was no present or legible patient name and number 1.68% (still 53,760 requisitions each year). In the radiology department, 12.6% of requisitions had no doctor information present and legible (50,400 each year) and 0.66% had no patient information present and legible (2,640 requisitions each year).
Figure 10. Analysis of Handwritten Patient Information in the Pathology Department.

One can see from Figure 10, above, that there is a significant difference in legibility for the visit number and patient date of birth fields. The handwritten requisitions were more illegible or blank for those two fields. There was no significant difference for the other three fields.

Figure 11. Analysis of Handwritten Patient Information in the Radiology Department.


One can see from Figure 11, above, that there is a significant difference in legibility for the visit number and patient date of birth fields. The handwritten requisitions were more illegible or blank for those two fields. There was no significant difference for the other three fields.

<table>
<thead>
<tr>
<th>Location (total)</th>
<th>ESA (358)</th>
<th>OBG (116)</th>
<th>BSP (115)</th>
<th>GIC (84)</th>
<th>BIM (79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor Num</td>
<td>94.1</td>
<td>13.8</td>
<td>13</td>
<td>10.7</td>
<td>22.8</td>
</tr>
<tr>
<td>Doctor Name</td>
<td>54.2</td>
<td>24.1</td>
<td>17.4</td>
<td>9.5</td>
<td>38</td>
</tr>
<tr>
<td>Patient RegNum</td>
<td>1.7</td>
<td>4.3</td>
<td>2.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Patient Name</td>
<td>1.5</td>
<td>1.7</td>
<td>0.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Patient DOB</td>
<td>5</td>
<td>6</td>
<td>8.7</td>
<td>1.2</td>
<td>8.9</td>
</tr>
<tr>
<td>Diagnosis Code</td>
<td>65.1</td>
<td>27.6</td>
<td>18.3</td>
<td>15.5</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 1. Key Field Percent of Requisitions Illegible or Blank for Highest Volume Locations in the Pathology Department

<table>
<thead>
<tr>
<th>Location (total)</th>
<th>OSA (252)</th>
<th>ESA (245)</th>
<th>POS (131)</th>
<th>EVL (72)</th>
<th>OTO (62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor Num</td>
<td>9.5</td>
<td>15.1</td>
<td>5.3</td>
<td>19.4</td>
<td>16.1</td>
</tr>
<tr>
<td>Doctor Name</td>
<td>98.4</td>
<td>10.2</td>
<td>4.6</td>
<td>9.8</td>
<td>50</td>
</tr>
<tr>
<td>Patient RegNum</td>
<td>1.6</td>
<td>0</td>
<td>0</td>
<td>1.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Patient Name</td>
<td>9.9</td>
<td>0</td>
<td>3.1</td>
<td>1.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Patient DOB</td>
<td>0</td>
<td>1.2</td>
<td>64.9</td>
<td>5.6</td>
<td>51.6</td>
</tr>
<tr>
<td>Diagnosis Code</td>
<td>10.3</td>
<td>3.7</td>
<td>11.5</td>
<td>0</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Table 2. Key Field Percent of Requisitions Illegible or Blank for Highest Volume Locations in Radiology Department

Tables 1 and 2 display the percentages of illegible or blank entries for several key fields. The group extracted the five highest volume location codes in each department, and computed statistics for the fields.

In the Pathology department (Table 1), the ESA location had the worst percentages of illegible or blank fields for doctor number, doctor name, as well as diagnosis code. OBG was the worst location for legible patient registration number and patient name, and BIM had the worst proportion of legible patient DOB. The large sample size of ESA may have contributed to the high number of illegible or blank fields found in the Pathology department for doctor identifiers and for the diagnosis code.

For the Radiology department (Table 2), OSA was by far the worst for doctor name, and was also the worst for patient name. EVL had the worst proportion for doctor number, and OTO was worst for patient registration number. The POS location code had the
worst proportion legible for the patient DOB and diagnosis code fields. Doctor name was significantly illegible or blank in the Radiology department, and this is reflected in that OSA was the highest volume collected and had such poor legibility for doctor name.

**Positive Patient Identification Statistics**

For positive patient identification, two out of three identifiers (name, registration number, and date of birth) are required, with three identifiers being optimal. In the Pathology department, 97.48% of requisitions have two out of three patient identifiers legible and 86.77% have all three. In the Radiology department, 96.95% of requisitions have two out of three patient identifiers legible and 69.59% have all three. The large difference between having two identifiers versus three identifiers for Radiology requisitions is most likely due to the high number of Radiology requisitions that are handwritten.

