Determining Direct Patient Utilization Costs in the Cardiovascular Clinic

Final Report

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Executive Summary

Michigan Medicine’s Frankel Cardiovascular Center (CVC) is a globally known medical center that treats over 40,000 patients yearly. The Cardiovascular Center would like to better understand the costs it incurs at each stage in the patient treatment processes. A team of undergraduate senior students from Industrial and Operations Engineering was asked to examine the direct patient utilization costs at the CVC, specifically for mitral valve patients. The project focused on provider and staff time spent with patients, as that is the majority of the variable clinic costs. The scope of the project included clinic flow for all visits to the CVC, time providers and staff spent with patients in clinic visits, and typical flow in the echocardiography (echo) lab. The costs of the actual operation are not in the scope of this project.

Background

The CVC performs approximately 200 mitral valve surgeries annually. Each of these patients must undergo the following clinic visits: new patient, history & physical, postoperative, and return visit. In the clinic they will be treated by providers including physicians (MD), physician’s assistants (PA), nurse practitioners (NP), and staff including nurses (RN), medical assistants (MA), and check-in and check-out staff. The team utilized various engineering approaches in order to capture the time each medical staff member spends with a patient for each type of clinic visit. It should be noted that all visits (except history & physical) take place on Mondays.

Additionally, these patients will undergo various tests, including echocardiograms (echos). Depending on the needs of the patient these echo tests could include stress (treadmill or dobutamine), transthoracic (TTE), and transesophageal (TEE) tests. These tests are also done in the CVC but are in a different area from the cardiac surgery clinic.

Key Issues

The following key issues are driving the need for this project:

- Difficulty of observing and measuring the true costs of caring for the mitral valve surgery patient population due to limited data on resource utilization
- Inability to quantify true costs hinder the health system’s ability to accurately measure and assess the value of care (outcomes / costs) delivered to patients for improvement projects
Goals and Objectives

To quantify the direct variable costs of provider and staff time at the CVC clinic for mitral valve patients, the student team has achieved the following tasks:

- Observe and understand the cardiac surgery clinic and echo lab process and tests involved
- Conduct time studies on the tasks involved with the cardiac surgery clinic process
- Interview and shadow providers and staff in the cardiac surgery clinic and echo lab

With this information, the team was able to:

- Develop swimlane diagrams for patient cardiac surgery clinic visits and patient echo testing related to mitral valve surgeries
- Document provider and staff times in the cardiac surgery clinic and the use of supplies for future financial analysis
- Provide standardized data collection techniques involving provider and staff time as the resource to be analyzed

Methods and Findings

The team used seven specific engineering methods to quantify the time providers spend with patients in the CVC clinic. From each of these methods, the team found relevant information in order to form conclusions and recommendations.

**Literature search**- The team consulted past IOE 481 reports related to time studies in order to formulate an approach that would be effective for collecting data at the CVC. These reports were used to draft patient forms that were later implemented in the clinic. One outside article was used to improve the depiction of the clinic flow charts. The works referenced aided the team in obtaining as much data as possible with a limited schedule and later gave the team several options on how to present the data collected.

**Observation**- Each team member initially observed the clinic to understand the flow and how the patient experience may vary depending on visit type, time of the day, and the physician being visited. These observations were used to break down the sequence of events used in the swimlane diagrams and time studies.

**Time studies**- From March 6 to March 27 the team conducted time studies every Monday in the cardiac surgery clinic. The team focused on how much time each member of the medical staff spent with each patient seen on those days. These time studies provided a sample size of 26 patients spanning over all of the different visit types.

**Patient forms**- Forms were developed for the patients to record which clinicians met with them during their CVC visit and for how long. From March 13 to March 31 patient forms were
implemented to capture data from the patients when the team members were unable to be in the clinic. These patient forms provided a sample size of 49 patients over all of the visit types.

*Medical staff interviews*- Throughout the time studies and patient form development medical staff members were formally and informally interviewed in order to receive feedback from those who had experience working in the clinic. Additional interviews were done once the flowcharts were completed as validation.

*Data analysis*- Using the data collected in clinic through time studies and patient forms, an analysis was conducted in order to quantify the times providers spent with the patients for each visit type. These times are used in conjunction with swimlane diagrams to depict who is spending time and how much time is spent with each patient per visit.

*Echocardiography lab studies*- The various echo tests patients may undergo for a mitral valve surgery were observed in order to make swimlane diagrams to depict the process. Due to the various types of testing done, time studies were not conducted and the group instead focused on creating detailed diagrams for each of the tests that could be used in the future for conducting time studies.

