University of Michigan Health System
Program and Operations Analysis

Current State Analysis of the Main Adult Emergency Department
Final Report

To: Jeff Desmond MD, Clinical Operations Manager – Emergency Department
   Steve Kronick MD MS, Associate Service Chief – Emergency Medicine
   Sam Clark, Industrial Engineer Lead and Lean Coach, Program and Operations Analysis
   Mark Van Oyen Ph. D., Associate Professor – Industrial and Operations Engineering 481

From: Industrial and Operations 481 Group 2, Program and Operations Analysis
   Daniel Bruce
   Joseph Du
   Trevor Young

Date of Submission: December 17, 2009
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES AND TABLES</td>
<td>3</td>
</tr>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>4</td>
</tr>
<tr>
<td>Background</td>
<td>4</td>
</tr>
<tr>
<td>Approach and Methodology</td>
<td>4</td>
</tr>
<tr>
<td>Performed Literature Search</td>
<td>4</td>
</tr>
<tr>
<td>Observed the Main Adult ED</td>
<td>4</td>
</tr>
<tr>
<td>Created Flowchart of Current Patient Exam Room Arrival Process</td>
<td>5</td>
</tr>
<tr>
<td>Performed Provider Task Breakdown Beeper Study</td>
<td>5</td>
</tr>
<tr>
<td>Performed Provider Patient Capacity Beeper Study</td>
<td>5</td>
</tr>
<tr>
<td>Analyzed Beeper Study Data</td>
<td>5</td>
</tr>
<tr>
<td>Analyzed Centricity Data</td>
<td>5</td>
</tr>
<tr>
<td>Findings and Conclusions</td>
<td>5</td>
</tr>
<tr>
<td>Recommendations</td>
<td>5</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>6</td>
</tr>
<tr>
<td>BACKGROUND</td>
<td>6</td>
</tr>
<tr>
<td>KEY ISSUES</td>
<td>7</td>
</tr>
<tr>
<td>GOALS AND OBJECTIVES</td>
<td>8</td>
</tr>
<tr>
<td>PROJECT SCOPE</td>
<td>8</td>
</tr>
<tr>
<td>APPROACH AND METHODOLOGY</td>
<td>8</td>
</tr>
<tr>
<td>Performed Literature Search</td>
<td>9</td>
</tr>
<tr>
<td>Observed the Main Adult ED</td>
<td>9</td>
</tr>
<tr>
<td>Performed Provider Task Breakdown Beeper Study</td>
<td>9</td>
</tr>
<tr>
<td>Performed Provider Patient Capacity Beeper Study</td>
<td>10</td>
</tr>
<tr>
<td>Analyzed Beeper Study Data</td>
<td>11</td>
</tr>
<tr>
<td>Analyzed Centricity Data</td>
<td>11</td>
</tr>
<tr>
<td>Presented Results and Recommendations to Clients</td>
<td>11</td>
</tr>
<tr>
<td>FINDINGS AND CONCLUSIONS</td>
<td>12</td>
</tr>
<tr>
<td>Main Adult ED Observations</td>
<td>12</td>
</tr>
<tr>
<td>Flowchart of Current Patient Exam Room Arrival Process</td>
<td>12</td>
</tr>
<tr>
<td>Provider Task Breakdown Beeper Study</td>
<td>14</td>
</tr>
<tr>
<td>Overall Provider Task Breakdown Findings</td>
<td>14</td>
</tr>
<tr>
<td>Overall Provider Task Breakdown Conclusions</td>
<td>15</td>
</tr>
<tr>
<td>Provider Task Breakdown by General Tasks Findings</td>
<td>15</td>
</tr>
<tr>
<td>Provider Task Breakdown by General Tasks Conclusions</td>
<td>18</td>
</tr>
<tr>
<td>Overall Task Breakdown by Four-Hour Time Shifts Findings</td>
<td>18</td>
</tr>
<tr>
<td>Overall Task Breakdown by Four-Hour Time Shifts Conclusions</td>
<td>19</td>
</tr>
</tbody>
</table>
LIST OF FIGURES AND TABLES

Figure 1: Flowchart of the Golden Rod Box Queuing System ................................................... 13
Figure 2: Percent of Time EM2’s Spend on Tasks ..................................................................... 15
Figure 3: Percent of Time EM3’s Spend on Tasks ..................................................................... 16
Figure 4: Percent of Time EM4’s Spend on Tasks ..................................................................... 16
Figure 5: Percent of Time IM’s Spend on Tasks ........................................................................ 17
Figure 6: Percent of Time PA’s Spend on Tasks ........................................................................ 17
Figure 7: Percent of Time Attendings Spend on Tasks .............................................................. 18
Figure 8: Probability of Taking Another Patient vs. Number of Current Patients ................. 21
Figure 9: Time of Day and Number of Marks for the Response “No One to See” ............... 21
Figure 10: Reasons Providers Cannot Take a New Patient ......................................................... 23
Figure 11: Reasons Providers Cannot See Another Patient – Excluding “No One to See” .... 24
Figure 12: Average Room to Doctor Time by Shift for Week of Workload Study ............... 26
Figure 13: Average Room to Doctor Time by Shift for Month of November, 2009 ........... 27
Figure 14: Patient Evaluation Percentages for 3pm – 7pm and 7pm – 11pm Shifts ............... 28
Figure 15: Patient Evaluation Data Points Fit Normal Distribution ......................................... 29
Figure 16: Average Room to Doctor Time by Day for Month of November, 2009 ............ 30

Table 1: Provider Task Breakdown ............................................................................................ 14
Table 2: Task Breakdown by 4 Hour Shifts ............................................................................... 19
Table 3: Percent Utilization by Shift .......................................................................................... 31
Table 4: Provider Tasks Performed During Highest and Lowest Percent Utilization Shifts .... 31
EXECUTIVE SUMMARY

The Emergency Department (ED) at the University of Michigan Health System (UMHS) is currently undergoing a continuous improvement project to improve flow and reduce the overall length of stay (LOS) of its patients. More specifically, the ED would like to reduce the amount of time that a patient spends in the exam room before a provider (physician, resident, intern, or physician assistant) arrives. To assist the ED with the current project, the Clinical Operations Manager, the Associate Service Chief, and the Industrial Engineer Lead and Lean Coach asked the team to analyze and quantify the current state of the ED.

Background

In order to perform a continuous improvement project on the Main Adult ED, the ED needs to determine the current process flow of patients into the Main Adult ED. Currently, the process flow is centralized around the “Golden Rod Box”, a box located in the Main ED that holds multiple golden rods. (A golden rod is a yellow piece of paper that has information about a single patient who is currently in an exam room but is not yet assigned a provider.) There are several flow-related problems with the Golden Rod Box: it is the only signal for providers to show there are new patients who require assistance; it is unorganized; and it is not always up-to-date. Also, the Whiteboard (a large electronic computer screen) shows important, relevant patient data, yet is not used as a signal for the providers that a new patient is available. Thus, this process needs to be changed to produce increased patient flow.

