Patient Transportation Project

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University of Michigan Hospitals

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University of Michigan
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EXECUTIVE SUMMARY

The University of Michigan Hospital currently uses three departments to service all of its patient transportation requirements. The radiology and physical therapy areas each have their own set of transporters which are only responsible for those departments. The rest of the hospital is serviced from one location known as the central dispatch. All three of these units reside under the control of the Materiel Services Department.

A study was conducted to determine the appropriate number of patient transporters necessary in each of the three units. Using these numbers as guidelines, the second objective was to develop a staff schedule for each department that would reduce idle time and increase the productivity of the transporters.

Preliminary research revealed that 84.22% of all patient transportation jobs were completed by the central dispatch employees. Radiology and physical therapy accounted for 7.06% and 8.72% of the jobs respectively. Another important statistic was the number of appointments that were completed on time. The rate of on time completion for the central dispatch area was 34.6%. This value remained virtually constant throughout the day regardless of the amount of employees or the level of demand.

Runs were also subject to delays at any point within their duration. These delays increased the length of the run and contributed to the lateness of appointments. In central dispatch, 79.5% of all runs experienced some sort of delay. This figure was slightly higher in radiology, 81%, and slightly less in physical therapy, 51%. These values suggest that run delays are occurring too frequently. Including the amount of delays, the average run time for any given job was 16.95 minutes in central dispatch, 11.89 minutes in radiology, and 10.53 minutes in physical therapy.

In order to allocate staffing levels in each department, productivity was the primary consideration. Productivity was chosen as the important characteristic after determining that regardless of the amount of workload and corresponding staff level, the number of on time runs completed remained constant. For example, in a period sampled in central dispatch from 7:00 a.m. to 10:00 a.m., the workload was minimal, but the maximum number of employees, 16, were on duty. During this time, 67% of the runs were late. However, in another period from 4:00 p.m. to 7:00 p.m. when the workload was at its peak and only
nine employees were present, only 68% of the runs were late. This represented a negligible difference. Therefore, the goal was to staff each area such that the level of productivity remained constant throughout the day. We defined productivity as the number of runs performed by a single transporter in a hour. Since the average run time was almost 17 minutes in central dispatch, we attempted to staff in this area so that a productivity level of three runs per hour per transporter could be attainable which allows for 20 minute runs.

During the weekdays, the central dispatch area experienced peak demand levels at 12:00 noon and from 4:00 p.m. to 7:00 p.m. In order to accommodate this workload and achieve a productivity level of three, we propose the following work schedule:

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The total number of employees to fill this schedule is 23 compared to the current level of 26. The maximum number of employees scheduled at any one time occurs between 4:00 p.m. and 7:00 p.m. and is 15 people. However, this staffing level does not reflect the need for specimen sweeps that occur in the ICU and burn unit every half hour, and in the ABC areas of each floor every hour. The sweeps on average take 43.72 minutes for the ABC units, 22.39 minutes for the ICUs and 17.96 minutes for the burn unit. Three additional people will be required to perform these sweeps during each shift.
The proposed weekend schedule for central dispatch is as follows:

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This creates a total of nine positions during the weekend whereas the current level is 22. However, once again an additional three people are needed to conduct appropriate sweeps.

PHYSICAL THERAPY

In the physical therapy transportation unit, the average run time was 10.53 minutes. Therefore, we attempted to staff such that a productivity level of five was constant. In other words, a transporter should be expected to perform five runs per hour. From this we determined that physical therapy needs only three full time transporters to service its needs. They currently employ seven transporters.

RADIOLOGY

Again a productivity level of five was utilized to compute the number of transporters needed in radiology since the average run time in this area was 11.89 minutes. This criterion revealed that only one transporter was necessary both during the week and on the weekend. However, two transporters are recommended. This would eliminate the possibility of one being on a run when an additional, more important appointment was to be scheduled immediately. Radiology transporters also perform random sweeps during the day which were not entered into the Headlee system and therefore we did not analyze. The employees were unable to specify how frequently these sweeps occurred and the approximate duration of each. Hence, we are unable to predict the number of transporters required to fulfill these additional responsibilities.
INTRODUCTION

Determining the number of workers needed and the appropriate staffing levels is a concern for all organizations. However, with a hospital systems organization, the concern for appropriate staffing is even greater than that of other organizations because lives are at stake on a regular basis. If the hospital system is not adequately staffed, many emergency situations could develop where patient lives would be in jeopardy. This study was undertaken to analyze the staffing levels of the patient transportation system within the University of Michigan Hospital which is divided into three areas.

