Analysis of Patient, Information, and Work Flow in the University of Michigan C.S. Mott Children's Hospital Perioperative Area - Final Report

Submitted to:

C.S. Mott Children's Hospital Perioperative Area Management Committee:
Ron Hirschl, MD, Section Chief, Pediatric Surgery
Karen Lam, RN, Clinical Nurse Manager, Operating Room
Jan Murray, RN, Clinical Nurse Manager, Pre-Op and Post-Op
Paul Reynolds, MD, Section Chief, Pediatric Anesthesia

Program and Operations Analysis Department:
David Anderson, Management Engineer Fellow
Richard Coffey, PhD, Director
Mary Duck, Management Systems Coordinator

Prepared by:
Jessica El-Hosni, Senior IOE student
Zachary Lackey, Senior IOE student
Jacqueline Lincoln, Senior IOE student
Stephanie Newell, Senior IOE student

December 14, 2005
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Executive Summary

Introduction

The C. S. Mott Children’s Hospital Perioperative Area sees more than 40 patients every weekday. The Industrial and Operations student project team has been told by the management committee for the Mott Perioperative Area that there is concern that patients are spending too much time waiting in the Perioperative Area, particularly in the pre-operating area (pre-op) and post anesthesia care unit (PACU or post-op). To quantify what occurs during a patient’s visit, the management committee has asked the current team to observe and analyze the work, information and patient flow through this area. With these findings the management committee can begin to improve the current level of service patients are receiving.

The purpose of this final report is to describe methods used to gather data and to present the quantified observations. The report also includes analysis and conclusions of the project team’s findings and recommendations to improve the process and reduce patient wait times in the Mott Perioperative Area.

Methodology

This study utilized various forms of observing and data collecting since the steps the patient must go through during a visit to the Mott Perioperative Area were not previously documented and quantified. Through observations and interviewing medical staff, the current team determined how the work done by the nurses, surgeon and anesthesiologist coincide during the Perioperative Area visit for a patient. The current team also conducted observations to determine the average amount of time a nurse, anesthesiologist or surgeon spends completing every step of the work with the patient, particularly in the pre-op and post-op sections. Data was recorded on a data collection sheet created by the team. Finally, the current team quantified the amount of time a patient spends with a Perioperative employee and the amount of time a patient spends waiting to move to the next step in the process. In addition to gathering and presenting data on these three issues, our team has analyzed data and identified primary areas of delays in the process and developed recommendations for possible changes in the current process in order to reduce patient wait time.

Summary of Findings and Conclusions

The team gathered a lot of information over the course of our project, and as a result we had several important findings and conclusions regarding both the pre-op and post-op processes. These findings and conclusions are summarized in Table 1.
# Table 1. Summary of Findings and Conclusions

<table>
<thead>
<tr>
<th>Pre-Operating Area (Pre-Op)</th>
<th>Findings</th>
<th>Conclusions</th>
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</thead>
</table>
| **Value-Added versus Non Value-Added Time** | °Average time in pre-op: 85.0 +/- 35.8 min  
°Only 24% of patients spent 60 minutes or less in pre-op | °Majority of patients are spending longer than the scheduled pre-op time of 1 hour in pre-op |
| °Value-added time: 33.3 +/- 7.8 minutes (39.2% of total time)  
°Non Value-added time: 51.6 +/- 35.9 minutes (60.8% of total time) | °Majority of time in pre-op is non value-added  
°Large variation in amount of non value-added time  
°Staff spends about the same amount of time with each patient (small variation in value-added time) |
| **Patient Flow Follows Two Paths** | °First-case patients check-in at Pre-Op, then are taken to PACU for all pre-op activities  
°99.7% of first-case patient's time is value-added  
°All other patients have all pre-op activities in the pre-op area | °Further analysis is needed to determine if it is feasible and/or beneficial for all patients to follow the first-case patient flow |
| **Rework in Information Flow** | °Many forms used in pre-op with repeatative information  
°Nursing, anesthesia, surgery all follow different work standards  
°No single document with all pre-op requirements | °Rework a key issue in the pre-op process  
°Work standards are not integrated so rework cannot be eliminated |
| **Lack of Communication in Work Flow** | °No two observed patients had the same pre-op experience  
°Anesthesia and surgery staff come to pre-op when available  
°Patients wait 12.2 +/- 7.7 minutes in between each staff member | °Lack of notification/alert system leads to large patient wait times |
| **Change in Nursing Assessment Procedure** | °30% of observed patients, MA started nursing assessment and RN completed; took 13.4 +/- 4.9 minutes plus 4.6 minutes wait time on average  
°Other 70%, RN did all of nursing assessment; took 10.8 +/- 3.9 minutes  
°Eliminated the process of MA starting assessment in early Nov. | °Changing the process so that RN did all of assessment was a good decision  
°2.6 minutes of process time and 4.6 minutes of wait time were eliminated on average |
<table>
<thead>
<tr>
<th>Pre-Operating Area (Pre-Op)</th>
<th>Findings</th>
<th>Conclusions</th>
</tr>
</thead>
</table>
| Effect of Patient Arrival Time on Process Delays | • 34% of patients arriving late spent 60 minutes or less in pre-op  
• only 14% of patients arriving early or on time spent 60 minutes or less in pre-op  
• patients arriving late are moved up in the process | • Patient arrival time is not a significant cause of delay in the pre-op area |
| Patient Types | • Inpatients do not have pre-op activities done in pre-op  
• Observed out-out patients spent 82.8 minutes in pre-op on average  
• Observed out-in patients spent 78.5 minutes in pre-op on average | • No major differences in pre-op experience between out-out patients and out-in patients |
| No Major Delays in Patient Flow | • Post-op much more patient driven than pre-op  
• Tasks occur much more sequentially in post-op  
• Observed patients spent 65.5 +/- 17.7 minutes in post-op on average | • Post-op much less complex in terms of process than pre-op |
| No Major Issues in Information and Work Flow | • Average time spent in phase I was 38.0 +/- 9.1 minutes  
• Average time spent in phase II was 23.5 +/- 16.0 minutes. | • No major delays due to patient flow in post-op |
| Post Anesthesia Care Unit (PACU or Post-Op) | • Transfer of information inherent to the process  
• One transfer between anesthesia and phase I nurse; took 5.5 +/- 2.8 minutes on average  
• Second transfer between phase I nurse and phase II nurse; 2.8 +/- 1.8 minutes on average | • No major delays due to information or work flow in post-op |
| Beds Not Fully Utilized | • Phase I was 62.5% utilized four hours out of the day on average  
• 10 AM to 11 AM, phase II was at about 67% of capacity  
• Phase II was only up to 39% full the rest of the day | • Phase I nor phase II were being fully utilized |
| Patient Types | • Inpatients are transferred from phase I to a unit  
• Inpatient spent 41 minutes in phase I  
• Outpatients spent 38.5 +/- 9.1 minutes in phase I | • No major difference in phase I for inpatients compared to outpatients |
Summary of Recommendations and Implementation