**Conclusion and Recommendations**

The team analyzed the data collected in order to find the total average times for each provider and staff involved with each type of visit. The team was also able to determine average patient wait times. In order to analyze the results of the data collected, the team separated the data by factors such as procedure type, visit type, and doctor seen. The team then looked for statistical differences between these different procedures, visits, and doctors.

Upon analysis, the group has made five conclusions about the Cardiac Surgery Clinic:

- There is **no** statistically significant difference between procedure type and time providers spend with patients
- There is **no** statistically significant difference between the two surgeons and the time they spend with patients
- There is a statistically significant difference between total appointment duration and time providers spend with patients
- There is **not** a significant amount of supplies used for patient care supplies

Based on these results from the analysis, the team recommends stratifying patients by appointment type in each clinic instead of by the diagnosis, doctor, or procedure when collecting data. As the CVC determines more costs associated with patient care, this will allow larger quantities of data and simpler procedures during data collection. Additionally, the team concluded that the echo lab has four significantly different procedures and recommends validating the swimlane diagrams with further time studies and staff validation.
Introduction

The Frankel Cardiovascular Center (CVC) at the University of Michigan provides advanced cardiovascular treatment and research to combat cardiovascular disease. Currently, there is little information on the direct variable costs involved with resource utilization in the CVC clinic. Direct variable cost is defined by the total time providers and staff contribute to patient care as well as supplies that may have a significant impact. Providers include physicians (MD), physician’s assistants (PA), nurse practitioners (NP), while staff include nurses (RN), medical assistants (MA), and check-in and check-out staff. A variety of tests may be done including EKGs and echocardiograms.

The CVC is making efforts to determine patient care costs, specifically for patients undergoing mitral valve surgeries. Two project managers from Michigan Medicine Clinical Design and Innovation and the CVC approached Team 5 from the University of Michigan IOE 481 class to investigate costs of mitral valve patient care and to appropriately document the findings. The team was asked to look specifically at the time providers and staff spend with patients at the new patient (NP), history & physical (H&P), postoperative (PostOp), and return visits (RV) parts of the clinic process in the CVC. This time with patients will be used by a future financial team to assign the cost per hour of each clinician in the clinic setting. Therefore, the IOE 481 team collected data on provider and staff time as well as supplies used during these clinic visits to assist in this cost analysis. Additionally, the team completed observations for several echocardiography (echo) tests, namely the stress (treadmill and dobutamine), transthoracic (TTE), and transesophageal (TEE) tests. This document provides detailed background on the project, the team’s methods, findings and conclusions, and recommendations for next steps.

Background

Michigan Medicine wants to understand how each unit is operating to improve both financial accountability and value delivered to patients. To do this, Michigan Medicine must understand the costs involved with caring for each individual patient at a departmental, clinical, and procedural level. The project team decided to begin this understanding at the CVC clinical level, specifically with mitral valve patients. The CVC performs approximately 200 mitral valve procedures annually. Each of these involves multiple clinical visits and interactions with various providers and staff, but it is unknown how long each of these visits take, exactly which supplies are being utilized, or how long each medical staff member is involved throughout the process. Clinician labor is a large, undocumented variable in the clinic, so it is critical to document the labor needs of each procedure from beginning to end in order to quantify direct variable costs.
The mitral valve procedure process begins once a patient has been referred to the CVC, and a new patient consultation is scheduled at the clinic. During the new patient visit, the cardiac surgeon and his/her team meets with the patient to determine if the patient is a proper candidate for mitral valve surgery. If so, diagnostic tests may be requested, which could include an EKG, TTE, TEE, or stress test. After testing, the surgeon and patient decide on whether surgery is the right course of action. If surgery is pursued, a history and physical visit is required to document the patient's condition pre-surgery. The surgery is scheduled and later performed by a CVC surgeon. Patients typically stay in the hospital for 3-6 days post-operation and receive care from the anesthesiology, pathology, respiratory, and physical or occupational therapy departments (in addition to those directly involved with cardiac care) over that time. A follow-up appointment is also required six weeks after the procedure to ensure the patient is recovering properly. If necessary, subsequent return visits occur depending on how well the patient recovers. This sequence of events is documented in Figure I below. The complete process from NP visit to PostOp visit is documented as an episode of care, and complete episode costs are presently difficult to measure.

