Michigan Pathology Department - Inpatient Phlebotomy Unit

University of Michigan Health System
Program and Operations Analysis

Analysis of AM Phlebotomy Process Flow

Final Report

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EXECUTIVE SUMMARY
Inpatient Phlebotomy at the University of Michigan Hospital collects blood samples from patients, which will then be processed for testing. The morning phlebotomy services workflow (4 a.m. to 10 a.m. - referred to as “AM” or the “morning sweep”) experiences a high volume of time-dependent blood samples. The Administrative Manager of Inpatient Phlebotomy asked IOE 481 Team 12 to assess the ability of AM phlebotomists to meet hospital demands, and determine, what problems, if any, Inpatient Phlebotomy faces. Team 12 accomplished their project goal by first observing the phlebotomy process to gain a basis of understanding of the current state. Next, team 12 facilitated an open discussion with providers, phlebotomists and a MiChart technician to gain their perspectives. Team 12 then interviewed providers, phlebotomists, and a MiChart technician to better understand the key stakeholders’ priorities. Team 12 then conducted a literature review to find articles that could be applied to this project. With the help of the Administrative Manager, team 12 acquired historical blood sample data and staffing data for October 2014 - March 2015 to use in summarizing on-time performance of phlebotomy draws. Team 12 identified 16 problems, noted in Appendix A, and after discussing the issues faced by Inpatient Phlebotomy with the Administrative Manager, chose the following 3 challenges to address by project completion:

- Develop onboarding education materials for nursing staff and residents
- Investigate the MiChart system default times for time critical orders
- Summarize on-time performance of phlebotomy blood draws

By completing these tasks, Team 12 has provided recommendations on how to best assess Inpatient Phlebotomy’s ability to meet hospital demands.

Background
Inpatient Phlebotomy draws blood for all blood work orders within the University Hospital, excluding ICU patients. Phlebotomists typically draw 500-600 blood samples a day, 300-400 of which occur from 4 a.m. to 10 a.m. Blood work orders are classified as Stat, Time Critical, or Routine, Stat orders being the highest priority, then Time Critical and then Routine orders being the lowest priority. The blood work is ordered in MiChart system by the providers, after which it is transferred to the SoftID/SoftLab system, which the phlebotomists use. The phlebotomists draw blood based on priority, and after each draw send the blood sample to lab for testing. After blood is tested, the results are entered into MiChart for the providers to view.

Methods
Team 12’s methods were split into three sections: data collection, data verification, and data analysis. The methods mentioned below were chosen in order to accomplish the project goal in the most efficient way possible.
Data Collection

- **Observations:** Each team member observed 2 phlebotomists from 4 a.m. to 8 a.m. separately for a total of 32 hours of observations. The purpose of the observations was to gain an understanding of the phlebotomy process and to help develop questions for an open discussion between the groups involved in the phlebotomy process.

- **Open Discussion:** Team 12 hosted an open discussion between doctors, nurses, a MiChart technician, and phlebotomists. Team 12 gave a brief explanation on the purpose of the project and then opened up the floor for the users of the phlebotomy process to voice their concerns. The purpose of the open discussion was to gauge the knowledge of the groups involved in the phlebotomy process, and develop interview questions.

- **Interviews:** Team 12 interviewed providers, nurses, and a MiChart technician after hosting the open discussion. The goal of the interviews was to gain an understanding of how the groups used Inpatient Phlebotomy, as well as determine what the different groups hoped to achieve from the project.

- **Literature Search:** A literature search was conducted to provide Team 12 with a background on existing phlebotomy departments.

Data Verification

- **Historical Data Verification:** The Administrative Manager pulled data from MiChart, and Team 12 cross checked it with written records. The historical data provided on-time performance statistics.

Historical Data Analysis

- **On-Time Performance Statistics:** Team 12 created Excel and Access templates that take, clean, organize, and summarize historical data. This was done to provide on-time performance statistics, as requested by the Administrative Manager.

Findings and Conclusions

Through observations, Team 12 found that the electronic blood draw order list that phlebotomy uses to prioritize draws is not updated till 4 a.m. Because the list is not updated till 4 a.m., midnight shift phlebotomists cannot help with the 4 a.m. time criticals. The update time for the list, as well as a high volume of time criticals, have placed a strain on the phlebotomists ability to complete the orders on time.

From the open discussion, Team 12 determined that there was lack of awareness of the Inpatient Phlebotomy workload, and a lack of trust in Inpatient Phlebotomy’s ability to complete orders on time. According to the nurses, doctors, and MiChart technician in attendance, it was not known that phlebotomy uses a different computer system to view blood work orders, as well as have procedures and protocols to follow when drawing blood. Lastly, Team 12 realized that the nurses and doctors were not confident that a majority of blood work was completed on time.
The interviews revealed to Team 12 that some doctors misclassify labs as stat or time critical labs, rather than routine, to ensure their orders are completed before they make rounds. It was also revealed that the comments phlebotomists make in SoftID regarding why a patient’s blood was not drawn are not transferred to MiChart and therefore never seen by the providers. Team 12 also determined the cause of the MiChart system time critical default times. Time criticals were defaulting to 4 a.m. because doctors had previously created a default setting; opposed to the notion that the MiChart system automatically defaulted Time criticals to a designated time.

After analyzing the historical data for the month of January, Team 12 found that there were not nearly as many late labs as the providers believed there to be. For the months of October 2014-March 2015, only 13% of labs were “late”, and these labs were late by an average of 40 minutes. It was also found that routine orders had a specified order time in MiChart, but not in the SoftID system the phlebotomists use. Additionally, the team found that as the number of phlebotomist working increases, the percentage of late labs decreases. The middle of the week had the fewest percent of late labs.

From the qualitative data collected through observations, open discussion, and interviews, as well as the quantitative results from the historical data analysis, Team 12 and the Administrative Manager concluded that an education piece would best resolve many of the issues facing Inpatient Phlebotomy. The education material will increase awareness of the phlebotomy process, provide summary statistics of current phlebotomy performance and provide advice on how to order labs to ensure results are delivered to MiChart on time.