In addition to changing the Golden Rod Box process, the ED is interested in quantifying the current state of the staff and processes. More specifically, it would like to know how often providers are performing their daily tasks, how a provider determines whether or not they can take another patient, and how the percent occupancy of the ED affects patient wait-times.

Approach and Methodology

Performed Literature Search. The first task the team performed was searching for past IOE 481 class projects which dealt with similar ED projects. Certain forms, along with other ideas, used in the teams studies were based off of forms found in the reports of the previous projects.

Observed the Main Adult ED. Next, the team observed the Main Adult ED for 20 hours over 5 shifts that represented various days. Observation included taking notes and questioning providers about the Golden Rod Box patient queuing system.
**Created Flowchart of Current Patient Exam Room Arrival Process.** The team created a flowchart of the current Golden Rod Box queuing system. The flowchart followed the process that takes place when a patient is waiting in an exam room for a provider.

**Performed Provider Task Breakdown Beeper Study.** The team performed a daily task breakdown beeper study to determine the percent breakdown of each task performed. This was done by sampling the providers with beepers set to vibrate roughly four times per hour. Every time the beeper vibrated, the provider recorded the time and the current task they were performing.

**Performed Provider Patient Capacity Beeper Study.** The team performed a provider patient capacity beeper study to determine the capability of the providers to take another patient. This was completed by sampling the providers with beepers set to vibrate roughly four times per hour.

**Analyzed Beeper Study Data.** The team used Microsoft Excel and Microsoft Access to analyze the collected beeper study data. The data was analyzed by both shift and provider-type.

**Analyzed Centricity Data.** The team analyzed Centricity data and compared the data to the results from the beeper studies using Microsoft Excel and Minitab. Statistical significance tests were used to determine whether or not the differences of provider tasks was significant.

**Findings and Conclusions**

After analyzing the task breakdown beeper study data, the team found that the most-performed task by all providers was patient evaluation. The second most-performed task was communicating patient care for all providers except attending physicians whose second most-performed task was documentation. However, at this point, the third, fourth, etc. most-performed tasks varied by provider type.

The results of the provider patient capacity beeper study showed that, for all providers, as they took on more patients, the probability that they could take on another patient decreased. However, when analyzed by time of day, the data showed that there was no correlation between the hour of the day and whether or not a provider could take another patient.

The results of the Centricity analysis showed that patient average wait-time doubles from 38 to 76 minutes between 3pm and 11pm. However, this increase in wait-time is not a result of the current state. It is a result of the previous 12 hours. From 7am to 7pm, the percent occupancy (number of exam rooms used divided by number of total exam rooms) doubles from 36% to 72%, thus, delaying the increase in patient-wait time until later in the day.

Although the Centricity analysis showed that there was a relationship between percent occupancy and average patient wait-time over the course of the day, no relationship was found when comparing these variables on a day to day basis. In other words, there did not seem to be a correlation between percent utilization and average patient wait-time for any given day.

**Recommendations**
After observing the ED, the team has recommended the following:

- Improve Golden Rod sheets
- Invest in a transparent Golden Rod Box that opens from both sides
- Group the patient priority levels by each drawer of the Golden Rod Box
- Move the Golden Rod Box to a more convenient location for the providers
- Implement the Whiteboard as a more effective signal for the providers

INTRODUCTION

The Emergency Department (ED) at the University of Michigan Health System (UMHS) is currently performing a continuous improvement project to reduce the length of stay (LOS) of patients. LOS is defined as the time between the point at which a patient enters the hospital and the point at which the patient leaves the hospital. One process that contributes to the LOS is the amount of time a patient waits in the examination room to be seen by a provider. Attending physicians (attendings), emergency medicine physicians (EM’s or residents), Internal Medicine Physicians (IM’s), and Physician Assistants (PA’s) are all categorized as providers. The ED believes that patient examination room wait time is greater in the Main Adult ED than it is in the Children’s Emergency Services (CES). The ED wants to focus part of their continuous improvement project on reducing patient examination room wait time in the Main Adult ED in order to increase patient throughput, and ultimately leading to decreasing the overall LOS of the patient.

However, the ED does not have enough data on the current day to day operations of the Main Adult ED to start a continuous improvement project to reduce the patient examination room wait time. Therefore, the ED asked the Industrial and Operations (IOE) Team 2 to gather and analyze more current state data on the Main Adult ED. The ED wants the team to determine the current process flow of patients into the Main Adult ED, gather data on the percent of time providers spend on certain tasks throughout the day, gather data on the patient capacity of providers and barriers to treating another patient during their shift, and analyze Centricity data on patient wait times, Main Adult ED occupancy, and percent utilization of Main Adult ED rooms. After determining current Main Adult ED process flow and analyzing data, the team will provide the ED with a better understanding of the current state of the Main Adult ED, which will then allow the ED to begin the continuous improvement project. The purpose of this final report is to present the background, goals, methods, findings, conclusions, and recommendations from the team’s project.

BACKGROUND

The ED includes four divisions: CES, Minor Adult Care Area (MECA), Main Adult ED, and Michigan Emergency Department Care Area (MEDPATH). The Main Adult ED is open 24 hours a day 7 days a week and treats the majority of adult patients as well as some pediatric patients. CES is only open from 11 am to 1 am everyday and only treats patients under the age of 18. If the CES is closed and a patient under the age of 18 needs care, the patient is sent to the Main Adult ED. MECA is open from 5 pm to 1 am everyday and treats patients with minor
conditions. Finally, MEDPATH is open 24 hours a day 7 days a week and treats patients who are expected to have long ED stays, but are waiting for a bed to become available in a nursing unit.

The ED is one of two main portals for a patient to enter the hospital. Therefore, the flow of the ED is very important to overall hospital operations. One of the most important hospital operations measurements being studied today is the LOS of patients. As part of a continuous improvement project, the ED is looking to reduce the LOS of patients. The shorter the LOS, the greater patient throughput, which means more patient’s can be seen each day. One portion of LOS is the amount of time a patient waits in an examination room to be seen by a provider. The ED believes that CES exam room wait times are shorter than Main Adult ED exam room wait times. The ED wants to perform a continuous improvement project on the Main Adult ED in order to shorten the patient examination room wait time.

In order to perform a continuous improvement project on the Main Adult ED, the ED needs to determine the current process flow of patients into the Main Adult ED. Currently, the Main Adult ED uses a “Golden Rod” system when patients enter an examination room. When a patient enters the ED, he or she is sent to triage in order to assess the severity of the patient’s problem and assign the patient a priority level. The patient’s information and priority level is written on a golden colored form known as a “Golden Rod”. When the patient is called to leave the waiting room and enter an examination room, the patient’s Golden Rod is placed in the “Golden Rod Box” based on priority level. Providers then go to the Golden Rod Box and choose the Golden Rod with the highest priority assigned to it as the next patient to visit. The ED is unsure of the effectiveness of the Golden Rod Box system and asked the team to analyze and look for improvements.

