University of Michigan Health System
Program and Operations Analysis

Echocardiogram Lab Workflow Redesign

Final Report

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Executive Summary

The Pediatric Cardiology Echocardiogram Lab at the University of Michigan Congenital Heart Center (MCHC) provides echocardiograms (echos) for both outpatients and inpatients of the hospital. In Winter 2014, IOE 481 students completed a project for the MCHC and determined that the echo lab needed to be further analyzed to improve the workflow at the MCHC. The echo lab has long wait times for scheduled patients, and sonographers sometimes have to skip lunches and breaks to keep up with patient demand. The staff do not have information regarding the daily or weekly volume distribution of echos and processes outside their responsibilities, which hinders their ability to predict and adapt to the peaks and valleys of appointment volume within lab. The current IOE 481 student team was asked to identify the echo lab workflow and any inefficiencies or areas for process improvement.

Key Issues and Goals

After speaking with staff, walking through the echo lab, and studying the previous students’ report, the team identified several key issues that drove the need for this project. These team categorized these issues into three groups: demand, process definition and process improvement. The issue regarding demand was staff unfamiliarity with patient distribution and the issue regarding process definition was staff unfamiliarity with the workflow processes outside of their individual responsibilities. The issues driving a need for process improvement were long scheduled patient wait times and sonographers’ dissatisfaction with forfeiting breaks and lunches as result of backed-up workflow.

From the key issues, the team formulated the following goals for the project. The first goal was to identify the weekly and daily distribution of echos. Next, the team aimed to define the echo lab’s workflow to raise staff’s knowledge of the entire system. The team sought to improve staff satisfaction by identifying areas for process improvements to ensure time for breaks and lunches. The team expects that the combination of these improvements will also reduce patient wait times.

Project Scope

The project focused on the echo lab within the MCHC and did not include processes in other areas of the MCHC, such as EKGs. The team studied, for both outpatient and inpatients, all non-sedated TTE and fetal echos. The studied echo process began when an echo order was placed and ended when the sonographer completed the report for that echo. The project did not include off site echos, transesophageal (TEE) echos, or sedated echos. Any staff and patient activities extraneous to the laboratory’s workflow were also excluded from this project.

Methodologies and Findings

To address the three issues of demand, process definition and process improvement, the student team conducted a variety of methodologies which included performing a literature research, analyzing historical data, observing the lab, attending staff meetings, creating workflow diagrams, conducting patient surveys, interviewing staff members, conducting time studies and creating value stream maps.
Identifying the Echo Lab Demand
The team analyzed historical data provided from Omnis and MiChart to identify the current echo lab demand. The provided data included the volume of echos over the last five years and appointment information from May and August of 2014 such as appointment time, date appointment was scheduled, patient arrival time and echo type. From this data, the team identified that there was not a significant difference in the total number of echos by day of the week. The team also determined that the lab is not starting echos at the time they are scheduled and that the majority of echos occur in the morning. On average, 30% of daily appointments are added on the same day that the echo was performed.

Defining the Echo Lab Process
The team observed the lab workflow, attended staff workflow meetings and created workflow diagrams to define the echo lab process. The team observed the lab workflow by shadowing two outpatient and three inpatient appointments and recording staff tasks. The observations gave the team a working knowledge of the lab workflow and confirmed that staff members were generally unfamiliar of tasks outside his or her’s own job responsibilities. The team attended three clinic staff workflow meetings where echo lab staff created a preliminary workflow diagram and discussed their job responsibilities and how their roles interlink. The team then took these preliminary diagrams and created three separate workflows based on patient type: outpatient, inpatient in-lab and inpatient portable. The workflows were created using Microsoft Word and were updated as the client requested changes.

Improving the Echo Lab Process
The team surveyed patients, attended staff workflow meetings, interviewed staff, conducted time studies and created value stream maps to improve the echo lab process. The team collected 151 patient surveys over a two week period. From these surveys, the team found that 28% of patients arrive late, 36% due to traffic, 42% due to parking and 6% due to directions. Out of the patients that were late, 32% are late for 8:00am appointments. From the workflow meetings, the team discovered that there were communication issues between staff members and that it was sometimes difficult for staff members to locate patients.

The team interviewed five key staff members, the scheduler, two sonographers and two medical assistants. They confirmed that there were communication issues in the lab and discovered that staff felt the system for scheduling and queuing patients was inefficient. The team then conducted sonographer time studies over the same two weeks as the patient surveys and collected 248 self reported forms. The sonographers used a collection sheet listing 16 sonographer tasks and recorded each task they performed and how much time that task took. The team determined the longest non-value added tasks were traveling to patients and waiting for patients to be ready, 12.2 minutes on average, and stocking linens and gels, 7.8 minutes on average.

The team created five current state value stream maps for outpatient echo only, outpatient clinic and echo, inpatient in-lab, inpatient portable stat and inpatient portable non-stat. From this the team determined that the process with the most non-value added time was inpatient in-lab. Out of a total process time of 124.3 minutes, 41.6 minutes were non-value added. The team also indicated that there were opportunities for improvement for the scheduling process, locating patients and stocking linens and gels from these maps creation.
Conclusions and Recommendations
The team has concluded through historical data, staff interviews, and clinic workflow meetings, that there is an opportunity to improve staff’s knowledge of both the lab’s workflow and appointment distribution. Therefore, the team recommends having an additional clinic workflow meeting to explain the finalized workflows, value stream maps and daily distributions provided by the team, making staff aware of the lab’s newly defined workflow.

Through process improvement, the team has determined that late patients are hindering the echo lab’s workflow, furthering patient wait times and pushing staff members’ shifts beyond their schedule. To address these issues, the team recommends distributing a notification to morning patients. This notification would illustrate routine traffic delays on popular commutes to C.S. Mott Children’s Hospital, as well as provide step-by-step parking instructions. Additionally, the team recommends instructing morning patients to arrive 10 minutes earlier, giving them ample time to arrive on time for their appointment.

