Comparative Evaluation of Medical Equipment Management System (MEMS®):
University of Michigan & Henry Ford Health Systems

Final Report

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Introduction

Managing medical equipment is a task that every hospital is faced with daily. Inefficient equipment management systems often lead to unavailability or slow delivery of medical equipment, underutilization of equipment, and increased cost associated with the equipment. The Medical Equipment Management System (MEMS®) from Rosebud Solutions is intended to address and improve this problem through the use of a centralized distribution process.

MEMS® has been implemented in both the University of Michigan Health System (UMHS) and the Henry Ford Health System (HFHS). Both hospitals are constantly looking for ways to decrease their equipment delivery time. Therefore, the Program and Operations Analysis Student Team studied both hospitals to look for ways to improve the mobile medical equipment delivery process. The purpose of the project was to quantify previously uninvestigated costs that are impacted by MEMS®, compare early and final stages of MEMS® implementation, and provide recommendations to Rosebud Solutions and the two hospitals. Henry Ford Hospital served as the early stages of the implementation model with their MEMS® on-line start date of November 2003 and the University of Michigan Hospital served as the final stages of the implementation model with their MEMS® on-line start date of June 2002 in this project.

The purpose of this report is to present our detailed findings and recommendations on best MEMS® implementation practices to each hospital and to Rosebud Solutions. The report starts with the presentation of our literature search and general hospital comparison findings. A thorough look at the hospitals’ equipment delivery process, the nursing survey, and cost of ownership findings are then presented in three separate sections. Each of these sections is broken up into a discussion of findings at HFHS and UMHS, followed by comparisons and recommendations. A summary of recommendations can be found at the end of the report.

Goals and Objectives

The project had the following goals:

- Quantify cost of ownership of medical equipment tracked in MEMS®
- Quantify amount and costs of nursing time spent on equipment handling
- Examine and flowchart current equipment management processes
- Identify current utilization levels of MEMS®-tracked equipment
- Identify current revenues related to patient billing for use of medical equipment
- Identify current quality assurance performance related to patient-to-patient equipment transfer
- Provide recommendations for improvement of equipment management practices to University of Michigan Hospital, Henry Ford Hospital and Rosebud Solutions
Background Information on MEMS® and Hospitals

Rosebud Solutions is a healthcare software firm based in Ann Arbor, Michigan, with a satellite office in Salt Lake City, Utah. One of Rosebud’s products, MEMS®, has been installed in nearly 80 hospitals throughout the United States, including University of Michigan Hospital in Ann Arbor, MI, and Henry Ford Hospital in Detroit, MI. The system utilizes a centralized distribution process and wireless palm-top scanners to track the use of medical equipment. This product is intended to improve quality of patient care, organize and simplify internal processes, and achieve measurable and positive financial impact. This project compared the use of MEMS® in the two hospitals and defined the benefits of implementation and areas of improvement for MEMS®. Some general information on each hospital can be seen in Table 1 below.

<table>
<thead>
<tr>
<th>Table 1: Hospital Background Information</th>
</tr>
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<tbody>
<tr>
<td><strong>HFHS</strong></td>
</tr>
<tr>
<td>Number of Licensed Beds</td>
</tr>
<tr>
<td>MEMS® On-line Date</td>
</tr>
<tr>
<td>Pieces of Equipment Tracked by MEMS®</td>
</tr>
</tbody>
</table>

1. All HFHS data provided by the Director of Integrated Support Services (Nov. 2004)
2. Provided by UMHS Director of Program and Operations Analysis (Nov. 2004)
3. Provided by the UMHS Manager of Patient Equipment (Nov. 2004)

Even though UMHS has fewer beds than HFHS, they have over twice the amount of equipment in the MEMS® system because HFHS tracks only the equipment in their main hospital while UMHS tracks equipment in both their main hospital and outpatient clinics. The inventory of equipment tracked in MEMS® at HFHS and UMHS can be found in Appendices A-1 and A-2, respectively. Furthermore, UMHS used a computerized management system (CAMS®) before implementing MEMS®, whereas HFHS had never had a computerized system before MEMS®. Not having a computerized equipment management system prior to MEMS® may have made the transition to MEMS® more difficult for HFHS than it was for UMHS.

Methodology & Approach

The team approached this project by starting with an overview of the systems and processes involved with MEMS®. We then narrowed our scope to get a more detailed understanding of two key metrics in the equipment delivery process: unnecessary nursing time spent and cost of ownership. The following section explains our approach and reasoning behind it.

- Performed Literature Search

The team conducted an extensive literature search to gain insight on the history of equipment management systems. We also focused on compiling literature on any
previous studies concerning nursing time spent on medical equipment issues and the factors affecting the cost of ownership.

- **Gathered General Information about Performance Measures**

The team gathered general information relating to MEMS® to get a sense of the effect of implementing the MEMS® software. The team researched revenue, utilization levels, and quality assurance issues. The type and size of inventory in the MEMS® system can be seen in Appendix A.

- **Developed Flowchart of Processes**

We spent roughly 25 hours interviewing and shadowing equipment delivery personnel at UMHS and HFHS. Based on the information gathered from each process, we created flowcharts of the equipment management process at each hospital. These flowcharts were used to develop recommendations to improve the efficiency of the process and delivery time. These flowcharts are included in Appendix B.

- **Conducted Nursing Surveys**

An online survey was administered to the nursing staff at each hospital. A focus group was held at UMHS to assess the nurses’ background knowledge of the equipment delivery system and to aid in composing questions to include in the survey. The survey was used to quantify the time nurses spend handling issues with mobile medical equipment. These issues consisted of time spent following up on an order, the time looking for equipment, and time spent being distracted while waiting for equipment delivery. The data collected was used to evaluate the cost savings in reducing nursing time spent on these issues.

- **Calculated Cost of Ownership**

We analyzed the data provided to us by our contacts at each hospital and Rosebud Solutions on cost of ownership. Specifically, we examined service contracts, repair and maintenance costs, and storage costs for all of the equipment managed by the MEMS® software. We also looked at the salaries and benefits for the employees working within the Patient Equipment department at UMHS and the Central Equipment department at HFHS. This data was used to quantify operating costs associated with medical equipment.

- **Summarized Recommendations**

In the final phase, we compared the use of MEMS® across the two hospitals. The flowcharts for both UMHS and HFHS were analyzed and we provided a thorough evaluation of each process. This has provided us with recommendations for further improvement of the use of MEMS® at each hospital.
Current Industry Literature Search Findings

To see the big picture beyond these two hospitals and our specific issues, we examined recent literature on the many approaches to equipment management within the medical field and in other industries. We also looked at previous studies concerning nursing time spent on non-direct patient care and the factors contributing to cost of owning mobile medical equipment.

MEMS® Includes Features Specific to the Healthcare Industry

MEMS® is one of many software solutions for equipment management. There are similar applications in almost every industry that can be made specific to a company or general enough to apply to multiple industries. Some of the different approaches to equipment management and locating mobile equipment are discussed below.

Equipment Management Systems in Many Industries

Many equipment management systems track equipment utilization and provide efficient maintenance of capital assets and optimization of billing opportunities. These systems stretch across numerous industries including manufacturing, education, government, and of course, healthcare. For instance, QUALCOMM offers a wireless management system for construction equipment that increases equipment utilization, reduces maintenance costs, and enhances rent-versus-buy decisions with improved utilization data (QUALCOMM, Solutions for Construction Equipment 3). Similarly, MEMS® offers these same services in the healthcare industry.

CAMS®: Previous UMHS Equipment Management System

Before using MEMS®, UMHS used software called Capital Asset Management System (CAMS®). CAMS® “tracks inventoriable equipment” that is generally classified as a “free-standing item having…a normal life expectancy of one year or longer” (University of California Davis Financial Information Systems 3). CAMS® differs from MEMS® in that it offers tracking services and inventory data management general enough for equipment in any industry. UMHS chose to investigate new medical equipment management systems when CAMS® services became limited and was unable to add more equipment.

Different Approaches to Locating Mobile Equipment

Similar equipment management systems use different types of positioning technologies. While MEMS® uses a wireless palm-top scanner to read barcodes on the equipment and assign it to a specific location or patient, other systems use Global Positioning System (GPS) or Radio Frequency Identification (RFID) to provide real time location of any piece of equipment in the hospital. Prototypes use GPS for acquiring location information, a Global Information System (GIS) for managing and processing data, and wireless internet for communication. These prototypes can enhance and improve the capabilities of existing equipment management systems (Park and Gao 3). RFID applications in manufacturing locate and track assets with radio frequencies. Each piece of equipment has a small transponder in the form of a tag. Activators are placed at key locations...
locations throughout the facility that send signals to the equipment tags. When a tag receives the signal, it “wakes up” and emits a radio signal giving the equipment’s general location (Wisetrack, WiseTrack Active Enterprise using Active RFID). The newest RFID applications can track up to ten meters away (Electro-com, Hyper-X - Long Range RFID Providing an Impressive 10 Meter Read Distance).

**Conclusion**

In conclusion, MEMS® is one of the few systems that is specific to the healthcare industry. MEMS® offers a wide variety of features like tracking of equipment location and utilization, bio-med downtime, labor productivity, billing and maintenance interfaces, and a quality control module to minimize equipment decontamination issues.

**Nursing Shortage and Time Deficiency Cause Frustration**

Nurses spend too much time gathering information and supplies. It has been reported that charting takes 30% of nurses’ time. Therefore, using new technology will “reduce the time they spend documenting, reduce redundancies, and increase the amount of time they spend with their patients” (Huff, Jan. 2004). Many health systems are implementing new software with which nurses will document patient care on laptops or handheld computers.

Nurses are feeling a strain on their time due to the shortages of qualified healthcare professionals. “The nursing shortage is ‘the worst it’s ever been, and there doesn’t seem to be relief in sight’, says Patricia A. Abbott, Ph.D., RN, director of the informatics program at the University of Maryland School of Nursing, Baltimore.” (Baldwin, March 2002). The strain on nursing staff causes nurses to work faster, harder, and in a more stressful environment. New technologies offer great opportunity to reduce stress and improve the work environment and workflow.

Similarly, nurses from HFHS and UMHS who completed our survey concerning mobile medical equipment delivery expressed their concerns and frustrations with the equipment order and delivery process. One UMHS nurse said, “It takes a lot of time away from patient care and sometimes adds a lot of frustration to my day”. Similarly, a nurse at HFHS commented, “It appears locating equipment is a great issue. Many times the doctors come down on us nurses, because they believe the problem is with us.” Any technology or process improvement that can reduce or eliminate inefficient use of nursing time will greatly reduce their stress and improve patient care.

**Cost of Ownership is a Key Metric for Important Decisions**

The cost of ownership of medical equipment is often many times more than the initial purchase price and, therefore, plays a vital role in the procurement decision (Herbert 1). In fact, one of the major goals of clinical engineers today is to use the cost of ownership and equipment performance data to study the hospital's needs and budget projections more effectively. Cost of ownership is now becoming a key metric in many cost and benefit analyses and needs to be monitored frequently.
Comparison of Hospitals’ General Measures

To better understand the comparisons between HFHS Integrated Support Services and UMHS Materiel Services, we compared each hospital’s medical equipment billing revenue, annual equipment utilization, and quality assurance issues from the time MEMS® was implemented to the present. We studied HFHS from November 2003 to present and UMHS from July 2002 to present.

Medical Equipment Billing Revenue

The revenue reported by both Materiel Services and Integrated Support Services is the revenue from equipment billing charges. As reported by the Integrated Support Systems financial documents, Figure 1 shows the noticeable increase in quarterly medical equipment billing revenue over the last year at HFHS. Henry Ford’s fiscal year runs from January 1st to December 31st.

![Figure 1: HFHS Quarterly Medical Equipment Billing Revenue*](image)

*Data provided by HFHS Director of Integrated Support Services, 10/25/2004
University of Michigan’s revenue is much higher than the revenue at HFHS. Figure 2 below shows the UMHS quarterly medical equipment billing revenue as tracked in MEMS® by fiscal year quarters. UMHS’s fiscal year is July 1st through June 30th.