**Recommendations**

Team 12 recommends that the Administrative Manager use the education material and update it quarterly to provide to nurses and doctors with process statistics, and to provide transparency on the current phlebotomy process. By using the template created by Team 12, the Administrative Manager will easily be able to analyze phlebotomy performance and share this with concerned parties. Team 12 determined that the best way to regain provider trust in phlebotomy performance is to inform providers of the process and the effects of ordering different classification of labs.

Team 12 also recommends that the Administrative Manager continue to develop the education material and encourage its use in provider onboarding. It would also be beneficial for a team to investigate and pursue the remaining identified problems, noted in Appendix A.
INTRODUCTION
The Inpatient Phlebotomy Services is a unit within the University of Michigan Health System (UMHS). This unit is responsible for collecting blood samples from patients, which will then be processed for testing. Providers place blood test orders using the online MiChart computer system, a part of the Epic healthcare software system that the hospital uses to track and document patient care information. The providers designate each test with a status that indicates the relative priority of the sample collection in the computer system. The phlebotomists use these relative priorities while drawing blood. According to the Administrative Manager of Phlebotomy Services, the department completes 500-600 blood draws every day. Of these draws, 200-300 need to be done during the AM sweep in order for the test results to be available when their providers round in the morning for treatment and discharge decisions.

The Administrative Manager reported that the Inpatient Phlebotomy department’s ability to meet demands is greatly dependent on the days staffing levels. Additionally, the orders are unevenly distributed in the window of time allotted to conduct the AM blood draws and are often not consolidated into one order per patient. As a result, the phlebotomists struggle to complete the AM blood draws in the window allotted for each test.

To identify the validity and impact of the above issues, the Administrative Manager requested an IOE 481 student team from the University of Michigan to analyze the current workflow, identify the needs of the services that use the Phlebotomy department, and provide recommendations to improve satisfaction with the Phlebotomy department. The primary goal of the project is to assess the clinical needs of the services and determine what problems, if any, Inpatient Phlebotomy faces. The purpose of this report is to provide a detailed explanation of the background, goals and objectives, project plan, methods, findings, conclusions, and recommendations.

BACKGROUND
Inpatient Phlebotomy, a service unit within the Department of Pathology of UMHS, is in service 24 hours a day/7 days a week. The Inpatient Phlebotomy department is responsible for drawing blood from patients in the University Hospital, excluding the University Hospitals ICU units, the Emergency Department and C.S. Mott Children’s Hospital.

The Administrative Manager reported that the Phlebotomy department is negatively impacted by a high turnover rate; 10 people have left the department in the past 6 months. Hiring a new phlebotomist takes a minimum of 3 weeks, and the training required to be a qualified phlebotomist takes 4-6 weeks. Phlebotomists take an additional 4 weeks to adjust to UMHS environment. The high turnover rate results in many hours spent hiring and training new employees.
Blood work orders are designated with three levels of urgency: stat, time critical, and routine. Stat means the test request needs to be collected and in lab within an hour of the order request. “Stat” is the most urgent designation possible; it requires phlebotomists to interrupt their current tasks to fill orders of this type as soon as possible. Time critical orders must be drawn and in lab within an hour, before or after, the specified draw time. However, the window in which a time critical should be drawn can vary based on the analyte (type of test). “Routine” means the test request needs to be fulfilled within the AM sweep, or before 10 am. “Routine” is the lowest level of urgency.

The blood work process is as follows. Providers order blood work for their patients in the MiChart system. Once the order is placed in MiChart it gets transferred to the SoftID computer system. The phlebotomists use SoftID to track blood draw orders and update the status of the blood draw requests. SoftID also ranks the blood draw orders by level of urgency and puts them in a priority queue. Phlebotomists use the queue information to visit patient rooms in order of priority and draw blood. Once blood is drawn from a patient it is labeled and scanned into SoftID by the phlebotomist, which signals that the blood draw has been completed. SoftID then clears the blood draw order from the order queue. Following the blood draw, the blood sample is transferred to Specimen Processing where it is scanned into the Laboratory Information System (LIS) and sent to the correct testing laboratory. The testing laboratory scans the receipt of the sample into LIS and processes the blood work. After the tests have been completed, the results are uploaded to the MiChart system for the providers to view. This process is illustrated in Figure 1 below.

![Flow chart of blood work process](image)

Figure 1. Flow chart of blood work process

The phlebotomists draw approximately 500-600 blood samples per day, with 200-300 of those samples needing to be drawn in the AM, according to the Administrative Manager. The AM orders need to be completed in a timely fashion because the results of these tests are needed when the providers make rounds on their patients. These results are paramount to the health care providers in order for them to make a timely decision. The Mayo Clinic estimates “60-70% of all decisions regarding a patient's diagnosis and treatment, hospital admission and discharge are
based on laboratory test results” [1] (Mayo Clinic, Medical Laboratory Sciences Field Description).

The test results must be completed before providers make rounds to provide the best care possible for patients and so that care decisions can be made promptly. Providers realize that blood work orders are processed in a priority queue. Additionally, the only way to designate that blood needs to be drawn at a specific time is to use a time critical designation. According to the Administrative Manager, providers might order tests as “time critical” and specify an early time (4 a.m.) to help ensure the results are ready for when they make rounds. According to the Administrative Manager there are two problems with these actions. First, the phlebotomists can be overwhelmed with the volume of 4 am time critical orders and cannot complete them in the time window they have advertised. Second, there is a risk that the time critical orders that need to be processed at a certain time due to medical reasons are being delayed by "time critical" orders placed to ensure test results are ready for rounds. This is potentially dangerous for patients who depend on critical test results.

Another problem with the current system is the potential to have to draw a patient’s blood several times in the AM. This is possible, for example, if there is a time critical order for 4 am and 7 am. In cases like these the patients will have their blood drawn two times in the AM. If the phlebotomists catch this scenario, they can check with the patient’s nurse and ask to draw blood for both tests at once at a middle time -- a request which is often granted. This exposes the problem mentioned above: did the 4 am and 7 am labs truly need to be drawn at their specified times? The scenario of drawing a patient’s blood more than once during the AM period is classified as redundant work if both tests could have been drawn at one time.

