University of Michigan Health System
Program and Operations Analysis

ANALYSIS OF UNIVERSITY HOSPITAL OPERATING ROOM TURNAROUND TIME

Final Report

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EXECUTIVE SUMMARY

Operating room (OR) personnel in The University of Michigan Health System (UMHS) have become concerned with the amount of time spent between surgical procedures (turnaround time). Turnaround time in the OR is defined as the period from dressing end at the conclusion of a surgical procedure to the first incision on the next case. The OR Core B Manager approached the team for an analysis of the causes of extended turnaround times for orthopedic surgeries at the University Hospital (UH). Furthermore, the OR Core B Manager requested recommendations for minimizing turnaround time, the primary goal of the project.

Methodology

Data collection on the turnaround process began with several informal OR observations. A literature search for current material on the topic was then conducted. The team also had interviews with key personnel involved in the turnaround process.

In total, 16 orthopedic procedures were observed to collect data on the current turnaround process. The collected data, both quantitative and qualitative, was used to determine the current state, develop a future state map, recommend changes, and suggest an implementation strategy. The team also used data from the Operating Room Management Information System (ORMIS)—specifically the OR time records and delay code reasons.

Current State

Figure 1 shows an overview of the current turnaround process.

*Figure 1- High Level Overview of Current State*

Source: P&OA student team OR observations (10.3.2007 – 10.16.2007)

Clean up/re-supply and Room set up are grouped together as there is no defined boundary between the processes.

Table 1 is a summary of turnaround time averages and a segmentation of major contributors to turnaround time.
Table 1-OR Turnaround Time Metrics and Segmentation

Overview

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mean Turnaround Time (min)</td>
<td>100</td>
</tr>
<tr>
<td>Standard Deviation (min)</td>
<td>19</td>
</tr>
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</table>

Turnaround Time Segmentation

<table>
<thead>
<tr>
<th>Time Period</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time PT(s) leaves - Room ready call</td>
<td>18</td>
</tr>
<tr>
<td>Room ready call - Patient arrival in OR</td>
<td>11</td>
</tr>
<tr>
<td>Patient moved to surgery table - First incision</td>
<td>19</td>
</tr>
<tr>
<td>1st time out - Intubation start</td>
<td>13</td>
</tr>
<tr>
<td>All other procedures</td>
<td>39</td>
</tr>
</tbody>
</table>

Source: Overview-ORMIS Data (10.4.2007-10.31.2007)
Turnaround Time Segmentation-P&OA student team OR observations (10.4.2007-10.31.2007)

Note: N = 16

‘% of Total’ numbers are averages from P&OA student OR observations
For complete list of procedures, please see Appendix A

Summary of Findings and Recommendations

The team identified key issues and processes that could be affected to decrease OR turnaround time. Table 2 summarizes the findings and recommendations for each issue.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Findings</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Clean Process</td>
<td>▪ PT(s) arrive in OR after 3 min (avg)</td>
<td>▪ Staff should ‘pre clean’ the OR prior to patient wheel-out</td>
</tr>
<tr>
<td></td>
<td>▪ Average cleaning times:</td>
<td>▪ Two PTs should clean each room</td>
</tr>
<tr>
<td></td>
<td>-2 PTs – 7 minutes</td>
<td>▪ Call PTs 5 minutes prior to patient wheel out</td>
</tr>
<tr>
<td></td>
<td>-3 PTs – 9 minutes</td>
<td>▪ Communication between OR staff and PTs should be standardized</td>
</tr>
<tr>
<td></td>
<td>▪ In 22% of cases, nurses performed some pre-cleaning tasks prior to PT arrival</td>
<td>▪ One PT should stay in the room to assist in opening surgical instruments</td>
</tr>
<tr>
<td>Room Ready Call</td>
<td>▪ There is no standard for room ready call timing</td>
<td>▪ The room ready call should be made as soon as the room is clean</td>
</tr>
<tr>
<td></td>
<td>▪ There is no incentive for the scrub nurse to make the room ready call sooner</td>
<td>▪ A PT should be retained to assist with opening surgical instruments</td>
</tr>
<tr>
<td></td>
<td>▪ No other tasks occur in the OR while instruments are being opened</td>
<td></td>
</tr>
<tr>
<td>Delay in Patient Entering OR</td>
<td>▪ Patients are late in 38% of ortho surgeries</td>
<td>▪ Further examine pre-op procedures to reduce delays</td>
</tr>
<tr>
<td></td>
<td>▪ The average time between the room ready call and patient wheel-in is 12 minutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Missing H&amp;P form and lack of consent are major reasons for late patient arrival</td>
<td></td>
</tr>
<tr>
<td>Patient Type</td>
<td>▪ Inpatients have the highest mean times between room ready call and patient wheel-in, while outpatients have the lowest</td>
<td>▪ Further investigate nurse availability to move inpatients to the OR for surgery</td>
</tr>
<tr>
<td></td>
<td>▪ Median times between room ready call and patient wheel-in are equal for all patient types</td>
<td>▪ Examine the method and timing of communication between the OR and nurses on the floor</td>
</tr>
<tr>
<td></td>
<td>▪ Further examine pre-op procedures to reduce delays</td>
<td>▪ Create a trigger point which determines when the circulating nurse calls for the patient</td>
</tr>
<tr>
<td>Issue (continued)</td>
<td>Findings (continued)</td>
<td>Recommendations (continued)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Staff Arriving to the OR Late | ▪ Attending anesthesiologists and surgeons are late coming to the OR primarily because they did not receive a page indicating they should come to the OR, or they had not yet completed a case in another OR  
▪ The circulating nurse and scrub nurse are often not in the OR after the PTs had completed cleaning the room | ▪ Standardize communication between key OR staff members  
▪ Standardize guidelines for late staff arrival  
▪ Scrub nurses and circulating nurses should not leave the OR following conclusion of the previous procedure |
| Surgeon Scrub-in Process      | ▪ There is no standard time for when surgical staff scrub in                           | ▪ Surgical staff should not scrub in at the same time  
▪ Surgical staff should not wait until just before first incision to scrub in |
| Unassigned Responsibilities   | ▪ Many tasks in the OR lack a specific person assigned to perform them                 | ▪ Tasks should be assigned to OR staff as indicated in Table 5 in the *Unassigned Responsibilities* section |
**Expected Impact**