Figure I. The sequence of visits a typical mitral valve patient at the CVC will undergo. Darker sections indicate out of scope processes for this project.

Once the complete costs of this procedure are documented, the team’s work will serve as a foundation for other procedures in the CVC to be analyzed. The hope is that this project will kick start an initiative to develop a comprehensive understanding of every procedures’ cost within the CVC.

Key Issues
The following key issues are driving the need for this project:

- Difficulty of observing and measuring the true costs of caring for the mitral valve surgery patient population due to limited data and lack of resource utilization
- Inability to quantify true costs hinder the health system’s ability to accurately measure and assess the value of care (outcomes / costs) delivered to patients for improvement projects
Goals and Objectives
To quantify the direct variable costs of provider and staff time at the CVC clinic for mitral valve patients, the student team has achieved the following tasks:

- Observe and understand the cardiac surgery clinic and echo lab process and tests involved
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With this information, the team was able to:

- Develop swimlane diagrams for patient cardiac surgery clinic visits and patient echo testing related to mitral valve surgeries
- Document provider and staff times in the cardiac surgery clinic and the use of supplies for future financial analysis
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Project Scope
The project includes the time nurses, medical assistants, physicians, physician assistants, nurse practitioners, residents, and check-in and out staff spend with patients. Data was collected from patients of two physicians involved with mitral valve cardiac procedures. The primary project included collecting data on time spent during new patient visits, history and physical visits, post-op visits, and return visits for patients of the two specified physicians. It also included collecting data on the supplies used in cardiac surgery clinic during these visits. For the echo lab, the scope included observing TTE, TEE and stress tests. The ordering physician nor the patient diagnosis mattered for these observations since the process is the same for all patients.

The time patients wait or spend in the clinic is out of scope. The costs associated with surgery and inpatient stay were not in the scope of this analysis. Furthermore, fixed indirect costs were not within the project scope.

Deliverables
The team presented the following information as deliverables:

- Explanation of methods to be used by teams collecting time data in other parts of the CVC and Michigan Medicine
- Analysis of data involving the time clinicians spent with patients
- Completion of eight swimlane diagrams detailing the current processes based on visit type in the cardiac surgery clinic and test given in the echocardiography clinic
  - Four swimlanes with complete time data associated with each clinician
  - Four draft swimlanes without time data
Methods

The team used seven specific engineering methods to quantify the time providers spend with patients in the CVC clinic: literature search, observation, time study, patient form collection, medical staff interviews, data analysis, and echocardiography lab observation.

Literature Search
A literature search was performed to learn how to conduct time studies in a healthcare setting, understand how a typical clinic operates, and gather ideas on how to construct a value stream map in a healthcare setting. Three main sources were found to be beneficial. The first was the “Methods” section of a final report from a past IOE 481 project team titled “Quantifying Qualitative Care: Patient and Staff Needs on UMHS 4B” [1]. This project involved observations of various clinical tasks through the use of time studies, and was used by the IOE 481 team to determine appropriate staffing needs for a specific floor of the hospital. Some of the methods employed by this group were adopted for use on the project, as the journal group’s initial observations of which clinical processes required the most provider time allowed the current team to quickly focus the time study observations. In addition, their research made the team aware of some hard constraints that needed to be considered such as surgery length, federal requirements, and documentation time.

The team used methodology found in a final report from another IOE 481 project titled “Patient Flow Analysis of Medical Procedures Unit” [2] to understand best practices for implementing a patient form as part of the time study. Outside of past IOE 481 projects, the team found a helpful report titled “Improving Quality through Value Stream Mapping: A Case Study of a Physician’s Clinic” [3]. Within this report, a section titled “Mapping the Present State” was very beneficial in helping the team understand value stream and process flow mapping, as that had the potential to become an important aspect of the project.

Observation
The team observed the cardiac surgery clinic on January 26, January 30, February 6, and February 20 to better understand the process a patient goes through as a surgery candidate. Observations primarily took place on Monday, Thursday, and Friday of each week. As part of this stage, the observations were aimed towards all CVC patients, not just mitral valve patients, to achieve the best possible understanding of clinical flow. The team’s observations were then used to establish a plan for specific time data collection techniques and how those would be applied in the cardiac surgery clinic.