The recommendations of the team focus on two key issues: reducing the patient wait time in pre-op by increasing communication between staff and increasing staff awareness of the overall Perioperative Process. We propose two follow up projects to our project. First, a project should be started to document and quantify staff activities beyond the pre-op area. Any non value-added time identified during this project can be eliminated to help reduce patient wait time. A second project should focus on establishing exactly what must be done in pre-op and post-op, and who is required by law, policy, or work standard to do it.

Both of these projects will help in launching an electronic information system in the Mott Perioperative Area by ensuring the system includes all necessary information for nursing, anesthesia, and surgery. While the system is being developed, an employee-task matrix should be created to bring all of the information for all staff members together. Ideally, the matrix should also be used to initiate the integration of work standards for nursing, anesthesia, and surgery so that rework is eliminated.

We intend for the information gathered in this project to be used as a basis for further projects in the C. S. Mott Children’s Hospital Perioperative Area. Our project and future projects will ensure that the patient experience in the Mott Perioperative Area is continuously improved.
Introduction

The C. S. Mott Children’s Hospital Perioperative Area sees more than 40 patients every weekday. The Industrial and Operations student project team has been told by the management committee for the Mott Perioperative Area that there is concern that patients are spending too much time waiting in the Perioperative Area, particularly in the pre-operating area (pre-op) and post anesthesia care unit (PACU or post-op). To quantify what occurs during a patient’s visit, the management committee has asked the current team to observe and analyze the work, information and patient flow through this area. With these findings the management committee can begin to improve the current level of service patients are receiving.

Prior to this project, all of the activities that a patient goes through in pre-op and post-op were not documented and quantified. Through observations and interviews, the project team determined how the work done by the nurses, surgeon and anesthesiologist coincide during the Perioperative Area visit for a patient. During observations, the team determined the average amount of time a nurse, anesthesiologist or surgeon spends completing every step of the work with the patient, particularly in the pre-op and post-op sections. Finally, the team quantified the amount of time a patient spends with a Perioperative employee and the amount of time a patient spends waiting to move to the next step in the process. In addition to gathering and presenting data on these three issues, our team has analyzed data and identified primary areas of delays in the process and developed recommendations for possible changes in the current process in order to reduce patient wait time.

The purpose of this final report is to describe methods used to gather data and to present the quantified observations. The report also includes analysis and conclusions of the project team’s findings and recommendations to improve the process and reduce patient wait times in the Mott Perioperative Area.

Background

The C.S. Mott Children’s Hospital Perioperative Area consists of a pre-op section, operating (or surgery) rooms, and a post-op section. The layout of the Perioperative Area is shown in Figure 1 on the next page.
The pre-op section is the first area to which patients go for scheduled surgeries. The post-op section is where patients are moved to after surgery. The post-op section is divided into two phases: Phase I and Phase II. Recently, the post-op Phase II area increased from eight beds to 18 beds, but the area is still only being used for post-surgery patients stable enough to be in phase II.

Throughout a patient's surgery experience, nurses, anesthesiologists and/or anesthesiology residents, and surgeons and/or surgery residents must complete specific tasks. If these tasks are not coordinated, the patient spends time waiting to be seen by the next employee. The Mott Perioperative Management Committee wants to know how the employees are coordinating the tasks, and how information is being passed from one employee to another employee.

Specifically, the student team was asked to answer the following key questions:

- What steps does the patient go through in each section during the Perioperative Area visit? What is the patient flow through the Perioperative Area?
- How and when does each employee (nurse, anesthesiologist, surgeon, resident) interact with the patient in each section during the visit? What is the general work flow through the Perioperative Area?
- How does each employee obtain information regarding the patient? What is the information flow through the Perioperative Area?
- How much time on average does each step take? What is the value-added time?
- How much time does the patient spend waiting between steps or tasks? What is the non-valued added time between tasks?