In addition to observing patient flow into the Main Adult ED and analyzing the Golden Rod Box system, the ED needs data on current state operations of the Main Adult ED in order to perform a continuous improvement project on patient examination room wait time. Centricity, a software used to help manage hospital operations at UMHS, currently collects data which describes the current state of the Main Adult ED, including: patient arrival rates, patient waiting room wait time, patient examination room wait time, occupancy levels, room utilization, and other hospital operation statistics. However, even though Centricity collects the data, no one is assigned to analyze the data. Also, there is more potential data which would help describe the current state of the Main Adult ED not collected by Centricity. The ED wants the team to determine current process flow of patients into the Main Adult ED, gather data on the percent of time providers spend on certain tasks throughout the day, gather data on the patient capacity of providers and barriers to treating another patient during their shift, and analyze Centricity data on patient wait times, Main Adult ED occupancy, and percent utilization of Main Adult ED rooms. After determining current Main Adult ED process flow and analyzing data, the team will provide the ED with a better understanding of the current state of the Main Adult ED, which will then allow the ED to begin the continuous improvement project.

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

- The ED is performing a continuous improvement project
- The ED believes patient examination room wait times are longer in the Main Adult ED than in CES
- The ED currently does not have a process map of the Golden Rod Box system
- The ED currently has Centricity data, but no one has analyzed it to determine the Main Adult ED’s current state
- The ED needs more detailed data collected and analyzed to gain a better understanding of the Main Adult ED’s current state

GOALS AND OBJECTIVES

The original goal of this project was to reduce the amount of time a patient waits in the examination room of the Main Adult ED to be seen by a provider. As the project progressed and data was collected, the team in conjunction with Dr. Desmond, Dr. Kronick, Sam Clark, and Professor Van Oyen, decided the project would be more beneficial if the focus was on continuing to collect further data. As a result, the final goal of the project was to gather and analyze data on the Main Adult ED in order to quantify the current state. To achieve the final goal, the team completed these secondary objectives:

- Determine the breakdown of how providers use their time throughout the day
- Clarify the patient capacity of providers
- Examine the barriers for a provider to treat another patient
- Establish the process flow of patients entering an exam room of the Main Adult ED
- Improve Golden Rod Box system
- Determine provider tasks during busy and slow work periods

PROJECT SCOPE

The scope of this project included collecting and analyzing current state data on the Main Adult ED and determining the process flow of patients entering an exam room of the Main Adult ED, including analyzing the Golden Rod Box system. The scope of this project did not include collecting or analyzing data in any other area of the ED besides the Main Adult ED.

APPROACH AND METHODOLOGY

The team used the following approach and methodology to determine the current Main Adult ED process flow and provide the ED with a better understanding of the current state of the Main Adult ED: performed literature search, observed the Main Adult ED, created flowchart of current patient exam room arrival process, performed provider task breakdown beeper study, performed provider capacity beeper study, analyzed beeper study data, analyzed Centricity data, and presented results and recommendations to clients.
Performed Literature Search

The first task the team performed was searching for past IOE 481 class projects which dealt with similar ED projects. The team hoped that past projects would generate ideas as well as provide insight and relevant data for the team’s current project.

The first former IOE 481 relevant project the team found was titled, “Emergency Department Attending Management of Transfer Phone Calls and Activities” and was submitted April 27, 2009. The purpose of this project was to analyze the impact of phone calls on the attendings’ time, identify the activities the attendings perform, and develop recommendations for improvement. This report helped the team identify data to be collected for the provider task beeper study.

Another former IOE 481 relevant project the team found was titled, “Improving Patient Throughput in the Emergency Department” and was submitted on December 13, 2004. The purpose of this report was to conduct a series of studies on physician workflow, patient flow options, and work distribution strategies in order to generate recommendations for improving patient throughput. This report was very similar to the team’s current project and helped the team determine what data to collect.

Finally, Soroush Saghafian provided the team with a document titled, “How Do Nurses and Physicians Spend Their Time in the Emergency Department?” This document discussed data relative to the team’s current project.

Observed the Main Adult ED

The team observed the Main Adult ED for 20 hours over 5 shifts that represented various days. This variation of observation ensured that the team observed the Main Adult ED under several different conditions and circumstances to have a better understanding of the processes. Observation included taking notes and questioning providers about the Golden Rod Box patient queuing system.

Created Flowchart of Current Patient Exam Room Arrival Process

After observing the Main Adult ED and taking notes on the patient arrival process, the team created a flowchart of the current Golden Rod Box queuing system. The flowchart would establish the current state process of what takes place between the time when a patient is brought to an examination room to when a provider enters the examination room. The flowchart was created using Microsoft Visio software.

Performed Provider Task Breakdown Beeper Study

In order to determine the percent of time providers spent on various tasks throughout the day, the team performed a provider task breakdown beeper study. The team collaborated with Dr. Desmond, Dr. Kronick, and Sam Clark to create a beeper study task sheet, which would be filled
out by providers during the beeper study. The beeper study task sheet was broken into the following major categories: coordinate patient flow, educating, direct patient care, indirect patient care, documentation, non-clinical interaction with staff, personal time, and other. Some of the major categories had secondary categories also. The beeper study task sheet can be viewed in Appendix A. Sam Clark provided the team with 9 beepers from the Program and Operations Department.

The study was conducted for 7 days from November 10, 2009 through November 17, 2009. During these 7 days, 6 different provider positions wore a beeper that vibrated an average of 4 times an hour. These provider positions were EM2, EM3, EM4, IM, PA, and Attending. When the beeper vibrated, the provider checked off what task they were currently performing on the beeper study task sheet. For the first two days, a team member was present during the 7 am, 3 pm, and 11pm shift changes to explain to each provider why the beeper study was being performed, how to fill out the task sheet, and where to return the sheets and beepers. Dr. Desmond also informed the Main Adult ED staff about the beeper study. After the first two days, a team member was present once every day to make sure the forms were being filled out properly and the beepers were working.

**Performed Provider Patient Capacity Beeper Study**

In order to determine what the maximum number of patients a provider could treat efficiently, the team performed a provider patient capacity beeper study. The team collaborated with Dr. Desmond, Dr. Kronick, and Sam Clark to create a beeper study capacity sheet, which would be filled out by providers during the beeper study. The beeper study capacity sheet first asked the provider how many patients he or she was actively managing. Active patients included patients handed off to the provider during a shift change. Next, the beeper study task sheet asked the provider if they could see another patient within the next five minutes. If the provider answered no, he or she would check off one of the following options for why not: at capacity, near end of shift, no one to see, need to do documentation, personal needs, and other. From these responses, the team could determine how many patients a provider can typically manage and the reasons why a provider could not treat another patient. The beeper study task sheet can be viewed in Appendix B. Sam Clark provided the team with 9 beepers from the Program and Operations Department. These were the same 9 beepers used for the provider task breakdown beeper study.

The study was conducted for 7 days from November 17, 2009 through November 24, 2009. During these 7 days, 6 different provider positions wore a beeper that vibrated an average of 4 times an hour. These provider positions were EM2, EM3, EM4, IM, PA, and Attending. When the beeper vibrated, the provider wrote the number of patients they were actively managing, if they could see another patient within the next five minutes, and if they answered no, why they could not. For the first two days, a team member was present during the 7 am, 3 pm, and 11pm shift changes to explain to each provider why the beeper study was being performed, how to fill out the task sheet, and where to return the sheets and beepers. Dr. Desmond also informed the Main Adult ED staff about the beeper study. After the first two days, a team member was present once every day to make sure the forms were being filled out properly and the beepers were working.
Analyzed Beeper Study Data

After the completion of both beeper studies on November 24, 2009, the team divided the beeper study sheets between members and entered the responses into a Microsoft Excel template. The template was created in conjunction with Sam Clark and was set up so the data could also be analyzed in Microsoft Access.