Time study
The team collected data for time studies by observing the cardiac surgery clinic on Mondays from 8:30 AM to 3:00 PM. The medical assistants gave the schedule of patients for the day to the team the morning of data collection, informing the team which patients were mitral valve surgery candidates to separate the data collected. Team members recorded how long each provider spent with all patients, not just mitral valve, including within intake rooms and at the checkout desk. Data was collected from 26 patients between March 6 and March 27. The patterns observed for all providers and staff involved with the mitral valve patients was noted and compared with non-mitral valve patients during data analysis.
**Patient form collection**

Patient forms were used to capture data in the cardiac surgery clinic from the patient perspective. The form is included in Appendix A. Originally the forms were meant to collect data when the team was unable to take time studies in person. However, due to clinic staffing constraints the team passed out and explained the forms a majority of the time. Therefore, the forms were used as a comparative tool to the team’s time studies to validate the accuracy of the forms for continued use in the CVC. The form used by the team was edited and evaluated by various clinical staff members to maximize ease of use for patients when they filled out the form independently. The patients who were willing to participate in the project were given a form when they were roomed and this form was collected at check out. The patients were asked to record who saw them, the time said provider or staff entered the room, and the time said provider or staff left the room. The team collected 49 patient forms.

**Medical staff interviews**

Informal and formal interviews with staff were used to validate how the team’s observations matched with provider and staff perceptions. The provider and staff insight allowed the team to plan effective data collection techniques with less trial and error. The interviews also validated the effectiveness of patient forms and provided tips to improve this data collection technique.

**Data analysis and validation**

The team compiled and merged the results of the data collection into pivot tables to understand the average time each provider or staff spent with the patient. This data was stratified based on appointment type, procedure, and doctor. The times were then used to create swimlane diagrams for each appointment type in the cardiac surgery clinic. The swimlanes detail the time providers and staff are with the patients, the wait time of patients, and also note any supplies used.

Data validation was performed to determine if the data collected using the patient forms was accurate. Patient form data was compared to data taken during team observations using Microsoft Excel and Minitab statistical software. Pivot tables were created in Microsoft Excel, using both patient and team data, to summarize provider time for each type of visit. This data was input into Minitab for comparison through descriptive statistics and boxplots.

**Echocardiography lab observation**

The team observed in the echo lab for three days, recording workflows for transthoracic (TTE), transesophageal (TEE), dobutamine stress, and treadmill stress tests. Eight total tests were observed with each test lasting between 45-90 min with the patient. Observations and staff interviews were conducted in order to understand the patient flow, the supplies used, and the time spent completing the visit without the patient present. Swimlane diagrams were made to depict this flow for each test.

**Findings and Conclusions**

From the methods, the team determined four main conclusions that follow directly from the findings. The conclusions are headed under two main deliverables: provider time analysis and swimlane diagrams.
Provider Time Analysis
Observations, interviews, and data analysis showed the team how some provider and staff positions take on similar roles in the clinical setting. Nurse practitioners (NP) and physician assistants (PA) are both considered mid-level providers which means they can care for patients at a higher level than nurses or medical assistants while still under the direction of a physician. This is important since during data analysis, there were discrepancies in time or amount of data that could be explained and alleviated by assuming the NP and PA had the same role. Therefore, the team decided to combine them in analysis and assume that NPs and PAs in the clinic could act in the same role as the other. Similarly, residents can do initial consultation with patients in the clinic like an NP and PA and otherwise spend their time shadowing the physician. Therefore, the team decided to drop analysis of resident time for this project.

Staff interviews allowed the team to revise the patient form and implement sections that would serve patients best while gathering the appropriate information. After the forms were implemented in the clinic, the staff continuously provided feedback to what parts of the form confused patients, how the patients were doing filling it out, and how the team could be more involved with the data collection. After the completion of the data collection, the team was able to develop statistics on patient wait time, provider and staff time spent with the patient, and the complete visit length for the patient. The patient form data with the team conducted time studies was also analyzed. The team found the mean, standard deviations, and range for the time each provider or staff spent with a patient in the exam room was stratified by appointment type, displayed in Table I and II below.