The team has also determined that sonographer’s self-stocking of linen and gels is taking a significant amount of time away from conducting echocardiograms, resulting in a large amount of non-value added work. Because of this, the team recommends this task be standardized, and reallocated to different personnel, reducing approximately 3.3 minutes from each echocardiogram.

The team has found some of the non-value added time associated with sonographers’ tasks could be reduced. To do this, the team recommends implementing a volunteer. The volunteers would wait with the patient for transport and walk them from room to room, reallocating some of this non-value added work. Based off of the team’s data, this would save approximately 3.3 minutes. The team has also concluded that the whiteboard staff use to track patients is not precise, and implementing the MiChart system would be a better option. The use of the schedule and dot system would make sonographers more aware of patients’ locations as well as which are ready and/or waiting to start their echo appointments, reducing patient wait times.

Lastly, the team has determined that a future study is necessary on the echo lab, focusing on patient wait time and the echo scheduling process. These studies would record data over a greater amount of time and more thoroughly investigate patients’ experience at the echo lab.
Introduction

The Pediatric Cardiology Echocardiogram Lab at the Michigan Congenital Heart Center (MCHC) within C.S. Mott Children’s Hospital provides echocardiograms (echos) for both outpatients and inpatients throughout the hospital. According to the clinic manager, this lab has one of the highest surgical volumes in the country and one of the most complex patient mixes. After a University of Michigan Industrial and Operations Engineering (IOE) 481 student project was completed for the MCHC in Winter 2014, it was determined that the echo lab needed to be examined further to improve the overall workflow at the MCHC.

As the demand for echos continued to grow, scheduled patients encountered long wait times, and the sonographers, who perform the echos, became dissatisfied due to missing lunches and breaks to keep the lab from falling behind. Through interaction with the lab manager, sonographers, and lab attendings, the team learned that the staff lacked information about the daily distribution of echos and workflow processes outside their responsibilities. It was observed that the staff’s lack of information hindered their ability to predict and account for the changes and high demands in the echo schedule and caused the lab to run behind during periods of high demand.

The current IOE 481 student team was asked to identify the current echo lab workflow and any inefficiencies or areas for process improvement, which was done through observations, time studies and interviews. This report details the team’s goals, approach, findings, conclusions and finally, recommendations for the echo lab.

Background

The echo lab at the MCHC provides echos for patients of the C.S. Mott Children’s Hospital. An echo is a type of ultrasound test that uses sound waves to create moving and still pictures of the heart to identify any abnormalities. The lab performs several types of echos including transthoracic (TTE), transesophageal (TEE) and fetal. The most common type of echo is a TTE, which can also be performed on sedated patients, if the patient is young and unable to lay still during the procedure. The echo lab runs normal operations Monday through Friday from 8:00am - 5:00pm and perform echos for MCHC patients, outpatients and inpatients throughout the hospital. The echos can be performed either in the lab or as a portable test for patients who are unable to leave their hospital rooms. Echos can be scheduled in advance (scheduled patients) or scheduled the same day (add-on patients). A large portion of the add-on patients come from clinic appointments in the echo lab, where a clinician will determine if an echo is needed. Depending on the type of patient, the type of echo and the location of the echos, the workflow flow through the echo lab can change.

The staff involved in the echo lab workflow include a scheduler, medical assistants (MA), attending physicians, nurse practitioners, sonographers, attending cardiologists and fellows. The scheduler is responsible for scheduling same day (add-on) appointments for both inpatient and outpatient echos as well as queuing the patients for echos when the patient arrives at the lab. If a patient has a clinic appointment, the attending physicians, fellows and nurse practitioners will determine if an echo is needed during the clinic. The medical assistants do the intake of any patients scheduled for a clinic visit. The sonographers perform the echo, which is then reviewed
by the attending cardiologists. The attending cardiologists and sonographers are also responsible for training the fellows, who are cardiologists in training.

According to a report generated from an Omnis 7 application (used throughout the echo lab to collect patient data), the total number of patients treated in the lab has increased from 8,585 patients in 2010 to 10,000 patients in 2013 as shown in Figure 1.

As the echo demand continues to grow, the clinic manager has noticed an increase in staff complaints and long wait times, especially for scheduled patients. From surveys, the previous IOE 481 team discovered that the average wait time for an echo is 22 minutes, but the standard deviation is 18 minutes.

The clinic manager wishes to address two problems: long scheduled patient wait times and the sonographer dissatisfaction that occurs when they have to skip lunches and breaks or stay past their scheduled time in order to meet patient demand. The clinic manager believes that the scheduled patients should not wait more than 15 minutes for an echo and that the lab has an adequate number of sonographers for the current demand. The clinic manager believes inefficiencies in the process prevent sonographers from doing their job to the best of their abilities. The manager also believes that the staff lack information regarding the daily distribution of echos and workflow processes outside their responsibilities, which prevents them from predicting and accounting for the peaks and valleys in the echo schedule.

**Key Issues**

The following key issues drove the need for this project.