The annual medical equipment billing revenue at UMHS is considerably higher than Henry Ford’s revenue because UMHS has more than twice the amount of equipment tracked by MEMS®. The difference in revenue can also be attributed to different billing processes at UMHS and HFHS. UMHS bills their equipment on a per day use while HFHS bills per issue. Also, it should be noted that HFHS recently increased their equipment prices when they realized they were still charging 1984 prices in their billing process. Similar to HFHS, UMHS’s revenue has increased steadily ever since MEMS® was implemented in June 2002.

**Annual Equipment Utilization**

The equipment utilization is an important factor in tracking equipment because it shows the amount of equipment the hospital is actually using in a given time period. MEMS® calculates annual percent utilization by dividing the number of times the equipment is issued by the number of possible days in that time period. Hospitals strive to maintain 75% annual equipment utilization to ensure they have enough equipment to meet their hospital’s needs. By tracking the equipment utilization frequently, the equipment department can see which types of equipment are underutilized and over utilized. The hospitals then make decisions to either reduce the amount of equipment or purchase more equipment.

Annual equipment utilization levels at UMHS have been consistently above 80% since MEMS® was implemented with 87% in FY03 and 81% in FY04. Therefore, UMHS owns a sufficient amount of medical equipment for their patient’s needs as long as it is...
managed effectively. Utilization levels at HFHS have also improved from 42% to 54% since MEMS® was implemented, but are not yet at their goal for equipment utilization. Furthermore, the equipment deliverers are currently issuing equipment to Standby instead of the patient room number. Therefore, annual utilization is still an important issue for Henry Ford to address.

**MEMS® Quality Assurance Concerns**

Quality assurance is a key metric tracked by MEMS®. A MEMS® quality assurance issue is defined as moving a piece of equipment from one patient to another patient without sending the equipment through the necessary Central Distribution decontamination cycle. It is important to track these quality assurance issues to ensure equipment is delivered accurately and efficiently without infection control issues. Each issue aids in identifying when equipment is issued to the wrong patient and, therefore, billed incorrectly. MEMS® will also report when equipment is issued without being returned and, therefore, not completing the cycle through Central Distribution decontamination. This situation could happen two different ways: the nurse cleans the equipment between uses without sending it through Central Distribution or the equipment is passed between patients without being cleaned at all. The first case causes inefficient use of nursing time on tasks that are non-direct patient care. The second case is a noncompliance with JCAHO standards. Finally, tracking quality assurance issues can help indicate if the hospital owns enough equipment to support its patient needs.

UMHS has considerably more quality assurance issues than HFHS in the last year. HFHS has recorded 2,897 incidences since November of 2003, but this is a limited sampling. UMHS had 16,063 incidences in FY03 and 11,658 in FY04. UMHS has more reported issues because they have more than twice the amount of equipment as Henry Ford tracked in MEMS®. Furthermore, Henry Ford just started doing floor checks in November 2004. During a floor check, a patient equipment employee makes rounds throughout the hospital, scanning equipment to check if it is in the right place and issued to the correct patient. Because equipment is often found in the wrong place, most of these quality assurance issues are found on these floor checks. UMHS conducts floor checks in the main hospital at 3am daily and in Mott’s Children’s Hospital at 7am, four days a week. Therefore, HFHS can anticipate their number of quality assurance issues to increase with the implementation of regular floor checks.

**Examination of Equipment Delivery Processes**

The ordering process for mobile medical equipment differs between hospitals as does the actual delivery of the equipment. After shadowing equipment delivery personnel at both hospitals as well as spending time on the patient floors, we detailed the respective processes to compare the strengths and weaknesses of each.
Findings on Henry Ford Hospital Equipment Delivery Process

After shadowing the delivery process for approximately 10 hours we created a detailed flowchart of the process. Below, in Figure 3, is a high-level flowchart of the current Henry Ford equipment ordering process. For a more detailed version, please refer to Appendix B-1.

<table>
<thead>
<tr>
<th>Nursing Unit</th>
<th>Doctor writes and flags equipment order on patient chart</th>
<th>Nurse enters order into computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Response Center</td>
<td>Order prints in Service Response Center (SRC)</td>
<td>Dispatcher enters order into SRC Program, which pages deliverer</td>
</tr>
<tr>
<td>Central Equipment</td>
<td></td>
<td>Deliverer takes equipment to patient room</td>
</tr>
</tbody>
</table>

Figure 3: Flow of Mobile Medical Equipment Delivery at HFHS*

*Observed Sept. 2004

As shown in Figure 3, the Henry Ford delivery process begins when a doctor writes an order for a piece of mobile medical equipment in the patient’s chart and flags this order. A nurse, nurse aid, or clerk, upon seeing the flag, checks the chart to see what piece(s) of equipment is needed. To order the equipment, the nurse uses a computer located on his/her floor. The nurse selects the correct patient and then the central equipment screen which brings up all available equipment choices. The nurse then simply clicks on the piece of equipment the patient needs.

After the nurse inputs the order into the computer, the order prints in the Service Response Center (SRC) in the basement of HFHS. The order sits on the print tray until it is picked up by one of the service response center dispatchers. Once the order is picked up, the dispatcher enters the order into the SRC program and decides which equipment deliverer to assign the order. Upon assignment, the equipment deliverer receives a page that includes the room number and the piece of equipment needed.
When the page is received, the equipment deliverer calls an automated phone system to accept the order. This may not be immediate if the deliverer is currently out on another job and not near a phone. Upon returning to Central Equipment, the deliverer looks for the correct piece of equipment. If one is not currently in Central Equipment, the deliverer must find one either in the cleaning room or on another floor and clean it. From there, the deliverer uses a book containing barcodes for all rooms and scans the correct room’s barcode using the wireless scanners. After scanning the room, the deliverer scans the piece of equipment, assigning that piece of equipment to the patient in that room.

After the deliverer replaces the wireless scanner, the piece of equipment is placed on a cart. The deliverer then takes the cart to the correct room and places it outside the door. The deliverer can then call to complete the order in the system or wait until returning to Central Equipment to do so. From here, the equipment deliverer may check for soiled equipment on the floor they are currently on, may check other floors, or may just return to Central Equipment. If the equipment deliverer has not already done so, they call the automated phone system to complete the order after returning to Central Equipment. A detailed flowchart of the process may be found in Appendix B-1.

Findings on University of Michigan Hospital Equipment Delivery Process

Similar process flowcharting was done over 12 hours of shadowing at UMHS. Below, in Figure 4, is a high-level flowchart of the current UMHS equipment ordering process. For a more detailed version, please refer to Appendix B-2.

![Figure 4: Flow of Mobile Medical Equipment Delivery at UMHS*](image)

*Observed Sept. 2004
Figure 4 shows that the process begins when the clerk enters the order upon a patient’s admittance to the unit or at the request of a nurse. The clerk then enters this information into a computer system, known as GroupWise®, which generates an email to Patient Equipment. The Patient Equipment dispatcher then prints two copies of the e-mail. The deliverer writes the equipment number to be delivered on one copy and gives it back to the dispatcher. The dispatcher then enters this information into MEMS® and issues the piece of equipment. The deliverer then takes the correct equipment to the patient room.

**Process Outlined from Dispatcher Perspective**
The dispatcher has a set of duties that are usually prioritized in the following order, yet may vary by dispatcher. Each duty is performed if necessary, while keeping in mind the priorities.

1. Dispatcher answers incoming phone calls
2. Dispatcher prints two copies of each order from GroupWise® emails
3. Dispatcher prepares standby delivery orders and delivers them if time (otherwise a deliverer will take the delivery)
4. Dispatcher enters orders into MEMS® to issue equipment
5. Dispatcher investigates any PEND orders
6. Dispatcher helps any of the deliverers

Standby delivery orders go to Recovery. In this case, the requested items are loaded onto a cart (they are not attached to mobile IV stands). Each item is issued to “Phase 1”, which is technically “standby”. A paper charge slip is attached to each item after the dispatcher writes that item’s barcode number on the slip. The items are then taken to the Recovery standby shelf and plugged into electrical outlets (the dispatcher or deliverer delivers these items). The nurse or clerk fills out the patient information when the equipment is used. These charge slips are then picked up periodically by the delivery personnel. These slips are used to issue equipment to patients in MEMS®.

Once the deliverer writes the equipment barcode number on one copy of the order, the dispatcher issues the equipment by entering the equipment number and then entering the patient ID number into MEMS®. If the patient ID number doesn’t exist in the system, MEMS® prompts the dispatcher to put the equipment in PEND mode. The order gets set aside and is re-issued later. If status is still PEND, the dispatcher must investigate why the patient number is not valid. If the dispatcher is trying to issue the equipment and it has not been “returned” after previous use, the dispatcher first “returns” the equipment and then issues it again.

**Process Outlined from Deliverer Perspective**
The deliverer is assigned a section of the hospital at the beginning of each shift; one person will be at Mott and one will be in each section A, B, C, and D. Halfway into the shift, the deliverers switch sections to balance the workload. The deliverer first checks if any deliveries need to be made by checking the table for printed orders. Each order has two copies. If there is an order, the deliverer gets the correct type of equipment from Patient Equipment. He/She writes the equipment barcode number on one copy of the
order and gives it back to the dispatcher or places it on the desk. The equipment is taken to the correct floor and left outside the patient’s door, after the patient name is verified. If the names do not match, the deliverer checks with the unit clerk to determine the problem.

If Patient Equipment does not have the equipment requested, the deliverer will check the soiled utility floors in his/her section to find the desired piece. The deliverers typically know where to look for certain pieces. Inside the soiled utility, the deliverer will clean the piece of equipment, and then deliver it to the patient room.

While making deliveries in the hospital, the deliverer checks the soiled utility rooms in his/her section for soiled equipment belonging to Patient Equipment. Equipment is prepared for travel (arranging cords, throwing away IV bags, etc.) and is carried to other floors until there is too much equipment to carry back to Patient Equipment. All poles are attached together when moving the equipment.

When equipment is brought back to Patient Equipment, the equipment is left in the hallway prior to cleaning, while the deliverer checks to make sure there are no urgent orders to take care of. If not, or in spare time, he/she will clean the equipment in the sterilization area and will “return” it using the MEMS® scanner.

**Equipment Delivery Process Comparisons**

Several differences exist between the delivery process at HFHS and UMHS. Both hospitals had aspects of their process that if implemented at the other hospital could be beneficial. The main differences are summarized in Table 2 below.

<table>
<thead>
<tr>
<th></th>
<th>HFHS</th>
<th>UMHS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order Entry</strong></td>
<td>Nurses and clerks enter order information</td>
<td>Only clerks enter order information</td>
</tr>
<tr>
<td><strong>Information Flow</strong></td>
<td>Order is sent to dispatch center and equipment deliverer is paged</td>
<td>Order e-mailed directly to equipment management department</td>
</tr>
<tr>
<td><strong>Equipment Assignment</strong></td>
<td>Equipment assigned to room number</td>
<td>Equipment is assigned to a patient</td>
</tr>
<tr>
<td><strong>Delivery Time</strong></td>
<td>Normal delivery expected in 1 hour or less (goal = 30 min)</td>
<td>Normal delivery expected in 1 hour or less (goal = 1 hour)</td>
</tr>
<tr>
<td><strong>Equipment Movement</strong></td>
<td>Equipment delivered on movable cart</td>
<td>Equipment often delivered attached to IV poles</td>
</tr>
<tr>
<td><strong>Cleaning</strong></td>
<td>Dedicated staff responsible for cleaning equipment</td>
<td>All equipment deliverers are responsible for cleaning equipment</td>
</tr>
</tbody>
</table>

*Observed Sept. 2004
The first process difference is who physically enters the order. At UMHS this is almost strictly done by the clerks and at HFHS it is done by the nurses. At UMHS the clerks, who are mainly responsible for ordering equipment, have several other functions to perform which can delay the entry of an equipment order increasing the time nurses must wait for a piece of equipment. However, the clerks at UMHS can pre-order equipment before a patient arrives on the floor. Advantages exist for both nurse entry and clerk entry, and changing either hospital to mirror the other would not result in a measurable difference in the delivery performance.