<table>
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<th>Total Sample Size: 49; Source: Patient Form data, IOE 481 Team; Collection Period: March 6-March 27 2017</th>
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<tr>
<td><strong>Average Time and Std. Dev. spent with Patient per Visit Type (min.)</strong></td>
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<tr>
<td><strong>New Patient</strong></td>
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<td>Sample Size: 22</td>
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<td><strong>Checkout Staff</strong></td>
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<td><strong>Intake MA</strong></td>
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<td><strong>Rooming MA</strong></td>
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<tr>
<td><strong>MAS</strong></td>
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<tr>
<td><strong>RN</strong></td>
</tr>
<tr>
<td><strong>NP or PA</strong></td>
</tr>
<tr>
<td><strong>MD</strong></td>
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</tbody>
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* Blank values indicates where the provider or staff is not involved with that particular visit type
** Checkout Staff data did not include visit type, *** Only 1 data point for H&P Rooming MA

Table I. Average time spent with patient by each provider for each visit type in minutes.
**Sample Size:** 49; **Source:** Patient Form data, IOE 481 Team; **Collection Period:** March 6-March 27 2017

### Ranges of Time spent with Patient per Visit Type (min.)

<table>
<thead>
<tr>
<th>Visit Type</th>
<th>New Patient</th>
<th>Health &amp; Physical</th>
<th>Postoperative</th>
<th>Return Visit</th>
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</thead>
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<tr>
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<tr>
<td>Checkout Staff</td>
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<td>-</td>
<td>[1, 19]</td>
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<tr>
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<tr>
<td>Rooming MA</td>
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<td>[4, 4]***</td>
<td>[1, 9]</td>
<td>[0, 3]</td>
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<tr>
<td>MAS</td>
<td>-</td>
<td>[12, 20]</td>
<td>[1, 12]</td>
<td>-</td>
</tr>
<tr>
<td>RN</td>
<td>[4, 41]</td>
<td>-</td>
<td>[10, 25]</td>
<td>[1, 8]</td>
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<td>NP or PA</td>
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<td>[19, 45]</td>
<td>[11, 34]</td>
<td>[6, 9]</td>
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<tr>
<td>MD</td>
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<td>-</td>
<td>[2, 25]</td>
<td>[3, 29]</td>
</tr>
</tbody>
</table>

* Blank values indicates where the provider or staff is not involved with that particular visit type
** Checkout Staff data did not include visit type, *** Only 1 data point for H&P Rooming MA

Table II. Ranges of time spent by each provider for each patient type in minutes.
Patient forms collected accurate data from patients while the team was not on-site at the clinic.

Validation of data acquired from patient forms confirmed the data to be reliable and fit for use in analysis. Data validation was completed by comparing time study results from the team’s observations to results from the same set of patients that filled out patient forms. Boxplots were created as a way to visually compare these sets of data.

Figure II. The comparison of patient form and team observation RN data.

It can be seen above in Figure 2 that there was no significant difference in RN times between patient data and team observation data, and the team observed similar results for the other providers and staff as well. With no significant difference between patient data and team observation data, the team concluded that the patient form data is accurate enough for use in data analysis. This was important, because being able to use patient form data for analysis provided the team with nearly twice as much data (larger sample size). For additional boxplots comparing patient and team data, see Appendix B.
There are statistically significant time differences between procedure type & between surgeons

Based on the team’s observations and findings within the CVC clinic, the team concludes that there is not a statistically significant difference between procedure type and time providers spend with patients. This is derived from finding no statistical significant differences for all providers and staff when comparing procedure type and in between surgeons. An example of the analysis for NP can be seen below in Figure 3.

![Nurse Practitioner Provider Time: Mitral vs. Other Procedures](image)

**Figure III.** The comparison of mitral valve procedure NP data against other procedure types.

Procedure type refers to the kind of surgery a patient will have or the procedure their diagnosis indicates. As seen from the previous sections, the data the team collected from mitral valve patients compared with other patients does not differ significantly. This is helpful for other studies knowing in this clinic setting, data does not have to be stratified by procedure. Second, the team concludes that there is not a statistically significant difference between surgeons and time spent with patients. A boxplot can be seen below in Figure 4 to visualize this similarity.
Although the surgeons have different approaches to what team members they take into the room with them and how they run their clinic, the times do not significantly between surgeons. If, in the future, industrial engineering teams at the CVC decide to look at other areas within the clinic, they can likely observe each clinic as a whole rather than studying each specific doctor individually. For additional boxplots comparing these data sets, see Appendix C.

There are statistically significant time differences between visit types
The data analysis shows the team that there is a statistically significant difference between visit type and the time spent with patients. New patient visits take the most total provider and staff time with H&P visits next. Since each visit has a vastly different purpose, the data proves the logic that these visits would have different provider time.