Based on the below impacts on turnaround time, the team estimates an immediate decrease in average turnaround time from 100 minutes to 77 minutes or 23%. Furthermore, Table 2 includes many ‘intangible’ recommendations such as improving OR communication. The team has not made specific estimates of possible time decreases that may result if these recommendations are adopted.

**Tangible Decreases in Turnaround Time:**
- 18 minutes - Make room ready call when OR is clean
- 3 minutes - PTs enter room immediately
- 3 minutes - Reduce variation in room ready call to patient wheel-in

**Intangible Decreases in Turnaround Time:**
- ‘Pre-cleaning’ of OR prior to patient wheel-out
- Standardize communication between OR staff
- PT stays to assist with room set up
- Pre-op procedure time reduction
- Staff availability to move in-patients from within UMHS
- Reduction in late staff arrival
- Surgeon scrub in procedure
- Assignment of unassigned tasks
- Circulating nurse as ‘Turnaround Champion’ (leadership of process)

**Implementation**

Proper implementation of the project is crucial to the realization of reduced turnaround times. Each circulating nurse should be trained as a Turnaround Champion, to act as principal change agent during each case. The Turnaround Champion will be responsible for fully understanding the results of this report, and ensuring that OR staff will change their work habits accordingly. Turnaround time will be benchmarked at 77 minutes, in accordance with the results of this study. Turnaround Champions will log each turnaround time, and conduct a root cause analysis if turnaround time exceeds 77 minutes.

The results of this report must be clearly and concisely communicated to OR staff by management. All staff should understand what their role is in reducing turnaround time. Staff should undergo training at an initial project kickoff meeting, and this training will be continuously reinforced by Turnaround Champions. After implementation, Turnaround Champions must meet monthly to discuss the current state of OR turnaround, including trends in turnaround time, best practices, and problems encountered during turnaround.
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INTRODUCTION

Recently, operating room (OR) personnel at the University Hospital (UH) in The University of Michigan Health System (UMHS) have become concerned with the amount of time spent between surgical procedures. In particular, the Operating Room Core B Manager is dissatisfied with the amount of time it takes to prepare the OR and ensure that the patient is ready for the next surgery (turnaround time). Turnaround time in the OR is defined as the period from dressing end at the conclusion of a surgical procedure, to the first incision on the next case. Dressing end is the medical term for the procedure to close and cover a patient’s incision with bandages and gauze. The OR Core B Manager approached the team for an analysis of the causes of extended turnaround times and recommendations for minimizing this time.

The team observed 16 surgical procedures to collect data on the current turnaround process for orthopedic surgeries at UH. Specifically, the team conducted time studies on the length of time for important turnaround operations, identified non-optimal processes, interviewed and held discussions with hospital personnel, and obtained electronic data on key OR metrics. The collected data, both quantitative and qualitative, was used to document and determine the current state, develop a future state map, recommend changes and suggest an implementation strategy.

This report is a summary of the project goals, methods, findings, conclusions, recommendations and implementation strategy for reducing turnaround time.

PROTECTED HEALTH INFORMATION DISCLAIMER

All rules and regulations regarding Confidentiality and Protected Health Information (PHI) have been strictly adhered to. The results in this report include only summary information. PHI has been specifically excluded in accordance with the Health Insurance Portability and Accountability Act of 1996 (HIPAA).

BACKGROUND

The current process and key issues were determined through discussions with the UMHS Operating Room Core B Manager, P&OA Management Engineer Fellow, and UMHS personnel.

Current Patient Turnaround Process

The current turnaround process for surgeries in the OR includes the following major steps.

1. Dressing end
2. Account for surgical instruments/sponges
3. Extubate patient (wake up process)
4. Complete relevant paperwork and compile files
5. Wheel patient out of OR
6. Restock supplies
Clean OR and various machines
(8) Arrival of scrub nurse with bipod (instruments and drapes)
(9) Setup tools and machines for next surgery
(10) Layout tools in sterile field
(11) Open sterile tool packages and count tools
(12) Wheel in ‘new’ patient and identify name/procedure (timeout)
(13) Intubate patient (administer anesthesia)
(14) Insert foley
(15) Position patient on surgical bed
(16) Sterilize patient’s skin around incision point
(17) Mark incision lines
(18) Perform initial incision

Figure 2 is a graphical overview of the current turnaround process beginning with dressing and ending with first incision for the next case.

Figure 2 - High Level Overview of Current State

Clean-up/re-supply and room setup are grouped together as there is no defined boundary between these processes.

Involved and Affected Parties in the OR Turnaround Process

Numerous individuals participate in the above process. The following list is arranged in the order personnel generally arrive in the OR at the beginning of a surgery:

- Circulating Nurse
- Scrub Nurse
- Medical Resident and Intern (Anesthesia)
- Medical Resident and Intern (Surgery)
- Attending Surgeon
- Patient
- Attending Anesthesiologist
- Perioperative Technician (PT)

Key Issues

The following is a summary of perceived key issues affecting UMHS OR turnaround time:
- Timing of PTs entering the OR following surgery
- Timing of the room ready call
- Duration of surgical instrument set-up and counting procedures
- Patient delays in entering the OR due to pre-op procedures
- Patient delays in entering the OR due to their patient type (inpatient, outpatient, or admit-day-of procedure)
- Staff arriving late to the OR
- Nonstandard responsibilities for certain OR tasks

Project Scope

This project focuses on the turnaround time (dressing end to incision of the next patient) between orthopedic surgeries in the UMHS OR.