The flow of information after the order is entered differs between the two processes. At HFHS each order is printed in the SRC. The order can sit for a substantial amount of time which further delays the equipment delivery time. To quantify this delay, 31 orders were sampled from three shifts to determine the average time the order, after being printed in the SRC, waits until it is dispatched to an equipment deliverer. Figure 5 below shows the percentage of total delivery time that each order waited in the SRC before being dispatched to a deliverer.

Averaging the numbers in the above graph, the orders waited in the SRC for 25% of the total delivery time before being dispatched. Since orders number 18 and 19, sampled on the midnight shift, were special cases, we removed them from the data. Therefore, the average time spent in the SRC was 11% of total delivery time.

The next difference was how the equipment is assigned to the correct patient for billing. At HFHS the piece of equipment is scanned and assigned to a room/bed. The
Admissions/Discharges/Transfers (ADT) interface at the hospital automatically assigns the piece of equipment and its charges to the person corresponding to the room. At UMHS, the dispatcher must key in a thirteen digit patient ID, which can lead to order entry error or an error if the patient is not in the system. Because of the data entry difficulties, the deliverers are not using the scanners to issue equipment.

The time of expected delivery also differs between the hospitals. HFHS has a one-hour-and-under policy for every normal delivery and 15 minutes for a STAT delivery. HFHS Integrated Support Services has instituted a delivery goal of 30 minutes, but their stated delivery time remains 1 hour or less. UMHS has a one-hour normal delivery time as well, but a STAT delivery is only 30 minutes or less.

Another issue is the transportation of the equipment. Most of the mobile medical equipment is placed on an IV pole while it is being used on a patient. At HFHS, however, the equipment is not transported attached to the pole. It is placed on a cart so that several pieces of equipment can easily be transported at once. The IV poles are left in the room and then cleaned by housekeeping in a normal room changeover. This leads to a much easier collection of soiled equipment. At UMHS, the employees must attempt to string the poles together, which is a less efficient process to collect an equal amount of soiled equipment.

Finally, at UMHS, each patient equipment employee is equally responsible for cleaning soiled equipment. This leads to large amounts of soiled equipment sitting outside the cleaning room if the department is busy. At HFHS, several employees are dedicated to cleaning soiled equipment and collecting soiled equipment when they are caught up on cleaning. These employees work about a half day but manage to prevent large amounts of soiled equipment.

Equipment Delivery Process Improvement Recommendations

For HFHS, we recommend that the hospital reevaluate an equipment order traveling through the SRC. On average, an order may remain in the SRC for up to 11% of total equipment delivery time. This extra process step is increasing the total delivery time and is a non-value added step. Ideally, we would recommend that the delivery of mobile medical equipment be completely independent of the SRC. An order for a piece of equipment would be sent directly to Central Equipment. An interface between the program in the SRC and MEMS® could be created so that the top half of the order entry would not change, but upon being entered into the system, MEMS® automatically pulls it out of the SRC program. We realize, however, this would entail some large-scale changes. A short term solution would be to standardize the work of the SRC employees so that an order is not allowed to sit on the print tray for more than a set period of time. Also, HFHS could add an alert to the SRC employees when an order is printed. This would allow the SRC employees to know an order is waiting to be dispatched even if they are not looking directly at the printer.
We also recommend that UMHS investigate eliminating the transport of medical equipment on IV poles and implement something similar to the current process at HFHS. It is more efficient for the deliverers to put several pieces of equipment on a single cart than to string several IV poles together and move from floor to floor, in and out of the elevator. This will improve the efficiency of the department as well as make the job of collecting soiled equipment much less frustrating.

For cleaning the soiled equipment, we recommend that UMHS investigate assigning an employee to clean equipment during high volume periods. At HFHS, this reduces the amount of excess equipment outside the cleaning room and returns the equipment back into the system sooner.

Lastly, both hospitals are currently performing an unnecessary double-entry for each piece of equipment ordered. UMHS enters the order into both GroupWise® and MEMS® and HFHS has a nurse and an SRC dispatcher entering the same order. In both processes this is a non-value added step. Upon the installation of the MEMS® order entry system at UMHS, the current double-entry will be eliminated as well as increase the deliverers use of the scanners. We recommend that UMHS make sure that order entry into MEMS® be compatible with the new system being installed with the Order Management Project. At HFHS, eliminating the need for an order to travel through the SRC, as stated above, would also eliminate the double-entry currently taking place in the process.

**Nursing Survey on Mobile Medical Equipment**

One of the study objectives was to quantify the unnecessary time nurses spend each shift dealing with medical equipment from the delivery process perspective. This includes time spent searching for equipment, cleaning it, being distracted while waiting for it, and checking up on orders after ordering it. We conducted nursing surveys at each hospital to estimate this time and gather general ideas from nurses on the effectiveness of the equipment delivery process, which is hypothesized to be improved by MEMS®.

**Findings from Nursing Focus Group at University of Michigan Hospital**

A nursing focus group was conducted at UMHS on November 1, 2004 to gather the opinions of nursing staff prior to conducting a survey. Six nurses were involved in the group, from four units of the main hospital. Their experience involved CNII, CNIII, and a unit host.

We prompted the group to discuss any problems they have with mobile medical equipment, processes for ordering this equipment, the usual time it takes to receive this equipment upon ordering, and what they do while they are waiting for equipment. Findings from this discussion are summarized below.

**General Nursing Statements on Medical Equipment**

- Standby equipment for “emergency” use is not available on most floors at UMHS.
Sometimes the equipment does not work properly when delivered, specifically, the heating pads at UMHS.

Nurses not only have to wait for the equipment to be delivered, but they also must wait for prescriptions to be received, so when both equipment and medication is used on a patient, sometimes the equipment delivery is not causing the delay.

The nurses agreed that about “2/3 of our time is spent dealing with medical equipment in one way or another”. This involves trying to work the equipment, monitoring the equipment, and ordering or receiving it. Nurses agreed that some of the equipment is difficult to use.

Nurses used to try and “stash” medical equipment on their floor for later use, but this doesn’t happen much anymore at UMHS.

The nurses have limited understanding of the billing process for patient equipment; yet they are aware that the patient is being charged when equipment is being used by them.

Nurses agree that on average, each nurse applies 2 pieces of equipment per shift to patients.

Nursing Statements Regarding Medical Equipment Delivery

- Nurses agree that the average delivery time is “over one hour”, which they feel is unacceptable.
- Often, nurses will order a piece of equipment as STAT just to receive it faster (the time goal for a STAT order is within 30 minutes at UMHS as compared to the normal goal of delivering within 1 hour).
- Patient Equipment shift changeover often causes delays in equipment delivery times as seen by the nurses.
- The night shift receives equipment faster, possibly because the elevators are faster at night due to less traffic.
- Sometimes the equipment is delivered to the wrong room, which may be due to a clerk error.

The statements made by nurses in the focus group were used to develop a survey given to a larger population of nurses at each hospital. Due to time constraints, a focus group was not conducted at Henry Ford Hospital, yet from informal meetings with nurses at HFHS, we estimated that HFHS nurses have similar experiences with mobile medical equipment as nurses at UMHS.

Steps Taken to Create Nursing Surveys

Upon completion of the focus groups, the team discussed possible nursing survey questions with Rosebud Solutions. The questions were aimed at quantifying the unnecessary time nurses spend dealing with mobile medical equipment tracked in MEMS® and delivered by Patient/Central Equipment. The phrasing of these questions was finalized with the help of Ed Karls, the Manager of Customer Satisfaction and Data Management at UMHS, who provided advice in writing effective and unbiased surveys. The team provided a Word document of the survey to Ed Karls, who then placed the
survey online in the system typically used by UMHS. Please see Appendix C-1 for the
Word document of survey questions.

Findings and Conclusions from the Nursing Survey at each Hospital

The team sent the online survey website link via email to 27 nurse managers at HFHS, who were then asked to forward the link to the nurses on their respective floors. The response rate was approximately 5%, with 24 responses. The team sent the online link to 16 nurse managers at UMHS, who were also asked to forward the survey. There were 92 responses, which yields an 11% response rate. The sample population is representative at each hospital because it was sent to registered nurses on various units and shifts. The survey was open from November 17, 2004 to December 2, 2004.

The complete survey results for Henry Ford Hospital and University of Michigan Hospital can be found in Appendices C-2 and C-3, respectively, where each question and an analysis of the responses can be found. The number of total respondents was not always identical to the number of respondents per question. Some respondents chose to not answer certain questions. Table 3 below summarizes the findings from the survey for each hospital.

<table>
<thead>
<tr>
<th></th>
<th>HFHS</th>
<th>UMHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Responses</td>
<td>24</td>
<td>92</td>
</tr>
<tr>
<td>Response Rate</td>
<td>5%</td>
<td>11%</td>
</tr>
<tr>
<td>Average Number of Pieces Applied Per Shift Per Nurse</td>
<td>2</td>
<td>1.6</td>
</tr>
<tr>
<td>Average Percent of Equipment Initially Ordered from Patient/Central Equipment</td>
<td>55.90%</td>
<td>59.50%</td>
</tr>
<tr>
<td>Average Delivery Time for One Piece of Equipment</td>
<td>73.2 min.</td>
<td>73.4 min.</td>
</tr>
<tr>
<td>Average Acceptable Delivery Time for One Piece of Equipment</td>
<td>25.7 min.</td>
<td>29.7 min.</td>
</tr>
<tr>
<td>Average Percent of Ordered Equipment Obtained From Other Sources</td>
<td>31.10%</td>
<td>19.80%</td>
</tr>
<tr>
<td>Average Time to Locate and Prepare a Single Piece of Equipment when Obtained From Other Sources</td>
<td>9.0 min.</td>
<td>8.0 min.</td>
</tr>
<tr>
<td>Average Amount of Time, per Piece of Equipment, Spent Checking on Order or Distracted While Waiting</td>
<td>26.9 min.</td>
<td>25.8 min.</td>
</tr>
</tbody>
</table>
Average Satisfaction Rating of Equipment Delivery Process from 1-5 where 1 is very unsatisfied and 5 is very satisfied

2.5 2.5

*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

It was hypothesized prior to the survey that UMHS would have generally more satisfied nurses because the MEMS® system had been in place longer than it was at HFHS. Yet, the results from Table 3 show very similar responses between hospitals in most categories. The nearly identical findings allow the responses to be treated as more conclusive because it seems that the replies are consistent among nurses at each hospital.

**Average Number of Pieces Applied Per Shift**

At HFHS, the average number of pieces applied per shift by each nurse is 2.0, yet the highest number of nurses (42%) answered 1 piece. At UMHS, the average number of pieces is 1.6 and 44.3% of nurses answered 1 piece. Therefore ordering medical equipment and waiting for its delivery only happens 1-2 times a shift per nurse on average. There is not a significant difference between the hospitals.

**Average Percent of Equipment Initially Ordered from Central/Patient Equipment**

At HFHS, on average, 55.9% of applied equipment is initially ordered by the nurse from Central Equipment. The highest number of nurses (25%) said that they initially order equipment from Central Equipment 95% of the time. At UMHS, 59.5% of applied equipment is ordered initially from Patient Equipment, with the highest number of nurses (40.7%) initially ordering from Patient Equipment 95% of the time. Other ways that the nurse could obtain equipment include cleaning a piece of soiled equipment from soiled utility, finding a piece in a patient’s room that is not in use and cleaning it, or finding a piece of equipment that was ordered and never applied. The percentage originally ordered from Central/Patient Equipment is slightly higher at UMHS than at HFHS. This could reflect that nurses are more confident in the delivery system at UMHS than at HFHS.

**Average Delivery Time for One Piece of Equipment**

The nurses at HFHS report an average of 73.2 minutes to receive one piece of equipment after ordering it. Central Equipment has a specification of delivering equipment in one hour or less, and according to the nursing staff, this is not being met. However, nurses are measuring the time from when the order is sent in the computer system to the time when they receive the equipment. When calculating delivery times, the same perspective must be used by Central Equipment, because they only see the order after it has passed through the SRC.