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1 Source: Mott OR/PACU Patient Flow Review Presentation, September 2005
• How much time does the patient spend waiting to be transferred into the next section, for example from pre-op to the operating room (what is the non-value added time between sections of the Perioperative Area)?
• Is there any difference in service time between these three types of patients: inpatients who go back to another unit after time in the Perioperative Area (remain inpatients), outpatients who are admitted after surgery (become inpatients), and outpatients who go home after the visit (remain outpatients)? If so, what is the difference in service time?

**Goals and Objectives**

The primary goal of this project was to quantify the current patient experience, particularly the amount of time a patient spends waiting, during a visit to the C.S. Mott Children’s Hospital Perioperative Area. To achieve this goal, the team has:

- Identified current patient, information, and employee flow throughout the Mott Perioperative Area sections by reviewing past Perioperative Area projects, observing each section, and interviewing key staff members.
- Quantified time required to complete required tasks in pre-op and post-op.
- Quantified value added and non-value added time from the patient perspective at each step in the process.
- Identified the differences in serving the three types of patients who are having scheduled surgeries in the Mott Perioperative Area.

With this information, the team has achieved the following:

- Provided visual representations, such as current value stream maps, that describe and quantify the current service patients are receiving in the Mott Perioperative Area.
- Identified bottlenecks in the overall Mott Perioperative Area process.
- Provided general recommendations to reduce the bottlenecks in the Perioperative Area and possibly to help better coordinate staff activities.

**Project Plan**

The Industrial and Operations Engineering student project team has analyzed the patient, information and work flow through the C.S. Mott Children’s Hospital Perioperative Area. The primary parties involved in this project were pre-operations clerks, anesthesiologists, anesthesia technicians, nurses, surgeons, surgical residents, and post anesthesia clerks. The following describes the scope of the project, methods used to obtain data, and how the data collected was analyzed.

**Project Scope**

The C.S. Mott Children’s Hospital Perioperative Area is a complex department that sees more than 40 patients per day on average. Since the time frame for this project prohibited examining all operations in the Perioperative Area, the project team focused on a limited amount of information. The project scope describes what was included and what was excluded in this project.
**Included**

The team looked at the work flow, information flow, and patient flow. The team also looked at value added time and non-value added time, in the pre-operating section, the operating rooms, and both phases of the post anesthesia care unit. However, a project completed in the Fall of 2003 by a Program and Operations Analysis Team looked specifically at the work, information, and patient flow in the operating room section of the Mott Perioperative Area. Instead of re-analyzing the OR section, our team used the past project information to fill in the data for the operating room section. As a result, our team's main focus was on the pre-op and post-op sections, and not on the actual operating rooms.

The current project focused on establishing the steps that a patient goes through, and the tasks that employees complete in the pre-op and post-op sections. Initial work had been done in flowcharting these processes by the Program and Operations Analysis department, so the student team built on that information.

The current project team primarily observed patients in pre-op and post-op who were having scheduled surgeries. The project team also observed two first arrival patients to determine if major differences exist in pre-op between the patients scheduled for the first surgeries of the day and patients scheduled for surgeries later in the day.

**Excluded**

To accomplish the goals for the project in the time available, the project did not include:

- Collecting specific data on surgeries for patients coming from the emergency room or patients having unscheduled surgeries.
- Establishing the tasks staff members performed when not with the patients being observed.
- Establishing a decision-making process for changing the flow of patients from one section of the Perioperative Area to the next.
- Evaluating the possibility of pre-op patients being staged in the phase II section of post-op.
- Evaluating or modifying block scheduling.
- Making specific recommendations to eliminate processes or tasks.

**Project Approach**

The project team has assessed the current situation in the C.S. Mott Children's Hospital Perioperative Area in a series of three project steps.

**Identified Perioperative Activities and Determined Data Collection Process**

The purpose of the first step was to gather background information to provide context for the activities taking place in the C. S. Mott Perioperative Area during data collection. Specifically, the project team:

- Obtained and reviewed the 2003 Mott Operating Room Project Report, Perioperative Area flowcharts, quantitative data on Mott Perioperative Area cases, and the Mott
Operating Room/Post Anesthesia Care Unit Patient Flow Review Report from the project coordinator.

- Performed initial observations of the pre-op and post-op sections to better understand what activities take place in these sections. Approximately six team hours were spent in pre-op, and four team hours were spent in post-op.
- Conducted an initial interview with three members of the Mott Perioperative Area Management Committee to better understand their roles and their staff’s role in the Mott Perioperative Area. Interview questions appear in Appendix A.
- Verified that the overall Mott Perioperative Area flowchart includes the main steps through which a patient goes in each area.
- Performed a literature search of Perioperative Area procedures, and of similar projects.

Collected Data on Work, Patient and Information Flow
To collect all of the data necessary to accomplish the project goals, the project team performed the following tasks during the second step of the project.