Differences in patient time in the clinic and clinician time
Second, the team concludes that there is a difference between the total time the patient is in the cardiac surgery clinic and the time the providers and staff actually spend with the patient. The time the patient checks into the clinic until they checkout or leave is the total appointment time. This conclusion came to light as a bi-product of data collection and analysis. Although patient wait time is out of scope, the team thought it was important to note. No further analysis was done on this data besides noting the difference.

Swimlane Diagrams
After collecting time study data at the clinic, the team determined value stream maps like those used in “Improving Quality through Value Stream Mapping: A Case Study of a Physician’s Clinic” [3] would not be helpful for analysis or presentation. Value stream maps can display
statistics such as cycle time and non-value added time which give great detail to the process. However, the clinic times and patient numbers the team gathered did not provide sufficient data for this detail nor is the detail necessary for the scope of the project.

The team was able to create flow diagrams of the clinic process after a five week span of observation, data collection, and informal interviews with staff and providers in the cardiac surgery clinic. Asking questions while observing the dynamic nature of the clinic allowed the team to understand what the standard flow of the clinic looks like. Three main findings are worth noting. First, the team found that the providers and staff who saw the patients differed depending on the type of visit. For example, a new patient visit requires more people to engage with the patient than a history and physical visit. Second, MAs who initially see the patient do the same process in the clinic regardless of what physician the patient is going to see. The time it takes the MAs to intake the patient only differs if the patient is new and has lots of medications to input, which is usually done after the patient leaves the room.

Third, a majority of variation in the clinic process depends on the amount of patients and staff present that day. Understaffing or many patients means providers may see patients one-on-one instead of in team to keep clinic flow moving. Rooming MAs might help with intake for similar reasons. See Appendix D. for more detailed diagrams of the clinic as well as specific times associated with each patient interaction, including details such as average times for each process, total average wait times, and total average times for each provider. Appendix E. contains a summary of the total average times for each clinician and provider stratified by appointment type.

For the echo lab, the team relied solely on staff interviews and observations. From 3 clinic observation times over 2 weeks and interviews with 7 staff members and providers, 4 flow charts were created to map out the process of 4 different echocardiograms: a TEE, TTE, dobutamine stress test and a treadmill stress test. The TTE and stress tests are primarily static procedures that vary in time depending on three factors: the patient's health history, what is seen on the echo as the test is performed, and how recently the patient has had an echo. The TEE is a more dynamic test since it involves a fellow and attending physician. Since four providers and staff are involved in this procedure, there is a potential for longer patient wait times because the fellow and attending work in three different TEE rooms. Therefore, though each procedure may be standard, the time to complete the procedure varies the most for a TEE. Each test’s standard workflow was documented in a swim lane diagram and can be found in Appendix F.

**Clinic and Echo lab flows can be standardized and documented**

Based on the team’s observations and findings at the cardiac surgery clinic and echo lab, there are two conclusions. First, the team concludes that in the cardiac surgery clinic, there is not a significant amount of supplies used. During H&P visits, 2 bottles of surgery scrub (costing $1.57/bottle), 1 bag (costing $0.01) and 1 Incentive Spirometer (costing $28.02) are given to the patient. Only one patient noted this on their form. The team also concludes that the echo lab has four significantly different procedures that follow a standardized pattern of processes. The processes are outlined with details of which staff and providers are involved with each procedure in Appendix F. The cardiac surgery clinic flow can also be documented as seen in Appendix D.
The cardiac surgery clinic is more dynamic in nature and the provider time analysis belonging to the swimlanes are of more interest to this project.

**Recommendations for Next Steps**

As stated in the introduction, this project is part of an effort on behalf of the CVC to better understand the costs the hospital incurs. To best utilize the information provided in this report, the team recommends three next steps for continuing the direct variable cost effort throughout the hospital.

1. The time values that each clinician spent with patients in the cardiac surgery clinic should be used by the finance team and clinic design team to apply monetary value to the clinician time. Based on the provider and staff time conclusions, the team recommends stratifying patients by visit type in each clinic instead of the surgeon or procedure. As the CVC determines more costs associated with patient care, this has the potential to allow larger quantities of data and simpler procedures during data collection.

2. The approach the team took during the project could be used in other clinics throughout the CVC and Michigan Medicine. Starting with observations, using patient forms validated by time studies, and interviews with staff proved to be a successful effort augmenting Michigan Medicine's understanding of the costs it incurs not just for an overall procedure but along the procedure itself.