At UMHS, the nurses report an average of 73.4 minutes to receive one piece of equipment after ordering it. Patient Equipment feels they are meeting a goal of delivering equipment in one hour or less, but the nurses do not agree. Nurses are measuring from when they tell the clerk the equipment is needed until they receive it. Patient Equipment does not see the time the clerk takes before placing the order or the time the clerk takes to enter the order into the computer system.
The average delivery time from the perspective of the nurse is approximately the same at each hospital, averaging around 73 minutes per piece. Therefore, neither hospital is meeting its goal according to the nurses.

**Average Acceptable Delivery Time for One Piece of Equipment**
At HFHS, nurses report an average acceptable delivery time of 25.7 minutes, and at UMHS, the average acceptable delivery time is 29.7 minutes. In either hospital, the nurses feel they need the equipment in half the time that Patient/Central Equipment is promising.

**Average Percent of Ordered Equipment Obtained from Other Sources**
At HFHS, 31.1% of the equipment originally ordered through Central Equipment is obtained using other means when the delivery time becomes unacceptable to the nurse. Equipment may be obtained by cleaning it from soiled utility, cleaning it from a patient’s room if not in use, or from a nurse’s “stash” of equipment. At UMHS, nurses obtain 19.8% of the equipment originally ordered through Patient Equipment using other means.

This percentage is approximately 10% higher at HFHS than at UMHS, which seems appropriate because general comments made by HFHS nurses reflect more equipment stashing and searching than nurses at UMHS report. Nurses at UMHS seem to have more confidence in the delivery system than nurses at HFHS have in their system, which may be because MEMS® has been in use longer at UMHS.

**Average Time to Prepare a Piece of Equipment when Obtained From Other Sources**
When nurses obtain equipment from other means, either initially or after ordering from Central/Patient Equipment and becoming frustrated, the nurse at HFHS takes, on average, 9.0 minutes to locate and prepare the equipment for patient use. The nurse takes 8.0 minutes, on average, at UMHS. This time is all non-value added because Central/Patient Equipment should be preparing and delivering equipment. Yet to nurses who need the equipment right away, 8-9 minutes is much faster than waiting 73 minutes for the equipment to be delivered, so nurses might try to locate equipment on their own before they order it.

**Average Amount of Time, per Piece, Spent Checking on Order or Distracted**
Nurses were asked how much of their time is spent being distracted from primary duties and checking on an order while they are waiting for equipment to be delivered. At HFHS, they reported an average of 26.9 minutes per piece of equipment, and at UMHS, the average was 25.75 minutes. While waiting for deliveries, nurses are performing other relevant nursing duties, but the nurses are often distracted because they are watching for equipment deliveries or they are calling Central/Patient Equipment to check on the order if it has not come in a reasonable time frame. The times are almost the same at each hospital.

**Average Satisfaction Rating of Equipment Delivery Process**
On a scale of 1 to 5 with 1 being very unsatisfied and 5 being very satisfied, nurses were asked to report their overall satisfaction with the equipment delivery process. At each
hospital, the average rating was 2.5, which falls somewhere between somewhat dissatisfied and neutral. The team’s previous perceptions were that UMHS nurses would be more satisfied with delivery than HFHS nurses, since MEMS® has been around longer at UMHS, but this is not the case.

**General Nursing Comments and Recommendations**

In addition to the questions analyzed above from the survey, the survey asked nurses for any comments or recommendations. Complete comments from nurses at HFHS and UMHS can be found in Appendices C-5 and C-6, respectively.

**Unnecessary Nursing Time Spent Dealing with Medical Equipment**

One of the objectives of this study was to quantify the amount of time nurses spend unnecessarily dealing with medical equipment, specifically in the order and delivery process. This excludes the amount of time they spend using and running the equipment.

Three possible order and delivery patterns can occur:

1. The nurse places the order with Patient/Central Equipment and receives the equipment by delivery. (This is what is supposed to occur). In this case, unnecessary time is the time a nurse spends checking on the order or being distracted while waiting for the order.
2. The nurse places the order with Patient/Central Equipment and ends up obtaining the equipment from some other source before the equipment is delivered. In this case, the unnecessary time is both the time spent checking on the order or being distracted and the time to locate and prepare the piece of equipment for use.
3. The nurse never orders from Patient/Central Equipment and just obtains the equipment from another source. The unnecessary time spent is the time to locate and prepare the piece of equipment for use.

The data obtained from the nursing survey can be used to calculate the total amount of unnecessary nursing time spent per shift per nurse. Prior to using the data, the data was reviewed and special case points were removed. A weighted average approach was taken, with the total time per piece of equipment being calculated by adding the average contribution from each of the three patterns discussed above. Then the time per piece was multiplied by the average number of pieces applied per shift to find the average unnecessary time per shift per nurse. This average number was used to calculate the dollars per nurse spent annually. Complete details and calculation steps can be found in Appendix C-4.

**Unnecessary Nursing Time at Henry Ford Hospital**

The average time at HFHS was 34.6 minutes per shift per nurse. The HFHS Director of Integrated Support Services provided us with an average nursing salary of $26.00 per hour, not including benefits. Assuming 5 shifts per week and 50 weeks per year, this unnecessary time corresponds to $3,748.33 per FTE nurse annually. (Please see Appendix C-4 for all calculation details).
The unnecessary time per shift does not vary much between nursing shifts, but it does between nursing units. A box plot of the unnecessary time by shift and nursing unit can be seen in Appendix C-4

Unnecessary Nursing Time at University of Michigan Hospital
The average unnecessary time nurses spend dealing with equipment at UMHS is 33.4 minutes per shift per nurse. The minimum value is 0 minutes and the maximum value is 126.6 minutes. The UMHS Director of Finance & Business Operations, Nursing Services provided us with an average nursing salary of $26.50 per hour, not including benefits. Assuming 5 shifts per week and 50 weeks per year, this unnecessary time corresponds to $3,687.92 per FTE nurse annually. (Please see Appendix C-4 for all calculation details).

The unnecessary time per shift does not vary much between nursing shifts, but it does vary between nursing units, which can be seen in a box plot in Appendix C-4

Conclusions and Further Investigations Arising from Nursing Studies
The team hypothesized that less unnecessary time would be spent by nurses dealing with medical equipment at UMHS than at HFHS because MEMS® is further along in the implementation process. However, the unnecessary time is only slightly lower at UMHS than at HFHS. Because these values are only estimates of the unnecessary time and because the time was based on nurse perception and not on time studies, care must be taken when interpreting these values. At either hospital, nearly $4,000 per year per nurse is spent unnecessarily dealing with medical equipment, which means there is room for improvement. If there are 1,000 full time equivalent nurses at each hospital working with this medical equipment, nearly $4,000,000 a year is spent on nurses unnecessarily dealing with medical equipment when they should be spending the time on patient care. By improving the delivery process and reducing the average delivery time at each hospital, we estimate that this cost could be reduced. Even if unnecessary time could be reduced by 5 minutes per nurse per shift, a savings of approximately $500 per nurse annually (and $500,000 total assuming 1,000 nurses) could be incurred.

Nurses are sometimes frustrated with the equipment itself, and this needs to be investigated further. Sometimes, especially if they are new, nurses have a difficult time calibrating and troubleshooting the equipment when it does not properly work.

A larger communication effort should be coordinated between Patient/Central Equipment and the nursing staff. Nurses would like to know the status of their order, especially if it is not available at the moment. Order status would be available if the hospitals implemented the MEMS® web order entry. Basically, the nurses want friendly communication with Patient/Central Equipment, especially when equipment is not available or orders are delayed. Also, we recommend that training be given to nurses on the equipment management process. Some nurses are unaware of the billing process involved when patients are using equipment. During MEMS® implementation at a new
hospital, staff from the centralized distribution department, as well as nursing staff, should have buy-in to the MEMS® system and strive to work together to improve equipment management.

If nurses felt more confident with the delivery system, they would be less inclined to check on orders and less distracted if they could expect the delivery in a certain time. An effective delivery process involves cooperation from both nursing staff and Patient/Central Equipment. Nursing staff needs to remove necessary lines and bags from the equipment when they are finished using them. Nurses also need to place the equipment in the proper place for pickup. Patient/Central Equipment needs to work to effectively deliver equipment.

Cost of Ownership of Mobile Medical Equipment

To determine the cost of ownership for each hospital we focused on operating expenses, including the following four areas:

- Service contracts associated with mobile medical equipment tracked by MEMS® at each hospital.
- Repair and maintenance costs of the mobile medical equipment tracked by MEMS® at each hospital. This included the salaries and benefits of full-time equivalent (FTE) employees that repair equipment and the parts expensed to Patient/Central Equipment.
- Total square footage used by each hospital’s equipment department and the cost corresponding to this space. This space included central equipment staff areas, central equipment, and equipment cleaning area. The cost per square foot included the following costs:
  - Housekeeping
  - Utilities
  - Building maintenance
  - Grounds maintenance
  - Building Depreciation
  - Building interest expense (from bonds)
- Salaries and benefits for all FTE’s assigned to Patient/Central Equipment at each hospital.

Findings on Total Cost of Central/Patient Equipment for each Hospital

HFHS does not have any service contracts, but has a contract with Sodexho to take care of any biomedical maintenance or repair of equipment. The repair/maintenance cost includes repairs, maintenance, and the salaries and benefits of the 2.5 FTE’s the biomedical engineering department assigns to Central Equipment. The amount of square footage allocated to Central Equipment is 2,407 square feet. Because HFHS indicated that they do not have a square footage rate to allocate space costs to specific departments,
we used UMHS’s rate of $22.65 per square foot. Finally, Central Equipment has a total of 11.2 FTE’s to manage and deliver medical equipment.

At UMHS, of the 4,374 pieces of equipment that MEMS® currently tracks, 88 pieces are covered under a one year parts and service warranty and 35 recently purchased infusion pumps are covered under a three year parts warranty. The biomedical engineering department indicated that many times, a one year parts and service warranty is standard when purchasing new equipment and comes at no additional cost. Additionally, UMHS can often negotiate longer warranties at no additional cost because they trade in parts and cover labor, and the suppliers want continuous business from such a large hospital. The repair/maintenance cost reported includes the parts expensed to Patient Equipment and the labor cost and benefits of employees performing the maintenance during fiscal year 2004. According to the UMHS finance department, Patient Equipment owns 2,000 square feet of space within the main hospital. This space includes the equipment room, a staff area, and the equipment cleaning area. Again, UMHS charges $22.65 per square foot to allocate costs to departments. Finally, Patient Equipment has a total of 20 FTE’s to manage and deliver equipment.

A summary of the individual costs and the total equipment cost is given in Table 4. Given the relevant costs at each hospital, HFHS spends a total of $566,368 on repairs and maintenance, cost of space, and employee salaries and benefits. UMHS spends a total of $875,362 on the same costs.