- Staff lacked information regarding workflow processes outside their responsibilities, which hindered their ability to handle the variations in demand
- Staff lacked information about the daily and weekly distribution of echos
- Staff dissatisfaction grew with demand, especially for sonographers who chose to miss lunches or work late in order to finish the echos for each day
- Staff felt that patient wait times are too long, especially for scheduled patients
The team categorized these key issues into three groups:

- **Demand**: Staff desired information about the daily and weekly distribution of echos
- **Process Definition**: Staff are unfamiliar with workflow processes outside their responsibilities
- **Process Improvements**: Staff are dissatisfied due to missing lunches or working late in order to finish the echos for the day and staff feel that patient wait times are too long, especially for scheduled patients

**Goals and Objectives**
The student team observed the workflow of the echo lab, collected and analyzed data, and developed recommendations to achieve the following goals:

**Demand:**
- Identify the daily and weekly distribution of echo appointments

**Process Definition:**
- Define the lab’s workflow to increase staff understanding of process

**Process Improvement:**
- Improve staff satisfaction by identifying areas for process improvements to ensure time for breaks and lunches
- Decrease scheduled patient wait time to 15 minutes

**Project Scope**
The echo lab within the MCHC at the C.S. Mott Children’s Hospital was the focus of this project. Within the echo lab, the processes for all non-sedated TTE and fetal echos for both outpatient and inpatients, beginning when an echo order was placed to when the sonographer completed the report for that echo, was included in the project. The team will not make any changes to the process of performing the echos or writing up the report, only to processes leading up to and following these tasks. Only the echo lab’s normal hours, Monday through Friday 8:00am to 5:00pm were included. The team did not include off-site echos that require sonographers to travel to a different location or transesophageal (TEE) echos which involve a separate attending cardiologist and have a much different process. Due to the complexity of the process, sedated echos were excluded in this analysis, but their resource requirements were considered, as they do affect the laboratory’s workflow. Staff and patient activities extraneous to the laboratory’s workflow were excluded from this project. Processes falling under other areas within the MCHC, such as EKGs, stress tests, and clinic appointments, or other areas of the C.S. Mott Children’s Hospital, were not included in the study.

**Methods and Findings**

To address the three key issues of identifying the demand, defining the echo lab workflow and improving the workflow in the echo lab at C.S. Mott Children's Hospital, the student team conducted a literature search, analyzed historical data and collected data through observations, staff workflow meetings, patient surveys, staff interviews and sonographer time studies. The collected data was then analyzed through Minitab statistical software and Microsoft Excel. The team developed recommendations from the analysis, which included a detailed value stream map that identifies inefficiencies in the process.
Literature Research
The team performed a literature search and found scientific articles, journals, and other publications relevant to workflow and scheduling improvement in medical labs. In particular, the team found a helpful article on facility planning and strategies to improve flow and reduce waste [1]. This article about managing echocardiography workflow isolated main contributors to workflow backup, such as unnecessary non-value added work including excessive travel and unclear communication in the workplace. Additionally, the team reviewed a previous IOE 481 project on the MCHC [2]. The previous report provided context and directed the team to existing problems within the echo lab’s workflow, as well as informing the team that the current echo wait time averages between 10-15 minutes.

Historical Data Analysis
To address the issue of identifying the echo lab demand, the team analyzed data given to them from MiChart and Omnis. This allowed the team to identify the daily and weekly distributions of echos.

Received data from Omnis
The team was granted access to two tracking spreadsheets from the echo lab. The first spreadsheet holds data from July 2013 to June 2014, listing individual patient echo records with appointment information including:

- Name
- Date
- Age
- Location of echo
- Study type
- Technician
- Sedation
- Verification

The second spreadsheet illustrates the volume of echos from July 2009 to June 2014, including fetal, TTE and TEE. Together, these documents reveal the daily/monthly volume, distribution of echos, and average lead time of scheduled appointment. The team used the summary data to create graphs that show the distribution of the lab per period of time.

Received data from MiChart
The team was also given access to MiChart data that describes clinic appointments for the echo lab during May 2014 and August 2014. The entry for each appointment contains the following information:

- Date of appointment
- Date appointment was made
- Check in time
- Study start time
- Inpatient/outpatient
- New/returning patients
- Echo Type (normal, portable, sedated, fetal)
Identified Weekly and Daily Distribution of Echos
To determine the weekly distribution of echos, the team stratified the MiChart data by day of the week and type of echo which included normal in-lab echos, portable echos, sedated echos and fetal echos. The resulting histogram is shown in Figure 2.

![Figure 2: Weekly Distribution of Echos](image)

The average number of echos performed daily is 40.0. Using Minitab, the team performed a one-way ANOVA analysis on the number of echos per day to determine if there was a difference in volume per day. The resulting p-value was 0.497 indicating that there is not a significant difference in the total number of echos per day. The lab only performs fetal echos on Wednesday, Thursday and Friday which is reflected in the histogram. The difference in the type of echos performed between days that perform fetal echos and days that do not is shown in Table 1.

<table>
<thead>
<tr>
<th>Day of Week</th>
<th>Normal</th>
<th>Portable</th>
<th>Sedate</th>
<th>Fetal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon/Tues</td>
<td>69.1%</td>
<td>23.0%</td>
<td>7.9%</td>
<td>0%</td>
</tr>
<tr>
<td>Wed/Thurs/Fri</td>
<td>47.8%</td>
<td>18.2%</td>
<td>4.5%</td>
<td>29.5%</td>
</tr>
</tbody>
</table>

The team created a graph to identify the daily distribution of the echo appointments using both the scheduled appointment time and actual appointment start time which is shown in Figure 3.
This graph shows that the lab is not performing echos at the time that they are scheduled. For example, the schedule indicates an average of 5.6 echos should be started between 8:00 am and 8:30 am, however only 3.2 are being started. The team also determined that 68% of the echos are performed in the morning from 8:00am to 1:00pm while 32% of echos are performed in the afternoon from 1:00pm to 5:00pm.

To investigate the echo demand in the lab, the proportions of add-on vs. scheduled appointments was analyzed. The percentage of add-on and scheduled appointment for each type of echo is shown in Figure 4.
The team found 30% of daily appointments were add-ons based on the two months of available data (May & August 2014). There was no significant differences in the amount of add-ons during the day of week or time of day.

**Observations**

To begin defining workflow process, the team shadowed staff members for one week to gain a basic understanding of the current echo lab workflow

*Shadowed clinic staff during echo appointments*

The team attended clinics and shadowed staff members from Monday, September 22nd to Friday the 26th, observing the current laboratory workflow. The team shadowed the appointments of three inpatients and two outpatients. During these observations, team members recorded each lab process on observation collection sheets, indicating a process’s activity name, start time, stop time and any details or comments. The observation collection sheet that the team used is included in Appendix A.