3. The echo swimlane diagrams should be validated and completed with time studies. The lab staff should go through the diagrams and ensure the swimlanes accurately represent what is happening in the lab. Time studies should also be done by to provide clinician time to be analyzed as the direct variable cost. The team recommends the lab staff record the times it takes for each process of a particular procedure to gather this data. One way staff could record these times are by having a clipboard outside each echo room. Since staff have to put hand sanitizer on when going in and out of a room, placing a clipboard right by the dispenser could remind them to quickly write down what time they enter or exit the room.
References


Appendix

Appendix A: Patient Form

<table>
<thead>
<tr>
<th>CVC CARDIAC SURGERY CLINIC PROVIDER TIME STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit Info</td>
</tr>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Service:</td>
</tr>
<tr>
<td>Appoint. Time:</td>
</tr>
<tr>
<td>Check In Time:</td>
</tr>
</tbody>
</table>

| Intake Bay Vitals | Rooming MA Times | Patient Label: |
| Start Time: | Start Time: | Name |
| End Time: | End Time: | MRN |

Directions: We are working to improve the patient experience and understand the nature of clinic delays. We need your help to do this! *Please fill in all blank white spaces on this form.*

Check which provider(s) see you as well as the time they spend with you.

The "Begin" time starts with the provider walks into the room. "End" is when they exit the room.

*Please give the completed sheet to the clerk at check out completion.*

This information will help us improve our service. Thank you!

<table>
<thead>
<tr>
<th>Time entered exam room at the beginning of visit:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Supplies Given (i.e. Spirometer or handbook)</th>
<th>Provider (More than one provider may be chosen)</th>
<th>Provider Time With Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Doctor (MD)</td>
<td>Registered Nurse (RN)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fellow/Resident</td>
<td>Medical Assistant Specialist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nurse Practitioner</td>
<td>Other</td>
</tr>
<tr>
<td>Provider Interaction 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provider Interaction 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provider Interaction 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provider Interaction 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Time left exam room at the end of visit: | |
|-----------------------------------------------|

<table>
<thead>
<tr>
<th>End of Visit</th>
<th>Check Out Staff</th>
<th>Surgery Scheduler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|          | | | |
Appendix B Data Validation - formatting still required

Figure B-I: MD Comparison

Figure B-II: NP/PA Comparison
Figure B-III: RN Comparison

Figure B-IV: MA Comparison
Appendix C: Data Analysis

Figure C-I: NP Comparison between Surgeons

Figure C-II: RN Comparison between Surgeons
Figure C-III: MD Comparison between Procedures

Figure C-IV: NP Comparison between Procedures
Figure C-V: RN Comparison between Procedures

Figure C-VI: MA Comparison between Procedures
Appendix D: Swimlane Diagrams of Clinic Flow for each Visit Type

Figure D-1: Swimlane diagram of a New Patient Visit

<table>
<thead>
<tr>
<th>Patient Wait Times</th>
<th>0 min</th>
<th>50</th>
<th>66</th>
<th>103</th>
<th>110</th>
<th>141</th>
<th>151</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clerk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 min</td>
</tr>
<tr>
<td></td>
<td>Checks patient in</td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Intake MA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 min</td>
</tr>
<tr>
<td></td>
<td>Takes patient in (W)</td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Rooming MA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 min</td>
</tr>
<tr>
<td></td>
<td>Prep patient in room (W)</td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>NP or PA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 min</td>
</tr>
<tr>
<td></td>
<td>Consult patient (17)</td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33 min</td>
</tr>
<tr>
<td>RN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44.09 min</td>
</tr>
<tr>
<td></td>
<td>Consult patient (16)</td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>MAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not Involved</td>
</tr>
</tbody>
</table>

* Total average times are calculated by finding average times for each process and summing them across each provider/staff. For processes that happen a % of the time, the % x extra time is included.

Example: RN Average time calculation: 17 x 10 = 3.5(16) = 5 = 44.09 min.
Figure D-II. Swimlane diagram of a Health & Physical Visit

### Clinic Flow - Health & Physical (H&P)

**Sample Size:** 7 patients in 3 clinic days

<table>
<thead>
<tr>
<th>Patient Wait Times</th>
<th>Clerk</th>
<th>Intake MA</th>
<th>Rooming MA</th>
<th>NP or PA</th>
<th>MD</th>
<th>RN</th>
<th>MAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected average time: 10 minutes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vitamins are taken (10)</td>
<td>Pulls patient in room (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>拉斯</td>
<td>[patient in room (7)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deliver patient ice to hedge room (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prep room for next patient (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discuss with patient (26)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>29 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Total average times are calculated by finding average times for each process and summing them across each provider/staff. For processes that happen a % of the time, the % x extra time is included.