Table 4: Costs of Equipment Ownership at HFHS and UMHS

<table>
<thead>
<tr>
<th></th>
<th>HFHS 1</th>
<th>UMHS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair/Maintenance Costs</td>
<td>$169,000</td>
<td>$162,183</td>
</tr>
<tr>
<td>Square Footage owned by</td>
<td>2,407</td>
<td>2,000 3</td>
</tr>
<tr>
<td>Central/Patient Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per Square Foot</td>
<td>$22.65</td>
<td>$22.65 3</td>
</tr>
<tr>
<td>Total Square Footage Cost</td>
<td>$54,519</td>
<td>$45,300</td>
</tr>
<tr>
<td>Central/Patient Equipment Employee Costs</td>
<td>11.2 FTE’s</td>
<td>20 FTE’s</td>
</tr>
<tr>
<td></td>
<td>$342,849</td>
<td>$667,879 4</td>
</tr>
<tr>
<td>Total Costs</td>
<td>$566,368</td>
<td>$875,362</td>
</tr>
</tbody>
</table>

1. All HFHS data and costs provided by Director of Integrated Support Services at HFHS Nov. 2004
2. Provided by Manager of Biomedical Engineering at UMHS Nov. 2004
3. Provided by Advisor-Finance from Budget Department at UMHS Nov. 2004
4. Provided by Manager of Patient Equipment at UMHS Nov. 2004

Findings on Cost per Piece of Equipment for each Hospital

Given Central/Patient Equipment tracks 2,109 and 4,374 pieces of equipment at HFHS and UMHS, respectively, the costs per piece of equipment is summarized in Table 5. UMHS spends a total of $200/piece whereas HFHS spends a total of $269/piece. It appears that HFHS spends a substantial amount more than UMHS on repair/maintenance of equipment and on square footage cost. HFHS has a large break room for Central Equipment employees and dedicated space for repairs/maintenance. This extra space may be the reason for the larger amount of square footage used and thus, the larger square
footage cost. With such large costs associated with mobile medical equipment, it is clear that effectively managing equipment is important.

| Table 5: Costs of Equipment Ownership per Piece of Equipment at HFHS and UMHS |
|---------------------------------|-----------------|---------------|
| HFHS                            | UMHS            |
| Pieces of Equipment             | $2,109<sup>1</sup> | $4,374<sup>2</sup> |
| Repair/Maintenance Costs per Piece | $80.13                | $37.08          |
| Total Square Footage Cost per Piece | $25.85              | $10.36          |
| Central/Patient Equipment Employee Costs per Piece | $162.56            | $152.69         |
| Total Cost per Piece            | $268.55          | $200.13        |

1. Provided by HFHS MEMS<sup>®</sup> database 2004
2. Provided by Manager of Patient Equipment at UMHS Nov. 2004

**Summary of Recommendations**

From our investigation we have developed several recommendations for the parties involved. All of the following recommendations are based on observations regarding the use of MEMS<sup>®</sup> at UMHS and HFHS. Since the financial impact of implementing the recommendations was not in the scope of our project they have not been thoroughly analyzed. A cost benefit analysis may need to be done before implementation of the changes. Recommendations for each entity have been summarized below.

**Recommendations for Rosebud Solutions**

Upon implementation of MEMS<sup>®</sup>, Rosebud Solutions should encourage the hospitals to install both the web order entry feature as well as the biomedical interface offered with the MEMS<sup>®</sup> program. The web order entry feature would improve both hospitals’ processes by reducing the need for double entry into multiple computer systems.

Secondly, we recommend that Rosebud make MEMS<sup>®</sup> more user-friendly by providing the information stored in the program in an accessible form. An accessible database will make it easier to perform analysis or discover trends and present performance reports. MEMS<sup>®</sup> should also allow users to stratify equipment delivery data over a specified time period to produce graphs that display periodical revenue or utilization. Currently, the user must enter each time period and run a single report for each month, which is time consuming. We also recommend upgrading the program to allow a user to save the graphs electronically that are created by MEMS<sup>®</sup> for further use.

In addition, we recommend that Rosebud Solutions upgrade their wireless scanners to scan in multiple pieces of equipment at one time. Currently, the user must issue each piece of equipment one at a time which is time consuming. Allowing multiple issues would increase the efficiency of the process.
Lastly, upon initial implementation at a new hospital, we recommend that Rosebud strongly encourage the hospital to provide education to the nursing staff. We feel that with more education on the MEMS® system, nurses will be more understanding and less frustrated with the equipment delivery process. In the long run, education of the nurses will reduce their tendency to “stash” the medical equipment rather than returning it back into the system.

**Recommendations for Henry Ford Hospital**

The study conducted during this project showed that the average time an order spends in the SRC waiting to be allocated was approximately 11% of the total delivery time. To reduce or eliminate this time, we recommend HFHS considers one of the following:

1) Create an interface that electronically places orders for MEMS® equipment into dispatch
2) Implement a system that alerts the SRC employees when an order has come in
3) Direct orders for MEMS® equipment to Central Equipment rather than the SRC

Directing orders to Central Equipment would require a system of assigning employees to the orders. One way would be assigning the working employees to unique floors each day. This helps to improve the accountability of the deliverers and can reduce the inefficiency that the pager system creates when the deliverers travel to completely opposite wings of the hospital. Even if the equipment orders are not directed to Central Equipment, this approach of assigning employees to certain floors may be beneficial.

The collection of soiled equipment is an important part of the delivery process that is often overlooked. If not done as a standard part of the delivery process, the lack of collecting can lead to shortages of available equipment and, in turn, lack of nursing trust in the system. To assure that the deliverers continually check for soiled equipment, we suggest that HFHS offer feedback on the employee’s performance, such as performance charts or incentives for top performers. We believe that these could motivate the employees to perform more effectively which would improve the efficiency of the equipment delivery process.

Also, to avoid problems between equipment deliverers and other employees, we recommend that HFHS supply the equipment deliverers with something to distinguish them from other employees in the hospital. This will keep doctors, nurses, and other employees from asking them to perform tasks that are not in their job description such as cleaning a room, or removing bed sheets. UMHS has used special Patient Equipment coats to identify their employees and it seems to be a success.

To avoid equipment hoarding and equipment transfers between patients, the nurses need to trust the equipment delivery system. To gain this trust, the nurses must have an understanding of the process. We recommend that HFHS supply the nursing staff with information on MEMS® and the equipment delivery process, explaining the benefits of MEMS® and motivating nurses to help the system run at full capability.
Recommendations for University of Michigan Hospital

Since the implementation of MEMS®, Patient Equipment has seen many benefits, including reducing patient-to-patient quality issues, keeping equipment utilization high, and capturing lost charges. However, we noticed some areas for further investigation in the equipment management and delivery process.

UMHS will be utilizing the MEMS® web order entry which will further simplify the order process. This new web ordering will eliminate the double entry into both the GroupWise® and MEMS® computer systems, which will reduce data errors that arise when entering information more than once. Web ordering will encourage the use of the wireless scanners by the equipment deliverers. The web order will also allow nurses or clerks to check the status of their order in real time, and allow Patient Equipment to track percent of on-time deliveries. The Order Management Project is scheduled to be implemented by 2006 at UMHS, which involves implementing a new order entry system. UMHS should be certain that the MEMS® order entry interfaces with this new system and is not an additional method of ordering.

Currently at UMHS, most medical equipment is delivered to the patient room on a mobile IV pole which seems to cause a major delay in the pickup process. To improve this process, we recommend that equipment be delivered and picked up using moveable carts. Each room should have a mobile IV stand for each bed that the nurse can hang the equipment on and plug in as usual. The IV pole could remain in the room and be cleaned during room changeover. This process is currently in place at Henry Ford Hospital and seems to work well.

At the beginning of this study, in September 2004, we were informed that UMHS delivered over 97% of orders in one hour or less. Because UMHS is successfully meeting the goal of delivering equipment in less than one hour and nurses have indicated an acceptable delivery time of approximately 30 minutes, we recommend that UMHS reduce their delivery time goal to 45 minutes or even 30 minutes.

At UMHS, equipment is cleaned by the deliverer who picked up the equipment. At Henry Ford Hospital, dedicated employees clean the equipment and there is less soiled equipment backlog at HFHS while the cleaners are working. Sometimes at UMHS, over 20 pieces of equipment are sitting in the hallway waiting to be cleaned in the decontamination area. We suggest assigning an employee to cleaning duty at key soiled equipment pickup times, which will reduce soiled equipment backlog.

To make the overall delivery process most effective, nurses and Patient Equipment employees must work together. Nurses need a thorough understanding of the process, which will increase their confidence in the delivery system. All employees must have buy-in of MEMS® in order to maximize the benefits of the system.
Works Cited


Brief Description on Contents of Appendices

Appendix A: lists of mobile medical equipment and the number of pieces of each type included in each hospital’s inventory

Appendix B: flowcharts mapping the equipment delivery process at each hospital

Appendix C:
- Nursing survey questions as asked to nurses online
- Detailed results from the nursing survey at each hospital and how the results were calculated from the raw data
- Explanation of calculation of unnecessary nursing time per shift and more detailed results of unnecessary nursing time per shift from each hospital.
- Comments from individual nurses provided on the nursing survey for each hospital
## Appendix A-1: Henry Ford Hospital MEMS®-Tracked Equipment Inventory*

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Description</th>
<th>Number of Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGDP</td>
<td>Gastric Drain-Pump-Hilo</td>
<td>24</td>
</tr>
<tr>
<td>AIRC</td>
<td>Air Cleaner - Filter</td>
<td>7</td>
</tr>
<tr>
<td>AIRF</td>
<td>Air Freshener - Deodorizer</td>
<td>6</td>
</tr>
<tr>
<td>ANCA</td>
<td>Nasal Aspirator, Crash Cart</td>
<td>14</td>
</tr>
<tr>
<td>ANCS</td>
<td>Nasal Aspirator, Crash Cart</td>
<td>45</td>
</tr>
<tr>
<td>ANPA</td>
<td>Nasal Aspirator, Portable</td>
<td>15</td>
</tr>
<tr>
<td>ANPS</td>
<td>Nasal Aspirator, Portable</td>
<td>26</td>
</tr>
<tr>
<td>ARCO</td>
<td>Air Compressor</td>
<td>3</td>
</tr>
<tr>
<td>ATHR</td>
<td>Chest Tube (mobl vac)</td>
<td>9</td>
</tr>
<tr>
<td>BCRB</td>
<td>Crib</td>
<td>30</td>
</tr>
<tr>
<td>COHD</td>
<td>Commode- Heavy Duty</td>
<td>41</td>
</tr>
<tr>
<td>CORG</td>
<td>Commode - Regular</td>
<td>48</td>
</tr>
<tr>
<td>CUIH</td>
<td>SCD Excel Machine</td>
<td>468</td>
</tr>
<tr>
<td>ELDM</td>
<td>CPM Leg Exerciser</td>
<td>9</td>
</tr>
<tr>
<td>HECG</td>
<td>Hyperthermia Unit, Heating Pad</td>
<td>13</td>
</tr>
<tr>
<td>HECS</td>
<td>Hyperthermia Unit, Aqua Pump</td>
<td>6</td>
</tr>
<tr>
<td>HOEG</td>
<td>Hypo/Hyperthermia Unit</td>
<td>16</td>
</tr>
<tr>
<td>HYPD</td>
<td>Hypo/Hyperthermia Pad</td>
<td>1</td>
</tr>
<tr>
<td>ICCO</td>
<td>Isolation Cart - Contact</td>
<td>7</td>
</tr>
<tr>
<td>ICTB</td>
<td>Isolation Cart - tb</td>
<td>12</td>
</tr>
<tr>
<td>INF3</td>
<td>Colleague CX Triple</td>
<td>160</td>
</tr>
<tr>
<td>INFP</td>
<td>Colleague CX Single</td>
<td>600</td>
</tr>
<tr>
<td>LAFC</td>
<td>Latex Free Cart</td>
<td>10</td>
</tr>
<tr>
<td>LBIK</td>
<td>Bladder Irrigator - Kang</td>
<td>2</td>
</tr>
<tr>
<td>LBIS</td>
<td>Bladder Irrigator - Kang</td>
<td>7</td>
</tr>
<tr>
<td>MPBL</td>
<td>MPBO Boot, Large</td>
<td>1</td>
</tr>
<tr>
<td>MPBM</td>
<td>MPBO Boot, Medium</td>
<td>1</td>
</tr>
<tr>
<td>MPBS</td>
<td>MPO Boot, Small</td>
<td>1</td>
</tr>
<tr>
<td>MPOB</td>
<td>MPO Boot, Extra Large</td>
<td>1</td>
</tr>
<tr>
<td>OMNI</td>
<td>Omni Infusion Pump</td>
<td>114</td>
</tr>
<tr>
<td>PCA3</td>
<td>PCA Infusion Pump</td>
<td>160</td>
</tr>
<tr>
<td>PEFR</td>
<td>Enteral Feeding Pump</td>
<td>170</td>
</tr>
<tr>
<td>POS</td>
<td>Portable Oral Suction</td>
<td>23</td>
</tr>
<tr>
<td>SCRD</td>
<td>Signal Cord</td>
<td>1</td>
</tr>
<tr>
<td>SLCL</td>
<td>SCD Sleeves Calf Large</td>
<td>1</td>
</tr>
<tr>
<td>SLCR</td>
<td>SCD Sleeves Calf Regular</td>
<td>1</td>
</tr>
<tr>
<td>SLTL</td>
<td>SCD Sleeves Thigh Large</td>
<td>2</td>
</tr>
<tr>
<td>SLTR</td>
<td>SCD Sleeves Thigh Regular</td>
<td>1</td>
</tr>
<tr>
<td>TBAH</td>
<td>TB Air Hood</td>
<td>11</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>TORI</td>
<td>Toilet Riser</td>
<td>34</td>
</tr>
<tr>
<td>TV</td>
<td>Allen Tech TV</td>
<td>1</td>
</tr>
<tr>
<td>WVOC</td>
<td>Wound Vac Machine</td>
<td>1</td>
</tr>
<tr>
<td>WVCC</td>
<td>Wound Vac Cannister</td>
<td>1</td>
</tr>
<tr>
<td>WVSA</td>
<td>Wound Vac Sponge Abdominal</td>
<td>1</td>
</tr>
<tr>
<td>WVSH</td>
<td>Wound Vac Sponge Hand</td>
<td>1</td>
</tr>
<tr>
<td>WVSM</td>
<td>Wound Vac Sponge Med</td>
<td>1</td>
</tr>
<tr>
<td>WVSS</td>
<td>Wound Vac Sponge Small</td>
<td>1</td>
</tr>
<tr>
<td>WVSW</td>
<td>Wound Vac Sponge Wht</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 2,109