The project did not include analysis of any other OR procedures, events in the Post Anesthesia Care Unit (PACU) or ancillary processes such as tool picking/sterilization, patient registration, patient scheduling and pre-operative tasks. Although no analyses of pre-op procedures were conducted, they are documented or otherwise discussed as a cause of extended turnaround times. Furthermore, although decreased turnaround times may reduce hospital costs, no cost analyses were conducted.

GOALS AND OBJECTIVES

To minimize OR turnaround time, the team focused on the following primary and secondary objectives.

Primary Objectives

- Minimize turnaround time
- Reduce turnaround time variation

Secondary Objectives

- Clarify, reorganize, and standardize personnel tasks
- Ensure surgeries start on time
- Minimize patient and staff wait times
- Improve OR utilization to reduce costs
- Improve patient and staff satisfaction

METHODOLOGY AND VALIDATION

The team collected and analyzed quantitative and qualitative data to reduce turnaround time and variation. This section provides details on the approach the team took to achieve these objectives.
Literature Search

The team conducted a literature search involving resources online and in medical journals. Additionally, the team received previous P&OA project data from a P&OA Management Engineer Fellow. Specifically, the team found the following information:

- Four articles in medical journals describing case studies to improve OR turnaround performance (see Appendix B)
- Information from previous UMHS studies on OR turnaround (see Appendix B)

Interviews

A key aspect of data collection was to interview OR staff and discuss the current turnaround process with hospital personnel.

Informal Discussion

During OR observations, the team informally discussed the turnaround process with staff. Discussion topics included specific processes that may increase turnaround time, root causes of delays and probable solutions.

Formal Interviews

The team also conducted formal 30-60 minute interviews with a circulating nurse, a PT and a scrub nurse. The interviews clarified staff perceptions on turnaround delays, offered a chance for the team to obtain preliminary feedback and raised several issues that had not previously been considered.

Team Observations and Time Studies

The team observed the current OR turnaround process and conducted time studies; recording observations on the data collection sheet (see Appendix C). Key personnel were also questioned before, during and after the surgical procedure to clarify roles and observations.

The team observed 16 complete OR turnarounds during 9 individual visits. The dates and specific procedures are listed in Appendix D. As shown in Appendix A, the time to complete key tasks were recorded for each staff member to create a swim lane chart.

Electronic Data Collection

UMHS keeps detailed computer records of all surgical procedures in a system called Operating Room Management Information System (ORMIS). These records, among other data, detail the times when key events occur. The circulating nurse enters this data before, during, and after a given surgical procedure. Furthermore, personnel delay and patient delay reasons are tracked in ORMIS.
Surgery Specific Data

The team obtained data from ORMIS for orthopedic surgeries, performed in UMHS, from September 4, 2007 through November 15, 2007. Specifically, the team analyzed the following data points from the larger data set:

- Surgery date
- Patient type – Inpatient (IP), Outpatient (OP), Admit-day-of-procedure patients (AP)
- Room ready call time
- Surgery start
- Surgery end
- Room start (patient in)
- Room stop (patient out)

Delay Codes

Delay code data from September 4, 2007 through October 31, 2007 for orthopedic surgeries was also obtained from ORMIS. The data indicates reasons for patient late arrival in the OR and other delays in turnaround (for example, difficult intubation). The delay code data was used to note issues that occur prior to patient arrival in the OR. Specifically, the data for why a patient arrived late in the OR was examined. In addition, the delay code was used to identify why key OR staff were late arriving to the OR.

ORMIS Data and Team Observation Correlation

The data in ORMIS was compared to the data collected by the team. Specifically, a regression analysis was conducted for first incision times of surgeries conducted on October 3, 2007 through November 20, 2007. The correlation coefficient was 99.9% between collected data and ORMIS records (see Appendix E). The high correlation coefficient indicates that the surgery start times are accurately recorded by the circulating nurses. Furthermore, there was a 99% correlation between collected data and ORMIS data for surgery end times (see Appendix E). Given the high degree of correlation between ORMIS records and team observations for two independent data points, the team has determined the ORMIS data is valid for analysis of the current state.

CURRENT STATE

From OR observations (October 3, 2007 – November 20, 2007), the team found averages and standard deviations between key events in the turnaround process. The mean turnaround time is 100 minutes with a standard deviation of 19 minutes. These findings and a detailed segmentation of turnaround time are listed in Appendix A. Furthermore, the team also created a swim lane chart (see Appendix F) showing the procedures performed by the attending surgeon, resident(s), PT(s), circulating nurse, scrub nurse, and anesthesia staff during turnaround time.

Figure 3 details the 4 largest components of turnaround time as a percentage of the total.
The two largest components of turnaround time are:

- Patient moved to surgery table – First incision
- Time PT(s) leaves OR – Room ready call

**PRIMARY ISSUES CAUSING EXTENDED TURNAROUND TIMES**

This section details the primary issues that lead to suboptimal turnaround times.

**Room Clean Process**

Following patient wheel out from the OR, the circulating nurse notifies the PTs that the surgery has been completed, and whether a surgery is scheduled to follow. If a surgery is scheduled to follow, the PT(s) arrive to the OR as soon as possible to begin cleaning.
The following cleanup tasks are completed by the PT(s):

- Remove trash
- Mop floor
- Wipe surgical table
- Set up surgical table
- Wipe pillows and replace pillow cases
- Wipe instrument carts
- Wipe equipment

There is a general perception by OR staff that PT(s) do not arrive in a timely manner and do not clean the room efficiently; leading to extended turnaround times.