GOALS AND OBJECTIVES
The primary goal of this project was to assess the ability of the Phlebotomy department to meet hospital demands, and determine what problems, if any, the phlebotomy department faces. To achieve this goal, the student team addressed the following tasks:

- Define the current workflow of the Phlebotomy department
- Assess clinical needs of the services that use the Phlebotomy department
- Define a potentially misprioritized blood draw request
- Identify inefficient or redundant tasks in the blood draw process

After accomplishing the primary goal of identifying the problems Inpatient Phlebotomy faces (located in Appendix A), Team 12 and the Administrative Manager chose the following 3 challenges to address by project completion:

- Develop onboarding education materials for nursing staff and residents
- Investigate the MiChart system default times for time critical orders
- Summarize on-time performance of phlebotomy blood draws
Key Issues
The following key issues drove the need for this project:

- Provider dissatisfaction with delayed blood work results
- Lack of awareness of phlebotomy process
- Delayed blood work
- Improper use of MiChart system

Project Scope
This project pertains to only the AM (4 a.m. to 10 a.m.) Phlebotomy department blood draw process. This involved all patients within the University hospital excluding the ICU patients (unless the patient has floor status). The blood draw process begins when a doctor requests blood work and is completed when the blood specimens are transported to the lab.

Any task not connected to the AM Phlebotomy blood draw process was not included in this project. More specifically, Team 12 did not study blood draws occurring outside the AM window. Team 12 did not analyze the method used to draw blood. Although any department outside the AM phlebotomy department was not be studied, any findings in this study could be extended to similar units in the future.

METHODS
Team 12 collected qualitative data through observations, open discussion, interviews, and a literature search, in order to accomplish the primary goal. Team 12 was given SoftID data from October 2014 - March 2015 containing staffing and blood draws records in order to provide summary statistics of the Phlebotomy Services on-time performance. This section details the data collection, data verification and data analysis for the project.

Data Collection
Team 12 worked to collect data through observations, an open discussion, interviews and a literature review, as detailed below.

Observations
Team 12 observed the phlebotomy process in order to better understand and define the current state. Observations were made by shadowing experienced and new phlebotomists to ensure observations were not biased. Team 12 also shadowed providers in the AM. This provided Team 12 with insight on how and why providers place blood work orders for patients with “routine,” “time critical,” and “stat” priorities.

Each team member shadowed phlebotomy staff twice, for a total of 8 observation periods from the February 3 - 20, 2015. Each member also shadowed 1-2 providers from February 23 - 27, 2015. The data collected from shadowing provided an accurate description of the current state and was used to develop questions for an open discussion between members of Phlebotomy
Services as well as interview questions. Average blood draw duration and blood specimen drop off times were determined from the observations.

Open Discussion
An open discussion between providers, phlebotomists, and MiChart technicians was hosted by Team 12 and the Administrative Manager. Team 12 introduced the project, and then allowed the attending University Hospital staff to openly discuss and voice their opinions and concerns with the phlebotomy process. The discussion helped Team 12 gain a general understanding of the units involved with the phlebotomy process. Team 12 also learned that most of the units involved with the phlebotomy process do not directly interact with each other; the discussion allowed the units to understand how each other works. The hour-long open discussion was held on Feb 19th and involved phlebotomy staff (2), nursing staff (5), doctors (3), and a MiChart representative. Team 12 gained valuable insight into the needs of each unit involved with the phlebotomy process. The needs of each unit were further assessed through interviews with staff who attended the discussion.

Interviews
Team 12 interviewed doctors (2), nurses (3), phlebotomists, and a MiChart representative involved with the phlebotomy process. The interviews provided an in-depth understanding of the key stakeholders’ priorities. Priorities and goals of Phlebotomy Services differ between doctors, nurses, and phlebotomists. By fully understanding the needs of each unit, Team 12 developed education material to improve the satisfaction with phlebotomy process. The interviews were held from February 23 – 27, 2015.

Literature Review
Team 12 found several sources that are relevant to their project. Thai writes about the impact of electronic health records (EHRs) on rounding and satisfaction of patients and providers with these systems [2]. This is relevant to this project since some phlebotomists feel that lab orders have been prioritized unnecessarily as "time critical" since the hospital switched to MiChart. Grasas discusses optimizing collecting blood samples from different collection points [3]. This article discusses pickup by car, but it is applicable to the hospital environment when phlebotomists are viewed as the pickup vehicles and patient rooms as the collection points. Wagar discusses improving phlebotomy service collection using quality engineering techniques such as statistical control charts and pareto charts [4]. This research is relevant because it discusses a 24-hour inpatient phlebotomy service and the application of process improvement tools to this environment. Dzik discusses applying statistical process control (SPC) to monitor errors in the collection and labeling of blood samples in a pretransfusion setting [5]. This research is applicable because it discusses the application of SPC in a hospital blood draw setting.
This research worked to provide Team 12 with articles about different phlebotomy services. Some of the research was not be relevant due to the progression of the goals of this project, however it established background for Team 12.

Data Verification
Team 12 verified the provided SoftID data to ensure accuracy. The method used to verify the data is detailed below.

Historical Data
The Administrative Manager provided historical records for October 2014 - March 2015 for every test that was ordered through Phlebotomy Services. This data includes the date and time the order was requested to be drawn, the date and time it was drawn, the date and time it was in lab, the date and time the results were delivered to MiChart, and the unique identifier of the phlebotomist that drew the sample. This data also contains information on which tests were ordered and what room the patient was in. It does not include the specialty that ordered the test.

To verify this data, Team 12 took the following two steps; first, the team verified with the Administrative Manager that the data collected through observations was consistent with the data in MiChart. Second, the team compared the handwritten records from the phlebotomists with the MiChart data. The team checked 7 random days from 3 phlebotomists. The data verification was completed the week of February 23-27, 2015.

Historical Data Analysis Methods
The Administrative Manager requested summary statistics to provide the doctors and nurses with metrics regarding phlebotomy blood draw performance. These summary statistics will be delivered in an Excel template that conducts analysis on any data that matches the form detailed in Appendix B. To deliver the summary statistics Team 12 conducted data analysis using Microsoft Excel and Access.

