Improvement of Sparrow Hospital's Emergency Department Processes

Megan Foster
Sonali Nanavati
Christina Webb

with the assistance of
Simreet Gill
Cory Gray

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Abstract: Using data collected from the Emergency Department at Sparrow Hospital, we identified the most important intervals affecting patient throughput. The top rate-limiting factors that, if corrected, will most dramatically decrease patient treatment time were found. We concluded that the triage-to-back-to-room and seen-by- doctor-to-discharge time intervals were the most significant. We make recommendations to reduce the mean time patients spend in each of these intervals.

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Introduction

Our objective was to analyze the efficiency of the current Emergency Department (ED) procedures of Sparrow Hospital, the primary medical facility for central Michigan. Using past patient throughput statistics, we modeled the patient flow to determine which processes need improvement to expedite a patient's visit. Currently, a patient's average length of stay at Sparrow's ED is considerably longer than hospitals of equivalent size.

We examined the factors, which affect the ED's throughput of patients. To do this, we collected data on the time between different stages of a patient's visit and combined this data with past annual statistics provided by Sparrow Hospital. We then performed a statistical analysis on the time data in order to rank the major time-rate limiting intervals. Finally, we formulated several recommendations for decreasing these time intervals.

Data Collection

We first observed the processes that a patient undergoes during a visit to Sparrow Hospital's ED. From these observations, we developed a flowchart (Appendix A) modeling each time checkpoint considered in our analysis. We then developed a worksheet (refer to Appendix B) for the ED personnel to record the specified checkpoint times. To increase our sample size, we also gathered the time data from past patient's charts. Our sample consisted of 173 records in all.

Because approximately 82 percent of ED patients are not admitted to the hospital, we chose to concentrate on the waiting times of patients for which the ED has primary control. Thus, our sample was composed solely of discharged patients. A study at the University Medical Center also used a similar sampling technique [1]. They found that implementing improvements to their ED resulted in not only a decrease in length of stay for non-admitted patients, but also for admitted patients.

After collecting the data, the data was organized in an Excel spreadsheet. The spreadsheet was designed so that a patient's time values could be extracted according to various characteristics --- patient identification, triage status, day, month, arrival time, and visit duration. This enabled us to group the data by various criteria in order to analyze the effect that significant factors have on a patient's visit.

Sparrow Background

In order to determine the steps that significantly affect patient throughput, we first had to analyze the infrastructure of the Sparrow Hospital ED. When a patient first enters the department, the triage nurse assesses his/her condition, and assigns to the patient one of three codes. The codes are *red*, *yellow* and *green*, ranked in order from most to least critical. Patients with non-critical conditions (green acuity) have the option to be treated in Sparrow's Fast Track Unit. This unit allows non-critical patients to be treated expeditiously, and frees up more open beds in the main treatment area of the ED. Next, the assessment nurse sees the patient and determines what type of bed his or her condition warrants. The *A Hall* of Sparrow's ED contains 16 monitored beds, while the *C Hall* has 11 non-monitored beds. There are also six hallway beds and two trauma bays. After treatment in the ED, a patient is either discharged or admitted to the hospital.

For a more in depth understanding of the process, we conducted interviews with

laboratory and X-Ray technicians and a charge nurse. We learned that ED personnel draw laboratory samples from the patients. The samples are then sent via a pneumatic tube to the laboratory for processing. The ED labs are given second priority behind surgical patients. The actual time for a standard analysis takes approximately ten minutes. Upon completion, the results are then sent to an ED printer. When radiology is needed, a form is sent from the ED to the Radiology Department by computer and then printed. Upon receipt, the orders are prioritized on a bulletin board. When radiology is ready to process the order and the patient is available, a transporter moves the patient from the ED to radiology. Radiology sends the X-Ray films digitally to a computer in the ED.

Determination of Rate Limiting Intervals

Using this information to make reasonable assumptions, we were able to fill in data missing from incomplete charts. For ambulance patients with missing triage times, we assumed that this time is equivalent to their assessment time. Similarly, a patient's discharge time is approximately his/her final reassessment time; we used this value for missing discharge times. When recorded, the median time from triage to assessment is 14 minutes. Thus, if we encountered absent values in these areas, we computed them accordingly. Since X-Rays are not found in the charts, the time of completion was not available. To find the X-Ray completion time, we considered two groups of patients --- patients with no diagnostics and those whose only diagnostic was X-Rays. After averaging the total stay of both groups, we found the difference between these values to be 63 minutes, and used that time as the time necessary for X-Ray completion [2].