For the provider task breakdown beeper study, the team performed analysis on the following: percent of time providers spend on tasks, percent of time providers spend on direct patient care, indirect patient care, and other tasks, percent of time spent on tasks during 4 hour shifts throughout the day, percent of time spent on direct patient care, indirect patient care, and other tasks during 4 hour shifts throughout the day, and comparing what tasks are performed during the highest occupancy times versus what tasks are performed during the lowest occupancy times. In order to obtain this information, the team ran multiple queries in Microsoft Access and placed the results of these queries into an Excel document. The team then created tables, pie charts, and bar graphs to help analyze the data.

For the provider patient capacity beeper study, the team performed analysis on the following: probability a provider would take another patient, predicting whether or not a provider will take another patient based on the number of patients he or she is currently treating, and determining reasons why a provider cannot take another patient. In order to obtain this information, the team ran multiple queries in Microsoft Access and placed the results of these queries into an Excel document. The team created scatter plots comparing the probability of a provider taking another patient versus the number of patients the provider was currently treating, regression lines for the scatter plots, and pie charts comparing reasons why providers could not treat another patient.

Analyzed Centricity Data

After the completion of both beeper studies on November 24, 2009, the team also analyzed Centricity data and compared the data to the results from the beeper studies. Sam Clark obtained the Centricity data for the entire month of November. The data contained the average occupancy, average number of room’s open, percent utilization of rooms, average patient waiting room wait time, and average patient examination room wait time for every hour of the day throughout the month of November. This data was given for the Main Adult ED and West Wing, the Main Adult ED without the West Wing, and MEDPATH. The team analyzed this data using Microsoft Excel. In Excel, the team created tables comparing occupancy levels and provider tasks being performed, and bar graphs comparing patient wait time to percent utilization of the rooms by time of day and day of week.

Presented Results and Recommendations to Clients

On December 15, 2009, the team presented their results and recommendations to Dr. Desmond, Dr. Kronick, Sam Clark, and other Programs and Operations staff members. The final report, final presentation, and all data documents were provided to the observers for future use.
FINDINGS AND CONCLUSIONS

After performing the previous approach and methodology, the team compiled the findings and conclusions on the following: Main Adult ED observations, flowchart of current patient exam room arrival process, provider task breakdown beeper study, provider patient capacity beeper study, and Centricity data.

**Main Adult ED Observations**

The team observed the provider’s spend unnecessary amounts of time walking to the Golden Rod Box. The box is located on the opposite side of the provider’s computer area, and when a provider wants to check the box for a Golden Rod he or she must walk around the counter to get to the box. Also, because the Golden Rod Box is not transparent, the provider cannot tell if there is a Golden Rod in the box until the provider walks up to the box and opens the drawer.

The team also observed the Golden Rod Box creates potential for a Last-In-First-Out (LIFO) queuing system, meaning that the patient form on top of the pile of forms will be the next patient a provider chooses regardless of how long other patients have been waiting. When a nurse places a Golden Rod in the box by priority level, patients with the same priority level who have been waiting longer may have their Golden Rod stuck under the new patient’s Golden Rod who had the same priority.

Finally, team observed that the Golden Rod Box is the only signal to provider’s that a new patient is waiting to be treated. The Main Adult ED also has a device called the “Whiteboard”. The Whiteboard is a large, flat screen television which displays information about patients in the Main Adult ED. The information displayed on the Whiteboard includes the patient’s name, patient’s nurse, patient’s doctor, and other information recognizable by the ED staff. While the Whiteboard displays easily accessible and valuable information, it does not receive as much attention from the providers as the Golden Rod Box. When asked about the Whiteboard, providers frequently replied they only use the Golden Rod Box as a signal that a new patient is waiting to be treated.

**Flowchart of Current Patient Exam Room Arrival Process**

After observing the Main Adult ED and taking notes on patient arrival process, the team created a flowchart of the current Golden Rod Box queuing system. Figure 1 on p. 13 shows the flowchart the team created.
The Golden Rod Box system starts when a patient is brought from the waiting room to a Main Adult ED exam room. The patient is placed in an exam room and the patient’s Golden Rod is placed in the Golden Rod Box. The Golden Rod Box has four drawers, however, all the Golden Rods are placed in the top drawer. Where the Golden Rod is placed in the pile depends on the priority assigned to the patient and the severity of the patient’s case decided by the nurse who places the Golden Rod in the Golden Rod Box. Highest priority Golden Rods are put on top and other priorities are put in order someplace else in the pile. If the nurse places the patient in an exam room and forgets to place the Golden Rod in the Golden Rod Box, the patient waits in the room and no providers are aware that the patient is waiting.

When a provider is not busy or is ready to treat another patient, he or she goes to the Golden Rod Box to see if there are any patients waiting for treatment. Once the provider gets to the box, he or she looks through the pile of Golden Rods to decide which patient to care for. Providers believe that the provider will choose the highest priority patient, but the team observed this does not always happen.

**Figure 1:** Flowchart of the Golden Rod Box Queuing System
If the provider chooses a Golden Rod, he or she will either go directly to the patient’s exam room or go to their computer to research the patient’s past history. Providers stated that the decision to go directly to the patient’s room or research the patient depends on the patient’s problem, priority level, and preference of the provider. After researching the patient, the provider will either go directly to the patient’s exam room or go perform another task. If another task is performed, the patient is left waiting in the exam room and no other provider is aware that he or she is waiting.

**Provider Task Breakdown Beeper Study**

*Overall Provider Task Breakdown Findings.* The team analyzed the percentage of time each provider spends on certain tasks throughout the day. Table 1 below shows the provider task breakdown.

<table>
<thead>
<tr>
<th>Task</th>
<th>EM2</th>
<th>EM3</th>
<th>EM4</th>
<th>IM</th>
<th>PA</th>
<th>Attending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Evaluation/Exam</td>
<td>28%</td>
<td>28%</td>
<td>25%</td>
<td>25%</td>
<td>21%</td>
<td>35%</td>
</tr>
<tr>
<td>Communicate Patient Care</td>
<td>25%</td>
<td>15%</td>
<td>20%</td>
<td>24%</td>
<td>18%</td>
<td>7%</td>
</tr>
<tr>
<td>Record Review</td>
<td>20%</td>
<td>9%</td>
<td>6%</td>
<td>7%</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>Data Integration/Thinking</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
<td>3%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Result Finding</td>
<td>7%</td>
<td>6%</td>
<td>4%</td>
<td>4%</td>
<td>11%</td>
<td>3%</td>
</tr>
<tr>
<td>Phone Call</td>
<td>5%</td>
<td>6%</td>
<td>4%</td>
<td>3%</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>Documentation</td>
<td>3%</td>
<td>5%</td>
<td>3%</td>
<td>11%</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>Personal Time</td>
<td>2%</td>
<td>1%</td>
<td>4%</td>
<td>5%</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>IPC Other</td>
<td>1%</td>
<td>4%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
<td>11%</td>
</tr>
<tr>
<td>PC Other</td>
<td>1%</td>
<td>5%</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Case Review</td>
<td>0%</td>
<td>2%</td>
<td>11%</td>
<td>2%</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Coordinate Patient Flow</td>
<td>0%</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Educating</td>
<td>0%</td>
<td>2%</td>
<td>5%</td>
<td>3%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Non-Clinical Interaction with Staff</td>
<td>0%</td>
<td>6%</td>
<td>3%</td>
<td>3%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Procedures</td>
<td>0%</td>
<td>3%</td>
<td>1%</td>
<td>3%</td>
<td>3%</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.*