**Findings**

After the patient leaves the OR, the nurse alerts the PT(s) that surgery has concluded in one of two ways:

- An announcement is made over the PA system
- PTs are electronically paged

In many cases, PTs are aware of the case’s scheduled end time and wait outside of the OR. The PTs are electronically paged if they do not arrive shortly after an announcement over the PA system. In these cases, often the PTs are cleaning another OR and would not have been able to hear the announcement. UMHS staff has reported a 2 minute lag in the electronic paging system.

The mean time for the PT(s) to arrive in the OR once called was 3 minutes, with standard deviation of 2 minutes. The PT(s) took an average of 8 minutes to complete the tasks listed above. In all cases, 2 or 3 PTs arrived to clean and set the room up for the next case. Respectively, the mean time to clean the OR was 9 minutes or 7 minutes when 2 or 3 PTs arrived.

Prior to the patient being wheeled out of the room and during dressing and extubation processes, the OR staff typically begins to clean and reorganize room. Specifically, in 22% of observed cases, nurses performed at least some tasks traditionally performed by PT(s) following patient wheel out. These tasks include:

- Remove trash
- Wipe surgical table
- Wipe pillows
- Wipe instrument carts
- Wipe equipment
Conclusions

With PTs arriving 3 minutes after notification and taking 8 minutes to clean the OR, the PT(s) do not contribute significantly to extended turnaround times. However, PT tasks, such as wiping the table, pillows, and instrument carts could be performed before the patient leaves the OR. Furthermore, better communication with the PTs would ensure there is not lag time between the PT notification and arrival in the OR.

The number of PTs cleaning the room had a minimal impact (an average of 2 minutes) on how fast the OR was cleaned.

Recommendations

- **OR Pre-clean:** To reduce turnaround time, OR staff not busy during extubation should ‘pre-clean’ the OR, including collecting garbage, taking plastic off of equipment, and moving equipment to their assigned locations.
- **Number of PT(s):** Two PTs should clean the room. Increasing the number of PTs cleaning the room by one decreases the time to clean the room by an average of only 2 minutes. The PTs are busy with tasks besides cleaning rooms, and this is not an efficient use of PT time.
- **PT Call:** Anesthesiologist to notify the circulating nurse 5 minutes before patient wheel out. At this point, the circulating nurse should page the PT(s) to ensure they are ready to enter as the patient leaves.
- **Communication:** To eliminate confusion of PTs to receiving information from multiple sources, communication between the OR staff and PTs should be standardized. Nextel phones or walkie-talkies may be an effective method of standardizing communication. UMHS should further examine various communication options.
- **OR Setup:** After PTs have completed cleaning and setting up the room, 1 PT should stay in the OR to help the scrub nurse or scrub tech open up (see next section, ‘Room Ready Call’)

Room Ready Call

The ‘room ready call’ is a signal to anesthesiology staff that the OR is ready to accept a new patient. Typically, the scrub nurse decides when to make the room ready call, and the circulating nurse will change the room’s status to ‘ready’ through the ORMIS system. This occurs after the scrub nurse has opened surgical instruments to the point where he/she believes the patient can enter the room. The instruments are never completely opened when the scrub nurse makes the room ready call; therefore, the scrub nurse continues to open the instruments after the room ready call. Once the room ready call has been made, the new patient enters the room in accordance with the ‘Delay in Patient Entering OR’ section. Typically, the scrub nurse finishes opening the instruments and counts the instruments after the patient has entered the room.
Findings

The main tasks that the scrub nurse must complete after the OR is clean, but before the surgery starts are as follows:

- Remove instruments from sterile boxes
- Arrange instruments on tables
- Count instruments

The team has identified several problems with the timing of the room ready call.

- The definition of when the room is ‘ready enough’ to make the room ready call varies by scrub nurse.
- In most cases, no other tasks are occurring in the OR when the scrub nurse is opening instruments before the room ready call.
- There is no existing incentive for the scrub nurse to make the room ready call earlier.

Additionally, there is an average 18-minute gap between the PTs leaving the room and the room ready call, shown below in Figure 4.

Figure 4 - On average, there is an 18 minute gap between the PTs leaving and the room ready call.

Both during and after the room ready call, either a PT or a scrub tech will sometimes help the scrub nurse open surgical instruments and set up the tables. Many times the scrub nurse is working alone to accomplish this task, and there is no set responsibility for a specific person to assist in this task.

Conclusions and Recommendations

At present, when the scrub nurse is opening surgical instruments, no other activity is taking place in the OR. Therefore, an opportunity exists for tasks to take place in parallel by moving the room ready call earlier, thus reducing turnaround time.

Since the patient can be moved into the room as soon as the room is clean, the room ready call should be made at this point. Processes such as anesthesia equipment setup and patient intubation, which are affected by moving the room ready call forward by 18 minutes, would occur in parallel with the scrub nurse opening instruments. Therefore, turnaround time could be reduced by average of 18 minutes or by approximately 18% by making this change.
Since the room ready call should be moved forward by an average of 18 minutes, the scrub nurse will have less time to finish opening the surgical instruments and setting up the sterile field. Therefore, after the PTs are done cleaning the room, the scrub nurse must retain 1 PT to help with opening instruments and setting up the sterile field.

**Delay in Patient Entering OR**

At room ready call, anesthesia staff is paged that the patient can be wheeled into the OR. The patient cannot be wheeled into the OR until all pre-op procedures are completed, such as completing the History and Physical (H&P) and Consent forms. A patient is considered late if he/she does not enter the OR within 10 minutes of room ready call.