We used the time data collected as well as the aforementioned assumptions to find the average time for each of the crucial time intervals of a patient's visit (Table 1).

Table 1. This table shows the approximate mean (in minutes) of interval times from data we collected from Sparrow Hospital's ED.

Time Interval	Mean
Total length of stay	249
Triage - back to room	53
Back to room - seen by doctor	13
Seen by doctor - discharge	183
Diagnostics	74

After computing the time intervals of Table 1, we investigated which intervals were consistent with other hospitals of comparable size. A study done by Stephen Hoffenberg, et al., presented average interval times for various sized hospitals [3]. Sparrow is considered a large hospital based on the number of patients it treats per month. Table 2 shows the average interval values for large hospitals given by the study.

Table 2. This table shows the approximate mean (in minutes) of interval times from data for large hospitals [3].

Time Interval	Mean
Total length of stay	176
Triage - back to room	35
Back to room - seen by doctor	23
Seen by doctor - discharge	118

By comparing Table 1 with Table 2, we can see that a patient's average length-of-stay, triage-to-back-to-room, and seen-by-doctor-to-discharge time intervals in Sparrow's ED are significantly greater than those of comparable hospitals. However, the back-to-room-to-seen-by-doctor time interval for Sparrow's ED is considerably lower. Hence, we determined our rate limiting factors occur within the triage-to-back-to-room and seen-by-doctor-to-discharge time intervals.

Diversion to Fast Track

Our research found that many successful hospitals routinely divert non-critical patients to their Fast Track unit during their busiest hours. Currently, Sparrow allows the patient to choose between Fast Track and the main treatment area. Figure 1 shows the average patient count by hour for the ED at Sparrow Hospital. Patient volume is greatest between 15:00 and midnight as seen in Figure 1.

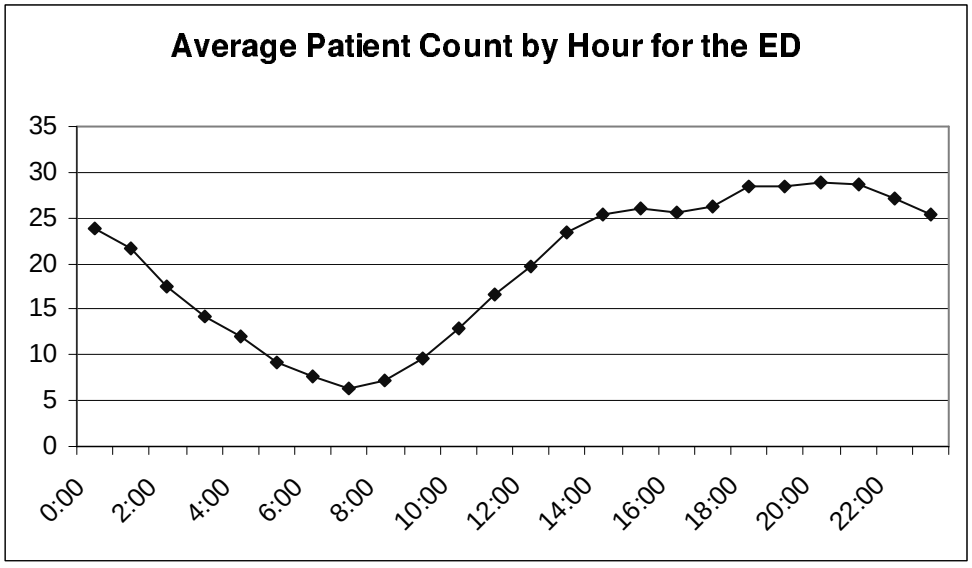

Figure 0. This graph shows the average patient count per hour of the day for the main treatment center of the ED.

Next, we examined the average patient arrival by hour in the Fast Track unit of the ED (Figure 2). In Figure 2, we see that the patient volume for Fast Track decreases between 15:00 and midnight. Also, notice that the greatest average volume per hour is five patients.