**Table 1: Provider Task Breakdown**

From Table 1, the task performed most by each provider throughout the day is patient evaluation/exam. Each provider spends around 25% of their time on patient evaluation/exam except for attendings, who spend 35% of their time on patient evaluation/exam. The task performed second most by all the providers except attendings is communicating patient care. Attendings spend the second most amount of time on documentation. Starting with the third most performed task is where each provider begins to deviate. EM2’s and EM3’s spend their third most time on record review (20% and 9% respectively), EM4’s spend their third most time on case review (11%), IM’s spend their third most time on documentation (11%), PA’s spend their third most time on result finding (11%), and attendings spend their third most time on
indirect patient care other (11%). The task each provider spent the fourth most time on was under 10% for all providers and therefore was not as significant.

*Overall Provider Task Breakdown Conclusions.* The team concluded from Table 1 that each provider performs similar tasks throughout the day except attendings. Attendings spent 7% more time on patient evaluation/exam than any other provider and also were the only provider with a different second most performed task, which was documentation rather than communicate patient care. Reasons for this could be attendings deal with difficult patient cases and therefore are forced to spend more time evaluating the patient. Also, because attendings have the most liability, it is possible that they spend more time on documentation to make sure it is right and also because they have more to document.

*Provider Task Breakdown by General Tasks Findings.* To analyze provider task breakdown on a broader scale, the team categorized individual tasks into three main categories: direct patient care, indirect patient care, and other tasks. Direct patient care consisted of patient evaluation/exam, procedures, and direct patient care other. Indirect patient care consisted of record review, communicate patient care, result finding, data integration/thinking, phone call, and indirect patient care other. Other tasks consisted of coordinate patient flow, case review, educating, documentation, non-clinical interaction with staff, personal time, and other. Figures 2 through 7 below show the percentage of time each provider spent on each category.

*Based on a sample of 230 data points received from Main Adult ED EM2’s between November 10, 2009 and November 17, 2009.*

*Figure 2:* Percent of Time EM2’s Spend on Tasks

From Figure 2, EM2’s spend 65% of their time performing indirect patient care, 29% of their time performing direct patient care, and 6% of their time performing other tasks.
Figure 3: Percent of Time EM3’s Spend on Tasks

From Figure 3, EM3’s spend 47% of their time performing indirect patient care, 35% of their time performing direct patient care, and 18% of their time performing other tasks.

*Based on a sample of 231 data points received from Main Adult ED EM3’s between November 10, 2009 and November 17, 2009.

Figure 4: Percent of Time EM4’s Spend on Tasks

From Figure 4, EM4’s spend 43% of their time performing indirect patient care, 27% of their time performing direct patient care, and 30% of their time performing other tasks.

*Based on a sample of 250 data points received from Main Adult ED EM4’s between November 10, 2009 and November 17, 2009.
From Figure 5, IM’s spend 41% of their time performing indirect patient care, 30% of their time performing direct patient care, and 29% of their time performing other tasks.

*Based on a sample of 223 data points received from Main Adult ED IM’s between November 10, 2009 and November 17, 2009.

**Figure 5:** Percent of Time IM’s Spend on Tasks

From Figure 6, PA’s spend 53% of their time performing indirect patient care, 26% of their time performing direct patient care, and 21% of their time performing other tasks.

*Based on a sample of 390 data points received from Main Adult ED PA’s between November 10, 2009 and November 17, 2009.

**Figure 6:** Percent of Time PA’s Spend on Tasks
Figure 7: Percent of Time Attendings Spend on Tasks

From Figure 7, Attendings spend 39% of their time performing indirect patient care, 41% of their time performing direct patient care, and 29% of their time performing other tasks.

Provider Task Breakdown by General Tasks Conclusions. From Figures 2 through 7, the team concluded there are differences in the tasks EM’s perform as their year increases. EM2’s, EM3’s, and EM4’s spend about equal percentage of time on direct patient care. However, as the EM’s year increases, the percent of time they spend on other tasks increases and the percent of time they spend on indirect patient care decreases. EM2’s spend 6% of their time on other tasks whereas EM4’s spend 30% of their time on other tasks. EM2’s also spend 65% of their time on indirect patient care whereas EM4’s spend 43% of their time on indirect patient care.

Looking across all providers, each provider spends the most amount of time on indirect patient care except attendings, which spend their most amount of time on direct patient care. Comparing this with Table 1 proves that attendings operate differently than other providers throughout the day.

Overall Task Breakdown by Four-Hour Time Shifts Findings. The team analyzed the percentage of time spent on certain tasks for six four hour shifts throughout the day. Table 2 on p. 19 shows the task breakdown by 4 hour time shifts.

*Based on a sample of 138 data points received from Main Adult ED Attending's between November 10, 2009 and November 17, 2009.
Table 2: Task Breakdown by 4 Hour Shifts

From Table 2, every shift has the most amount of time spent on patient evaluation/exam (about 25% each) except for the 3pm to 7pm where communicate patient care is the most performed task (23%). The second most performed task during each shift is communicate patient care (about 19% each), except for the 3pm to 7pm shift where patient evaluation/exam is the most performed task (19%).

Overall Task Breakdown by Four-Hour Time Shifts Conclusions. The team concluded that the task breakdown by 4 hour shifts showed similar results to the provider task breakdown. For both task breakdown by 4 hour shifts and provider task breakdown, the most performed task was patient evaluation/exam and the second most performed task was communicated patient care. The rest of the tasks varied, but they had low percentages and weren’t as significant.

Provider Patient Capacity Beeper Study

A key factor that plays an important role in the workings of the ED is a provider’s capability of taking another patient. Whether or not the provider can take another patient is determined by, but is not limited to, the following factors:

- The provider is at capacity
- The provider is busy doing documentation
• The provider needs to tend to personal needs
• The time is near the end of the provider’s shift
• There are no new patients to see

To determine which factors play the most prominent roles in whether or not a provider can see another patient, the team administered a beeper study. The following are the findings and conclusions of the study.