A key performance metric is the percentage of on-time blood draws (blood draws delivered inside the window of time that phlebotomy expects to draw blood). This metric is of primary interest in order to establish provider trust in the phlebotomy department and provide transparency regarding the percentage of on-time labs. Team 12 defined an on-time blood draw in the following way:

<table>
<thead>
<tr>
<th>Lab Classification</th>
<th>Late if...</th>
<th># Min Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stat</td>
<td>Drawn more than 1 hour after order time</td>
<td>Draw_Time - Order_Time</td>
</tr>
<tr>
<td>Time Critical</td>
<td>Drawn more than 1 hour after order time</td>
<td>Draw_Time - Order_Time</td>
</tr>
<tr>
<td>Routine</td>
<td>Drawn after 9am</td>
<td>Draw_Time - (9:00am)</td>
</tr>
</tbody>
</table>

Table 1: Lab classification standards.
The team started the analysis by creating an Access query that filtered the data by window of study (4:00 am to 10:00 am order or draw time), location (only locations where phlebotomy draws), and test type (specified by Administrative Manager - tests that had a volume greater than 500 tests in the month of January 2015). The query text is detailed in Appendix C, and the required data format is detailed in Appendix D. The table resulting from this query is called the “filtered data”.

The “filtered data” is transferred to an Excel document (“FilteredFinalData” tab) where further analysis is conducted. The times between the DRAW_DATETIME and ORDER_DATETIME, DRAW_DATETIME and INLAB_DATETIME, and ORDER_DATETIME to TIMESTAMP_MESSAGE calculated. For some columns, only labs defined as late are considered. Other columns analyze all the data. Additionally, the “FilteredFinalData” tab calculates other fields used in the analysis such as draw_hour and draw_time (in minutes past midnight). The summary statistics are calculated in another tab (“Final Results Live”). This tab will auto-populate as the “FilteredFinalData” tab is filled in from the query. The excel template conducts analysis on the % of specimens that are delivered late, the average time that late labs are delivered, and the percentage of each classification represented in the late labs. It provides information about the average volume of each classification by day of week. (see E.1 in Appendix E).

The team conducted analysis on how the hour a specimen was ordered is related to the hour it is drawn (see E.2 in Appendix E). Each cell (A,B) in the matrix represents the number of specimens that were ordered in hour A and drawn in hour B. If all specimens were ordered in the same hour they were drawn the diagonals of the matrix would have 100% in them and all other cells would have 0%.

For each classification of lab the team analyzed the following factors:

- average time of day labs are ordered
- average time of day labs are drawn
- average time of day labs are returned
- average number of specimens/day
- average time between order and draw
- average time between order and results uploaded to MiChart

In addition to these factors the team provided a histogram of the on time performance for each lab classification (see E.3 in Appendix E) and a specific matrix of how order hour is related to draw hour (see E.4 in Appendix E).

The team also looked at how the percent of late labs and the volume of labs are related, broken up by day of week and day of month. To come up with one metric to look at volume the team created a “weighted volume score”. This score is determined as follows:

\[
Weighted\ Score = 3 \times (%Stat\ Labs) + 2 \times (%Time\ Critical\ Labs) + (%Routine\ Labs)
\]
The team chose to look at volume percent to normalize each day with respect to volume. The weighting factor comes from the relative inconvenience to the phlebotomists. Stat and time critical labs cause phlebotomists to interrupt their workflow to address the draw, and this is inefficient. Routine lab draws are the most efficient, and therefore are the lowest weighted. On days when more of the labs are ordered routine, the weighted score will be lower. A day can have a high weighted volume by having a large percentage of stat and time critical labs, or a much larger percentage of routine labs.

For routine labs, the team looked at how the percentage of routine labs ordered affected the on time performance of results delivered (see E.5 in Appendix E). The team took days in the ‘high volume of specimens’ category - over 1000 specimens drawn - sorted these days by % of routine labs. The top 10 (those with the highest percent routine labs) were selected as “High % Routine” days. The bottom 10 (those with the lowest percent routine labs) were selected as “Low % Routine” days. The team used those two categories to look at how the % of routine labs affected the hour results were delivered.

Additionally the team received staffing data from the Administrative Manager. This data was for October 2014 - March 2015 and it contained the date, time, and phlebotomist ID for each draw completed. Team 12 consolidated this data with an Access query to give the number of phlebotomists working each hour of each day for all days in this time period. The team then looked at how the percentage of labs that were late related to the average number of phlebotomists, broken up by day of month and day of week.

**FINDINGS and CONCLUSIONS**

Upon completion of the data collection and analysis, Team 12 developed a series of findings and conclusions. Originally, Team 12 was asked to assess the ability of the Phlebotomy Department to meet hospital demands, and determine what problems, if any, Inpatient Phlebotomy faces. Team 12 accomplished this goal, and with the help of the Administrative Manager, selected 3 challenges to address:

- Develop onboarding education materials for nursing staff and residents
- Investigate the MiChart system default times for time critical orders
- Summarize on-time performance of phlebotomy blood draws

Through observations, Team 12 found that the electronic blood draw order list that phlebotomy uses to prioritize draws does not update until 4 a.m. Because the list is not updated until 4 a.m., midnight shift phlebotomists cannot help with the 4 a.m. time critical lab draws and the morning shift phlebotomists cannot start on them until 4 a.m. at the earliest. Team 12 also observed that every morning, Inpatient Phlebotomy meets for approximately 10-20 minutes before collecting their equipment and starting their sweeps. This results in Phlebotomy starting blood draws for the AM sweep at approximately 4:10 a.m. The 4:10 a.m. start time, coupled with the fact that the midnight shift cannot help handle the 4 a.m. time criticals, has placed a strain on Inpatient Phlebotomy’s ability to complete the 4 a.m. time criticals in the allotted window of time. Team
12 also observed that some patients had to be drawn multiple times in a single sweep because they had time critical orders for various times within the sweep. Some phlebotomists believe that the providers are purposely misclassifying labs to ensure that their labs are completed on time.

From the observations, Team 12 found that it takes phlebotomists an average of 10 minutes to draw a patient’s blood. Team 12 also found a lack of consistency in phlebotomist blood draw procedures. Some phlebotomists would batch draws, drawing 5 or 6 patients before dropping off the blood samples, where other phlebotomists would drop off blood samples every time they drew a patient (the latter is the expected practice). The batching of orders overloads the lab, and could lead to delays in results. Team 12 also observed that the line draw list, which phlebotomists use to determine whether a patient has a central line, is not consistently updated; patients with central lines may not be listed on the line draw list. The line draw list may not be consistently updated because there is confusion as to whose responsibility it is to update the list. As a result, phlebotomists will sometimes enter a room to draw a patient’s blood, only to find the patient has a central line. This inefficient use of time negatively affects the efficiency of the phlebotomists.