**Findings**

The team observed that even when the OR was ready, often the patient was not brought into the OR immediately. Figure 5 below shows the time between room ready call and when the patient entered the OR for orthopedic surgeries.

*Figure 5 - Time from Room Ready Call to Patient Entering OR*

![Figure 5 - Time from Room Ready Call to Patient Entering OR](image)

*Source: ORMIS data (9.4.2007 – 10.31.2007)*

*Note: N = 496*
Using the same ORMIS data (September 4, 2007 – October 31, 2007), the average time between the room ready call and the patient entering the OR was 12 minutes, and the patient was late in 38% of all orthopedic surgeries.

Using the delay codes from ORMIS (September 4, 2007 - November 15, 2007), reasons for the patient entering the OR late are summarized below in Figure 6. The file is a compilation of issues encountered during cases where it took the patient more than 10 minutes to arrive after room ready. A delay code was not given in every case where the patient was late.

**Figure 6 - Reasons Patients are Late Entering the OR**

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting on Lab Results</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Scheduling in Pre-op</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>Patient Arrive Late to Pre-op</td>
<td>14</td>
<td>60</td>
</tr>
<tr>
<td>Medical Complications</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>Questions from Patient's Family</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Anesthesia Procedure</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Missing H&amp;P and Consent</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: ORMIS data (9.4.2007 – 11.15.2007)
Note: N = 17

Of the delay reasons of the patient entering the OR late, lack of consent and H&P occurred in 35.3% of the delays. The second most frequent reason of patient entering the OR late was anesthesia procedure, which occurred in 29.4% of delays. The anesthesia procedure includes IV lines being placed, which is a procedure that the anesthesiology staff does not have to perform.

**Conclusions**

Patients arrive late to the OR 38% of the time, significantly impacting turnaround time. To ensure the surgeries start on time, patients must arrive to the OR as soon as possible after the room ready call is made.

**Recommendations**

The team recommends further examining the pre-op procedures—specifically, the H&P and consent form completion process. Another P&OA student team is analyzing pre-op procedures; their report provides specific recommendations for reducing pre-op delays.
**Patient Type**

Patients are categorized as being inpatient (IP), outpatient (OP) or admit-day-of procedure (ADP). Table 3, shows the 3 patient types, the description of each, and how it is perceived to affect turnaround time:

*Table 3 - Patient Type and Turnaround Time*

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>Description</th>
<th>Contribution to Long Turnaround Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient (IP)</td>
<td>Arrive in OR from hospital room within UMHS. Patient will return to hospital room following surgery.</td>
<td>Perceived to take longer than other types as patient must be brought from another department within UMHS (staff availability issue). Patients are also typically ‘sicker’ and may require special care/procedures.</td>
</tr>
<tr>
<td>Outpatient (OP)</td>
<td>Arrive at UMHS for surgery and leave UMHS after surgery.</td>
<td>N/A</td>
</tr>
<tr>
<td>Admit-day-of-procedure</td>
<td>Arrive at UMHS for surgery (not previously admitted). Will not leave UMHS following surgery but will be admitted to a hospital room.</td>
<td>Additional paperwork and coordination done prior to surgery.</td>
</tr>
<tr>
<td>Patient (ADP)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: Discussion with P&OA Management Engineering Fellow (11.27.2007)*

The turnaround times of inpatients are perceived to take the longest, followed by ADPs, then outpatients.

**Findings**

Table 4 shows the percent of cases, based on patient type, when the patient arrived late in the OR (more than 10 minutes after room ready call).

*Table 4 - Percent of Cases When Patient Arrived to OR Late*

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>% of Cases Patient is Late Arriving in OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>41</td>
</tr>
<tr>
<td>OP</td>
<td>34</td>
</tr>
<tr>
<td>ADP</td>
<td>39</td>
</tr>
</tbody>
</table>

*Source: ORMIS data (9.4.2007 – 10.31.2007)*

*Note: N = 40,160, 236 for IP, OP and ADP respectively*
The data in Table 4 indicates that the percent of late arrivals in the OR are similar, irrespective of patient type.

Furthermore, a box plot of the times between room ready call and the patient entering the OR, for each patient type, was generated, shown below in Figure 7.

*Figure 7 - Box Plot of Time Between Room Ready Call and Patient Entering the OR*

![Box Plot](image)

*Source: ORMIS data (9.4.2007 – 10.31.2007)*
*Note: N = 40,160, 236 for IP, OP and ADP respectively*

The box plot shows that the medians for all patient types are 8 minutes. This box plot supports that outliers in IP and ADP cases cause longer mean turnaround and patient arrival times.

**Conclusions**

As perceived, patient type affects OR turnaround time. IPs had the longest turnaround time, and OPs had the shortest turnaround time of the 3 types. As the medians are the same for all patient types longer turnaround in IP and ADP cases result from outliers.

**Recommendations**

Further investigation should be performed on staff availability to move the patient and the method and timing of communication between OR staff and nurses on the floor. A specific trigger point needs to be determined for when the circulating nurse should call to the floor the patient is staying on.
Staff Arriving to the OR Late

Throughout the case, key staff members must be in the OR at certain times. If the right staff members are not available, the surgery start time may be delayed.

Crucial staff members and times include:

- Scrub nurse or scrub tech not in OR after PTs finish cleaning
- Circulating nurse not in room when room ready call should be made
- Anesthesia faculty not in room when patient is in room
- Surgical faculty not in room for patient prep and first incision

Findings

The team used the surgery delay reasons provided by ORMIS data from September 4, 2007 – November 15, 2007. The data is a compilation of issues encountered during cases where specific, predefined procedures took what was perceived to be an inordinate amount of time. There are no standards or guidelines for when these types of delays should be noted. Furthermore, delays caused by the scrub nurse, circulating nurse and PT(s) are not tracked.