**Undeliverable Tests Results Data and Analysis**

![Undeliverable Requisitions in Pathology Department (From MCIT)](image)

<table>
<thead>
<tr>
<th>Key field problems</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLANK_DR_CNT (0)</td>
<td>2.00</td>
</tr>
<tr>
<td>FREETEXT_DR_CNT</td>
<td>2.50</td>
</tr>
<tr>
<td>ILLEGIBLE_DR_CNT (9000)</td>
<td>1.00</td>
</tr>
<tr>
<td>UNKNOWN_DR_CNT (9999)</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Source: 1,873,875 Pathology requisitions sent to CDR
Figure 12. Undeliverable Requisitions as queried by MCIT from the CDR in the Pathology Department
Figure 12 indicates the proportion of undeliverable requisitions in the Pathology department. The total size of the population was 1,873,875 results. This information was received from Bill Hubbard with Pathology Data Systems, who queried the data from the CDR. These values are from outpatient radiology requisitions that were sent to physician’s CareWeb Inboxes. The four measured areas are blank doctor name and number (2.22% or 45,153), freetext doctor count, which occurs when the doctor name cannot be matched with a doctor number, (2.60% or 52,814), illegible doctor name and number (0.83% or 16,912), and unknown doctor, where the doctor is not in the system (2.12% or 43,612). These undeliverable requisitions amounted to 7.78% in the Pathology department (or 158,041 requisitions each year). This number is lower than what was found in this study because of rework done by clerks to find the correct information, as well as the fact that some of the clerks are more experienced and are familiar with doctor signatures and numbers.

The team also corresponded with Mary Davidson to get an idea of the number of undeliverable results in the Radiology department. Between test results sent to physicians in the hospital as well as physicians outside the hospital, Mary estimated that around 15-20 results are sent back due to a wrong address that does not have a valid forwarding address. This amounts to approximately 3750-5000 undeliverable requisitions per year (based on 250 work days per year).

**Consequences**

Requisitions with missing information delay patient care and increase administrative costs to locate the missing information. The consequences associated with missing requisition information differ between the Pathology and Radiology departments.

For the Radiology department, when there is no doctor information on a requisition, there are two possible situations: one, a clerk can call the ordering clinic to try and track down the ordering doctor or two, the requisition is stored in a drawer to wait for further action. When only one piece of doctor information is missing, the clerk will search through a list of doctors and attempt to match the given doctor information with a doctor in the database. Unsuccessful matches are stored in the aforementioned drawer and successful matches are recorded and the test can be scheduled. In the event of missing patient information, the clerk will either call the clinic to locate the information or find the information in a patient database. Without verified patient information, the test cannot be scheduled, so correct and complete patient information is crucial to the requisition process.

For the Pathology department, when there is no doctor information, there is no attempt to gather this information and the sample is still used. However, the results of the test cannot be sent to a doctor, so this situation most likely results in the test needing to be done again. For patient identification, the requisition is required to have the first and last name, plus the registration number or another identifier which can be either date of birth or a social security number. If this information is not provided on the requisition and specimen, the sample is not accepted. The clinician is then notified, the test is cancelled.
and another sample must be submitted. If the specimen is properly labeled with two identifiers but the requisition is not, a new requisition must be submitted. If other information is missing and required in order to perform the test, that information is tracked down. A requisition missing an ICD-9 code prevents the hospital from billing the payer for any tests performed. At this time the Pathology Department is using an outside company to obtain lab diagnoses for approximately $5000 per month or $60,000 a year. All of these circumstances result in delayed patient care, extra staffing, and additional costs for the hospital.

Recommendations

The team has come up with several preliminary recommendations as a result of the above data. One recommendation is the standardization of requisition forms, which should allow for more accurate and efficient processing of requisitions. As mentioned in the “Results and Analysis” section, the most common Radiology requisition states that a signature is required from the physician initiating the order. There is no clear reason for this requirement. If there is not a legal reason to have a doctor’s signature on the requisition, then that requirement should be eliminated because it only worsens legibility problems. If there is a legal reason for having a signature, then a label should be used in conjunction with the signature to solve legibility problems. The utilization of typed and legible labels would lessen the problem of missing patient and doctor information, as shown previously in figure 9. Current sticker labels contain information including ordering doctor name and number; patient name, number, and date of birth; as well as visit number and the date in a standard format. The education of doctors and clerks on required data fields and the impact of illegible and blank fields may help to alleviate this problem as well. Bolding required fields could deter confusion about which fields are truly required. Finally, the initiation of the move to computer order entry for all requisitions (including outpatient) should be implemented as soon as possible.