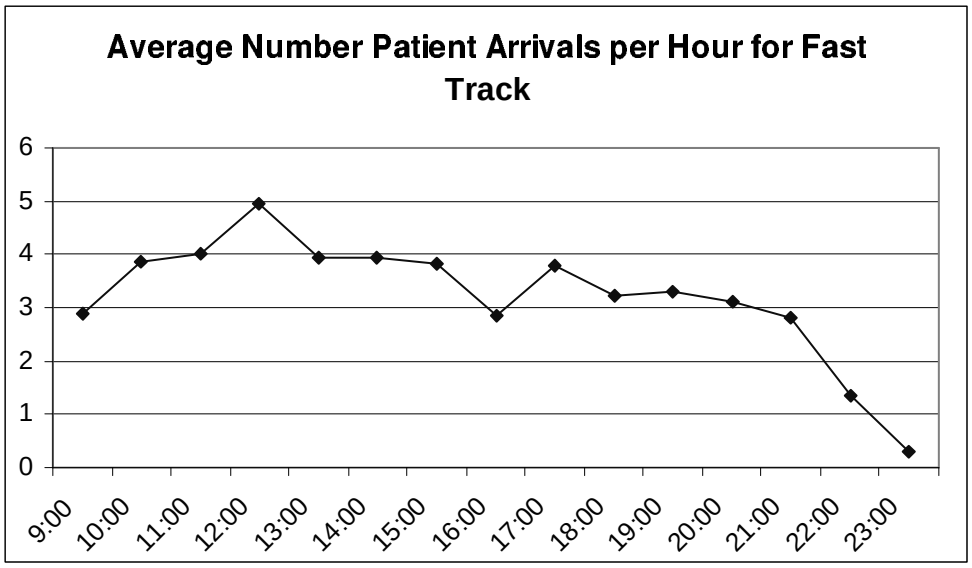

Figure 1. This graph shows the average number patient arriving per hour of the day for the Fast Track unit from 9:00 to 23:00.

In short, Figure 2 shows that there is an increase in volume for the ED at the same time that the Fast Track volume is decreasing. Our data shows that approximately 45 percent of all patients with green acuity arrive during the hours of 15:00 to 23:00. The Fast Track unit could treat many of these patients. Sparrow Hospital's data indicates there are approximately 28 patients with green acuity per day. We assumed 45 percent, or 13, of green acuity patients arrive between 15:00 and 23:00. Sending some of these patients to Fast Track for treatment would free up bed space in the ED, as well as increase the volume in Fast Track during its slower period. During operating hours, Fast Track is staffed with one RN and one technician. They should be able to cope with 1.6 more patients per hour.

Research has shown that by sending lower acuity patients to Fast Track, total ED waiting time is decreased. In the study at Johns Hopkins Bayview Medical Center, diverting low acuity patients to their Fast Track equivalent decreased total ED waiting time from a median of two hours 28 minutes to one hour 46 minutes [4]. Not only was the length of stay for diverted patients reduced, but also the length of stay for patients in the main treatment area.

Utilization of Color-Coded Labels

Another way to reduce patient throughput time is by concentrating on decreasing the length of the "seen by doctor to discharge" time interval (seen in Table 1). Major factors in this interval are diagnostic tests. This can be seen in Figure 3.