From the open discussion, Team 12 determined that there was lack of awareness of the overall phlebotomy process. The providers were uninformed about the sweep times of the phlebotomy department, and did not know there were timed guidelines for the drawing stat, time critical, and routine orders. Also, the nurses, doctors, and MiChart technician in attendance were under the impression that phlebotomists use MiChart, not SoftID. There was also confusion regarding central line draws. The nurses were confused why phlebotomists would enter rooms of patients with central lines. The nurses were misinformed and thought that the phlebotomist’s SoftID system contained the information regarding central lines. This is likely due the fact that the nurses, doctors, and MiChart technician believed phlebotomists used MiChart. Team 12 also found that there was a lack of trust in Inpatient Phlebotomy’s ability to complete labs on time. The nurses and doctors are not confident that labs ordered as routine will be completed on time.

From the interviews, Team 12 found that doctors are purposely misclassifying labs. The doctors do not trust that the phlebotomy staff will complete labs on time if they order labs as routine. They are also under the impression that the phlebotomy staff will sometimes skip labs. After further investigation, the team found that this is linked to the lack of communication between the SoftID and MiChart systems; if a phlebotomist is unable to draw a patient, the phlebotomist will make a comment in SoftID. However, this comment is not transferred to MiChart, and as a result the doctors aren’t able to view the comment and assume the phlebotomists skipped the patient. This results in a loss of trust in phlebotomy’s ability to meet demands. Also, doctors and nurses were under the impression that routine labs had a specific draw time which they could specify. This is due to the fact that routine labs have a designated draw time in MiChart. However, phlebotomy procedures and the SoftID system have no designated routine draw time.
The interviews also revealed that time critical orders were defaulting to 4 a.m. if a time was not specified. The team consulted with a MiChart technician and found that the time criticals defaulting to 4 a.m. was a result of the providers adjusting their MiChart settings. In order for a time critical to default to a certain time, a doctor would have had to create a default setting at some point before having ordered the time critical. Team 12 also learned that the providers have a limited knowledge of the capabilities of MiChart due to a lack of training. According to the MiChart technician, MiChart was given less than a day to train the providers on MiChart’s uses. However, the MiChart technician estimated that this process was should to take 3 days.

After analyzing the historical data from October 2014 - March 2015, Team 12 found that there were not nearly as many late labs as the providers believed there to be. For the months of October 2014 - March 2015, only 13% of labs were late (as defined in the Methods section), and these labs were late by an average of 40 minutes. Of the labs that were late, 59% were time critical, 34% were routine, and 7% were stat. On average, the most routine labs were ordered for Wednesday, while the most time critical labs were ordered for Monday (See E.1 in Appendix E). Team 12 also found that the least percent of late labs was on Wednesday (8.51%) while the highest percentage of late labs was on Monday (16.23%). Team 12 found that the percent of late labs correlated with the average number of routine labs with a correlation value of -0.88. This means that as the number of routine labs increases, the percent of late labs decreases (see E.6 in Appendix E). Additionally, Team 12 looked at how the weighted volume score correlated with the percent of late labs, broken down by day (see E.7 in Appendix E). The correlation value of these was 0.932, meaning that as the volume score decreased the percent of late labs also decreased.

Team 12 looked at a matrix-style graph (see E.2 in Appendix E) that plotted order hour vs. draw hour. The Team found that a little under half of the labs were drawn in the same hour that they were ordered. Routines were the least likely to be drawn in the hour they were ordered, while stats were the most likely. Similarly, the Team looked at how the hour that results were returned was related to the hour the lab was ordered. The majority of labs were delivered between one and two hours after they were ordered. Stat orders were delivered more quickly than routine orders. Team 12 found the following statistics about individual lab categories:

<table>
<thead>
<tr>
<th>Routine Labs</th>
<th>Time Critical Labs</th>
<th>Stat Labs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average order time: 5:53 am</td>
<td>Average order time: 5:14 am</td>
<td>Average time between order and draw: 26 minutes</td>
</tr>
<tr>
<td>Average draw time: 6:36 am</td>
<td>Average draw time: 5:34 am</td>
<td>Average time between order and results uploaded: 112</td>
</tr>
<tr>
<td>Average number of routines/AM: 509</td>
<td>Average number of time criticals/AM: 533</td>
<td>Average number of stats/AM: 107</td>
</tr>
</tbody>
</table>

Table 2: Statistics for each classification type.
Additionally, the Team created histograms to provide information about the different lab classifications (see E.3 in Appendix E). Most notably, time critical labs are drawn an average of 20 minutes after the order time, and draw times are distributed normally. Routines are drawn approximately 30 minutes late, and draw times are distributed normally.

Since routine labs have no order time, Team 12 conducted an individual analysis for them (see E.5 in Appendix E). The Team looked at how the percentage of routine labs affected the hour results were delivered and found that when the percentage of routine labs was higher, the results were delivered faster (76% delivered before 9 am vs 57% delivered before 9 am).

Lastly, the team analyzed staffing data. The Team found that, when broken up by day of week, as the average number of phlebotomists on staff increases the percent of late labs decreases (see E.8 in Appendix E). This has a correlation value of -0.8, indicating a strong negative relationship. The staffing level is highest on Wednesday, with an average of 12.42 phlebotomists on staff.

RECOMMENDATIONS
Team 12 recommends that the Administrative Manager release the education material (provided in Appendix F) to the staff in charge of onboarding the residents and nurses. The education material is meant to help providers understand how to use the Inpatient Phlebotomy department effectively. Most importantly, it gives them statistics about the process and details how to get labs back on time. The statistics on this sheet come from the Excel template that Team 12 has provided (instructions for using the analysis material are given in Appendix G). Team 12 recommends that the Administrative Manager continues to update the statistics quarterly to monitor the Inpatient Phlebotomy Department. The education material should also be updated quarterly with the statistics from the Excel template. Publishing updated statistics about Inpatient Phlebotomy serves two purposes: to establish transparency in the phlebotomy process and to provide incentive for providers to order labs correctly. Lastly, Team 12 recommends that the remaining issues addressed in Appendix A should be investigated and pursued. The remaining issues provide opportunities to continue to optimize the phlebotomy services.