Expected Impact

This project will have two immediate impacts. First, data collected in this project will serve as baseline data for the Clinical Documents Delivery Project (CDDP) to benchmark future improvements made to processes. Second, the improved data collection methodology will result in more accurate and precise data collection in the future.

The ultimate result of these improvements will be lower costs associated with test requisition analysis, more efficient patient care, increased patient-staff satisfaction, fewer misdirected and undeliverable requisitions, and improved document and data reliability.
Appendix A – Requisition Collection Software User Guide

Installing Rex
Step 1 Double click the file “Rex 6.msi” to begin the installation process of the data collection software (Rex).
Step 2 The default directory is C:/Program Files/Rex/Rex 6, but any directory may be specified.
Step 3 The Access databases are stored in the subdirectory called “databases”. A number of sample databases are included in the package. There are two blank databases included: “requisitions.mdb” and “blank database - save for backup.mdb”.

Using Rex

Starting Rex
Use either the Rex 6 icon on your desktop or in your start menu to open the application. You will be presented with an “Open database” prompt, at which point you browse to the location on your hard drive where your database is. Rex will only add requisitions to the database; it will not delete or modify them. If you would like to delete entries or clear an entire database, please see the section titled “Deleting and Editing Requisitions”.

Requisitions currently in the database appear in a data grid on the main screen of Rex. You cannot edit any information directly in this data grid. The data grid can be sorted by any field by clicking a column header, such as “location”. Basic statistics on requisition quality are displayed in the bottom right hand side of the main screen.

Adding a Requisition
To add a requisition to the current database, click on the “ADD Requisition” button. The requisition legibility data entry window will appear. All fields are required. To save the requisition and add it to the database, click the “Save Requisition” button on this screen.

Step 1 Click on the “Add Requisition” button and a new interface will open.
Step 2 Click on either “Radiology” or “Pathology” depending on the department the requisition is from.
Step 3 Type in the location code if it is legible or click on “Illegible” or “Blank”.
Step 4 Type in the doctor number if it is legible or click on “Illegible” or “Blank”.
Step 5 Click on “Legible”, “Illegible” or “Blank” for each field based on the information from the requisition.
Step 6 Click on “Add Requisition” after all the information is entered to add the new requisition to the database.

Interpretation of the 0/1/2 legibility codes used in the database is as follows:
0 represents a legible field.
1 represents an illegible field.
2 represents a blank field.
Descriptions of each field recorded in the database are outlined below:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Database Identifier</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>The department, either Radiology or Pathology</td>
<td>Department</td>
<td>Fixed text</td>
</tr>
<tr>
<td>Location Code</td>
<td>The location code where the results are to be sent to</td>
<td>Location</td>
<td>Text</td>
</tr>
<tr>
<td>Ordering Doctor Num.</td>
<td>The doctor number of the ordering doctor</td>
<td>Docnum</td>
<td>Number</td>
</tr>
<tr>
<td>Ordering Doctor Name</td>
<td>The ordering doctor’s name</td>
<td>Docname</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Secondary Doctor Num.</td>
<td>The doctor number of an additional doctor (such as a house officer)</td>
<td>Houseofficernum</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Secondary Doctor Name</td>
<td>The doctor name of an additional doctor</td>
<td>houseofficename</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Visit Num</td>
<td>The visit number assigned to a patient visit</td>
<td>Visitnum</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Regnum</td>
<td>The patient regnum</td>
<td>Regnum</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Patient Name</td>
<td>The patient’s name</td>
<td>Patient</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>D.O.B.</td>
<td>The patient’s date of birth</td>
<td>Dob</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Collection Date</td>
<td>Test collection time and/or date</td>
<td>Collectiondate</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Diagnosis code, such as ICD-9. Required for billing purposes.</td>
<td>Diagnosis</td>
<td>0, 1, or 2</td>
</tr>
<tr>
<td>Handwritten?</td>
<td>Whether or not the patient information is handwritten, or stamped/typed.</td>
<td>Handwritten</td>
<td>0 = no, 1 = yes</td>
</tr>
<tr>
<td>N/A</td>
<td>Automatic unique identifier added for each requisition</td>
<td>ID</td>
<td>Number, Automatic</td>
</tr>
<tr>
<td>N/A</td>
<td>Time and date requisition was added to the database</td>
<td>Dateandtime</td>
<td>Text, Automatic</td>
</tr>
</tbody>
</table>