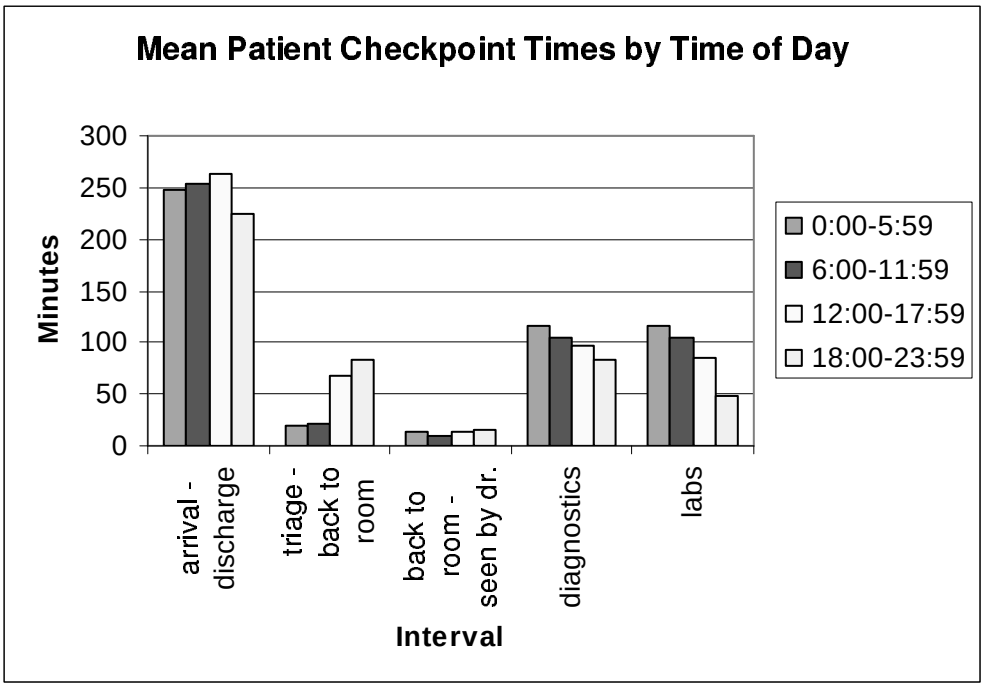

Figure 2. This graph shows the average total duration for each interval based on the time of the day.

This figure shows that the greatest portion of a patient's visit is consumed by diagnostic processing. Diagnostics and laboratory tests follow approximately the same distribution over various periods of the day. Therefore, we looked at the time difference from order to receipt of laboratory results. According to our data, the correlation between the laboratory times and the total length of stay was approximately 0.3. Many other parameters, which we did not consider in our analysis, such as number of admissions, number of patients, variability of ED staff, and patient acuity level, increase the variability of these results [5]. Since there is a positive correlation between total laboratory time and total length of stay, a reduction in total laboratory time will result in a reduction in total length of stay.

Although theoretically ED laboratory samples are of high priority, there is no visual cue to identify ED specimens. To identify ED specimens throughout the laboratory process, a unique color label should be used. This saves time by allowing for quick identification of ED samples by laboratory technicians. In a study at the University Medical Center in Tucson, Arizona, before using colored labels, only 88 percent of specimens were analyzed and reported to the ED within the target time interval. Upon implementation of colored labels, the number of specimens available within the target range increased to 94 percent [1].

Creating a Community

Research has shown that in an efficient ED, there is a universal sense of responsibility and pride in the department. Therefore, a sense of community will unite all members in the goal of decreasing patient throughput time [1]. One way to reach this goal is by setting target times for different intervals of a patient's visit and by assigning a staff

member to ensure that these goals are met [3]. Posting weekly summaries detailing the progress made towards the targeted times gives immediate performance feedback to the staff, boosting morale and motivation to achieve the goal [6].

Summary of Recommendations

1. Divert green acuity patients arriving from 15:00 to 23:00 to Fast Track.
2. Color code samples sent from the ED to the lab for ready identification.
3. Make decreasing patient throughput time a department goal.

Future Work

In this final section, we indicate several directions of research that a future team might consider. We recommend that more patient record data be collected to obtain a more representative sample. Included in this broader sample should be patients admitted to the hospital from the ED. This would allow the team to examine the processes a patient goes through before admission. Although the assumption we made for X-Ray duration times appears valid, collecting the actual completion time would allow for further analysis of this stage.

Next, a computer simulation of the ED would enable the manipulation of variables to determine their affect on patient throughput. Variables to consider are the number of nurses on staff, number of beds per nurse, time of day, and number of patients seeking treatment [7].

In addition, computerized self-scheduling should be considered. Self-scheduling decreases the time the assistant department managers must spend determining employee shifts. It also improves shift-to-shift cooperation, unit productivity, and the ability of staff to meet personal needs [8]. Self-scheduling uses a computer program to place employees into appropriate shifts based on hospital needs, personal preferences and seniority. Sparrow Hospital currently uses manual self-scheduling. Computerizing this process would eliminate any biases and reduce human error [9].

Last, a satisfaction survey would be beneficial in measuring the impact that future changes would have on a patient's viewpoint of the ED. A standard survey could be used before and after the improvements are implemented. The results from these surveys would show the effect of these implemented procedures, as well as identify areas needing additional attention [10].

References

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Appendix A. Flowchart of Patient Throughput.