*Data received from Rosebud Solutions Nov. 2004*
Appendix A-2: University of Michigan Hospital MEMS®-Tracked Equipment Inventory*

<table>
<thead>
<tr>
<th>Equipment Number</th>
<th>Description</th>
<th>Number of Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>Warmflo Blood/Solution Warmer</td>
<td>105</td>
</tr>
<tr>
<td>0004</td>
<td>P.C.A. Pump</td>
<td>156</td>
</tr>
<tr>
<td>0005</td>
<td>Wall Suction</td>
<td>1163</td>
</tr>
<tr>
<td>0006</td>
<td>Flowtron Compression Device</td>
<td>420</td>
</tr>
<tr>
<td>0007</td>
<td>Kangaroo Feeding Pump</td>
<td>160</td>
</tr>
<tr>
<td>0008</td>
<td>Circle Bed</td>
<td>1</td>
</tr>
<tr>
<td>0009</td>
<td>Wedge Frame</td>
<td>3</td>
</tr>
<tr>
<td>0010</td>
<td>Peritoneal Dialysis Cycler</td>
<td>10</td>
</tr>
<tr>
<td>0011</td>
<td>Moblevac</td>
<td>8</td>
</tr>
<tr>
<td>0012</td>
<td>Foot Comp.</td>
<td>3</td>
</tr>
<tr>
<td>0013</td>
<td>Wound Vac</td>
<td>24</td>
</tr>
<tr>
<td>0014</td>
<td>Blanketrol II (Hypothermia Blanket)</td>
<td>24</td>
</tr>
<tr>
<td>0016</td>
<td>ICP Monitor</td>
<td>15</td>
</tr>
<tr>
<td>0018</td>
<td>Epidural Pump</td>
<td>48</td>
</tr>
<tr>
<td>0034</td>
<td>Pacemaker</td>
<td>95</td>
</tr>
<tr>
<td>0040</td>
<td>Gaymar T-Pad</td>
<td>70</td>
</tr>
<tr>
<td>0042</td>
<td>Syringe Pump</td>
<td>200</td>
</tr>
<tr>
<td>0076</td>
<td>Alaris Single Pump</td>
<td>872</td>
</tr>
<tr>
<td>0077</td>
<td>Double Alaris Pump</td>
<td>199</td>
</tr>
<tr>
<td>0084</td>
<td>Hepa Filter</td>
<td>24</td>
</tr>
<tr>
<td>0090</td>
<td>Laredal Suction</td>
<td>42</td>
</tr>
<tr>
<td>0900</td>
<td>Marquette Mon.</td>
<td>62</td>
</tr>
<tr>
<td>1008</td>
<td>Bair Hugger</td>
<td>56</td>
</tr>
<tr>
<td>1012</td>
<td>Medfusion Syr.</td>
<td>514</td>
</tr>
<tr>
<td>1014</td>
<td>Omni Flow</td>
<td>85</td>
</tr>
<tr>
<td>1020</td>
<td>Arrest Cart</td>
<td>1</td>
</tr>
<tr>
<td>1022</td>
<td>Trilogy Pump</td>
<td>1</td>
</tr>
<tr>
<td>FLON</td>
<td>Flolan Pump</td>
<td>3</td>
</tr>
<tr>
<td>PAPR</td>
<td>Portable Respirator Units</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>4,374</strong></td>
</tr>
</tbody>
</table>

*Data received from UMHS Patient Equipment Manager Nov. 2004
Appendix B-1: Henry Ford Hospital Equipment Delivery Flowchart
(Observed Sept. 2004)

1. Doctor writes down order in chart and flags it.
2. Nurse reads order.
3. Place order in computer.
5. Dispatcher takes sheet and enters it into computer.
6. Dispatcher pages next available equipment deliverer.
7. Equipment deliverer receives page with equipment and room #.
8. Is the deliverer available?
   - NO: Wait
   - YES: Delivered uses phone to call in and accept job.
9. Is equipment available?
   - NO: Search for piece of equipment on hospital floor.
     - YES: Take to scanner and assign piece to designated room.
10. Place on cart and take to room.
11. Leave equipment outside assigned room.
12. Does deliverer look for soiled equipment on current floor?
   - NO: Return to Central Equipment.
   - YES: Pick up any soiled equipment.
13. Does deliverer look for soiled equipment on other floors?
   - NO: Does deliverer look for soiled equipment on current floor?
     - NO: Return to Central Equipment.
     - YES: Pick up any soiled equipment.
   - YES: Does deliverer look for soiled equipment on current floor?
     - NO: Return to Central Equipment.
     - YES: Pick up any soiled equipment.
Appendix B-2: University of Michigan Hospital Equipment Delivery Flowcharts
(Observed Sept. 2004)

Perspective of Patient Equipment Deliverer

Are there timely orders for your section sitting on the desk?

Pick up 2 printed copies of each order from desk and gather the equipment

Write the equipment number on 1 copy of order and set it back on desk

Mentally order the deliveries to minimize walking time

Are there deliveries on the way to soiled utility where the equipment is estimated to be?

Check soiled utilities to find needed equipment and clean it inside soiled utility room

Are equipment for current order available?

Are you delivering to recovery?

Find patient room

Do patient name on order match the name on room?

See clerk to verify or find the correct patient

Leave equipment with clerk and check for charge slips to pickup

Are there more orders?

Are you in the recovery area?

GO TO PAGE 2: Do you have equipment in the hallway that needs to be cleaned or scanned after pickup?

GO TO PAGE 3: Are you in the recovery area?
Are you in the recovery area?

Is there equipment in the floor’s soiled utility room?

Does the equipment have all lines/bags removed?

Remove lines/bags and place in sink in soiled utility

Take equipment after preparing for move

Is there soiled equipment in the hallways?

Does equipment have all lines/bags removed?

Leave equipment in hallway

Take equipment after preparing for move

Do you anticipate there to be more deliveries waiting for you/is it a busy time?

Are your hands full?

Attach soiled equipment together, take it to the next floor

Take equipment down the Patient Equipment and leave in hallway

Are there timely orders for your floors sitting on the desk?
Perspective of Patient Equipment Dispatcher

- **Is the phone ringing?**
  - Yes: Answer the phone and any questions
  - No: Print out 2 copies of order and set on table

- **Is there an email in GroupWise®?**
  - Yes: Load requested items onto cart
  - No: Enter the equipment number into MEMS®

- **Is there a standby delivery order that needs to be prepared?**
  - Yes: Attach charge slips to each item after writing the equipment number on the slip
  - No: Return the equipment

- **Are there orders that need to be entered into MEMS®?**
  - Yes: Enter the patient number into MEMS®
  - No: Issue each item to "Phase 1" in MEMS® with the scanner

- **Is there a PEND order to be investigated?**
  - Yes: Does the patient ID exist?
    - Yes: Issue the equipment to this patient
    - No: Place the equipment in PEND status and set the order aside or investigate if this is the second time
  - No: Help deliverers or wait
Introduction

We are senior Industrial and Operations Engineering students from the University of Michigan College of Engineering. We are conducting a study on Nursing and moveable medical equipment, (i.e. PCA pumps, Flow-trons, CPM’s, hypothermia blankets, SCD’s, etc.) which are typically ordered by nursing for patient application from Central Distribution/Patient Equipment.

The management of both Henry Ford Hospital and The University of Michigan Hospital support this study. Candid, thoughtful answers will help us improve the support for nursing at both hospitals, in terms of mobile medical equipment delivery.

Questions

1. During your last shift, how many times did you apply a new piece of medical equipment (i.e. PCA pump, Flow-tron, CPM...) to a patient?

   0  1  2  3  4  5+

2. How many times out of every ten times that you apply equipment (i.e. PCA pump, Flow-tron, CPM...) to patients do you order this equipment from Central Equipment/Patient Equipment?

   0  1-2  3-4  5-6  7-8  9-10

3. When receiving equipment from Central Equipment, what is the average time for equipment delivery?

   Average delivery time: __________ minutes

4. When receiving equipment from Central Equipment, realistically, what would be an acceptable delivery time?

   Acceptable delivery time: _______ minutes

5. How many times out of every ten times that you order equipment from Central equipment do you end up securing this equipment from other sources other than Central Equipment?

   0  1-2  3-4  5-6  7-8  9-10
6. On average, in the past week, how long (in minutes) does it take you to locate and ready a single piece of equipment secured from places other than Central Distributions/Patient Equipment?

   1-3  4-6  7-9  10-12  13-15+

7. Are you satisfied with the time it takes to deliver equipment from Central Distribution/Patient Equipment? (Circle one of the following)

   1  2  3  4  5
   Very Unsatisfied       Very Satisfied

8. Does waiting for equipment delivery hinder the productivity of your normal nursing duties?

   Yes        No

9. What do you estimate is the average amount of time, for a single piece of equipment, you spend following up on the order or distracted because you’re waiting for equipment delivery?

   Average time per piece of equipment: ____________

Your Nursing Unit______________________________________

Your normal shift_________________________________________

General Comments and/or Recommendations:

Thank You.
Appendix C-2: Henry Ford Hospital Nursing Survey (11/17/04-12/2/04)
Calculations and Results

Data was provided in an Excel spreadsheet by nursing response and by question. We arranged the data into a readable format. Specifically, for the closed response questions, where the nurse could only respond to a list of 5-6 choices, we translated the radio button response number to the number it actually represented on the survey. Next, for the responses that were open-ended and attempting to quantify average times, we arranged this data into a usable format. Specifically, we put all answers in minutes, took out text, and if the nurse provided a range, the average of this range was calculated and recorded. For nursing unit and shift, we translated these into common answers, like “day shift”, “midnight shift”, etc. Nursing open-ended comments and recommendations were collected and placed into Appendix C-5.

The number of responses for each question varies as some nurses chose not to answer certain questions.

1. During your last shift, how many times did you apply a new piece of medical equipment (i.e. PCA Pump, Flow-tron, CPM…) to a patient?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>5+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5+</td>
</tr>
</tbody>
</table>

For calculation purposes, “5+” was only counted as “5”.

Mean = 1.96 pieces
Standard Deviation = 1.77 pieces

Number of Pieces Applied Per Shift at HFHS*

*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04
2. How many times out of every ten times that you apply equipment (i.e. PCA pump, Flow-tron, CPM…) to patients do you order this equipment from Central Equipment/Patient Equipment?