PURPOSE

The patient transportation system currently operates under the management of the Materiel Services Department. A central dispatch location is utilized to allocate selected transporters for use throughout the University Hospital. In addition to those in central dispatch, transporters are also permanently stationed in radiology and physical therapy for their individual needs. The purpose of this project was to determine the number of transporters required for each area to adequately service the demand. After ascertaining this number, the optimal schedule was then developed for each shift during the week.

The goal of this project was to decrease downtime among transporters, thereby effectively utilizing their time and reducing costs. By insuring that the appropriate number of transporters are on staff during each shift, patients will not have to wait to be serviced which will result in greater customer satisfaction.

LIMITATIONS OF STUDY

Before we outline our analysis, it is critical to address the limitations of our study that might effect the conclusions we developed. The data reviewed to conduct this study was collected from the Headlee database system. The receptionist and the dispatcher of the central dispatch location both operate on computer terminals and enter the appointments on them. Once entered into the computer, these appointments become part of the database. After surveying the data, we determined that some possible data entry errors may have occurred.
First of all, although sweeps are to be performed every hour and half hour, many of these did not appear on the data we obtained. This indicates that they were probably not inputted to the computer via the dispatcher. In addition, some runs indicated a completion time but did not specify a dispatch time. This resulted in a total run time of zero as calculated by the database system. Again, this is probably a failure of the dispatcher to actually dispatch these runs. He/she may have dispatched the runs over the radio, however, did not update the computer system. Another source of error resulted from runs which were supposedly completed at the same time they were dispatched which is not feasible. This generated another run of zero duration and more bad data.

After identifying this bad data throughout our collection, we eliminated it and proceeded with the analysis. Given these limitations, we conducted the study outlined in the following sections.

**APPROACH AND METHODOLOGY**

One month's (February '92) worth of data from the Headlee system was utilized in this project. The data was divided into the following three areas: radiology, physical therapy, and central dispatch. This allowed for separate analysis of each department. Then, the radiology and central dispatch areas were further divided into weekday and weekend components since different workers are present and a different staff schedule is used. The physical therapy area is closed on weekends and therefore did not need to be divided in this manner.

Once all of these divisions were completed, histograms were developed which displayed the number of runs versus the time of day partitioned into one hour intervals. These histograms enabled us to see the "peak" times of demand (where the workload was the highest). Then, graphs of FTE transporters needed versus time of day in one hour intervals were prepared. The formula used to calculate the FTE transporters needed was:

\[
\text{FTE transporters needed} = \frac{\text{# of runs} \times \text{Avg. runtime in hours}}{\text{# of days of service in sample}}
\]
The number of days varied depending on if a weekday or weekend schedule was used. These graphs provided the number of FTE transporters needed to handle 50% of the workload at any given time which could be compared to the number of FTE transporters currently scheduled in each of the one hour intervals. See Appendix for detailed graphs describing these results.

Then, more graphs were produced which determined the number of FTE transporters needed to handle 95% of the workload in one hour intervals. The formula used to calculate the FTE transporters needed to complete 95% of the work was:

\[
\text{FTE transporters needed for 95\% of the work} = \frac{\# \text{ of runs} \times (Z(.95)\sigma + \mu)}{\# \text{ of days of service}}
\]

where \(Z(.95) = 1.65\), \(\sigma\) is the standard deviation of all the actual run times, and \(\mu\) is the average runtime calculated from the entire sample of data for each respective department. These graphs enabled us to compute the number of FTE transporters that would be necessary to complete 95% of the workload at any given time. See Appendix for detailed graphs describing these results. The normality assumption is valid based on the distribution of the run duration which is approximately normal with a positive skew. See figure 1.

![Central Dispatch Run Time Distribution](image)

**Figure 1.**
Therefore, the Z value at the 95th percentile under the normal assumption is 1.65.

The final graphs created were the FTE transporter staffing levels for optimal productivity. These graphs portrayed the staffing level versus the time of day in one hour intervals. The formula used to calculate the staffing level was:

\[
\text{Staffing Level} = \frac{\text{# of runs}}{\text{# of days of service} \times \text{productivity level}}
\]

Productivity is a measurement of the number of runs one FTE performs each hour. A productivity of three corresponds to a FTE transporter completing a run every 20 minutes. In order to achieve this level, the transporter must be allowed twenty minutes after being dispatched before the appointment time instead of the current practice of allowing only 15 minutes. If runs were completed every 15 minutes, a productivity level of four would result. However, since the average run time is greater than 15 in central dispatch, it is unreasonable to expect four runs to be completed each hour. The actual productivity level varied depending on the time of day, level of staff, and number of appointments. Refer to the appendix for a detailed graph of the current productivity levels of central dispatch throughout the day.