*Probability of Taking Another Patient vs. Number of Current Patients Findings.* The provider patient capacity beeper study provided the team with data on the probability that a provider would treat another patient given the number of patients the provider was currently treating. Figure 8 on p. 21 shows the result of the data for all providers combined. Appendices I through L show the result of this data for each provider. In Figure 8 below, the probability of taking a patient was broken down into three separate lines. One line is for all the original data obtained and is labeled Probability of Taking Patient (ALL). The second line is for all the original data obtained except the response of not taking a patient because “there was no patient to see” was removed and is labeled Probability of Taking Another Patient (minus “No One to See”). The final line is for all the original data except all responses for not taking another patient because “there was no patient to see” were turned into yes responses in being able to see another patient. This line is labeled Probability of Taking a New Patient because the team believes this most accurately represents the actual capacity of providers to take another patient. If the only reason a provider did not take another patient was because there were no patients to see, then the provider actually was capable of taking another patient. Since the Probability of Taking a New Patient line was most representative, the team fit a trend line and R² value (correlation coefficient) to the line for each provider. The trend line predicted the probability of the provider taking another patient, and the R² value verified how accurate the trend line equation was at predicting the probability. The higher the R² value, the better the line fits the data.
*Based on a sample of 207 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

**Figure 8:** Probability of Taking Another Patient vs. Number of Current Patients

Figure 9 below shows the time of day the option “No One to See” was marked and how many marks it received.

*Based on a sample of 40 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

**Figure 9:** Time of Day and Number of Marks for the Response “No One to See”
The findings in Figure 9 on p. 21 show that there was a fairly even distribution of ticks for “No One to See” from 12am to 7pm. However, there are no tick marks from 8pm to 11pm. This may be due to the fact that these hours are typically one of the busiest times (high percent occupancy) of the day.

**Probability of Taking Another Patient vs. Number of Current Patients Conclusions.** After looking at the line that shows all of the data (without excluding “no one to see” or changing them all to “yes”), we see that when a provider has zero or one patients, there is a 33% chance that they cannot see a new patient. When we remove the data pertaining to “no one to see” or change those points to “yes”, there is a 100% chance that the providers can take another patient. This seems like a more reasonable conclusion.

Another interesting observation is that for every “number of current patients” up until seven patients, the probability that a provider can take another patient increases when the “no one to see” data points are excluded or changed to “yes”. This means that often times when a provider has up to seven patients, they are capable of taking another patient, but there are none to see.

**Probability of Taking Another Patient vs. Shift Findings.** In addition to breaking down the beeper study data by “number of current patients”, the team broke down the data by time of day (or shift). For ease of finding trends, the hours of the day were broken up into the following three shifts:

- 12am – 8am
- 8am – 4pm
- 4pm – 12am

Each shift has its own graph. Appendices M through O show the result of this data for each shift.

**Probability of Taking Another Patient vs. Shift Conclusions.** Not many conclusions can be drawn from these findings. The major reason why no conclusions can be drawn is because, throughout the day, there are many overlapping provider shifts. For example, EM’s and PA’s shifts do not start or end at the same time. Because of this difference in provider shifts, there is much randomization in the data collected from the beeper study in terms of time of day.

One would expect that as a provider’s shift is nearing its end, that provider is not as likely to take another patient when compared to a provider just beginning their shift. Thus, since there are many overlapping shifts, the average probability of taking a new patient varies from hour-to-hour, and unless the exact start and end times are known for each provider, it is difficult to determine what the trends are and why several outliers exist.

**Reasons for Not Taking Another Patient.** For each instance when a provider cannot take another patient, a reason was given by that provider. The team compiled all of these reasons, and they are shown on p. 23 in Figure 10.
*Based on a sample of 137 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

**Figure 10:** Reasons Providers Cannot Take a New Patient

Figure 10 shows that the biggest reason that a provider cannot see a patient is that there is no new patient to see. This occurs 29% of the time. “No One to See”, however, is an external reason as to why the provider cannot see another patient. Since it is more important to know the provider’s internal factors that determine whether or not they can see another patient, the team re-analyzed the data without “No One to See”. Figure 11 shows this data on p. 24.
Based on a sample of 97 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

Figure 11: Reasons Providers Cannot See Another Patient – Excluding “No One to See”

Excluding “No One to See”, the team concluded that the most frequently used reason why providers cannot see another patient is because they are already at capacity (used 39% of the time). The second-most used reason is a tie at 24% between documentation and “other”. Providers use the fact that they are nearing the end of their shift 11% of the time. Assuming that the average provider shift length is 10 hours, then this reason is usually used for the entire hour of the last hour of a provider’s shift.

Centricity Data

The ED uses Centricity, an electronic database, to record and file detailed information about each patient. A wide variety of information is stored in this database including the patient name, their priority level, their time spent in waiting room, their time spent in exam room before provider arrives, their time spent in exam room after provider arrives, etc. The database also includes general current state information about the ED such as the average occupancy (the number of rooms currently in use), the average number of rooms available, and the percent utilization of the rooms.
The team was assigned to perform an analysis on this data. Thus, the average room to doctor time (time spent in an exam room) and the percent utilization were analyzed and compared to findings from the workload beeper study.

The Centricity wait time data given to the team was the average wait time per hour per day for each day of the month of November. For example, for any particular day, the team was given 24 values, one for each hour of the day. Each value represented the average wait time of all patients in the exam rooms for the current hour. The percent-utilization data was provided in the same fashion – the average percent utilization of rooms for each hour of the day for each day of the month of November.

*Average Room to Doctor Time Analysis by Shift Findings.* The team analyzed the average room to doctor time (exam room wait time) and average percent utilization of exam rooms to determine whether or not there was a correlation between them. First, these two variables were analyzed by shift. Both the average exam room wait-time and average percent utilization were found for the week of the first beeper study (November 10 – November 17, 2009) for the following four-hour time periods:

- 7am – 11am
- 11am – 3pm
- 3pm – 7pm
- 7pm – 11pm
- 11pm – 3am
- 3am – 7am

To find these values, the team averaged all of the values for each time period for each day from November 10 to November 17, 2009. Thus, for each time period, a total of 32 values (4 values per shift for 8 days) were averaged to find the overall average wait time. The percent utilization for each shift was found in the exact same manner: 32 values were averaged to find the overall average percent utilization for each four hour period. The findings are shown in Figure 12 on p. 26.
*Based on a sample of 192 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

**Figure 12:** Average Room to Doctor Time by Shift for Week of Workload Study

The team also calculated the average exam room wait time and room percent utilization for the entire month of November. This was completed in the same way as the previous calculations: the team averaged all of the values for each time period for each all 30 days of the month of November. Thus, the wait-time and percent utilization for each shift is the average of 120 values (4 values per shift for 30 days). The findings are shown in Figure 13 on p. 27.
Based on a sample of 720 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

Figure 13: Average Room to Doctor Time by Shift for Month of November, 2009

The figure shows that the trends of both the wait times and percent utilizations are very similar between the week of the workload study and the entire month of November. Thus, the team studied the findings from the entire month instead of just the week of the workload study since the data should be more representative of the ED.

Average Room to Doctor Time Analysis by Shift Conclusions. The findings in Figure 13 show that the average exam room wait time only increases from 29 to 38 minutes during the 12-hour period from 7am – 7pm. During this time, however, the average percent utilization doubles from 36% to 72%. Looking further into the day, the average wait time doubles from 38 to 76 minutes during the period from 3pm – 11pm. However, during this same time period, the average percent utilization drops from 72% to 71%. Thus, the large increase in average wait-time is not an effect of the current state. It is an effect of the increase in percent utilization over the previous 12 hours.