*Discovered opportunity to improve workflow knowledge among clinic staff*

The observations gave the team a working knowledge of the laboratory workflow which helped to begin defining the lab workflow. The team confirmed that the staff was unfamiliar with workflow processes outside their responsibility and did not fully understand other staff member’s responsibilities and how they were interlinked. The team also discovered the sonographers often had difficulty locating patients and staff.

**Clinic Staff Workflow Meetings**
To assist in defining the echo lab workflow process, the student team attended three monthly workflow meetings organized by the echo lab staff. These meetings gave the opportunity for representatives from each echo lab role to collaborate in outlining the current processes and potential areas of concern or improvement.

**Identified process steps in echo lab meetings**
The team attended the clinic staff two-hour workflow meetings on September 30th, October 28th, and November 20th. The first meeting was split into two sections; the first section was a brainstorming session with input from all the staff to identify the steps in the current workflow process. The second section was dedicated to collectively outlining the current outpatient workflow process from check-in to check-out. The second meeting outlined the inpatient workflow process and identified areas of improvement for the outpatient workflow such as delays in check-in and difficulty finding patients or equipment. The last meeting was dedicated to identifying areas of improvement for the inpatient workflow and then reviewing both workflows.

**Exposed knowledge gaps and lab workflow**
These meetings gave the team insight into the echo lab workflow and exposed knowledge gaps between staff members’ responsibilities. These gaps included inadequate knowledge of patient, physician, and equipment availability during working hours. Areas of improvement identified for the outpatient workflow include patients backed up at check-in desk, process of scheduling add-ons, sonographer waiting for clinician to finish with patient, sonographer looking for blood pressure equipment, and patient unsure of appointment times. The staff agreed that the combination of these factors attributed for delays in workflow. The team used the information from both workflow diagrams to create the value stream map.

**Workflow Diagrams**
In order to help define the current process, the team created summarized workflow diagrams. These diagrams were based on the preliminary workflows that were formulated during the clinic staff workflow meetings. A total of three workflow diagrams were created, one for each major patient process. This included a diagram for outpatients, inpatients in-lab, and inpatients portable. Within the inpatients portable workflow, the processes were separated into those conducted for stat and non-stat patients. These diagrams can be found in Appendix B.

**Created Concise Visual Representations of Echo Lab Workflow**
The echo lab workflows that the team created helped to summarize and define the major processes. These workflows were used to bridge knowledge gaps for the team and staff as well a starting point to develop value stream maps.

**Patient Surveys**
To begin improving the echo lab workflow, the team conducted patient surveys to better understand the patient experience and in the echo lab, the team collected patient surveys to determine patient satisfaction and patient wait times.

**Collected 151 patient surveys**
Since voice of customer is an important criterion for designs, the team surveyed outpatients to determine patient satisfaction, patient wait time and how patient behavior could affect lab
workflow. To do this, the team created a patient survey form that includes questions about patient satisfaction, patient experience, and wait times for the echo lab. This form is included in Appendix C. The team distributed the forms at the clinic check-in desks and patients were asked to voluntarily complete this survey during their visit. Due to the nature of patient accessibility, this survey only reached both pre-scheduled and scheduled day-of outpatients who arrive directly at the echo lab or who are outpatients of the MCHC. The team conducted the study from October 17th through October 31st, on the same timeline as the sonographer time studies, and collected 151 patient satisfaction surveys.

*Patients with earlier appointment times are more likely to arrive late*

The patient surveys provided insight into patient data and mechanics of the current echo scheduling system. Using Microsoft Excel, the team was able to determine the average time patients are late, the tardiness of patients based on appointment time, the most common customer-identified appointment barriers and patient satisfaction levels. The tardiness of the patients is shown in Figure 4.

![Figure 4: Tardiness of patients by appointment time](image)

The patient surveys revealed that 32% of outpatients arrive late. After removing the outliers (upper/lower 5% of data), the team found that the average time late patients arrive is approximately 14 minutes after his or her’s scheduled appointment time. Upon further analysis, the team found that earlier the appointment, the higher the probability that patients would arrive late, with 9:00am having the most recorded late arrivals of 44% and 8:00am with the second highest of 42%, also seen in Figure 5. The survey data also indicated that traffic and parking are the biggest barriers for patients’ appointments, with 36% and 42% of patient surveys indicating this, respectively. Of those who listed traffic or parking as a barrier to his or her’s visit, 76% arrived late to his or her’s appointment time. The average patient satisfaction from a scale from 1 to 5, with 5 being most satisfied, was 4.68. This data reflected pre-scheduled and day-of scheduled echos.
**Staff Interviews**

To better understand and improve the echo lab workflow, the team interviewed five key staff members involved in the workflow.

*Interviewed five staff members involved in the echo lab workflow*

On October 3rd, two members of the team interviewed five staff members including the scheduler, two sonographers, and two medical assistants. Each participant was asked the same eight questions shown in Appendix D and the responses were recorded on that same form. The sample size of five staff members was deemed adequate as a sample from each critical staff member will allow the team to gain context from all working levels.

The team initially planned to conduct follow-up interviews with the sonographers after the sonographer time study data collection was complete. However, upon completion, the team realized that the data received from sonographers was clear and comprehensive and that follow-up interviews with MAs and sonographers was not necessary. The team did conduct a follow up interview with the scheduler to better understand the scheduler’s responsibilities in the workflow. The team asked the scheduler to clarify the specific steps taken to schedule each type of patient including outpatients, inpatients in the echo lab, and inpatient portables. Specifically the order in which the patient paperwork is received, the patient is arrived in the system by the scheduler, and when the patient is assigned a spot on the whiteboard was clarified. The whiteboard is a visual tool for the staff to gain knowledge about which patients are with which sonographers. Sonographers typically write their name next to the patient they are seeing, and then erase the slot once they are done with the appointment. The team also learned the process variations between the different types of echos.