- Created a data collection sheet, which is included as Appendix B to this report.
- Determined the most efficient procedure for collecting data, which was for each team member to pair up with one patient and document what occurs from the time the patient enters pre-op (or post-op) to the time the patient leaves pre-op (or post-op).
- Observed 23 scheduled surgery patients in pre-op and 13 patients in both phases of post-op, and recorded chronologically the activities involving the patient in each section.
- Conducted informal interviews with 3-5 employees for each patient as the employee interacted with a patient, and documented all activities between the employee and the patient, including the time to complete these activities.
- Conducted a literature search on laws and policies governing pre-op and post-op activities, as well as background information on staff roles.

Analyzed Data and Generated Recommendations
To analyze and develop conclusions regarding the data collected in the second step of the project, the team completed the following tasks:

- Calculated mean times, and standard deviation from the mean, for each activity performed by employees.
- Calculated the mean value added and mean non-value added time, as well as the standard deviation of these times, each of the three types of patients spend in each section (pre-op, post-op phase I, and post-op phase II).
- Constructed current value stream maps of the pre-op and post-op sections.
- Established the efficiency of the current situation, and identified the major bottlenecks in patient, information, and work flow throughout the various sections.
- Generated recommendations on possible improvements to the current situation in the Perioperative Area.

The current value stream maps show the activities and cycle times that occur in the Mott Perioperative Area required for a patient to have surgery. The value stream maps also reflect bottlenecks in the Mott Perioperative Area.
Findings and Conclusions

The project team observed 23 patients in pre-op and 13 patients in the post-op from October 25, 2005 to November 21, 2005. From these observations and from interviews with Mott Perioperative Area employees, we identified the current situation in the pre-op and post-op areas.

Pre-Operating Area (Pre-Op)

The team observed a total of 23 patients in the pre-op from October 25, 2005 to November 21, 2005. The team initially expected each observation of a single patient to take approximately one hour, basing the estimate on the requested patient arrival time of 60 minutes prior to the scheduled surgery time. The actual average time an observation took, which was also the average time a patient spent in pre-op, was 85.0 minutes, +/- 35.8 min. Detailed pre-op observation data can be found in Appendix C. Figure 2 shows the percentage of patients who spent 40-60 minutes, 61-80 minutes, 81-100 minutes, 101-120 minutes, and more than 120 minutes total in pre-op.

Figure 2. Distribution of Patient Time in Pre-Op

This figure shows that only 24% of the patients observed had pre-op activities that lasted less than or equal to the scheduled 60 minute pre-op appointment. The majority of patients observed spent between one and two hours in pre-op before being transferred to the operating room (OR).
Value-added versus Non value-added Time

One of the primary goals for the project was to identify how much value-added and non value-added time a patient spends in pre-op. During observations, the team kept track of the amount of time a patient spent with one Mott Perioperative Area employee (value-added time) and the amount of time spent waiting to see different employees (non value-added time). We observed that on average, a patient spends 33.3 +/- 7.8 minutes in value-added activities in pre-op, and 51.6 +/- 35.9 minutes of non value-added time in pre-op. Therefore, only 39.2% of a patient’s time in pre-op was value-added. Table 2 shows the overall, value-added and non value-added time.

Table 2. Observed Patient Time in Pre-Op

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Value-Added</th>
<th>Non Value-Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (in minutes)</td>
<td>85.0</td>
<td>33.3</td>
<td>51.6</td>
</tr>
<tr>
<td>Standard Deviation (in minutes)</td>
<td>38.5</td>
<td>7.8</td>
<td>35.9</td>
</tr>
<tr>
<td>Percent of Overall</td>
<td>100.0%</td>
<td>39.2%</td>
<td>60.8%</td>
</tr>
</tbody>
</table>

Source: IOE 481 Preoject Team Observations
Dates: October 25, 2005 to November 11, 2005
Sample Size: 21 Patients (First-case-of-the day not included)

The team analyzed the value-added activities, and concluded that the History and Physical takes almost a third of the total value-added time, and the anesthesia interview takes almost a fifth of the value-added time. Figure 3 shows the breakdown of value-added time.

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2 Value-added, for the purpose of this project, is any time a patient spends with an employee during pre-operation, operation, or post-operation care. Non-value added refers to time the patient spends waiting while conscious and coherent, and not under the care of an employee or participating in any activities related to such care.
Figure 3. Percentage of Value-Added Time by Activity

The current value stream map (see Appendix E) for the pre-op area shows the value-added time for each activity, and the non value-added wait time between activities.

Patient Flow Follows Two Paths

During initial observations, the team discovered two paths of patient flow from pre-op to the operating room (OR). The first patient flow path was limited to first-case patients, who check-in at pre-op but are then transferred to the post anesthesia care unit (PACU) to be seen by the nurse (RN), anesthesiologist, Certified Registered Nurse Anesthetist (CRNA), circulator, surgeon, and/or surgical resident. These patients are then transferred from PACU to the OR. The team observed two patients who received pre-operation care in this manner.

The second patient flow path, which is the path on which the team focused because 80% or more patients follow this path, consists of the patients receiving all pre-operation care in the pre-op area. The patient is then transferred directly from pre-op to the OR. The pre-op value stream map (Appendix E) was developed using data collected on the second patient flow path.

The team found that, on average, 59.7% of a first-case patient’s pre-operation time was value-added while the patients on the second flow path have value-added time that makes up only
39.2% of the total pre-operation care time. However, further analysis is needed to determine if it is feasible and/or beneficial for all patients to follow the first-case patient flow.