Similarly, the increase in patient wait time from 76 to 85 minutes during the 8 hour period from 7pm – 3am is not an effect of the current state since the percent utilization actually decreases by 12% over this period. This increase in patient wait time is an effect of the previous state’s high percent utilization and wait times.
In an attempt to identify any additional factors that may be affecting the large increase in patient wait time from 3pm – 11pm, the team compared the workload task percentages of all providers as a whole between the two shifts. The only task that changed significantly from the first shift (3pm – 7pm) to the second shift (7pm – 11pm) was the “Patient Evaluation/Exam” task. Patient evaluation increased from 19% to 27% over this time, as shown below in Figure 14.

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

**Figure 14:** Patient Evaluation Percentages for 3pm – 7pm and 7pm – 11pm Shifts

The team statistically tested the hypothesis that the amount of time spent evaluating patients during the second shift was greater than the time spent evaluating patients during the first shift. This hypothesis was tested using the following process to find a distribution for the patient evaluation percentage:

1. Included all data points from 3pm – 7pm
2. Assigned random number to each data point
3. Sorted points by random number
4. Created samples of 10 random data points
5. Found patient evaluation % for each sample
6. Found overall mean and standard deviation of samples
7. Fit data to normal distribution
The following histogram in Figure 15 shows how the data points fit a normal distribution:

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

Figure 15: Patient Evaluation Data Points Fit Normal Distribution

Once the mean and standard deviation were derived from the distribution, a one-tailed z-test was performed using 95% confidence to see if the difference in the amount of time spent evaluating patients was, in fact, statistically significant. This was performed by testing to see if the percentage of time spent evaluating patients for the 7pm – 11pm shift fell outside of the 95% interval of the 3pm – 7pm distribution. This value did fall outside of the 95% interval. Thus, with 95% confidence, the providers were spending more time evaluating patients during the 7pm – 11pm shift than during the 3pm – 11pm shift.

Average Room to Doctor Time Analysis by Day Findings. The team analyzed the average room to doctor time (exam room wait time) and average percent utilization of exam rooms and organized them by day to determine whether or not there was a correlation between them. Both the average exam room wait time and average percent utilization were found for the entire month of November, 2009 for each day of the week. These values were found by averaging the average exam room wait times and percent utilizations for each hour of the day. Then, the averages were found for each common day of the week (all Mondays, Tuesdays, etc.) The results are shown on p. 30 in Figure 16.
*Based on a sample of 720 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

**Figure 16: Average Room to Doctor Time by Day for Month of November, 2009**

The results from this analysis are not as staggering as those from comparing the data across different shifts, but conclusions can still be drawn from these findings.

**Average Room to Doctor Time Analysis by Day Conclusions.** The results from Figure 16 show that the average wait time for Saturday is 28 minutes greater than the average wait time for Tuesday even though they have the same percent utilization of 61%. Another interesting point is that the average wait time for Monday is 19 minutes less than the average wait time for Sunday even though they only differ by 1% in terms of exam room percent utilization.

These large differences in wait times in spite of similar percent utilizations may be an effect of the previous night’s percent utilization. For example, the high average wait time for Saturday may be a result of a high occupancy ED during Friday night. Likewise, the low average wait time for Monday may be a result of a low occupancy ED during Sunday night.

**Task Variation Based on Percent Utilization of Rooms Findings.** Using the Centricity data, the team found the shift with the highest percent utilization of rooms during the week of the provider task breakdown beeper study as well as the shift with the lowest percent utilization. Table 3 on p. 31 shows the percent utilization of each shift during the seven days between November 10, 2009 and November 17, 2009.
Table 3: Percent Utilization by Shift

Table 3 shows that the 3pm to 7pm shift had the highest percent utilization (72%) and the 7am to 11am shift had the lowest percent utilization (36%).

Task Variation Based on Percent Utilization of Rooms Conclusions. The team wanted to determine if the tasks of providers was different during the highest percent utilization shift compared to the lowest percent utilization shift. Using data obtained from the provider task breakdown beeper study, the team compared the tasks performed during the highest percent utilization shift and lowest percent utilization shift. The results are shown in Table 4 below.

<table>
<thead>
<tr>
<th>Task</th>
<th>3pm - 7pm</th>
<th>Task</th>
<th>7am - 11am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicate Patient Care</td>
<td>23%</td>
<td>Patient Evaluation/Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Patient Evaluation/Exam</td>
<td>19%</td>
<td>Communicate Patient Care</td>
<td>16%</td>
</tr>
<tr>
<td>Non-Clinical Interaction with Staff</td>
<td>9%</td>
<td>Non-Clinical Interaction with Staff</td>
<td>11%</td>
</tr>
<tr>
<td>Procedures</td>
<td>6%</td>
<td>Result Finding</td>
<td>8%</td>
</tr>
<tr>
<td>Personal Time</td>
<td>6%</td>
<td>Data Integration/Thinking</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>6%</td>
<td>Procedures</td>
<td>6%</td>
</tr>
<tr>
<td>PC Other</td>
<td>5%</td>
<td>Documentation</td>
<td>5%</td>
</tr>
<tr>
<td>Result Finding</td>
<td>5%</td>
<td>Other</td>
<td>4%</td>
</tr>
<tr>
<td>Coordinate Patient Flow</td>
<td>5%</td>
<td>Coordinate Patient Flow</td>
<td>4%</td>
</tr>
<tr>
<td>Documentation</td>
<td>5%</td>
<td>Personal Time</td>
<td>3%</td>
</tr>
<tr>
<td>IPC Other</td>
<td>3%</td>
<td>PC Other</td>
<td>3%</td>
</tr>
<tr>
<td>Case Review</td>
<td>3%</td>
<td>Case Review</td>
<td>3%</td>
</tr>
<tr>
<td>Data Integration/Thinking</td>
<td>2%</td>
<td>Phone Call</td>
<td>2%</td>
</tr>
<tr>
<td>Phone Call</td>
<td>2%</td>
<td>IPC Other</td>
<td>2%</td>
</tr>
<tr>
<td>Educating</td>
<td>1%</td>
<td>Record Review</td>
<td>2%</td>
</tr>
<tr>
<td>Record Review</td>
<td>1%</td>
<td>Educating</td>
<td>2%</td>
</tr>
</tbody>
</table>

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.
From Table 4 on p. 31, the team concluded there is a difference in the major tasks performed during the highest and lowest percent utilization shifts. During the highest percent utilization shift of 3pm to 7pm, the most performed task was communicate patient care (23%). During the lowest percent utilization shift of 7am to 11am, the most performed task was patient evaluation/exam (25%). For the second most performed task, the 3pm to 7pm shift was patient evaluation/exam (19%) and the 7am to 11am shift was communicate patient care (16%). The third most performed task was non-clinical interaction with staff for both shifts. After the third most performed task, the tasks begin to vary. Due to these tasks low percentages, they are not as significant.