EXPECTED IMPACT
If the recommendations are put into place in the Inpatient Phlebotomy Department, provider trust in Phlebotomy services will increase. Team 12 also expects increased satisfaction with the Phlebotomy Services. By increasing the trust and satisfaction between providers and Phlebotomy Services, Team 12 expects a reduction in late labs which will result in an increase in the number of on-time blood draws. Team 12 expects an increase in the number of on-time blood draws by the AM phlebotomists and a reduction in the amount of duplicate work. Lastly, Team 12 expects that highlighting the remaining problems will allow for future studies to further improve Phlebotomy Services.
APPENDICES
A. List of Problems
B. Screenshot of Excel Template
C. Query Text
D. Required Data Format for Excel Sheet
E. Supporting Figures
F. Education Material
G. Using the Query and Preparing Data for Excel Template
Appendix A: List of problems

Provider Perspective

Routine Labs
The lowest priority of labs is “routine”, and these labs are set to be collected in a “sweep” - or set times of high phlebotomy collection and staffing. Providers use this designation to indicate tests that must be done in a sweep but are not time sensitive outside of this window. In MiChart, AM routine labs have a specified collection time of 6 am, but this time is not honored (or in the procedure) in the phlebotomy system. Providers are frustrated that the labs are not getting drawn in time to be used during morning rounds, so they tend to reorder them as “stat”, or stop ordering “routine” labs altogether in favor of the “time critical” designation.

Dropped Labs
When a patient is housed in the Emergency Department, all the blood draws are nurse collect. However, when the patient is transferred to the University Hospital, the blood draws are lab collect. When a patient is transferred to UH, a provider has to manually go in and change the type of collect or the lab will be dropped. This leads to reordering and not getting results on time to make medical decisions. A recurring order is also called a parent/child order. The parent is the actual order with labs and the child is each time the lab is drawn. If a provider cancels the child order, they are actually canceling all orders (parent order).

Duplicate Labs
There are two main situations in which duplicate labs occur. First, some labs are not delivered by the time provider needs the results. This could happen for a variety of reasons (dropped labs, accidentally canceled labs, late labs, etc.), and when this happens providers tend to reorder labs as “stat” at that specific time. The second situation is when a provider wants to add a test that could be done with an existing tube of blood that was just drawn. It is not readily apparent which tests can be added on, and to do this providers often have to call the lab and request an additional test. Additionally, even if a provider knows which test to add on there is not an easy way to do this in the computer. Both of these situations could lead to poking a patient twice for the same lab.

Complaints
When providers do not receive their results on time or if a certain lab is not drawn on time, they have the ability to draft a complaint in the system. Most providers do not use this because it is easier to reorder a lab than to submit a complaint. This leads to same labs being drawn.
Nurse Perspective

Line Draw Procedure
All line draw labs were nurse collect. However, a study done by a Lean team suggested that allowing the phlebotomists to do line draws will be beneficial. When a phlebotomist does a line draw, they have to ensure that any pumps (medications, saline, etc.) are stopped before they can draw the blood. Pausing the pumps requires finding the patient’s nurse since a phlebotomist cannot stop the pump. This creates more work for both the phlebotomist and the nurse. The nurse has to interrupt on his/her daily routine to go stop the pump and restart the pump.

Line Draw Sheet
Line draws require special training. A sheet exists in each nurse station to indicate which patients have lines. This sheet should be updated every day, but it is often inaccurate. This lack of accuracy leads to phlebotomists entering a patient's room several times - one to identify the patient has a line, a second time with a phlebotomist that’s trained in line draws.

Unloading Samples
Phlebotomists have a standard procedure to deliver the blood samples to the lab: after each draw, they place it in a cubby for the lab to collect. Lab technicians come approximately every 20 minutes to collect the samples and bring them to the lab. Pneumatic tubing also exists that goes directly to the lab. Some phlebotomists collect several samples at once and then drop them in either the cubby or the pneumatic tube container. Batching labs could lead to an unequal balance of work in the lab, and this in turn could affect the delivery times of the test results.

Lack of Education
It would be beneficial to add an educational document detailing what phlebotomy is in the onboarding packet that all incoming nurses receive. This will improve the awareness and create a better understanding of what phlebotomy is. This document will include what a phlebotomist does and what their workflow looks like. Also, it would be useful to have laminated documents posted around the floors that briefly describe phlebotomy.

Patient Concerns
Phlebotomy operates at all hours. Phlebotomists start drawing blood at 4 am for the morning sweep. Nurses are concerned that patients get woken up too early and too often, and this schedule is not conducive to patient satisfaction.
**Phlebotomy Perspective**

*Provider Satisfaction*
Providers are unhappy that their labs are not delivered by the time they round. This makes them unusable at rounds and disrupts their workflow. This has been a recurring problem in all computer systems, and has led to a distrust in the system. Additionally, there is a lack of transparency within the computer systems. Providers cannot see when a lab has been delayed (for example, when a patient is not in their room or refuses a lab), and as a result they are unaware of the current state and distrust the system. This leads to multiple lab orders, an uneven balance of work, and a host of other problems.

*Staffing*
There is no clear understanding of what the phlebotomy services staffing model looks like. This includes the frequency and the duration of breaks and lunch. How are the 4-hour and 8-hour shifts determined? What level of transparency is acceptable?

*Lack of Education About Phlebotomy Services*
It is important for the phlebotomists to be aware of all the different blood draw designations and what they mean. There needs to be a universal definition of what a TACRO means, for example. Also, it is important the phlebotomists to understand their workflow (everything other than the actual blood draw). This is allow them to work more efficiently.

*Labs Drawn Late*
As the number of “time critical” orders in a period of time increases, the staffing needed to draw the samples also increases. Phlebotomists are a limited resource, and currently the uneven distribution of lab orders in the AM period is straining their system. If more “time critical” orders are placed then the phlebotomists can handle some of the “time critical” labs will be drawn outside of the specified window.

**MiChart Perspective**

*Minimal Education on Ordering Labs*
Providers have minimal time to receive education on the MiChart system. Currently they spend less than 30 minutes receiving instructions on the lab ordering process. This could lead to accidental misuse of the lab ordering system.