**Rework in Information Flow**

The team discovered through observations and interviews that the process for obtaining and distributing patient information in the C.S. Mott Perioperative Area is inconsistent across all surgery departments. The section chief for general pediatric surgery told the team that the History and Physical (H&P), and Consent forms are available electronically for patients having general pediatric surgery, but not necessarily for other surgery patients. The section chief also informed the team that a consent form is valid for six months if the same procedure is repeated, and the H&P is valid for 30 days.

Several forms are used in the pre-op area. Through observations in pre-op and interviews with the nursing manager for pre-op and the section chief of pediatric surgery, the team identified a H&P form, nursing assessment form, an anesthesia questionnaire, an anesthesia form, and a consent form. Inconsistencies in form usage could not be quantified as each patient had a different experience, but several qualitative observations were made by the project team.

**Nursing Assessment Form and H&P Form.** The nursing assessment form goes with a patient throughout the entire Perioperative Area visit, beginning in pre-op, through the OR, and through both phases of post-op. Most of the information on the nursing assessment form is history and physical information. However, The nursing assessment form is separate from the H&P form. The H&P form is used by physicians, and the form is completed during a screening visit prior to the actual surgery visit.

**Anesthesia Questionnaire and Anesthesia Form.** The anesthesia questionnaire is given to the patient’s guardian by the pre-op clerk, filled out immediately by the guardian, and returned to the pre-op clerk. The anesthesia form is filled out by anesthesia staff, including CRNAs, anesthesia residents, anesthesia fellows, and attending anesthesiologists. During observations, the team determined that many of the same items appear on both the nursing assessment form and the anesthesia form. Patients were asked many of the same questions by both nursing staff and anesthesia staff. Anesthesia staff was observed transferring information from the nursing assessment form to the anesthesia form.

**Work Standards.** Through information gathered during interviews and observations, the team discovered that nursing, anesthesia, and surgery have different standards that all employees must follow. However, these standards have not been integrated across all groups. Therefore, staff members are required to obtain certain information from the patient, regardless of whether another staff member has already received that information. The team observed that the guardians of some patients became irritated when asked the same question several times. The team learned from the section chief of pediatric surgery that each staff member is trained on healthcare policies that relate directly to the employee’s responsibilities. The team also learned that certain information, such as the guardians understanding of the procedure, must be obtained more than once. However, the team discovered that no single document exists that lists exactly what information must be obtained from the patient during the pre-op appointment and which
staff member’s responsibility it is to obtain that information. The team concluded that rework occurs because each staff member completes his or her respective paperwork, and the forms have redundant information. Also, staff members did the work they were required to do, but the work between nursing, anesthesia, and surgery is not integrated.

**Lack of Communication in Work Flow**

The team observed 23 patients in the pre-op area, and determined that no two patients have the same experience. The team observed several different variations of work flow in pre-op, such as:

- Staff arriving to see a patient at a different point during each patient’s pre-op appointment.
- Staff coming to see the patient without knowing if the patient had arrived, was ready, etc.
- Staff seeing the patient without knowing who else has seen the patient already
- More than one staff member arriving to see the patient at the same time.

Through these observations and informal interviews the team concluded that there was no standardized process for staff meeting with patients. The team learned from several staff members that the staff members are not notified when the patient is ready to be seen. The nursing manager for pre-op and post-op told the team that employees are not paged because if they are not in pre-op, they are most likely involved in a procedure in the OR and should not be disturbed. Staff members come to pre-op when they are available to see the patient, and in at least 24% of the observed cases, several staff members were ready to meet with the patient at the same time. Employees are paged by the pre-op clerk only when:

- H&P is missing/incomplete.
- Consent is missing/incomplete.
- Patient has not marked.

Because staff members are not told when the patient is ready to be seen, the observed patients spent 12.2 +/- 7.7 minutes waiting in between staff members on average. The project team discovered that the lack of communication between nursing, anesthesia, and surgery staff members contributes greatly to the patient wait times.

**Change in Nursing Assessment Procedure**

During observations, the team noted that for 30% of the patients, a medical assistant (MA) began the nursing assessment form, and then the pre-op RN would complete the nursing assessment. For the other 70%, the pre-op RN did the entire pre-op nursing assessment. Most of the observations of an RN doing all of the nursing assessment occurred later in the observation period. During an interview with the nursing manager of pre-op and post-op, the team learned that as of early November, medical assistants no longer did any of the nursing assessment.

The team observed that the nursing assessment took 13.4 +/- 4.9 minutes when started by an MA and completed by an RN. Patients also waited 4.6 minutes on average between the MA and RN.
When the RN did the entire nursing assessment, the assessment took 10.8 +/- 3.9 minutes. The team concluded that the change to only RN’s doing the nursing assessment was a time-saving decision. The time to do the assessment was reduced by 2.6 minutes on average, and 4.6 minutes of patient wait time were eliminated.

**Effect of Patient Arrival Time on Process Delays**

In 2003 a project team examined room turnover in the C. S. Mott Children’s Hospital Operating Room\(^3\). The 2003 project team suggested that one reason patients were not getting into the OR at the scheduled surgery time was that some patients do not arrive a full 60 minutes before the surgery time. Because patients arriving late had been identified previously as a reason for delays in the Mott Perioperative process, the current project team compared patient arrival time to total time in the pre-op area. Of the 23 patients observed in pre-op from October 25, 2005 to November 21, 2005, 14 arrived early or on time and nine arrived late. Figures 4 and 5 show the average time spent in pre-op for patients who arrived early or on time and late, respectively.