*Discovered staff believe echo lab workflow is inefficient*

From the initial interviews, the team gained a better understanding of the echo lab workflow and the clients’ main issues associated with it. The team decided to perform time studies on the sonographer tasks because the sonographers have the greatest impact on the workflow. The interviews illustrated that sonographers often spend time searching for their patients and walking to various clinic rooms to find them. From the interviews, the team found no system is utilized to combat this issue. Additionally, the staff commented how late patient arrivals force them to stay beyond their scheduled shift. Collectively, the initial interviews directed the team’s investigation towards areas of workflow improvement, such as patient tracking.

From the scheduler’s follow-up interview the team found that the scheduler’s process was complex and in need of standardization. The team also learned that the echo staff believed the whiteboard method of tracking the patient was inefficient. The team found that improvement of the current scheduling process was required. Additionally, the team learned about the opportunity to improve workflow by changing the current whiteboard process. Since scheduling interacts with other departments the team decided that the scheduler process was outside the scope of this project.
**Sonographer Task Time Studies**
To better understand the sonographers’ tasks in the echo lab workflow and know how to improve the workflow, the team conducted a time study to collect data on the length and frequency of the sonographers’ daily tasks.

*Collected two weeks of data on sonographer task times in the echo lab*
The team used a self-reporting method for the sonographer time studies. The Clinic Manager worked with sonographers to create a complete list of the sonographers’ 16 daily tasks. Using the list of the 16 daily tasks, the team created a data collection sheet and distributed copies to each sonographer. To help ensure accuracy, the team provided detailed descriptions of the tasks on the data collection form, and gave the sonographers the team’s contact information for clarification, if needed. The sonographers were asked to fill out the data collection sheet, indicating which tasks they completed and the start and end time of the tasks. The team also provided a field for comments to help clarify the use of “other.” During data collection, the team updated the form, for clarification, to include patient information data. The updated form is included in Appendix E. The time studies were performed from October 17th through October 31st and 248 forms were collected.

*Sonographers spend 12.2 minutes waiting for and traveling to patients*
The team analyzed the time study data with Microsoft Excel to find the frequency and length of sonographer tasks and to determine which processes required the most improvement to reduce delays in the echo lab workflow. The analysis was conducted using descriptive statistics, finding which tasks had high variability or extraneous amounts of time. While cleaning the data, the team noted that several of the comments for “Other” had to do with sonographers waiting for patients to change. The team decided to make “patient changing” its own task. The team also found that many of the sonographers had combined tasks 14 and 15 into one step. The team decided to combine tasks 14 and 15 for analysis, considering the step as “Travel to patient and wait for patient to be ready”. This left the team with a total of 16 tasks to analyze. The team found the average length of each task and identified the order of sonographers task from the longest to the shortest with the top five longest tasks being “Perform Echo,” “Lunch,” “Write Report,” “Travel and wait for patients,” and “Other.” Since the team did not plan to reduce the length of time it takes for a sonographer to perform an echo, write a report, or eat lunch, the most significant finding was that sonographer’s spend 12.2 minutes waiting for and traveling to patients. The lengths of each task, excluding “Other,” in order of longest to shortest can be seen in Figure 6.
In addition to locating and waiting for patients to be ready, the data showed that the sonographers were spending 30.1% of their time performing other non-value added tasks. The longest of these non-value added tasks was traveling to and waiting for patients which was 12.2 minutes followed by picking up patients which was 5.7 minutes. The sonographers also spent 5.4 minutes waiting for an attending to review their echo study, 4.0 minutes waiting for patients to change, and 3.3 minutes walking patients out. The time spent stocking linens and gels was 7.8 minutes, but typically only occurs once a day at inconsistent times of the day.

Though the team did not plan to change the length of the first three longest tasks which were performing the echo, lunch and writing the report, it was still important to understand the task lengths in order to create the value stream maps. For the value stream maps, for several of the tasks, including task such as “performing echo” and “writing the report,” the data was stratified by echo patient type, as different patient appointments yield different task data. The task times used in the value stream maps are shown in Table 2.

![Figure 6: Sonographer task times](image)

**Table 2: Sonographer Task Times**

<table>
<thead>
<tr>
<th>Task</th>
<th>Outpatient</th>
<th>Inpatient Inlab</th>
<th>Inpatient Portable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocking Linens/Gels</td>
<td>7.8</td>
<td>24.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Study Prep</td>
<td>7.6</td>
<td>5.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Pick up patient</td>
<td>1.0</td>
<td>41.9</td>
<td>28.0</td>
</tr>
<tr>
<td>Height/Weight</td>
<td>5.7</td>
<td>5.7</td>
<td>7.0</td>
</tr>
<tr>
<td>Performing study</td>
<td>31.7</td>
<td>7.6</td>
<td>5.7</td>
</tr>
<tr>
<td>Reviewing study</td>
<td>2.5</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Adult images</td>
<td>2.5</td>
<td>4.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>11.6</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Walk patient out</td>
<td>3.2</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Writing Report</td>
<td>3.2</td>
<td>27.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Turnover</td>
<td>3.2</td>
<td>25.0</td>
<td>19.6</td>
</tr>
<tr>
<td>Lunch</td>
<td>18.0</td>
<td>25.0</td>
<td>9.6</td>
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<tr>
<td>Travel to/Wait for Pt</td>
<td>9.6</td>
<td>9.6</td>
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<tr>
<td>Patient changing</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
</tr>
</tbody>
</table>

*data not available for all echo types

The team recognized the task of taking additional images as rework in the echo process. This task contributed 7.2 minutes to the total process time. By comparing the total number of echo studies performed and the total number of times additional images were taken, the team found that rework occurred 38% of the time in lab and 28% of the time on a portable study. This data was also used in the value stream maps.
**Develop Value Stream Map**
The final step in improving the echo lab workflow was creating value stream maps (VSM) to show both process and information flow throughout the echo lab. The VSMs were used to provide a visual representation of the process and to identify areas for improvement.