*Status of Labs*
The current system has no way of letting providers know of the status of labs. If a lab has been delayed, the provider is not notified. This might lead to the provider reordering the same lab and creating more work for the phlebotomists. It would be helpful to have a feature in the system that
allows the provider to track their orders in order to reduce redundant work. It would also be helpful to see which vials can be used for which tests to make it easier for providers to use the add-on feature in the system.

*Time Specific Tests*
In MiChart, morning routine labs are ordered with a collection time of 6am. This time is not relevant to the phlebotomists but could lead the providers to believe that labs will be drawn before the time phlebotomy will draw them. “Time critical” orders in the morning default to 4 am. This could lead to an imbalance of orders and blood being drawn outside of the specified time window.
Appendix B: Screenshot of Excel Template
**Appendix C: Query Text**

```sql
SELECT UH_Draw_Query.ORDER_DATETIME, Hour(ORDER_DATETIME) AS ORDER_HOUR, UH_Draw_Query.DRAW_DATETIME, Hour(DRAW_DATETIME) AS DRAW_HOUR, UH_Draw_Query.INLAB_DATETIME,
UH_Draw_Query.TIMESTAMP_MESSAGE, UH_Draw_Query.LOCATION,
UH_Draw_Query.ORDER_NUMBER, UH_Draw_Query.MNEMONIC,
UH_Draw_Query.ACCESSION, UH_Draw_Query.COLLECTION_PRIORITY INTO Filtered_Data_T_Edit
FROM UH_Draw_Query
WHERE ((([UH_Draw_Query].[LOCATION]) In ('1A','1OBS','4A','4AS','4B','4C','5A','5ATB','5B','5B1','5C','6A','6B','6B1','6C','7A1','7B','7C','8A 2','8A3','8A8C','8B1','8B2','8C','9C','AMOU','CVC5')) AND
((([UH_Draw_Query].[LOCATION]) In ('MAG','BASIC','CBCP','PHOS','PT7','CBCPD','COMP','HEPARIN','PTT','BLD','ICAL','TS','TR OP','RENAL','UN','LDH','LIVER','FIB','URIC','TACRO','VANCO TR')) AND
((Hour([ORDER_DATETIME]))>3 And (Hour([ORDER_DATETIME]))<11)) OR
(((([UH_Draw_Query].[LOCATION]) In ('1A','1OBS','4A','4AS','4B','4C','5A','5ATB','5B','5B1','5C','6A','6B','6B1','6C','7A1','7B','7C','8A 2','8A3','8A8C','8B1','8B2','8C','9C','AMOU','CVC5')) AND
((([UH_Draw_Query].[LOCATION]) In ('MAG','BASIC','CBCP','PHOS','PT7','CBCPD','COMP','HEPARIN','PTT','BLD','ICAL','TS','TR OP','RENAL','UN','LDH','LIVER','FIB','URIC','TACRO','VANCO TR')) AND
((Hour([DRAW_DATETIME]))>3 And (Hour([DRAW_DATETIME]))<11));
```
Appendix D: Required Data Format for Excel Sheet

Data must be uploaded in Access called “UH_Draw_Query”. It must contain the following fields:

- ORDER_DATETIME - the date and time the order was placed
- DRAW_DATETIME - the date and time the blood was drawn
- INLAB_DATETIME - the date and time the sample was scanned into the lab
- TIMESTAMP_MESSAGE - the date and time the test results were uploaded to MiChart
- LOCATION - the location of the draw
- ORDER_NUMBER - the number assigned to the specific test and draw
- MNEMONIC - the abbreviation of the specific test
- ACCESSION - the number generated by the Soft system
- COLLECTION_PRIORITY - the level of urgency (“routine” or “R”, “time critical” or “T”, or “stat” or S)

The resulting table, called “Filtered_Data_T”, will contain the filtered data. Clear the current data in the columns A-K in the excel sheet titled “FilteredFinalData”, and paste the excel data into table, labels and all, into the now-empty rows A-K.
Appendix E: Supporting Figures

E.1

Average Number of Specimens by DOW and Urgency

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<th>Stat</th>
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<td>Monday</td>
<td>509.13</td>
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<td>Tuesday</td>
<td>546.54</td>
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<td>Saturday</td>
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### Order Hour vs. Draw Hour

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- **Order Hour**
- **Draw Hour**

- **4th to 10th Hour**
E.4

### Routine

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Shows when routine results are delivered vs the order time of routine orders.

### Time Critical

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Shows when time critical results are delivered vs the order time of time critical orders.

### Stat

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</tr>
</tbody>
</table>

Shows the time Stat order results are delivered vs the time stat orders are placed.
<table>
<thead>
<tr>
<th>Hour</th>
<th>HIGH % ROUTINE (50% Labs Ordered as Routine)</th>
<th>LOW % ROUTINE (38% Labs Ordered as Routine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>10</td>
<td>4%</td>
<td>9%</td>
</tr>
</tbody>
</table>
Average Number of Routines and %Labs That are Late vs. Day of Week (Correlation = -0.88)
Percent of Labs that are Late vs Wtd Volume Score:
Correlation = 0.932
E.8

Average Phlebotomists and % Labs That are Late vs. Day of Week (Correlation = -0.80)

Avg Number of Phlebotomists

Day of Week (Sunday - Saturday)

Average Number of Late Labs

- AvgPhlebCount
- % Labs That Are Late
Appendix F: Education Material

Inpatient Phlebotomy

Key Facts

- University of Michigan Inpatient Phlebotomy Department draws 500-600 blood samples a day for University Hospital, 300 of which are drawn between 4 a.m. to 10 a.m.
- Phlebotomy is most efficient drawing routine labs. Time critical and stat labs disrupt phlebotomist work flow.
- Phlebotomists will attempt to draw every patient that requires blood work.
- Routine labs are placed in the following sweep. They will not be drawn during the current sweep.
- Routine labs will not be drawn at a specified time. If a lab needs to be drawn at a specific time, order time critical.

Blood Work Classifications

**STAT:**
Drawn and in lab within an hour

**Time Critical:**
Drawn and in lab +/- 1 hour from order time

**Routine:**
Drawn during sweep

Unless labs need to be completed immediately or at a specific time, order as routine. Phlebotomists are most efficient drawing routine labs.