![Figure 4. Time spent in pre-op for patients who arrived early or on time](image)

\(^3\) Source: C.S. Mott Children’s Hospital Operating Room Surgery Turnover Time Analysis Final Report, December 2003
Figure 5. Time spent in pre-op for patients who arrived late

The current project team did not observe that patients arriving late spent more time in pre-op. Only 33% of patients arriving late spent more than 80 minutes in pre-op, compared with 42% of patients who arrived on time or early. We concluded that late patient arrival is not a major cause of delay in the pre-op area.

**Patient Types**

The project team was asked to determine whether there was a difference in experience in the Mott Perioperative Area for different patient types:

- outpatients who are discharged after surgery (out-out).
- outpatients who are admitted after surgery (out-in).
- inpatients who have surgery and remain in the hospital’s care after surgery (in-in).

Through interviews with Mott Perioperative Area staff, the team determined that inpatients are not seen at all in the pre-op area. All pre-operation care is done in the unit in which the patient is being treated in or PACU. Therefore, our team did not observe the pre-op process for any in-in patients.
Although the majority of the patients observed were outpatients who were discharged after surgery, the team did observe two patients who were admitted after the surgery was complete. Table 3 compares value-added and non value-added time in pre-op for out-out patients and out-in patients.

### Table 3. Value-Added versus Non Value-Added Time in Pre-Op for Outpatients

<table>
<thead>
<tr>
<th></th>
<th>Value-Added</th>
<th>Non Value-Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-In Patients</td>
<td>78.5</td>
<td>49.0</td>
</tr>
<tr>
<td>Out-Out Patients</td>
<td>82.8</td>
<td>51.3</td>
</tr>
</tbody>
</table>

Source: IOE 481 Project Team Observations  
Dates: October 25, 2005 to November 11, 2005  
Sample Size: 21 Patients (First case-of-the day not included)

The team concluded that there was not a significant difference in value-added and non value-added pre-op time between outpatients who are discharged after surgery and outpatients who are admitted after surgery. This confirmed the team assumption that there would not be a significant difference because all of the patients were treated as outpatients prior to surgery.

**Post Anesthesia Care Unit (PACU or Post-Op)**

The patient care process is much different in the post anesthesia care unit from the process in pre-op. The process is more patient driven, which verified by observations and confirmed by the section chief of pediatric surgery. The team discovered that establishing what was value-added time and what was non value-added time was more difficult in post-op because the patient is at different levels of consciousness throughout post-op. However, the team also found that establishing the required steps a patient must go through in post-op was easier than in pre-op because post-op tasks have to be performed more sequentially. Observed patients spent 65.5 +/- 17.7 minutes in post-op on average. The results of the observations are summarized in Appendix D. From these observations, the team developed a current state value stream map of the post-op area. The post-op current state value stream map appears in Appendix F.

**No Major Delays in Patient Flow**

Through a background literature search, observations, and interviews, the team learned that patients are transferred in PACU phase I directly from the OR. Of the 13 patients observed in the PACU, the average time spent in phase I was 38.0 +/- 9.1 minutes. Once the patient is awake and stable enough to move to phase II, they are transferred to phase II. The assessment of stability is done by the RN assigned to the patient in phase I. The average time spent in phase II was 23.5 +/- 16.0 minutes. The patient is then discharged to the guardians and able to leave the hospital. The team concluded that patient flow occurred smoothly though post-op. The team did not discover any major delays in the process.
**No Major Issues in Information and Work Flow**

The transfer of information occurred smoothly overall in the PACU. The purpose of the PACU, to monitor a patient after surgery until the patient is stable enough to go home or be moved to a unit elsewhere in the hospital, demands communication between staff members. Anesthesia arrives with the patient in PACU phase I, and updates the phase I RN responsible for the patient on the patient’s situation. The team observed that on average this transfer of information took 5.5 +/- 2.8 minutes. The next transfer of information occurs between the phase I RN and the phase II RN when the patient is stable enough to be transferred to phase II. The second transfer of information during observations took 2.8 +/- 1.8 minutes. The team concluded that information and work flow occurred smoothly through post-op. The team did not discover any major delays in the process.

**Beds Not Fully Utilized**

The team did random sampling of the bed utilization in phase I and phase II of post-op. Nineteen observations were taken in phase I and also in phase II. The purpose was to determine the extent to which the new area of post-op is being used. Figure 6 shows the average bed utilization in phase I by hour, and Figure 7 shows the average bed utilization in phase II.

![Figure 6. PACU Phase I Bed Utilization](image-url)
Phase I was 62.5% utilized four hours out of the day on average. From 10 AM to 11 AM, phase II was at about 67% of capacity, but the other times the phase II was only up to 39% full. The team determined that neither phase I nor phase II were being fully utilized.

**Patient Types**

The team discovered through interviews and review of past Program and Operations Analysis projects that patients who were being discharged spent time in both phase I and phase II of PACU, while patients who were being admitted or who were remaining inpatients initially come to phase I of PACU but are then transferred to a unit instead of going to phase II. Observations done by the team confirmed this process. Of the 13 patients observed in post-op, one was a patient who was transferred to a room after the patient was stable enough to leave phase I. The length of time this inpatient spent in phase I was 41 minutes. The average time outpatients spent in phase I was 38.0 +/- 9.1 minutes. Forty-one minutes is well within one standard deviation from the mean. There is not a major difference between the time outpatients spend in phase I and the time inpatients spend in phase I.