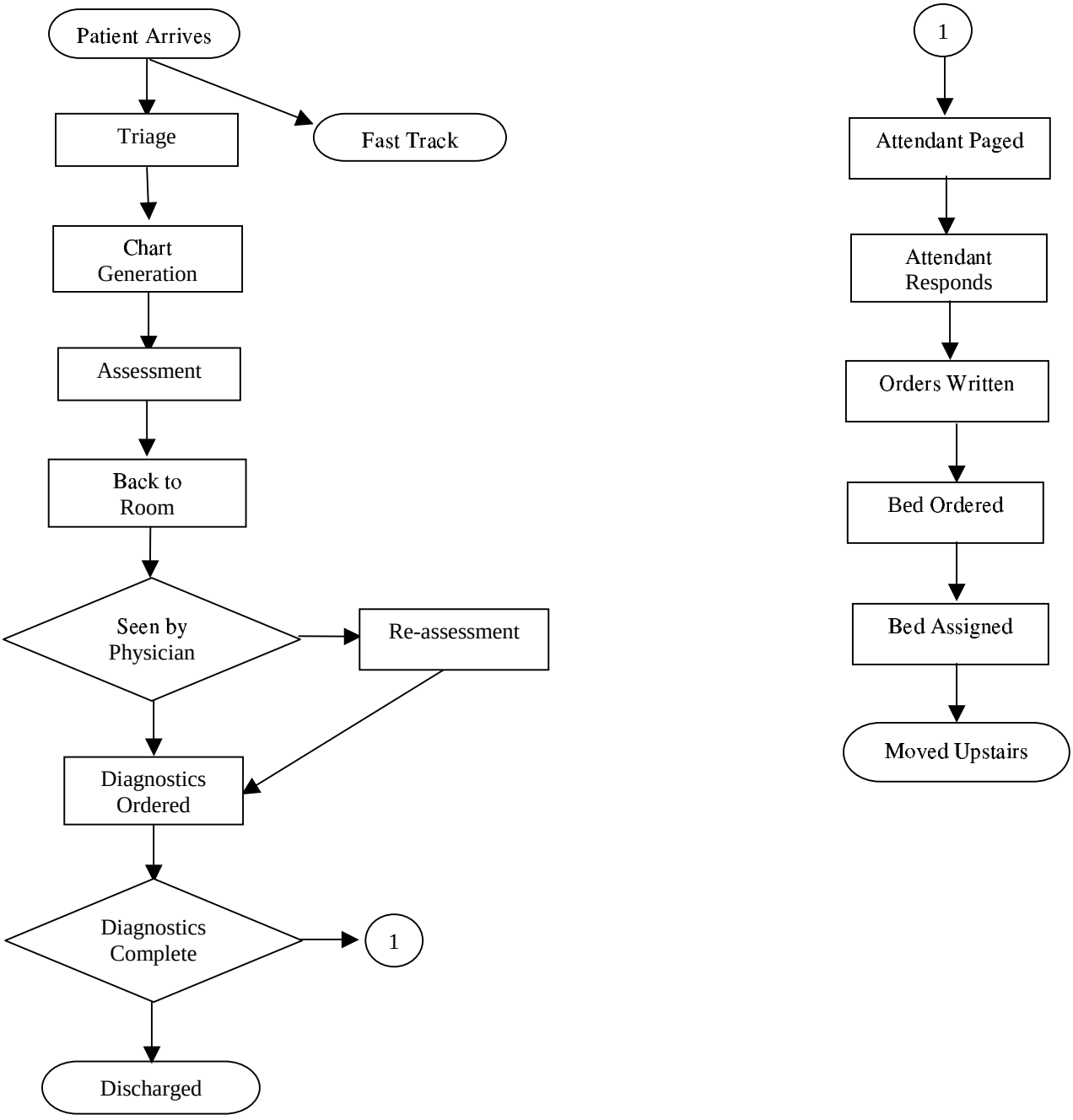

Figure 4. The flowchart models a patient's visit to the Emergency Department.

Appendix B. Worksheet for Data Collection.

SPARROW HOSPITAL TIME STUDY Conducted by Michigan State University, Industrial Mathematics	
History Number: **Date:** **Triage Level:** **Mode of Arrival:**	**Time**
Triage or Fast-Track	
Chart Generation	
Assessment	
Re-assessment	
Back to Room	
Seen by Physician	
Diagnostics Ordered	
Labs	
CT Scan	
X-Ray	
EKG	
Other	
Diagnostics Complete	
Labs	
CT Scan	
X-Ray	
EKG	
Other	
Admitting Physician Called	
Orders Written	
Bed Ordered	
Bed Assigned	
Moved Upstairs	
Discharged	

Figure 5. This is the worksheet used to collect the patient time values.