*Created workflows and VSM using collected data and research*
The team first created workflows of the outpatient echo, inpatient portable echos and inpatient in-lab echo using collected information from the clinic staff workflow meetings and observations of the echo lab process, which are shown in Appendix B. Using these workflows and the data collected during sonographer time studies and patient surveys, the team used Microsoft Visio to create five VSMs: outpatient add-on, outpatient scheduled, inpatient portable stat, inpatient portable normal and inpatient in-lab, which are shown in Appendix F. These VSM’s clearly identify the workflow, value added and non-value added time as well as areas of improvement, which are shown with purple Kaizen bursts.

*Identified areas of improvement*
From the value stream maps, the team has concluded that many of the areas of improvement included either locating patients or waiting for patients to be ready. The team used the value stream maps to calculate the total process time for each patient type, shown in Table 3.

![Value-Added vs. Non-Value-Added Times](image)

**Figure 7: Echo lab process times**

As shown in Figure 7, inpatient, in-lab echos involve the longest process, 124.3 minutes. However, the biggest reason that the inpatient in-lab process is so much longer is because the non-value added time is twice as long as all of the other processes’ non-value added times.
Conclusions
From the above methodologies and findings, the team has formulated five main conclusions.

- Through observations, clinic workflow meetings and staff interviews, the team confirmed there is an opportunity to improve staff’s knowledge regarding the lab workflow and daily distribution of echos, which impacts the staff’s ability to adjust to the variability within the lab.
- The team concluded that the whiteboard the staff use to track patients is inefficient at tracking patients because it is a source of miscommunication between staff and sonographers, causing workflow backup.
- Late patient arrivals, primarily caused by inaccurate directions, parking and traffic, are causing delays in the lab workflow, increasing patient wait times and forcing staff members to work beyond their scheduled shifts.
- The non-value added sonographer tasks include either locating patients or having to wait patients to be ready, which could be reallocated to different personnel.
- Stocking linens and gels is one of the primary non-value added tasks that sonographers are performing. Stocking is not a standardized process and could be reallocated to other staff members.

Recommendations
The team has developed seven recommendations that will decrease scheduled patient wait times and improve staff satisfaction for the echo lab.

Recommendation 1: Distribute Findings to Echo Lab Staff
The team recommends that the current state workflows be distributed to all involved staff members and posted in central areas for staff members to see and refer to as needed. This constant visual reminder will help staff reach a common understanding on the overall workflow and processes within the echo lab. The workflows should also help staff understand the roles and responsibilities of their colleagues. Moreover, the team believes the workflows will be most beneficial if they are updated as changes to the echo lab processes are made. Updated workflows will keep this information relevant and useful for the future. Additionally, the team recommends that the major findings from the historical data be shared with staff. The daily and weekly distributions will help staff members better prepare for the peaks and valleys of echo lab demand. Together these pieces of information should help to define the echo lab workflow.

Recommendation 2: Implement Strategies to Reduce Late Patient Arrivals
To address the delay in lab workflow caused by tardy morning arrivals, the team has two recommendations. The first being improving the directions provided to patients and notifying patients about the traffic surrounding C.S. Mott Children’s Hospital in the morning. This notification would include estimated time the traffic will add to the patient’s commute and a detailed list of available parking. The notification would describe routine traffic delays on Fuller Street, US 23B, I-94, and M-14, and an estimate of how much time each route’s traffic adds to one’s commute to the hospital. The notification’s parking component would describe where to first attempt to park, and then where to park if said parking lot is full, providing a step-by-step guide of where to park. This will ensure patients timely arrival as they are always directed to possible parking areas.
The team also recommends that the lab requests patients arrive 10 minutes earlier. This will allow more time for traffic and parking delays to occur without effecting patient’s arrival time. Together, these recommendations will reduce workflow backup and delays, improving staff satisfaction and reducing patient wait times.

**Recommendation 3: Future Study**
The team recognizes that some of the key issues identified in this project are not directly resolved by the above recommendations. There are two main issues which the lab should focus future study: the patient wait times and the echo lab scheduler process.

First, to reduce patient wait times further study on the patient experience would need to be conducted. While the team believes that the recommendations provided will improve the echo lab process, there is not sufficient data available to conclude that patient wait time would in fact be changed by the process changes. The team recommends conducting studies, such as patient follow studies, which would track patients from arrival to end of echo and determine the specific cause of patient wait time. Based on the team’s experience from the patient surveys, the patient data would be more accurate and informative if recorded by someone other than the patient, especially for the patient tardiness fields as many were incorrectly populated. The team also recommends conducting the patient studies during different months to get a better idea of average patient wait times. The clients indicated that the months studied in this project were not necessarily representative of typical patient volume. Future study would also need to be conducted on sonographer utilization to determine if changes to the sonographer process have effect on the patient wait time. From the sonographer time studies the team was not able to determine down times and therefore could not calculate sonographer utilization.

The team also recommends that a future study be directed to the look at scheduler process. As the team indicated, the patient scheduling process is complex and inefficient. The process is a source of dissatisfaction and frustration for staff. The scheduler process presents significant opportunities for improvement. Improving this process could improve the entire echo lab process and contribute to reduced patient wait time.

**Recommendation 4: Standardizing and Reallocating Stocking Linens and Gels**
To improve staff satisfaction and workflow efficiency, the team recommends first standardizing, then reallocating the task of restocking linens and gels to housekeeping staff. Standardizing the process will ensure accuracy and consistency so sonographers will always have adequate supplies to perform an echo. This includes having a standard restocking time and location, as well as having a predetermined quantity available at the start of each shift. The time predicts that this standardization will save 3.3 minutes from each echo.