RECOMMENDATIONS

To improve the Golden Rod Box queuing system at the Main Adult ED, the team recommends the following improvements.

Redesign and Relocation of Golden Rod Box

If the ED improves the Golden Rod Box, patients’ Golden Rod sheets will arrive in the box more efficiently and providers will have easier access to the box. To reduce the time that providers spend on walking around the counter and checking the content of the box, the team recommends a transparent Golden Rod Box that allows the providers to know whether there are Golden Rods in the box without leaving their seats. Also, to reduce the time providers spend to sort the Golden Rod sheets based on triage level when inserting and taking them out of the box, the team recommends five drawers, one for each triage level for the redesigned Golden Rod Box. To address the problem of unnecessary walking, the Golden Rod Box should open both ways; from the hall way and from behind the counter. Alternatively, the team recommends moving the Box to a more convenient location for the providers to reduce unnecessary walking.

To address the issue of the Golden Rod Box being the only alert to providers that patients are waiting to be seen, the team recommends more effective uses of the Whiteboard. If the ED uses the Whiteboard more effectively, providers will be alerted of waiting patients faster. In addition to the Golden Rod Box, the team recommends using the Whiteboard as a secondary method of alerting the providers that patients are waiting to be seen. Based on ergonomic principals, the team recommends making new patient information flash to alert providers a patient is waiting to be seen. In fact, the team believes that color coding patient information to indicate triage level will make the Whiteboard more useful and allow providers to access patient information at a glance.

EXPECTED OUTCOMES

The previous recommendations and analysis are expected to:

- Provide the ED staff with current state, quantified information
- Assist in fixing staff scheduling problems in the ED
• Reduce patient exam room wait time in the Main Adult ED
• Assist in future continuous improvement projects to reduce the LOS in the ED
• Generate ideas for further current state analysis

SUPPORT OF OPERATING ENTITIES

The Clinical Operations Manager and Associate Service Chief provided details of the problem, requirements, expectations, staff contact information, and requested historical data. The Manager and the Chief assisted the team set up and management of beeper studies with the ED providers.

The project coordinator provided help maintaining the analytical quality and a healthy client relationship throughout the project. The project coordinator gave the team historical data that was relevant to the team’s project. In addition, the coordinator provided the team with feedback on progress and helped the team develop and maintain professional skills.

ACKNOWLEDGMENTS

The team would like to thank the following people for all their hard work and contribution to the project:

• Jeff Desmond MD, Clinical Operations Manager – Emergency Department
• Steve Kronick MD MS, Associate Service Chief – Emergency Medicine
• Sam Clark, Industrial Engineer Lead and Lean Coach, Program and Operations Analysis
• Mark Van Oyen Ph. D., Associate Professor – Industrial and Operations Engineering 481
• Brock Husby – Graduated Student Instructor – Industrial and Operations Engineering 481
• Mary Lind – Technical Communications Lecturer
• Sharon Connolly – ED Operations
• Soroush Saghafian
• Main Adult ED staff

The team learned more than they ever imagined about hospital operations and will be able to use the skills and experiences they learned during this project in future work experiences.
WORKS CITED


Pan, Qing, Bernardus F. Christiawan, Grace Tjin, and Emil W. Ng. *Emergency Department Attending Management of Transfer Phone Calls and Activities. Program in Operations and Analysis*. University of Michigan, 27 Apr. 2009.
## APPENDICES

### Appendix A: Provider Task Breakdown Beeper Study Task Sheet

Please use a new form each shift.

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Every time beeper goes off, please place one tick mark in the corresponding time column.

<table>
<thead>
<tr>
<th>Start Time (Please write time and Circle AM or PM):</th>
<th>AM</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LIST OF ACTIVITIES**

<table>
<thead>
<tr>
<th>Coordinate Patient Flow</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Patient Care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient Evaluation/Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect Patient Care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Patient Care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Integration/Thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone Call</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Clinical Interaction w/Staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Appendix B: Provider Patient Capacity Beeper Study Capacity Sheet

Please use a new form each shift.

Every time beeper goes off, please place one tick mark in the corresponding time column.

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**QUESTIONS**

<table>
<thead>
<tr>
<th># of Patients Actively Managing*</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could you see 1 more patient within the next 5 minutes?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**If No, Why?**

<table>
<thead>
<tr>
<th>All capacity</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>New end of shift</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No one to see</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need to do Documentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Please include all patients requiring active management. Exclude patients handed off to inpatient service waiting for bed unless they are requiring active management.
Appendix C: Task Breakdown by Provider – Direct Patient Care

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

Appendix D: Task Breakdown by Provider – Indirect Patient Care

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.
**Appendix E: Task Breakdown by Provider – Other Tasks**

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.*

**Appendix F: Task Breakdown by Hour – Direct Patient Care**

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.*
Appendix G: Task Breakdown by Hour – Indirect Patient Care

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.

Appendix H: Task Breakdown by Hour – Other Tasks

*Based on a sample of 1,643 data points received from Main Adult ED providers between November 10, 2009 and November 17, 2009.
**Appendix I:** Probability of Taking Another Patient vs. Number of Current Patients – Attendings

*Based on a sample of 27 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.*

**Appendix J:** Probability of Taking Another Patient vs. Number of Current Patients – EM

*Based on a sample of 92 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.*
Appendix K: Probability of Taking Another Patient vs. Number of Current Patients – IM

*Based on a sample of 22 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

\[ y = -0.1857x + 1.4 \]
\[ R^2 = 0.6898 \]

Appendix L: Probability of Taking Another Patient vs. Number of Current Patients - PA

*Based on a sample of 66 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

\[ y = -0.15x + 1.0499 \]
\[ R^2 = 0.9417 \]
Appendix M: Probability of Taking Another Patient from 12am – 8am – All Providers

*Based on a sample of 40 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

\[ y = 0.0467x + 0.6135 \]

\[ R^2 = 0.2297 \]

Appendix N: Probability of Taking Another Patient from 8am – 4pm – All Providers

*Based on a sample of 56 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

\[ y = -0.0708x + 1.0084 \]

\[ R^2 = 0.5537 \]
Appendix O: Probability of Taking Another Patient from 4pm – 12am – All Providers

Probability of Taking Another Patient from 4pm - 12am - All Providers

*Based on a sample of 111 data points received from Main Adult ED providers between November 17, 2009 and November 24, 2009.

Appendix P: Beeper Assignments

<table>
<thead>
<tr>
<th>Beeper #</th>
<th>Staff Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EM 3</td>
</tr>
<tr>
<td>2</td>
<td>IM</td>
</tr>
<tr>
<td>4</td>
<td>EM 2</td>
</tr>
<tr>
<td>5</td>
<td>EM 4</td>
</tr>
<tr>
<td>6</td>
<td>PA 11 - 11</td>
</tr>
<tr>
<td>7</td>
<td>PA 12 - 12</td>
</tr>
<tr>
<td>8</td>
<td>Med Path 8 - 4 / 3:30 - 11:30</td>
</tr>
<tr>
<td>11</td>
<td>Faculty 3 - 11</td>
</tr>
</tbody>
</table>