When either the attending anesthesiologist or surgeon was late arriving to the OR, the average delay time was 25 minutes. This occurred primarily because these staff members did not receive the page indicating they should come to the OR, or the staff member had not yet completed a case in a different OR. In the latter instance, turnaround time averaged 49% longer.

The team observed that the circulating nurse and scrub nurse are often not in the OR after the PT(s) had completed cleaning. This caused delays in both setting up the OR and consequently when the room ready call could be made.

Conclusions and Recommendations

Availability of key personnel in the OR can cause extended turnaround times.

The team recommends the following changes:

- **Communication:** Communication methods should be standardized and improved between key OR staff members. Nextel phones or walkie-talkies might be effective in this regard.
- **Late Arrival:** Guidelines for late staff arrival should be created and standardized. Specifically, staff should be coded as late if arrival is greater than 5 minutes after notification.
- **Scheduling:** Scheduling procedures and process should be further examined to ensure OR staff will be available in OR when needed as often as possible.
- **Circulating Nurse:** The circulating nurse should not leave the OR following conclusion of the previous procedure. As noted in the ‘Implementation’ section below, the circulating nurse will act as the ‘Turnaround Champion’ to improve efficiency and ensure the room ready call is made prior to the PT(s) completing cleaning tasks.

**Surgeon Scrub-in Procedures**

The attending surgeon and resident surgeons are usually in the room when the patient arrives. Before first incision the resident(s) and attending surgeon need to leave the OR to sterilize. These individuals then return to the OR and put on sterilized scrubs.

**Findings**

Currently there is no standard time for when the attending surgeon and resident surgeon(s) leave the OR to sterilize and come back into the room to put on sterile scrubs (surgeon scrub in procedure). Typically there is 1 attending surgeon and either 1 or 2 resident surgeons in the OR. Often, the attending surgeon and resident(s) will all leave the OR at the same time to begin the scrub in procedure. When the surgeons left the OR all at once, the procedure reaches a standstill and does not continue until they have put on the sterile scrubs. This delay averaged 5 minutes.

**Conclusions and Recommendations**

The time the attending surgeon and resident surgeon(s) leave the OR to scrub in affects turnaround time.

The team recommends that the attending surgeon and resident(s) not leave the OR at the same time to scrub in. The recommended scrub in order is as follows:

- Most senior resident
- Attending surgeon
- Other resident (if present)

This order will ensure that procedures performed prior to first incision can continue while the surgeons (both resident(s) and attending are scrubbing in).

**Unassigned Responsibilities**

A major force inhibiting fast turnaround times is the lack of standardized responsibilities among OR staff. Many tasks that must be performed during the turnaround procedure are completed by the most available or motivated person in the OR, because no one individual is assigned to do so. The lack of responsibilities contributes to an ‘it’s not my job’ mentality in the OR, and significantly slows down turnaround.

**Findings**

The following tasks lack formal responsibility in the OR.
- Setting up surgical bed for the next patient
- Paging the surgical staff to come to the room
- Making the room ready call
- Assisting the scrub nurse to open surgical tools
- Putting drapes on the patient before surgery

**Conclusions and Recommendations**

All of the tasks listed in *Findings* should have OR members assigned to them to increase efficiency. The team recommends that they be assigned as detailed in Table 5, below.

**Table 5 - Recommended Assignments to OR Staff for Unassigned Tasks**

<table>
<thead>
<tr>
<th>Task</th>
<th>Assignment</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting up surgical bed for the next patient</td>
<td>PT</td>
<td>The PTs are trained to set up surgical beds, and should set up the bed directly following room cleaning.</td>
</tr>
<tr>
<td>Notifying the surgical staff to come to the room</td>
<td>Circulating Nurse</td>
<td>The circulating nurse is not sterile and has frequent interaction with ORMIS.</td>
</tr>
<tr>
<td>Making the room ready call</td>
<td>Circulating Nurse</td>
<td>The circulating nurse is not sterile and has frequent interaction with ORMIS.</td>
</tr>
<tr>
<td>Assisting the scrub nurse to count surgical tools</td>
<td>Circulating Nurse</td>
<td>The circulating nurse is one of the only people qualified to help the scrub nurse count surgical instruments. The circulating nurse does not need to be with the patient during intubation or induction.</td>
</tr>
<tr>
<td>Putting drapes on the patient before surgery</td>
<td>Resident Surgeon</td>
<td>Many residents prefer to put drapes on patient themselves.</td>
</tr>
</tbody>
</table>

*Source: P&OA student team OR observations (10.3.2007 – 11.20.2007)*

**FUTURE STATE**

Appendix G details the recommended future state swim lane chart. The chart shows the procedures performed by the attending surgeon, resident(s), PT(s), circulating nurse, scrub nurse, and anesthesia staff during turnaround time. The expected decrease in turnaround time is from 100 minutes (average found through team observations) to 77 minutes, or a 23% decrease.