**Saving Detailed Statistics Reports**
To save and view a detailed statistics report on the current database, choose “SAVE Detailed Statistics” button. Choose the location on your hard drive in which you would like the report saved. The report is saved in HTML format for flexible viewing options, and is opened automatically when you click the save button. A number of sample reports are included in the “reports” subfolder of the Rex installation directory.

**Deleting and Editing Requisitions**
Step 1 Requisitions can only be modified and deleted from within Access. From within Rex, click the button called “SEND to MS Access”. This will launch your current
database in Microsoft Access. All of the requisitions are stored in the table "requisitions".

Step 2 Double click this table to show a listing of all requisitions in the database.

Step 3 Right clicking in the area to the left of each record will enable you to delete individual records, or ranges of records (left click and drag to select a range).

Step 4 Pressing CTRL-A and then delete will remove all entries from the database.

Step 5 To edit an entry, simply edit the text of the desired field in the table.

**Removing Rex**

Step 1 Click on the Start Menu
Step 2 Click on Control Panel
Step 3 Click on Add/Remove Programs
Step 4 Scroll down until you find Rex 6
Step 5 Select "Remove" to remove the program

**Sample SQL Queries**

Sample SQL queries are included with Rex 6 databases. To view/run these queries,

Step 1 Open the database in Microsoft Access by double clicking on the file, or using the "SEND to MS Access" button from within Rex.
Step 2 Click on the "Queries" link on the left side of the database window
Step 3 Run the query by double clicking on it.
Step 4 View or change the SQL statement by clicking "View -> SQL View"
Appendix B – Pathology Statistics Report

Total Number of Requisitions in Database: 2971

<table>
<thead>
<tr>
<th>Field</th>
<th>Legible</th>
<th></th>
<th>Illegible</th>
<th></th>
<th>Blank</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>percent</td>
<td>number</td>
<td>percent</td>
<td>number</td>
<td>percent</td>
</tr>
<tr>
<td>Location Code</td>
<td>2679</td>
<td>90.17%</td>
<td>63</td>
<td>2.12%</td>
<td>229</td>
<td>7.71%</td>
</tr>
<tr>
<td>Ordering Doctor Number</td>
<td>2008</td>
<td>67.59%</td>
<td>156</td>
<td>5.25%</td>
<td>807</td>
<td>27.16%</td>
</tr>
<tr>
<td>Ordering Doctor Name</td>
<td>2042</td>
<td>68.73%</td>
<td>286</td>
<td>9.63%</td>
<td>643</td>
<td>21.64%</td>
</tr>
<tr>
<td>Attending Doctor Name</td>
<td>253</td>
<td>8.52%</td>
<td>43</td>
<td>1.45%</td>
<td>2675</td>
<td>90.04%</td>
</tr>
<tr>
<td>Attending Doctor Number</td>
<td>221</td>
<td>7.44%</td>
<td>18</td>
<td>0.61%</td>
<td>2732</td>
<td>91.96%</td>
</tr>
<tr>
<td>Visit Number</td>
<td>1693</td>
<td>56.98%</td>
<td>66</td>
<td>2.22%</td>
<td>1212</td>
<td>40.79%</td>
</tr>
<tr>
<td>Patient Regnum</td>
<td>2800</td>
<td>94.24%</td>
<td>157</td>
<td>5.28%</td>
<td>14</td>
<td>0.47%</td>
</tr>
<tr>
<td>Patient Name</td>
<td>2887</td>
<td>97.17%</td>
<td>82</td>
<td>2.76%</td>
<td>2</td>
<td>0.07%</td>
</tr>
<tr>
<td>Patient Date of Birth</td>
<td>2721</td>
<td>91.59%</td>
<td>60</td>
<td>2.02%</td>
<td>190</td>
<td>6.4%</td>
</tr>
<tr>
<td>Collection Date/Time</td>
<td>1562</td>
<td>52.57%</td>
<td>19</td>
<td>0.64%</td>
<td>1390</td>
<td>46.79%</td>
</tr>
<tr>
<td>Diagnosis Code</td>
<td>1796</td>
<td>60.45%</td>
<td>84</td>
<td>2.83%</td>
<td>1091</td>
<td>36.72%</td>
</tr>
</tbody>
</table>