Reallocating this stocking process reduces the outside responsibilities of the sonographer and allows them to spend more time performing echos. This will improving workflow efficiency by decreasing the amount of non-value added work. Furthermore, this will contribute to sonographers leaving at their scheduled time, improving their satisfaction.
**Recommendation 5: Volunteers to wait with patient**
According to the sonographer time studies, sonographers spend time bringing inpatients back to their hospital rooms from the echo lab. This was confirmed to be a source of frustration with staff because the wait for the transport department to pick up the patients from the echo lab is longer than sonographers want to wait. The sonographers feel they must remain with the patients while waiting for transport to arrive because so many of the patients are young and cannot be left on their own. The age of the patient is also a concern when sonographers want to leave the echo room to find an attending for image review. Not only does this take valuable time from the Sonographer but leaves children unattended. The team recommends that the lab have volunteers available in the lab to stay with the patients while sonographers work. The volunteers would help to eliminate time sonographers spend walking patients out to the clinic or elevators, which currently takes 3.3 minutes of sonographers time and eliminate time sonographers spend taking patients back to room or waiting for transport. The volunteer could also reduce time spent waiting for attending because sonographers can leave the room to go get the attending and speak with them about the echo images without worrying about leaving the patient.

**Recommendation 6: MiChart Schedule and Dot System**
Through client meetings, the team discovered the capabilities of the MiChart Schedule and Dot System. The MiChart Schedule can be customized for each staff member to show patients from specific areas of the hospital, specific echo types and specific clinics. The schedule displays the current day patients that are check-in to the system. The dot system interacts with the MiChart schedule and allows staff to track patients throughout their clinic visit. The dot system displays a colored dot next to each patient’s name in the schedule. The colors of the dots can be assigned to represent different steps of the patient’s process in the clinic. For example, a blue dot may indicate that a particular patient is having their echo done. When staff assign the color of the dot they can also “arrive” the patient in a room which will display the rooms location in MiChart.

From the sonographer task time studies value stream maps, the team has concluded that many of the non-value added tasks included either locating patients or waiting for patients to be ready. The team believes the dot system will reduce the time sonographers spend searching for patients before appointments, walking to meet patients in other locations, or waiting for patients who are not ready to be taken to the echo lab. The dot system is already integrated into the MiChart software, but requires some additional work for implementation. Locations such as echo rooms or the waiting room may need to be added to the system. The clinic staff would also have to assign meanings to the dot colors and make this standard across the clinic to avoid misunderstandings. The clinic staff would have to agree to a standard of updating the dot system anytime they interact with a patient. It would be up to each staff member to accurately update dot colors and arrive patients to location. Though this would be a change in routine and an additional step to add for sonographers, the team believes the additional time would be negligible because the sonographers already have MiChart open on their computer from the patient history research. This would eliminate sonographers searching for patients, reducing the length of echos and promoting a more efficient workflow. The team recommends implementation of the MiChart Dot System to reduce delays in the echo lab workflow.
To address communication issues between sonographers, MA’s, and physicians, the team recommends reconstructing the current whiteboard system, possibly through technology in MiChart. The team believes the MiChart schedule feature can be an initial replacement to the current whiteboard system in the echo lab. A real time electronic system can help reduce the non-value added time that health providers currently spend locating patients and colleagues. The MiChart Schedule has the capability for staff such as sonographers and the scheduler to view an electronic version of the schedule that can be customized to the view they prefer based on their patient volume. Using MiChart schedule rather than another scheduling system would also be efficient since the dot system can also be displayed on the same page. Since the schedule can be viewed by these staff from the computers in their rooms, the combination of the MiChart schedule view and MiChart dot system would eliminate the need for staff to use a whiteboard to communicate to each other about which patients were waiting on echos and which sonographers were with which patients. This would reduce time staff spend walking to find each other to ask about patients. The use of the schedule and dot system would make sonographers more aware of which patients are ready and waiting to start their echo appointments which could help to reduce patient wait time.

**Recommendation 7: Continue Clinic Staff Workflow Meetings**

To increase staff knowledge regarding the lab workflow and distribution of echos, the team recommends that the echo lab staff continue having additional staff workflow meetings. The meetings would be used to explain the current state workflows, value stream maps and daily distributions provided by the team. Recommendations 2 through 6 also require team discussions which could occur during these meetings. The team also recommends holding additional meetings as needed and updating the posted workflows as the lab continues to improve the process.

**Expected Impact**

First, the team expects to improve the echo lab staff understanding and awareness of the process by clearly defining the workflow and distributing and displaying the workflow diagrams and value stream maps. The team also expects that staff will improve their understanding of the current echo lab workflow due to identification of the daily and weekly distribution of echo appointments. The team expects that implementation of the recommendations will result in the following process time decreases:

- Decrease of 3.3 minutes for stocking linens and gels as a result of standardizing the stocking process.
- Decrease of 2.4 minutes for time spent locating patients and walking to patient location due to implementation of MiChart dot system.
- Decrease of 3.3 minutes by eliminating the time spent walking patient back to elevator or rooms due to volunteers taking over this task.

The tasks of locating and waiting for the patient and walking the patient back to the elevator or rooms both happen per patient. Considering that sonographers see about 5 patients per day, 

\[(2.4 + 3.3) \times 5 = 28.5 \text{ minutes per day}
\]

will be saved by these two recommendations. Considering that stocking linens and gels takes place once a day, 3.3 minutes will be saved per day. Adding these three recommendations together, 

\[28.5 + 3.3 = 31.8 \text{ minutes per day}
\]

will be saved. Since sonographers spent an average of 27 minutes per day for lunch, when they could get it, they
should all now have enough time in the day to have lunch. The extra 4 minutes saved may help to reduce patient wait time. By creating enough time in the day for lunch, the team expects to improve sonographer satisfaction.
References


Appendices
<table>
<thead>
<tr>
<th>Activity</th>
<th>Start</th>
<th>Stop</th>
<th>Comments</th>
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Instructions:

Please take this survey with you throughout your visit here. This information will be used to improve the efficiency of your visit.