Figure 8, below displays the expected tangible decreases in turnaround time. Additionally, some process improvements will decrease turnaround time to an extent that we cannot quantify in this report:

- ‘Pre-cleaning’ of OR prior to patient wheel-out
- Standardize communication between OR staff
- PT stays to assist with room set up
- Pre-op procedure time reduction
- Staff availability to move in-patients from within UMHS
- Reduction in late staff arrival
- Surgeon scrub in procedure
- Assignment of unassigned tasks
- Circulating nurse as ‘Turnaround Champion’ (leadership of process)

**Figure 8 – Sources of Tangible Reduction in OR Turnaround Time**

![Pie chart showing sources of reduction in OR turnaround time]

*Source: P&OA student team OR observations (10.3.2007 – 11.20.2007)*

**EXPECTED IMPACT**

The following is a list of possible outcomes from implementing the team’s recommendations:

- Decrease turnaround time by up to 23%
- Decrease turnaround variability
- Assign unassigned processes to a specific job function
- Shift existing responsibilities among personnel
- Change tasks once performed in series to parallel
- Start surgeries on time
- Decrease staff and patient wait time
- Decrease overall system cost due to improved OR utilization
- Increase overall staff and patient satisfaction

**IMPLEMENTATION**

This section provides details on the approach the client should take to implement the results of this study.
Schedule

The following presents a milestone schedule that includes estimated dates for the following events:

- Project implementation kickoff
- Week one project review
- Week four project review
- Monthly turnaround reviews thereafter

Roles and Responsibilities

Each OR staff member must be cognizant of the specific actions that he or she must follow to work toward the goal of reducing turnaround time. The ‘Summary of Recommendations’ section below includes a table outlining the specific actions that each person must take.

Turnaround Champions

Turnaround Champions should be established. Turnaround Champions are specific people present during each case that act as change agents to reduce turnaround time, and inherit the following responsibilities:

- Familiarity with the results of this report
- Complete understanding of what each person must do to reduce turnaround times
- Conviction to continuously push other team members forward, even if the consequences are unpleasant
- Tracking turnaround time (see ‘Benchmarking’ below)
- Analyzing the turnaround process and finding a root cause in the event that the benchmark is not met (see ‘Benchmarking’ below)

The team suggests that each circulating nurse be trained as a Turnaround Champion, since they are not sterile during or before the procedure, and are responsible for using the electronic paging system.

OR Staff

Each team member must make a step-change in work habits to achieve the desired result. Staff members must be aware of what their precise responsibilities are during the turnaround process. Turnaround Champions will facilitate this.

Benchmarking

A patient is considered ‘late’ entering the OR if they enter more than 10 minutes after the room ready call is made. However, there are currently no such goals or metrics in place to measure turnaround time.
A new turnaround benchmark of 77 minutes (as outlined in ‘FUTURE STATE’) should be instated. Turnaround time should be tracked for each case, and there must be a concrete goal of meeting the turnaround benchmark for each case. If the turnaround time exceeds the benchmark, the Turnaround Champion should perform a root cause analysis and log the results. The results will then be presented during monthly Turnaround Champion meetings (see ‘Maintenance’, below), and best practices can be established to avoid these problems in future turnarounds.

Communication

A team approach must be utilized during execution to achieve maximum results, and blame should be avoided. Management must communicate the following basic messages to staff in the most clear, concise, and direct means possible:

- What is the problem, and why is an improvement necessary?
- What steps will be taken to improve the situation?
- Why everyone stands to benefit?
- What is the current state of turnaround (mean time of turnaround), and what is the reduction goal?
- What are each individual’s specific roles and responsibilities pertaining to turnaround?
- Why is it important that everyone change their work habits to achieve the desired results?
- Who are the Turnaround Champions, and what are their roles in implementing this change?
- How have turnaround times decreased due to the results of this project?

Team members should be cognizant of a clearly defined schedule and workflow for the project and discuss the method and tools for internal review, control, and direction. The schedules for all major activities, including required reviews, should be identified.

Training

OR staff should be trained in their roles and responsibilities during the initial kickoff meeting. At the week one project review, management must continue to emphasize the importance of this project, regardless of the initial difficulty inherent in any major workflow change.

New staff must be made aware of the importance of short turnaround times in the OR, and the specific task in the process for which they are responsible.

Maintenance

Even if the results of this study are successfully implemented, the turnaround process will require continuous maintenance to ensure turnaround times remain low. Monthly meetings among Turnaround Champions must take place, where each Champion gives a ‘case study’ of a problem that they observed in turnaround over the previous month, and what can be done to correct that problem. Data detailing the average turnaround time over the past month, and the trend over the last 12 months should be presented to help quantify process improvements. The
goals of these monthly meetings are to keep Turnaround Champions cognizant of their responsibilities in maintaining a short turnaround time.

_Benchmarking_

In the interest of continuous improvement, turnaround benchmark times should continuously be lowered. Once 90% of turnarounds meet the benchmark, the turnaround process should be analyzed to determine how to make further improvements. At this point, new recommendations can be given and a lower benchmark set.
APPENDIX A – Components of Turnaround Time (Team Observations)

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Average (min)</th>
<th>Standard Deviation (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressing End</td>
<td>Extubation start</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Extubation start</td>
<td>Extubation end</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Extubation end</td>
<td>Patient wheel out</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Patient wheel out</td>
<td>Call for PT(s)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Call for PT(s)</td>
<td>Time PT(s) enters</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Time PT(s) enters</td>
<td>Time PT(s) leaves</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Time PT(s) leaves</td>
<td>Room Ready Call</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>Room Ready Call</td>
<td>Patient arrival in the OR</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Patient arrival in the OR</td>
<td>1st time out</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1st time out</td>
<td>Intubation start</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Intubation start</td>
<td>Intubation end</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Intubation end</td>
<td>Moved to surgery table</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Moved to surgery table</td>
<td>First incision</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total Process</strong></td>
<td><strong>100</strong></td>
<td><strong>19</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: P&OA student team OR observations (10.3.2007 – 11.20.2007)

Note: Average and standard deviation times are in minutes
APPENDIX B – Literature Search: Bibliography

Medical Journals:


Previous UMHS Studies:


### OR OBSERVATION LOG

**IOE 481 - OR Turnaround Time**

| Yoko Konishi | Thomas J. Steiner | Michael A. Voice |

#### General Information

<table>
<thead>
<tr>
<th>Date</th>
<th>Procedure</th>
<th>Procedure number</th>
<th>Scheduled surgery start</th>
<th>Scheduled surgery length</th>
<th>Attending surgeon</th>
</tr>
</thead>
</table>