For this question, the average of each provided range was taken, and then turned into a percent. For instance, the range “3-4” would be used in later calculations as 35%.

Mean = 55.87%
Standard Deviation = 30.44%

3. When receiving equipment from Central Equipment, what is the average time for equipment delivery? How many minutes?

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation. Using all original data points, the original mean was 84.39 minutes and the standard deviation was 72.53 minutes. When using statistical control charts, often the upper control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 301.97 minutes and one point, 330 minutes, was above this upper control limit. Therefore this point was taken out of the data set. The following are the final results upon removal of the out-of-control point.

N=22
Mean = 73.23 minutes
Standard Deviation = 50.01 minutes
Minimum = 12.5 minutes  
Maximum = 180 minutes

4. When receiving equipment from Central Equipment, realistically, what would be an acceptable delivery time? How many minutes?

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation.

N = 23  
Mean = 25.65 minutes  
Standard Deviation = 14.39 minutes  
Minimum = 5 minutes  
Maximum = 60 minutes
5. How many times out of every ten times that you order equipment from Central Equipment do you end up securing this equipment from other sources other than Central Equipment?

<table>
<thead>
<tr>
<th>Response</th>
<th>0</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-8</th>
<th>9-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td>31.09%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td></td>
<td>24.95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For this question, the average of each provided range was taken, and then turned into a percent. For instance, the range “3-4” would be used in later calculations as 35%.
6. On average, in the past week, how long (in minutes) does it take you to locate and ready a single piece of equipment secured from places other than Patient Equipment?

1-3  4-6  7-9  10-12  13-15+

For this question, the average of each provided range was taken. For example, if the response was “4-6”, 5 minutes was used. For the “13-15+” range, the value “13” was used as an average.

Mean = 9 minutes
Standard Deviation = 4.19 minutes
7. How satisfied are you with the time it takes to deliver equipment from Patient/Central Equipment?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Unsatisfied</td>
<td></td>
<td></td>
<td></td>
<td>Very Satisfied</td>
</tr>
</tbody>
</table>

Mean = 2.5  
Standard Deviation = 1.06
8. What do you estimate is the average amount of time, for a single piece of equipment, you spend following up on the order or distracted because you’re waiting for equipment delivery?

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation. Before any analysis, the data was “cleaned” by taking out any responses where the number provided here was greater than the number provided when quantifying the average delivery time. If no number was provided for average delivery time, the average distracted time value was kept. The average amount of distracted time cannot be more than the time it took to receive the equipment.

N=18
Mean = 32.08 minutes
Standard Deviation = 31.11 minutes
Minimum = 0 minutes
Maximum = 120 minutes
9. What is your nursing unit?

Scatter Plot of Distracted Time Per Piece at HFHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

Responses by Nursing Unit at HFHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04
It is not known exactly how many nurses from each unit received the email link to the survey, so the response rate by unit cannot be calculated. However, we estimate this response rate to be low. Yet the response does come from a variety of units.

The units correspond to the following titles:

F3 = General Medicine
B2 = General Medicine
B3 = Pediatrics/Adult Surgical Stay
H4 = Trauma, Transplant, General Surgery
MCC/ICU = Medical Critical Care/Intensive Care Unit
I4 = Trauma, Transplant, General Surgery
I5 = Cardiology
H5 = Cardiology
CICU = Cardiac Intensive Care Unit
B1 = General Medicine
F2 = General Medicine/Pulmonary

10. What is your normal shift?

<table>
<thead>
<tr>
<th>Shift</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>18</td>
</tr>
<tr>
<td>Variable</td>
<td>4</td>
</tr>
<tr>
<td>Midnight</td>
<td>4</td>
</tr>
<tr>
<td>Evenings</td>
<td>2</td>
</tr>
</tbody>
</table>

N=23

Responses by Shift at HFHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

It is not known exactly how many nurses from each shift received the email link to the survey, so the response rate by shift cannot be calculated. However, we estimate this response rate to be low. Yet the response does represent most shifts. The shifts vary in time, from 8 to 12 hours.
Appendix C-3: University of Michigan Hospital Nursing Survey (11/17/04-12/2/04)
Calculations and Results

Data was provided in an Excel spreadsheet by nursing response and by question. We arranged the data into a readable format. Specifically, for the closed response questions, where the nurse could only respond to a list of 5-6 choices, we translated the radio button response number to the number it actually represented on the survey. Next, for the responses that were open-ended and attempting to quantify average times, we arranged this data into a usable format. Specifically, we put all answers in minutes, took out text, and if the nurse provided a range, the average of this range was calculated and recorded. For nursing unit and shift, we translated these into common answers, like “day shift”, “midnight shift”, etc. Nursing open-ended comments and recommendations were collected and placed into Appendix C-6.

Prior to analyzing the data, 4 complete survey responses were removed. These responses were from nurses on the SWAT and Survival Flight units, and from their open-ended comments, these nurses do not order and receive mobile medical equipment on a daily basis from Patient Equipment. Therefore, their responses were considered invalid because of the purposes of this survey – to quantify nursing time spent unnecessarily dealing with medical equipment and its delivery.

The number of responses for each question varies as some nurses chose not to answer certain questions.

1. **During your last shift, how many times did you apply a new piece of medical equipment (i.e. PCA Pump, Flow-tron, CPM…) to a patient?**
   
   0  1  2  3  4  5+

   For calculation purposes, “5+” was only counted as “5”.
   
   Mean = 1.57 pieces
   Standard Deviation = 1.26 pieces
2. How many times out of every ten times that you apply equipment (i.e. PCA pump, Flow-tron, CPM...) to patients do you order this equipment from Patient Equipment?

For this question, the average of each provided range was taken, and then turned into a percent. For instance, the range “3-4” would be used in later calculations as 35%.

Mean = 59.48%
Standard Deviation = 36.28%
3. When receiving equipment from Patient Equipment, what is the average time for equipment delivery? How many minutes?

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation. Using all original data points, the original mean was 90.47 minutes and the standard deviation was 158.84 minutes. When using statistical control charts, often the upper control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 566.99 minutes and one point, 1440 minutes, was above this upper control limit. Therefore this point was taken out of the data set. The following are the final results upon removal of the out-of-control point.

N=79
Mean = 73.40 minutes
Standard Deviation = 43.70 minutes
Minimum = 12.5 minutes
Maximum = 240 minutes

Scatter Plot of Average Delivery Times at UMHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

4. When receiving equipment from Patient Equipment, realistically, what would be an acceptable delivery time? How many minutes?

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation. Using all original data points, the original mean was 30.39 minutes and the standard deviation was 15.56 minutes. When using statistical control charts, often the upper
control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 77.06 minutes and one point, 90 minutes, was above this upper control limit. Therefore this point was taken out of the data set. The following are the final results upon removal of the out-of-control point.

N = 82  
Mean = 29.66 minutes  
Standard Deviation = 14.16 minutes  
Minimum = 7.5 minutes  
Maximum = 75 minutes

5. How many times out of every ten times that you order equipment from Patient Equipment do you end up securing this equipment from other sources other than Patient Equipment?

<table>
<thead>
<tr>
<th>Response</th>
<th>0</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-8</th>
<th>9-10</th>
</tr>
</thead>
</table>

For this question, the average of each provided range was taken, and then turned into a percent. For instance, the range “3-4” would be used in later calculations as 35%.

Mean = 19.76%  
Standard Deviation = 17.32%
6. On average, in the past week, how long (in minutes) does it take you to locate and ready a single piece of equipment secured from places other than Patient Equipment?

1-3  4-6  7-9  10-12  13-15+

For this question, the average of each provided range was taken. For example, if the response was “4-6”, 5 minutes was used. For the “13-15+” range, the value “13” was used as an average.

Mean = 8.0 minutes
Standard Deviation = 4.0 minutes
7. How satisfied are you with the time it takes to deliver equipment from Patient/Central Equipment?

1  2  3  4  5  
Very Unsatisfied  Very Satisfied

Mean = 2.48
Standard Deviation = 0.78
8. **What do you estimate is the average amount of time, for a single piece of equipment, you spend following up on the order or distracted because you’re waiting for equipment delivery?**

If the nurse provided a range, the average of that range (in minutes) was used. For example, if the nurse answered “1-2 hours”, 90 minutes was used for further calculation. Before any analysis, the data was “cleaned” by taking out any responses where the number provided here was greater than the number provided when quantifying the average delivery time. If no number was provided for average delivery time, the average distracted time value was kept. The average amount of distracted time cannot be more than the time it took to receive the equipment.

Using all original data points, the original mean was 29.35 minutes and the standard deviation was 26.43 minutes. When using statistical control charts, often the upper control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 108.62 minutes and two points, each valued at 150 minutes, were above this upper control limit. Therefore these points were taken out of the data set. The following are the final results upon removal of the out-of-control points.
N=67
Mean = 25.75 minutes
Standard Deviation = 16.28 minutes
Minimum = 2.5 minutes
Maximum = 75 minutes

9. What is your nursing unit?

It is not known exactly how many nurses from each unit received the email link to the survey, so the response rate by unit cannot be calculated. However, we estimate this response rate to be low. Yet the response does come from a variety of units.
The units correspond to the following titles:

4A = Neurology  
4DS = Neurology ICU  
5A = Trauma/Ortho  
5B = Vascular  
5C = Transplant/GI  
5D = Surgery ICU  
6A = Rehab  
6B = Acute Care Med  
6C = Pulm/Gen Med  
8C = General Surgery/Medicine  
TBICU = Trauma Burn ICU  
9C = Adult Psych
10. What is your normal shift?

![Bar chart showing responses by shift at UMHS.](chart.jpg)

<table>
<thead>
<tr>
<th>Shift</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>45</td>
</tr>
<tr>
<td>Days and Evenings</td>
<td>20</td>
</tr>
<tr>
<td>Evenings</td>
<td>15</td>
</tr>
<tr>
<td>Midnights</td>
<td>5</td>
</tr>
<tr>
<td>P</td>
<td>2</td>
</tr>
<tr>
<td>Rotator</td>
<td>2</td>
</tr>
</tbody>
</table>

**Responses by Shift at UMHS**

*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04*

It is not known exactly how many nurses from each shift received the email link to the survey, so the response rate by shift cannot be calculated. However, we estimate this response rate to be low. Yet the response does represent most shifts. The shifts vary in time, from 8 to 12 hours. We are unsure of the “P” shift, yet since there were 2 responses that said this, we counted it as a separate shift.
Appendix C-4: Calculation Details of Unnecessary Nursing Time

Data was obtained from nursing surveys conducted at HFHS and UMHS 11/17/04 to 12/2/04.

There are three possible patterns an order and delivery from Central/Patient Equipment can follow:

1. The nurse places the order with Patient/Central Equipment and receives the equipment by delivery. (This is what is supposed to occur). In this case, unnecessary time is the time a nurse spends checking up on the order or being distracted while waiting for the order.
2. The nurse places the order with Patient/Central Equipment and ends up obtaining the equipment from some other source before the equipment is delivered. In this case, the unnecessary time is both the time spent checking up on the order or being distracted and the time it takes to locate and prepare the piece of equipment for use.
3. The nurse never orders from Patient/Central Equipment and just obtains the equipment from another source. The unnecessary time spent here is the time it takes to locate and prepare the piece of equipment for use.

To calculate the unnecessary time per order per nurse, a weighted average approach was taken.

First, the percent of time a nurse orders originally from Patient/Central Equipment is calculated using the responses from Survey Question 2.

To determine the percent of time a nurse originally does not order from Patient/Central Equipment, subtract the percent obtained from Survey Question 2 from 100%.

Survey Question 5 provides the percent of the percent originally ordered from Patient/Central Equipment that are obtained in other ways. This percent was multiplied by the percent ordered originally from Patient/Central Equipment to obtain the overall percent of all orders that are obtained in this manner (ordered but obtained in other manners).