![Blood Work Classifications Diagram]

Percent of Routine Labs Returned

<table>
<thead>
<tr>
<th>Hour of Return</th>
<th>50% of all Labs are Routine (Avg 10 Days)</th>
<th>38% of all Labs are Routine (Avg 10 Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2%</td>
<td>2%</td>
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<tr>
<td>5</td>
<td>10%</td>
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<td>10</td>
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</tbody>
</table>

When more routine labs are ordered, the routine results are returned more quickly. Here, 77% vs 57% of routine labs are returned by 8 when 50% of all labs are routine rather than 38%.

![Percent of Labs that are Late vs Wtd Volume Score Graph]

This graph shows how the % of late labs is related to the volume of specimens ordered in the AM period. The weighted score is: Weighted score = 3*% stat specimens + 2* (% time critical specimens) + (% routine specimens). This gives more importance to stat labs, because they require immediate attention and the phlebotomy non-value add time increases (i.e. walking, assessing, route planning, disruption of flow).

<table>
<thead>
<tr>
<th>% Stat Results Delivered Based on Order Hour</th>
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</thead>
<tbody>
<tr>
<td>10</td>
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<td>9</td>
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<td>4</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>% Tim Critical Results Delivered Based on Order Hour</th>
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<tbody>
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<td>10</td>
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<td>9</td>
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<td>5</td>
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<td>4</td>
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</tbody>
</table>
Inpatient Phlebotomy

What does it do?
- Responsible for all University Hospital blood draws, excluding the ICU, Emergency Department, and C.S. Mott Children’s Hospital, and runs 24/7.
- 500-600 blood draws done daily, 200-300 occurring between 4 am and 10 am.
- Blood work is ordered as Stat, Time Critical, or Routine.
- Blood draws take place during sweeps that occur over three shifts: day shift, afternoon shift, and midnight shift.
  - Day shift sweep times: 4:00 am, 9:00 am, 10:30 am, and 12:30 pm.
  - Afternoon shift sweep times: 2:30 pm, 4:00 pm, 6:00 pm, and 9:00 pm.
  - Midnight shift offers stat and time critical services only. When all Stat and Time Critical orders are complete, routine morning lab orders are serviced.
- 60% - 70% of medical decisions are based off of lab results.

How long does it take?
- Usually 3 phlebotomists are assigned to a floor, at least 1 of whom can draw from central lines.
- A phlebotomist can handle approximately 6 blood draws per hour. So phlebotomy can handle approximately 18 blood draws per floor per hour.
- Stat orders are drawn approximately 26 minutes after ordering.
- Time Critical orders are, on average, ordered for 5:14 am and drawn approximately 21 minutes from specified draw time.
- Routine labs, on average, are drawn at 6:36 am.
- Time Critical results are ready, on average, at 7:02 am.
- Routine results are ready, on average, at 8:09 am.
- Routine lab are the most efficient for phlebotomists to draw. As the number of routine labs ordered in a day increases, the number of late labs decreases.

What is the phlebotomy process?
- Providers order blood work.
- Phlebotomists draw blood. Send to lab for testing.
- Lab tests blood. Posts results to MiChart.
- Labs are classified as Stat, Time Critical, or Routine.
  - Stat orders are 1st priority and must be drawn and in lab within 1 hour of being ordered.
  - Time Critical orders are 2nd priority and must be drawn within an hour before or after their specified draw time.
  - Routine orders are 3rd priority and must be drawn during the sweep they were ordered for after all stat or time critical orders have been handled. If a patient has a Time Critical or Stat order and a Routine, the Routine order will be handled at the time of the Stat or Time Critical.

How can you help phlebotomy?
- Order labs as routine unless time critical or stat is required.
- Phlebotomists can draw routine labs most efficiently. They do not need to move all around the hospital trying to complete the stat and time critical orders before starting routines.
- Add on to already drawn blood. It saves the patient from having to be poked, and the results are ready more quickly.
- Update the line draw list, or leave a note on the doors of patients with central lines. SoftID doesn’t specify what patients have central lines.

How to get labs on time?
- Make sure orders are classified correctly. Misclassified blood work overloads phlebotomy and delays lab work.
  - Does the order need to be done immediately? If so, order as stat.
  - Does the order need to be done at a certain time? If so, order as a time critical.
  - Does the order need to be completed during the next sweep? If so, order as a routine. A routine order will be processed during the next phlebotomy sweep, not the current sweep.
  - If a patient has recently had blood drawn, try to add tests to the already drawn blood. It eliminates all the time it takes to draw and send the blood to lab, and the patient doesn’t need to be poked again.

SoftID vs. MiChart
- Phlebotomy doesn’t use MiChart. It uses SoftID.
- Lists blood draw orders in priority order: Stat, then time critical, then routine.
- The SoftID blood draw list is not updated until 4:00 am. This means the midnight shift cannot help with the 4:00 am time critical orders.
- Routine orders do not have a draw time in SoftID, even though a draw time can be specified in MiChart.
- If a phlebotomist is unable to draw a patient’s blood in the case they are missing or having other tests done, a comment will be made in SoftID. Comments do not transfer to MiChart.
- SoftID doesn’t specify if a patient has a central line. Phlebotomists rely on line draw sheets on each floor.
Appendix G: Using the Query and Preparing Data for Excel Template

1. Open the data in Excel (see required format in Appendix B) and open the Access database (called XXXXXXXXXX)
2. Import the data into Access
   a. Use “External Data” tab, and choose the “Excel” button. Follow the wizard to import the data you want.
   b. Make sure you choose the correct sheet, and indicate that the first row of your data contains column headings.
   c. Ignore any formatting errors access might give you. They shouldn’t matter.
3. Change the table name of the data you just imported to “UH_Draw_Query” by right clicking on the table text and selecting “Rename”
4. Run “CleanDataFinalQuery”. If you’ve imported and named the table correctly you should get a message letting you know that the query is about to paste rows into a table called “Filtered_Data_Final_T”. Hit YES! This is your cleaned data!
5. Open “Filtered_Data_Final_T” to view the cleaned data. This data now contains only certain tests and locations drawn in the AM (4am-10am).
6. Copy this entire table, and paste it into the “FilteredFinalData” tab in the Excel Template
7. Navigate to the “FinalResultsLive” tab and click the button called “Find last row”. This runs a macro that finds the last day in the data set and updates all the calculations accordingly.