**Summary of Findings and Conclusions**

The team gathered a lot of information over the course of our project, and as a result we had several important findings and conclusions regarding both the pre-op and post-op processes. These findings and conclusions are summarized in Table 4.
Table 4. Summary of Findings and Conclusions

<table>
<thead>
<tr>
<th>Pre-Operating Area (Pre-Op)</th>
<th>Findings</th>
<th>Conclusions</th>
</tr>
</thead>
</table>
| **Value-Added versus Non Value-Added Time** | °Average time in pre-op: 85.0 +/- 35.8 min  
°Only 24% of patients spent 60 minutes or less in pre-op  
°Value-added time: 33.3 +/- 7.8 minutes (39.2% of total time)  
°Non Value-added time: 51.6 +/- 35.9 minutes (60.8% of total time) | °Majority of patients are spending longer than the scheduled pre-op time of 1 hour in pre-op  
°Majority of time in pre-op is non value-added  
°Large variation in amount of non value-added time  
°Staff spends about the same amount of time with each patient (small variation in value-added time) |
| **Patient Flow Follows Two Paths** | °First-case patients check-in at Pre-Op, then are taken to PACU for all pre-op activities  
°59.7% of first-case patient's time is value-added  
°All other patients have all pre-op activities in the pre-op area | °Further analysis is needed to determine if it is feasible and/or beneficial for all patients to follow the first-case patient flow |
| **Rework in Information Flow** | °Many forms used in pre-op with repetitive information  
°Nursing, anesthesia, surgery all follow different work standards  
°No single document with all pre-op requirements | °Rework a key issue in the pre-op process  
°Work standards are not integrated so rework cannot be eliminated |
| **Lack of Communication in Work Flow** | °No two observed patients had the same pre-op experience  
°Anesthesia and surgery staff come to pre-op when available  
°Patients wait 12.2 +/- 7.7 minutes in between each staff member | °Lack of notification/alert system leads to large patient wait times |
| **Change in Nursing Assessment Procedure** | °30% of observed patients, MA started nursing assessment and RN completed; took 13.4 +/- 4.9 minutes plus 4.6 minutes wait time on average  
°Other 70%, RN did all of nursing assessment; took 10.8 +/- 3.9 minutes  
°Eliminated the process of MA starting assessment in early Nov. | °Changing the process so that RN did all of assessment was a good decision  
°2.6 minutes of process time and 4.6 minutes of wait time were eliminated on average |
### Table 3. Summary of Findings and Conclusions (Continued)

<table>
<thead>
<tr>
<th>Pre-Operating Area (Pre-Op)</th>
<th>Findings</th>
<th>Conclusions</th>
</tr>
</thead>
</table>
| **Effect of Patient Arrival Time on Process Delays** | *34% of patients arriving late spent 60 minutes or less in pre-op  
*only 14% of patients arriving early or on time spent 60 minutes or less in pre-op  
*paticents arriving late are moved up in the process | *Patient arrival time is not a significant cause of delay in the pre-op area |
| Patient Types | *Inpatients do not have pre-op activities done in pre-op  
*Observed out-out patients spent 82.8 minutes in pre-op on average  
*Observed out-in patients spent 78.5 minutes in pre-op on average | *No major differences in pre-op experience between out-out patients and out-in patients |
| Pre-Operating Area (Post-Op) | | |
| **No Major Delays in Patient Flow** | *Post-op much more patient driven than pre-op  
*Tasks occur much more sequentially in post-op  
*Observed patients spent 65.5 +/- 17.7 minutes in post-op on average | *Post-op much less complex in terms of process than pre-op |
| **No Major Issues in Information and Work Flow** | *Average time spent in phase I was 38.0 +/- 9.1 minutes  
*Average time spent in phase II was 23.5 +/- 16.0 minutes. | *No major delays due to patient flow in post-op |
| **Beds Not Fully Utilized** | *Phase I was 62.5% utilized four hours out of the day on average  
*10 AM to 11 AM, phase II was at about 67% of capacity  
*Phase II was only up to 39% full the rest of the day | *Phase I nor phase II were being fully utilized |
| **Patient Types** | *Inpatients are transferred from phase I to a unit  
*Inpatient spent 41 minutes in phase I  
*Outpatients spent 38.5 +/- 9.1 minutes in phase I | *No major difference in phase I for inpatients compared to outpatients |
Recommendations and Implementation

The primary goal of the project was to document and quantify the current state of pre-op and post-op activities, which the team achieved. In addition, the team was also able to achieve the secondary goals of the project, which were to identify some major process delays or other key issues and develop recommendations to address these delays and/or issues. The team's recommendations include uses for the information we obtained during the project, and possible tools for improving the process.

Use of Information

During the project, the team identified some key issues that led to increased patient wait time and employee rework. However, before making changes to processes, the team feels that more study of certain areas is needed. Therefore, the team recommends that two new projects be launched to gather information.

Employee Activities Outside of Pre-Op

The team established that patients spend over 12 minutes on average in pre-op waiting to be seen by the next staff member. In order to implement changes to the process, such as alerting employees when a patient is ready to be seen, a project should be done to determine what employees are doing while a patient is waiting for them in pre-op. It may be that the employee is in the OR, involved in a procedure, and cannot be disturbed. However, employee activities outside of pre-op have not been documented and quantified, so conclusions cannot be drawn about these activities. Job shadowing of nursing, anesthesia, and surgery would help determine possible ways of reducing patient wait time.