The proper staffing level for each hour of the day is directly related to the workload in that hour. These graphs were the most important because they were used to recommend a staff schedule which could be implemented.

Another step in our methodology in solving this problem was to observe the actions of the FTE transporters and dispatchers while at work in the three areas we have studied. This enabled us to gain a deeper understanding of how the system actually functioned.

CURRENT SITUATION

At present, the patient transportation services uses a total of 26 FTE transporters for the central dispatch area, 7 FTE transporters for the physical therapy, and 8 FTE transporters for radiology. The current staff schedule for these three areas are as follows:
<table>
<thead>
<tr>
<th>Time</th>
<th>CENTRAL DISPATCH</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30 AM - 3:00 PM</td>
<td>8:00 AM - 4:30 PM</td>
<td>7:00 AM - 3:30 PM</td>
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<tr>
<td>7:00 AM - 3:30 PM</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>RADIOLOGY</th>
<th>Time</th>
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<tbody>
<tr>
<td>7:30 AM - 4:00 PM</td>
<td>12:00 AM - 8:00 PM</td>
<td>7:30 AM - 4:00 PM</td>
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<td>7:30 AM - 4:00 PM</td>
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<td>7:30 AM - 4:00 PM</td>
<td>5:00 PM - 9:00 PM</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>PHYSICAL THERAPY</th>
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<td>7:30 AM - 4:00 PM</td>
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On the weekends central dispatch has 9 FTE transporters on the day shift (8:00 a.m to 4:00 p.m), 7 FTE transporters on the evening shift (4:00 p.m to midnight), and 3 FTE transporters on the midnight shift (midnight to 8:00 a.m.).

**ALTERNATIVES AND HYPOTHESES CONSIDERED**

Possible problematic areas and recommendations to solve them were considered before data analysis. The feasibility of these alternatives were to be explored through the analysis. Alternatives that were considered before the study were the following:

- Whether the utilization of the FTE transporters in the three areas being examined was at a reasonable level.

- Whether the percent on time was extraordinarily effected by the allotted time to perform the “run”.

- Whether the factor of dispatching the FTE transporter only 15 minutes before the appointment time made a significant difference in the percentage of “runs” completed on time.

- Whether separating the radiology and physical therapy departments from the central dispatch was feasible.

**FINDINGS AND CONCLUSIONS**

After dividing the data up into the three areas of central dispatch, radiology, and physical therapy we found that 84.22% of all the patient transportation jobs were dispatched from the central dispatch area. Radiology and physical therapy accounted for 7.06% and 8.72% of the jobs respectively. Refer to figure 2.
The percent of runs that were completed on time remained constant throughout the day. Central dispatch had 34.6% on time which deviated only by one or two percentage points at any time during the day. See figure 3.

The aforementioned analyses (from the Approach and Methodology section of this report) were then performed on the three targeted areas. As stated
earlier, the proper staffing level for each hour of the day is directly related to the workload in that hour. This information in conjunction with the average time a run takes to perform would yield the proper staffing level. From this we determined the appropriate staff schedule with the desired productivity level of three (allowing 20 minutes to complete a run instead of the current amount of 15 minutes).

On the weekdays the central dispatch area had peak times of 12:00 noon and from 4:00 p.m. - 7:00 p.m. See figure 4.

The occurrence of peak workload times for the FTE transporters could not have come at worse times of the day. During the 12:00 noon hour, transporters are on lunch and 4:00 p.m. is when a new shift begins. These problems had the effect of lowering the work capacity of the FTE transporter work force during this time. This is exactly opposite of what is desirable: all workers working at maximum efficiency during this time. The mean time for all runs in this area was found to be 16.95 minutes and the standard deviation was found to be 9.62
minutes on the weekdays. On the basis of our optimal productivity level we found that the appropriate staffing levels for central dispatch during the weekdays were:

<table>
<thead>
<tr>
<th>FTE Staffing Level for Optimal Productivity (Weekday Central Dispatch)</th>
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<tbody>
<tr>
<td>Time of Day</td>
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<tr>
<td>Staffing Level</td>
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</table>

Figure 5.

On the weekend the central dispatch area had peak times of 8:00 a.m. with a steady decrease throughout the day. Refer to figure 6.
As depicted in figure 6, there were very few jobs needing to be performed from midnight to 8:00 a.m. The mean runtime and standard deviation for this area on the weekends was the same as for the weekdays. On the basis of our optimal productivity level we found that the appropriate staffing levels for the weekend at central dispatch were:
The peak time for radiology on the weekdays was found to be at 5:00 p.m. to 7:00 p.m. and on the weekends from 9:00 a.m. to 11:00 a.m. and from 2:00 p.m. to 3:00 p.m. See figures 8 and 9.
Figure 8.