**For a CABC H&P, Surgical Scrub (2 bottles) were given to patient.**
Figure D-III. Swimlane diagram of a Return Visit

Clinic Flow - Return Visit (RV)

Accumulated average times: 9 minutes 25 27 28 57 62 67 92

**Patient Wait Times***

- **Clerk**: Checks patient in
- **Intake MA**: Takes vital signs (9), Puts patient in room (2)
- **Rooming MA**: Puts patient in exam room (12)

*When clinic is busy and understaffed, the Rooming MA may perform the duty.*


- **Sample size**: 7 patients NP: 14% (17) MD: 59% (40) NP: 14% (17) MD: 59% (40) RN: 14% (17) RN: 59% (40)

Sample size: 7 patients NP: 14% (17) MD: 59% (40) RN: 14% (17) RN: 59% (40)

Sample size: 7 patients NP: 14% (17) MD: 59% (40) RN: 14% (17)

Sample size: 7 patients RN: 14% (17) MD: 59% (40)

- **NP or PA**: Sample size: 7 patients NP: 14% (17) MD: 59% (40) RN: 14% (17) RN: 59% (40)

Sample size: 7 patients NP: 14% (17) MD: 59% (40) RN: 14% (17)

Sample size: 7 patients RN: 14% (17) MD: 59% (40)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Sample size: 7 patients RN: 14% (17)

Total Average Time: 5 min

Total Average Time: 11 min

Total Average Time: 5 min

Total Average Time: 7.24 min

Total Average Time: 13.37 min

Total Average Time: 9.48 min

Total Average Time: 1.54 min

*Total average times are calculated by finding average times for each process and summing them across each provider/staff. For processes that happen a % of the time, the % x extra time is included.

Example: RN Total Average time calculation: .14(11) + .59(5) + .14(5) + .14(11) = 9.48 min.
Figure D-IV: Swimlane diagram of a Postoperative Visit

Clinic Flow - Postoperative (PostOp)

Patient Wait Times
* Ranges from 3 min. to 1.5 hours

Clerk
Checks patient in

Intake MA
Takes vital signs (10)
Prep patient in room (2)

Rooming MA
* When clinic is busy and understaffed, the Rooming MA may perform this duty
Puts patient in room (17)
Delivers patient info to Team Room (1)

NP or PA
Consult patient (16)

MD
Consult patient (6)

RN
Consult patient (16)

MAS
Consult patient (16)

Sample Size: 12 patients in 4 clinic days
Patient Average Time: 123 min
Total Average Time: 5 min

Accumulated average times: 0 minutes 52 54 55 60 97 105 126

* Total average times are calculated by finding average times for each process and summing them across each provider/staff. For processes that happen a % of the time, the % x extra time is included.
Example: MD Total Average time calculation: .55(16) + .08(16) + 17 + .17(6) + .17(6) + .06(9) = 27.34 min.
Appendix E: Summary of Swimlane Diagram Total Average Time Data

Figure E-I. Visualizes the total average times of each provider for each visit type calculated with the swimlane diagrams in Appendix C.

![Swimlane Diagram](image)
Appendix F: Swimlane Diagrams of the Echocardiogram (Echo) Tests

Figure F-1. Swimlane diagram of TTE Test
Dobutamine Stress Test Flow (Draft)

**MD**
- (On stand-by in case something goes wrong)
- *Reacts, echo and signs report*

**Sonographer**
- Prepares patient report and other set-up
- Surface Echo and Baseline Images

**RN**
- Prepares paperwork
- Pages patient, brings back to room
- Set up, patient consent, EKG and IV in
- Drug set up and prep
- Drug Stress Test performed (including recovery, post pictures, and post EKGs)
- Writes report
- Exits System
- *Transcribe and submit report*

**Exercise Physiologist**
- Not Involved

**Fellow**
- Not Involved
Figure F-III: Swimlane diagram of Treadmill Stress Test
Figure F-IV. TEE Test

Transesophageal Echo (TEE) Flow (Draft)

1. Report setup
2. Surface Echo
3. Transcribes and finishes report
4. Exits System
5. Patient Recovery
6. Patient to next procedure
7. Nurse and Sonographer calls attending MD
8. Exercise Physiologist
9. Follow
10. MD
11. RN
12. Sonographer
13. Input info?