Laws, Policies, and Work Standards for Pre-Op Activities

The second project suggestion, to research the laws, policies, and work standards for pre-op activities, was developed after the team discovered that nursing, anesthesia, and surgery gather a lot of the same information regarding a patient. This rework may be due to overlaps in the different departments' work standards. Each employee is required to follow the work standards for his or her department, but the work standards are not integrated across departments. Though the collect of information is regulated by healthcare laws, hospital policies, and department-specific operating standards, all of this information cannot be found in one place. The team spent several hours researching requirements for pre-op and post-op, not a lot of information could be found, and the team determined that more time than we had available would need to be spent on this issue. If this project is launched, staff members from nursing, anesthesia, and surgery should all be consulted in order to guarantee that all of these departments are addressed.
Other Uses of Information

The team hopes that information we obtained during this project will be used as basis for other planned projects as well. Particularly, the team feels that our information regarding post-op bed utilization should be expanded upon, and ideas for utilizing the space more effectively should be developed. Most importantly, we hope that our information will be used to help continuously improve the patient experience in C.S. Mott Children’s Hospital Perioperative Area.

Tools To Improve the Perioperative Area Process

The team discovered that multiple forms are used throughout the Perioperative process, but there is no system for integrating all of this information. Therefore, the team recommends implementing some tools to help make the information more effective.

Electronic Information System

The team strongly believes that the optimal solution would be to go to an electronic system. This would help to eliminate extra forms and guarantee that information is not obtained from the patient more times than necessary. During an interviews, the team discovered that a plan is in place to eventually have all departments of using a computerized system for patient information. A similar system is now being piloted in the main University of Michigan Hospital Operating Department. The team has developed several recommendations for the electronic information system. The system should:

• Incorporate all aspects of the Perioperative Area process into the system.
• Be accessible and used by all employees in all departments.
• Consist of one form screen to used by all employees. This screen should have space for each required piece of information.
• Include a notification system to alert employees when one staff member has completed work with the patient, and the patient is ready to be seen by the next employee.
• Include a method for notifying the pre-op clerk and/or staff member is a specified time period has elapsed and certain information has not been entered. This notification will help reduce patient wait times by encouraging staff members to come to pre-op when the patient is ready.

Employee Task Matrix

In order to begin improving patient wait times in pre-op before an electronic system can be implemented, we recommend forming a team to develop an employee task matrix. The matrix would be a single document that incorporates all healthcare laws, hospital policies and department work standards regarding pre-operation care. The development of this task matrix could be combined with the project suggested previously, which was to research all laws, policies, and work standards surrounding the Perioperative process.
The team developing the matrix would need to include a representative from nursing, anesthesia, and surgery, as well as individuals not directly involved with the pre-op process in order to guarantee all aspects of pre-operating care are incorporated. The matrix would be a chart with employee roles along the top and tasks and/or information needed from the patient along the side. We have developed a basic matrix for a future project team to build on. This matrix appears in Appendix G.

Although the matrix and the electronic information system will help employees understand how their activities fit into the overall process, it will not solve the issue of overlaps in the nursing, anesthesia, and surgery work standards. Ideally, the work standards for all three groups should be revised so that the standards are integrated and the same information is not obtained by multiple groups.

**Summary of Recommendations and Implementation**

The recommendations of the team focus on two key issues: reducing the patient wait time in pre-op by increasing communication between staff and increasing staff awareness of the overall Perioperative Process. We propose two follow up projects to our project. First, a project should be started to document and quantify staff activities beyond the pre-op area. Any non value-added time identified during this project can be eliminated to help reduce patient wait time. A second project should focus on establishing exactly what must be done in pre-op and post-op, and who is required by law, policy, or work standard to do it.

Both of these projects will help in launching an electronic information system in the Mott Perioperative Area by ensuring the system includes all necessary information for nursing, anesthesia, and surgery. While the system is being developed, an employee-task matrix should be created to bring all of the information for all staff members together. Ideally, the matrix should also be used to initiate the integration of work standards for nursing, anesthesia, and surgery so that rework is eliminated.

We intend for the information gathered in this project to be used as a basis for further projects in the C. S. Mott Children’s Hospital Perioperative Area. Our project and future projects will ensure that the patient experience in the Mott Perioperative Area is continuously improved.
Appendix A. Interview Questions

1. What patient information is given to pre-op staff prior to seeing a patient?

2. What information is obtained from the patient in pre-op?

3. What are routine procedures the staff must go through with a patient?

4. Are there specific steps for different types of patients?

5. Where does the patient information collected in pre-op go?

6. What delays are encountered during routine procedures? Are some of these delays unavoidable? Are some of these delays necessary?

7. Is there any delay due to transition of shifts?

8. How many nurses and other employees are staffed in pre-op and post-op?

9. Is there an organizational chart or job descriptions of staff duties?

10. Is there a difference between what is required and what is actually done? Are extra steps taken?

11. What are the average shift times?

12. Are there specific issues that are important to you or your staff that may be preventing them from doing their jobs efficiently, such as incomplete patient information?

13. Any other obstacles aside from time delays?