Figure 9.
The mean runtime for radiology was 11.89 minutes with a standard deviation of 7.13 minutes. On the basis of our optimal productivity level we found that the appropriate staffing levels for radiology for the weekdays and the weekends were:

**FTE Staffing Level for Optimal Productivity**

*(Weekday Radiology)*

---

**Figure 10.**
Figure 11.
The physical therapy area had peak times from 9:30 a.m. to 11:00 a.m. See figure 12.

The mean and standard deviation for the runtimes from this areas were 10.53 minutes and 7.41 minutes respectively.
On the basis of our optimal productivity level we found that the appropriate staffing levels for physical therapy were:

**FTE Staffing Level for Optimal Productivity**

(Weekday Physical Therapy)

![Bar Graph Showing Optimal Staffing Levels](image)

**Figure 13.**
RECOMMENDATIONS

CENTRAL DISPATCH

After thorough analysis and observations, we have generated a list of recommendations which include a staff schedule of the central dispatch location and the appropriate number of transporters needed in both radiology and physical therapy respectively. These should be considered by the Materiel Services Department in order to decrease worker idle time and maintain a constant productivity level.

In order to allocate staffing levels in each department, productivity was the primary consideration. Productivity was chosen as the important characteristic after determining that regardless of the amount of workload and corresponding staff level, the number of on time runs completed remained constant. For example, in a period sampled in central dispatch from 7:00 a.m. to 10:00 a.m., the workload was minimal, but the maximum number of employees, 16, were on duty. During this time, 67% of the runs were late. However, in another period from 4:00 p.m. to 7:00 p.m. when the workload was at its peak and only nine employees were present, only 68% of the runs were late. This represented a negligible difference. Therefore, the goal was to staff each area such that the level of productivity remained constant throughout the day. We defined productivity as the number of runs performed by a single transporter in an hour. Since the average run time was almost 17 minutes in central dispatch, we attempted to staff in this area so that a productivity level of three runs per hour per transporter could be attainable which allows for 20 minute runs.
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PHYSICAL THERAPY

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RADIOLOGY

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Given the previously stated limitations of this study, it may be desirable for management to address the possible user errors that are occurring. Until these errors have been alleviated, the system will not be fully operational. Observations of the central dispatch area revealed that different personnel are rotating through the dispatch position throughout the same shift. This may be leading to inconsistencies regarding the entry of data. Furthermore, unqualified individuals may be rotating through the position who do not have full knowledge of how to operate the system. If possible, it is recommended that only one individual perform dispatching duties during any shift which would produce consistent results. This dispatcher should first be trained on the proper usage of the system.
APPENDIX
FTEs Needed vs. Time of Day (Weekday Central Dispatch)
95% On Time Completion
FTEs Needed vs. Time of Day
(Weekday Central Dispatch)
FTEs Needed vs. Time of Day
(Weekend Central Dispatch)
FTEs Needed vs. Time of Day
(Weekend Radiology)
FTEs Needed vs. Time of Day
(Weekday Physical Therapy)
Percent of Total Runs from Each Area

- Radiology: 8.72%
- PMR: 7.06%
- Central: 84.22%
Central Dispatch
Run Time Distribution

Average = 16.9478
Median = 15
Standard Deviation = 9.6248
Central Dispatch Percent On Time

- Late: 34.6%
- On Time: 65.4%
Central Dispatch Percent Delayed

- No Delay: 79.5%
- Delayed: 20.5%

Average Delay = 11.27687 Minutes
Radiology Percent Delayed

- 19% No Delay
- 81% Delayed

Average Run Time = 11.89 minutes
Average Delay = 6.87
PM&R Percent Delayed

Average Delay = 5.56 minutes
Average Run Time = 10.53 minutes
This is what you are currently doing.

This is what your productivity will look like following our recommendations.
Number of Runs vs. Time of Day (Weekday Physical Therapy)
FTE Staffing level for Optimal Productivity (Weekday Physical Therapy)
Number of Runs vs. Time of Day
(Weekday Radiology)
FTE Staffing Level for Optimal Productivity (Weekend Radiology)
Number of Runs vs. Time of Day
(Weekday Central Dispatch)
FTE Staffing Level for Optimal Productivity
(Weekend Central Dispatch)
<table>
<thead>
<tr>
<th>Materiel Services Department</th>
<th>University of Michigan Medical Center Present Weekend Schedule Central Dispatch</th>
<th>Patient Transportation Project</th>
</tr>
</thead>
</table>

<table>
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