Ordering Doctor Number and Ordering Doctor Name
Both fields illegible or blank

<table>
<thead>
<tr>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>482</td>
<td>16.22%</td>
</tr>
</tbody>
</table>

Ordering Doctor Number and Ordering Doctor Name
Both fields legible

<table>
<thead>
<tr>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1544</td>
<td>51.97%</td>
</tr>
</tbody>
</table>

Patient Regnum, Patient Name, Patient Date of Birth
At least 2 of 3 fields legible

<table>
<thead>
<tr>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2896</td>
<td>97.48%</td>
</tr>
</tbody>
</table>

Patient Regnum, Patient Name, Patient Date of Birth
All 3 fields legible legible

<table>
<thead>
<tr>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2578</td>
<td>86.77%</td>
</tr>
</tbody>
</table>
Appendix C – Radiology Statistics Report

Total Number of Requisitions in Database: 2884

<table>
<thead>
<tr>
<th>Field</th>
<th>Legible</th>
<th></th>
<th>Illegible</th>
<th></th>
<th>Blank</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>percent</td>
<td>number</td>
<td>percent</td>
<td>number</td>
<td>percent</td>
</tr>
<tr>
<td>Location Code</td>
<td>2409</td>
<td>83.53%</td>
<td>123</td>
<td>4.26%</td>
<td>352</td>
<td>12.21%</td>
</tr>
<tr>
<td>Ordering Doctor Number</td>
<td>2381</td>
<td>82.56%</td>
<td>314</td>
<td>10.89%</td>
<td>189</td>
<td>6.55%</td>
</tr>
<tr>
<td>Ordering Doctor Name</td>
<td>1875</td>
<td>65.01%</td>
<td>950</td>
<td>32.94%</td>
<td>59</td>
<td>2.05%</td>
</tr>
<tr>
<td>Attending Doctor Name</td>
<td>605</td>
<td>20.98%</td>
<td>168</td>
<td>5.83%</td>
<td>2111</td>
<td>73.2%</td>
</tr>
<tr>
<td>Attending Doctor Number</td>
<td>503</td>
<td>17.44%</td>
<td>61</td>
<td>2.12%</td>
<td>2320</td>
<td>80.44%</td>
</tr>
<tr>
<td>Visit Number</td>
<td>1090</td>
<td>37.79%</td>
<td>11</td>
<td>0.38%</td>
<td>1783</td>
<td>61.82%</td>
</tr>
<tr>
<td>Patient Regnum</td>
<td>2823</td>
<td>97.88%</td>
<td>20</td>
<td>0.69%</td>
<td>41</td>
<td>1.42%</td>
</tr>
<tr>
<td>Patient Name</td>
<td>2811</td>
<td>97.47%</td>
<td>65</td>
<td>2.25%</td>
<td>8</td>
<td>0.28%</td>
</tr>
<tr>
<td>Patient Date of Birth</td>
<td>2041</td>
<td>70.77%</td>
<td>38</td>
<td>1.32%</td>
<td>805</td>
<td>27.91%</td>
</tr>
<tr>
<td>Collection Date/Time</td>
<td>1550</td>
<td>53.74%</td>
<td>16</td>
<td>0.55%</td>
<td>1318</td>
<td>45.7%</td>
</tr>
<tr>
<td>Diagnosis Code</td>
<td>2627</td>
<td>91.09%</td>
<td>158</td>
<td>5.48%</td>
<td>99</td>
<td>3.43%</td>
</tr>
</tbody>
</table>

Ordering Doctor Number and Ordering Doctor Name
Both fields illegible or blank

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>294</td>
<td>10.19%</td>
</tr>
</tbody>
</table>

Ordering Doctor Number and Ordering Doctor Name
Both fields legible

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1666</td>
<td>57.77%</td>
</tr>
</tbody>
</table>

Patient Regnum, Patient Name, Patient Date of Birth
At least 2 of 3 fields legible

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2796</td>
<td>96.95%</td>
</tr>
</tbody>
</table>

Patient Regnum, Patient Name, Patient Date of Birth
All 3 fields legible legible

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2007</td>
<td>69.59%</td>
</tr>
</tbody>
</table>