Use the other side of this survey to help collect information.

1. Write down the date of your visit, scheduled appointment time, time you checked-in at the reception desk and which provider your visit is with.
2. Please indicate the start and end times for clinic activities. Should you need an echo study, please also include start and end times for your echo. It is not necessary to include other testing.
   - For example, if you had an echo start at 10:21 AM and end at 11:26 AM write the following:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>10:21 AM</td>
<td>11:26 AM</td>
</tr>
</tbody>
</table>

3. Please return this survey to the check-out when your visit is completed.

Survey: Please answer the following questions.

- Were there any barriers to arriving to your appointment on time today?
  - ☐ Yes ☐ No
- If yes, what was the barrier?
  - ☐ Parking ☐ Miscommunication about appointment time
  - ☐ Unclear or Wrong Directions ☐ Other: ______________________

- How satisfied are you with your overall experience today?

  1 2 3 4 5

  Not satisfied Very Satisfied

- What part of your visit could have been better? Please explain.

- What part of your visit were you most pleased with? Please explain.

- Any other comments?

Please flip over for the survey
Michigan Congenital Heart Center
Patient Data Collection Survey

October 2014

Date of Visit:  
Appointment Time:  
Check-In Time:  

Who is your provider?  
New or returning patient?  

Inpatient or outpatient?  

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Height, weight &amp; other info taken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 First visit w/ clinician</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Second visit w/ clinician</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If your echo was scheduled prior to today's visit, please skip to question 9.

If you were not scheduled for an echo until today, please fill out the entire form.

<table>
<thead>
<tr>
<th>Day-of scheduled echo</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Time you were told you needed echo:</td>
</tr>
<tr>
<td>5 Time taken to echo lab:</td>
</tr>
<tr>
<td>6 Were you given the option to schedule your echo for another day?</td>
</tr>
<tr>
<td>7 Were you told how long you might have to wait for an echo today?</td>
</tr>
<tr>
<td>8 If so, what was the expected wait time for an echo?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>All echos</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 What time is your echo scheduled for?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Echo</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
</table>

10 Echo study:

Notes:

Thank you!
1. What prevents you from doing your job efficiently?

2. Are you ever stuck waiting on something or someone else when doing your job? What? For how long?

3. Do you ever miss lunch or have to stay late if the lab is running behind? How often?

4. What is longest task you have to do to complete your job? Approximately how long does it take you?

5. What is your opinion of the overall echo lab efficiency?

6. Do you see any areas that need improvement? If so, why?

7. Do you have any suggestions for reducing variation in the process? e.g. Do you think it would be helpful for the MAs to intake both clinic and echocardiogram only patients?

8. Do you have any other suggestions?
SONOGRAPHERS: Please fill out form with activity number, start times, and end times. Please try to fill out the form as you perform the tasks throughout the day to get the most accurate times. Please make sure to explain any use of “other.” Use as many data collection forms as necessary to capture a full day’s activities.

|------------------------------------------------|---------------------------------|-----------------------------------------------|-----------------------------|---------------------------------------|---------------------------------------------|-------------------------------|---------------------------------------------|---------------------------------------------|-------------------------|-----------------------------------------------|-------------------|---------------------------------------------|---------------------------------|---------------------------------------------|-----------------------------------------------|------------------|

**Echo Study 1**

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<tr>
<th>Patient Type?</th>
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<th>Outpatient</th>
<th>Was the patient sedated?</th>
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<th>No</th>
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<tr>
<td>New patient?</td>
<td>New</td>
<td>Returning</td>
<td>Location of Echo?</td>
<td>In Lab</td>
<td>Portable</td>
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<tr>
<td>Echo Type?</td>
<td>TTE</td>
<td>Fetal</td>
<td>Other: ____________________</td>
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</table>

**Activity** | **Start Time** | **End Time** | **Comments**
---|---|---|---

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Circle all that apply below:

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<thead>
<tr>
<th>Patient Type?</th>
<th>Inpatient</th>
<th>Outpatient</th>
<th>Was the patient sedated?</th>
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<th>No</th>
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<td>New patient?</td>
<td>New</td>
<td>Returning</td>
<td>Location of Echo?</td>
<td>In Lab</td>
<td>Portable</td>
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<tr>
<td>Echo Type?</td>
<td>TTE</td>
<td>Fetal</td>
<td>Other: ___________________</td>
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<tr>
<th>Activity</th>
<th>Start Time</th>
<th>End Time</th>
<th>Comments</th>
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</table>
Outpatient Clinic and Echo

Total Time: 94.4 minutes
Value Added: 73.8 minutes
Non-Value Added: 20.6 minutes

Patient

MiChart

MiChart dot system to reduce time spent locating patients

Occasional Rework

Process Paperwork

Review Paperwork
Determine Appt Time (if needed)
Write On Whiteboard
Arrive Patient
Page Sonographer
Time = 5 minutes
1 Scheduler

Echo Prep

Walk to get patient
Time = 5.2 minutes

Perform Echo

Wait for Attending Physician to Arrive
Time = 5.4 minutes

Review Echo

1

Need future study to determine non value added scheduling tasks

Take Blood Pressure

Walk patient out
Time = 3.3 minutes
1 Sonographer

Complete Report

Turnover for Next Patient

Stock Linens/Gels

Standardize and reallocate stocking

1

1

1

1

1

1

1

1

1

1

1 Sonographer

Time = 31.7 minutes
1 Sonographer

35% Rework
Rework = 7.2 minutes

Time = 7.6 minutes
1 Attending

Time = 2.0 minutes
1 Sonographer

Time = 14.2 minutes
1 Sonographer