#### Key Event Timeline

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Ready Call</td>
<td></td>
</tr>
<tr>
<td>Patient arrival in the OR</td>
<td></td>
</tr>
<tr>
<td>Patient moved onto surgery table</td>
<td></td>
</tr>
<tr>
<td>1st time out</td>
<td></td>
</tr>
<tr>
<td>Intubation start</td>
<td></td>
</tr>
<tr>
<td>Intubation end</td>
<td></td>
</tr>
<tr>
<td>First incision</td>
<td></td>
</tr>
<tr>
<td>Dressing end</td>
<td></td>
</tr>
<tr>
<td>Exutubation start</td>
<td></td>
</tr>
<tr>
<td>Exutubation end</td>
<td></td>
</tr>
<tr>
<td>Patient wheel out</td>
<td></td>
</tr>
<tr>
<td>Call for PT(s)</td>
<td></td>
</tr>
<tr>
<td>Time PT(s) enters</td>
<td></td>
</tr>
<tr>
<td>Time PT(s) leaves</td>
<td></td>
</tr>
</tbody>
</table>

#### Observations

<table>
<thead>
<tr>
<th>Question</th>
<th>Check if Yes</th>
<th>Other Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient arrived in OR</td>
<td></td>
<td>Why was patient late-</td>
</tr>
<tr>
<td>Patient shaved in the OR</td>
<td></td>
<td>Time required-</td>
</tr>
<tr>
<td>Arterial line needed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who puts drapes on patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurses perform PT tasks prior to wheel out</td>
<td></td>
<td>Garbage moved to hall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instruments removed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Person-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machines (cauterizing etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disconnected/moved away</td>
</tr>
<tr>
<td>How many PT's arrive</td>
<td></td>
<td>Arrive at same time</td>
</tr>
<tr>
<td>Foley used</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Other Notes

- What condition is the room in @ room ready call-
- Scrub nurse scrubbed in?
- How far a long in tool opening?

#### Additional Notes

Make other notes on back of sheet
## APPENDIX D – OR Surgeries Observed

<table>
<thead>
<tr>
<th>Date</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.03.2007</td>
<td>Lameinecomies</td>
</tr>
<tr>
<td>10.16.2007</td>
<td>Lameinecomies</td>
</tr>
<tr>
<td>11.05.2007</td>
<td>Orif Ankle Right Medial Mal</td>
</tr>
<tr>
<td></td>
<td>Orif Ankle Right Medial Mal</td>
</tr>
<tr>
<td>11.06.2007</td>
<td>Foraminal Microdiscectomy</td>
</tr>
<tr>
<td></td>
<td>L-45 decompression &amp; posterior lumbar spinal fusion</td>
</tr>
<tr>
<td>11.07.2007</td>
<td>Total Hip Arthroplasty</td>
</tr>
<tr>
<td></td>
<td>Hemi Arthroplasty</td>
</tr>
<tr>
<td>11.08.2007</td>
<td>NKDA</td>
</tr>
<tr>
<td>11.12.2007</td>
<td>Microdisectomy</td>
</tr>
<tr>
<td></td>
<td>Lameinecomies</td>
</tr>
<tr>
<td></td>
<td>Posterior Fusion</td>
</tr>
<tr>
<td>11.14.2007</td>
<td>Left knee replacement</td>
</tr>
<tr>
<td></td>
<td>THA (Left)</td>
</tr>
<tr>
<td>11.20.2007</td>
<td>Laminectoney</td>
</tr>
<tr>
<td></td>
<td>Exc. Prominent Spinous</td>
</tr>
</tbody>
</table>

*Source: P&OA student team OR observations (10.3.2007 – 11.20.2007)*
APPENDIX E – Regression Analysis of P&OA Student Team Observation and ORMIS Data

First Incision Times
ORMIS Data = 0.000675 + 0.9984 Team Observation

Sources: ORMIS data and OR observations (10.3.2007 – 11.20.2007)

Dressing End Times
ORMIS Data 2 = 0.02155 + 0.9561 Team Observation 2

Sources: ORMIS data and OR observations (10.3.2007 – 11.20.2007)
APPENDIX F – Current OR Swim Lane Chart

Source: P&OA student team OR observations (10.3.2007 – 11.20.2007)
## APPENDIX G – Future OR Swim Lane Chart

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Anesthesia</th>
<th>Resident</th>
<th>Circulating Nurse</th>
<th>Scrub Nurse</th>
<th>PT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extubation procedure</td>
<td>Equipment set-up</td>
<td>Induction and set-up</td>
<td>Intubation procedure</td>
<td>Room set up, assisting Scrub nurse, data entry</td>
</tr>
<tr>
<td></td>
<td>Prep work, scrub in procedure, instruction, assist with set up</td>
<td>Patient monitoring</td>
<td>Prep work, scrub in procedure, instruction from surgeon, assist with set up</td>
<td>Assisting Surgeon</td>
<td>Circulating</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assist Opening Instruments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assist Opening Instruments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mop floor, take out trash</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Recommended First Incision

<table>
<thead>
<tr>
<th>Current First Incision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

### Room Ready Call

- Patient Wheel Out, PTs Enter
- Patient Arrival in OR
- Time Out
- Instubation Start
- Instubation End
- Patient Moved to Surgery Table

### Dressing End

- Prep work, scrub in procedure, resident instruction, assist with set up
- Performing Surgery
- Assisting Surgeon
- Scrub Nurse
- PT

### Extubation End

- Mop floor, take out trash
- 105

### Patient Monitor

1. initial
2. end
3. current first incision