Total time per order = Contribution from Pattern 1 + Contribution from Pattern 2 + Contribution from Pattern 3

Contribution from Pattern 1 = (Percent originally ordered-overall percent ordered but obtained in other manners)*Distracted time from Survey Question 8

Contribution from Pattern 2 = (Overall percent ordered but obtained in other manners)*(Distracted time from Survey Question 8 + Time to Prepare from Survey Question 6)
Contribution from Pattern 3 = (Percent originally not ordered)*(Time to Prepare from Survey Question 6)

The unnecessary time per order was calculated for each COMPLETE survey response. If a nurse left one of the components used in this calculation blank, the response was not used for calculation.

Next, each nurse’s unnecessary time per order was multiplied by the number of pieces that nurse answered as applying per shift. This results in the desired number, the average unnecessary time per shift per nurse.

Sample Calculation

Raw Data
Number of Pieces Applied Per Shift = 1  
Percent Originally Ordered from Patient Equipment = 35% (Survey Answer: 3-4 out of 10)  
Percent Obtained from Elsewhere AFTER ordering from Patient Equipment = 15% (Survey Answer: 1-2 out of 10)  
Average Time to Locate and Prepare = 13 minutes (Survey Answer: 13-15+)  
Average Time Distracted = 15 minutes

Calculation
Percent originally obtained from other sources = 100%-35% = 65%  
Overall percent ordered but obtained in other manners = 35%*15% = 5.25%

Contribution from Pattern 1 = (0.35-0.0525)*(15 min.) = 4.4625 min.  
Contribution from Pattern 2 = 0.0525*(15 min. + 13 min.) = 1.47 min.  
Contribution from Pattern 3 = 0.65*13 min. = 8.45 min.

Total Time per piece of equipment = 4.46+1.47+8.45 = 14.38 min. per piece  
Total Time per shift = 14.38 min. per piece * 1 piece per shift = 14.38 min. per shift

Calculations Specific to Henry Ford Hospital

Using all original data points, the original mean was 52.06 minutes and the standard deviation was 83.19 minutes. When using statistical control charts, often the upper control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 301.63 minutes and one point, 349.51 minutes, was above this upper control limit. Therefore this point was taken out of the data set. The following are the final results upon removal of the out-of-control points.
N = 17
Mean = 34.56 minutes
Standard Deviation = 38.70 minutes
Minimum = 0 minutes
Maximum = 117.06 minutes

Scatterplot Showing All Calculated Values of Unnecessary Nursing Time at HFHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04
Box plots of HFHS Unnecessary Nursing Time by Shift*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

HFHS Box Plots of Unnecessary Nursing Time Per Shift*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04
The unnecessary time per shift varies between nursing units, but not between shifts.

**Calculation of Dollars Spent per Nurse Annually at HFHS**

The HFHS Director of Integrated Support Services provided us with an average nursing salary rate of $26.00 per hour, not including benefits. The team estimated that a full-time equivalent nurse works approximately 5 shifts per week and 50 weeks per year. The following shows the calculations used to obtain the dollars spent per nurse annually:

\[
\frac{26.00 \text{ per hour}}{60 \text{ minutes per hour}} = 0.433 \text{ per minute} \\
34.6 \text{ minutes per shift unnecessary time} \times 0.433 \text{ per minute} = 14.98 \text{ per shift} \\
14.98 \text{ per shift} \times 5 \text{ shifts per week} = 74.91 \text{ per week} \\
74.91 \text{ per week} \times 50 \text{ weeks per year} = 3,748.33 \text{ per year} \\
\text{(un-rounded values used for final calculation)}
\]

**Calculations Specific to University of Michigan Hospital**

Using all original data points, the original mean was 35.32 minutes and the standard deviation was 33.99 minutes. When using statistical control charts, often the upper control limit is the mean +/- three times the standard deviation. Points above or below this range are considered out of control and are often thrown out of the data collection. The (mean + 3*standard deviation) was 137.3 minutes and one point, 147.51 minutes, was above this upper control limit. Therefore this point was taken out of the data set. The following are the final results upon removal of the out-of-control points.

\[
N = 57 \\
\text{Mean} = 33.35 \text{ minutes} \\
\text{Standard Deviation} = 30.78 \text{ minutes} \\
\text{Minimum} = 0 \text{ minutes} \\
\text{Maximum} = 126.60 \text{ minutes}
\]
Scatterplot Showing All Calculated Values of Unnecessary Nursing Time at UMHS*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04

Box plots of UMHS Unnecessary Nursing Time by Shift*
*Data obtained from nursing surveys conducted at HFHS and UMHS 11/17/04-12/2/04
The unnecessary time per shift varies between nursing units, but not between shifts.

**Calculation of Dollars Spent per Nurse Annually at UMHS**
The UMHS Director of Finance & Business Operations, Nursing Services provided us with an average nursing salary rate of $26.50 per hour, not including benefits. The team estimated that a full-time equivalent nurse works approximately 5 shifts per week and 50 weeks per year. The following shows the calculations used to obtain the dollars spent per nurse annually:

- $26.50 per hour / 60 minutes per hour = $0.442 per minute
- 33.4 minutes per shift unnecessary time * $0.442 per minute = $14.75 per shift
- $14.75 per shift * 5 shifts per week = $73.76 per week
- $73.76 per week * 50 weeks per year = $3,687.92 per year

(un-rounded values used for final calculation)
Appendix C-5: Henry Ford Hospital General Nursing Comments

This appendix includes the general comments and recommendations as given by the nurses that completed our mobile medical equipment delivery survey conducted 11/17/04 to 12/2/04 at Henry Ford Health System. Some information was deleted as to protect the identity of the survey respondent.

Comments:
“If the floors were better equipped with items and if the items could be found in the same area that would be helpful. Instead items are placed in different places or supplies are low and then the big search begins.”

“It appears locating equipment is a great issue. I think we don't have enough equipment for me to do my job. This is a hospital for goodness sakes! Many times the doctors come down on us nurses, because they believe the problem is with us. There is far too much blame, and not enough getting to the root cause. I hope this survey helps us out, and quickly!!”

“Rooms should have standard equipment stocked, such as IV poles, pumps, O2 trees, O2 flow meters.”

“[It is] very common to look for extra equipment on the floor before ordering from central supply because most often it takes hours before you receive the equipment you need.”

“There are many times when a patient is D/C that we clean equipment because we are waiting for that equipment for another patient to use. I do understand that it is a loss of money when a patient is not charged for the use, but I'm putting patient care first.”

“ER should transfer the pump with the patient. The pump is billed to the patient and we are supposed to return unused pumps anyway. Dopamine, Dobutamine, Nitro, Heparin, and Primacor can not be stopped for long, especially on a cardiac floor.”

“Improve the delivery time.”

“Central Supply is not usually a problem. We do keep some IV pumps here because…we need them stat, but other supplies usually come in reasonable time.”

“We have been waiting for IV poles for about 4 months, and using paper clips to hang bags. We go racing around to find an IV pump for a patient in need. Also PCA pumps.”
Appendix C-6: University of Michigan Hospital General Nursing Comments

This appendix includes the general comments and recommendations as given by the nurses that completed our mobile medical equipment delivery survey conducted 11/17/04 to 12/2/04 at the University of Michigan Health System. Some information was deleted as to protect the identity of the survey respondent.

Comments:
“Occasionally, there is a glitch and things do not arrive, but as a rule this service is responsive.”

“In order to order equipment we must have a patient name and REG number (which sometimes we get just moments before a patient arrives). Sometimes we don't have the equipment BEFORE a patient arrives which means we need to clean dirty IV pumps, warmers, etc. to be ready for a patient. We need the supplies before the patient arrives from the OR or ER.”

“I am waiting for a kangaroo pump right now. I called for it 2 hours ago. This is a frequent problem. Please do your best to help fix it.”

“A lot of the patient equipment staff needs a class on customer service. The majority is very rude or mean on the phone when calling back about equipment that is taking a long time to get to the unit. Or if they don't have the equipment, they don't call you to tell you until you call them back 3 hours later. It is very frustrating to do your job when people are rude and incompetent. I would rather find it elsewhere than deal with that type of treatment. I get enough abuse from my patients.”

“I have noticed a difference depending on where in the hospital you work. It seems like it takes less time to receive equipment while working on a floor than it does working in an ICU. People in medical equipment sometimes seem not to know who is to be transporting the equipment to you or may say that the equipment was already delivered and it wasn't. This is particularly frustrating when it is an emergent situation and the item is taking over an hour to arrive. Whether the reason being that they are out of pumps or just don't have the man power to get the equipment to us. I feel it is a real burden to staff and patients.”

“There are times when it takes a while for the equipment. Our clerks are good about ordering it before admits come in.”

“Usually, if the ward clerk orders the equipment when she is processing the orders delivery time is excellent. If the equipment is not ordered with order processing then delivery time can be significantly delayed particularly when we are very busy.”

“Several times when the wrong equipment is delivered it gets very frustrating.”

“Evening shift is better than days for delivery.”
“It is very hard to know how long it takes to get equipment. If I order it myself, it usually comes right away (within 15-30 min.) When I ask a clerk to order it, it usually takes longer because they do not order it right away or forget to order it. I think that clerical delay is the biggest reason we don't get equipment on a timely basis on the day shift.”

“In the central supply I worked in during nursing school, we were required to use the power washer (used on the surgery tray carts) to clean the wheels. Many of the pumps poles, or equipment on wheels have sticky wheels or defective wheels. Noisy and jerky when I'm trying to move a patient down the hallways during the night. Thanks for asking for the nurses opinions.”

“Many times equipment ordered on night shift has not arrived by 7am and must be reordered by the day clerk.”

“Overall, I think you guys do a good job, however it takes sometimes too long to get IV pumps to acute general care. This process often keeps us from giving patients medications they need so it's really important to get the supplies ASAP.”

“The main problem I have had consistently is that if a piece of equipment is excessively late in arriving (well over an hour) and I call the Patient Equipment office, the person who answers the phone is invariably abrupt to the point of rudeness. I can barely get half a sentence out of my mouth before the person shouts, ‘YEAH WE KNOW. IT’S ON ITS WAY!’ and slams the phone down. Learn some basic telephone manners, guys. Thanks.”

“It seems to me the delivery people are overworked, or at least they frequently seem so, and that there is not enough equipment.”

“A lot of times we need to order the equipment again and I am not sure why.”

“[I recommend] faster service and to pick up dirty equipment more often. Sometimes we are skipped over if they see too much in the dirty room and leave it for the next shift. Then we are told they don't have it when they could of cleaned it downstairs. Instead of nursing cleaning to put in service (Time wasted).”

“I have worked here for 10 years and over the years the service has gotten better. It used to take hours to get equipment. I would resort to ordering my equipment STAT to get it in a timely manner. There has been a big improvement over the years. Realistically, when a patient needs a piece of equipment for something, we need it quickly because their in pain etc. Their expectation is a quick response and when nursing can't give them that quick response it makes their stay more intolerable. I think a response time of 30 minutes or less is reasonable. We get NOW and STAT orders for medications all the time and if we don't have a safe, monitored way to deliver them we can't effectively do our job and the patient ultimately suffers. I hope this information helps. Thanks for the survey.”
“I am glad to see someone addressing this issue. It takes a lot of time away from patient care and sometimes adds a lot of frustration to my day. Good luck with your project.”

“Patient Equipment does a good job.”

“I wonder if all equipment is cleaned properly”

“If equipment is unavailable I would like a call back telling me this instead of letting me wait it out or repeating phone calls. IV pumps, PCA pumps, and Bair huggers should get priority over SCD’s. If we call for something stat we should know its going to come in 10 minutes or less.”

“Possible storage of clean items for usage on the floor so that people could run up to floor and deliver it, or let nursing have access to such a room”

“More time is spent on troubleshooting IV pumps than wasted in waiting for equipment to come.”

“You need a better online search engine first of all. Then when the order is in a way to find out if the item is available and when you can expect it. Also you need to have a way to get things 'stat' = immediately when needed.”

“It's best to work nights. Service is much better.”

“Order hierarchy - i.e., stat, now, standard times”

“Some equipment doesn't matter (i.e. SCDs), but the most important thing to get very quickly is IV pumps because we could be putting someone on a gtt or whatever.”