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SIMULATING AN EMERGENCY DEPARTMENT "IS AS MUCH FUN AS..."

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ABSTRACT

The purpose of this project is to improve the operation of Peninsula Regional Medical Center's (PRMC) Emergency Department (ED) and decrease patient dissatisfaction with length of stay. The goal is to reduce patient throughput times and determine the appropriate staffing levels. An additional goal is to aid in identifying other system changes to improve patient and department flows in the ED through the use of simulation.

1 INTRODUCTION

The objectives of this project are to reduce the patient's length-of-stay in the ED, and to decide the appropriate staffing levels for registered nurses and technicians. The operating environment of the ED had experienced significant changes in the past two years, first was a 16% reduction in patient visits, second were operational changes that required a revision of the productivity system that had not been updated in four years, and last was increased patient dissatisfaction with long waiting and treatment times in the ED.

The project examined 11 different alternatives to improve patient flow and determined the appropriate staffing mix based on patient volume. The top three alternatives were: first using a fast track system in minor care, second the staging of patients to the next available treatment room, and third using point-of-care testing. The impact of changes is a reduction in patient turnaround time by 38 minutes.

2 OVERVIEW

Peninsula Regional Medical Center is a 400+ bed tertiary care medical center in eastern Maryland. The ED typically treats 40,000 patients per year. The ED is the only level II trauma center on the Eastern Shore of Maryland, it has minor care facilities, serves as the regional Emergency Medical Services (EMS) base station, and an acute psychiatric evaluation center.

The ED was experiencing significant changes in its environment: (1) a reduction in the number of patient visits over the past two years from 48,000 to 40,000, (2) departmental productivity and comparative indicators were declining, (3) the department had recently completed an expansion and renovation, and (4) patient dissatisfaction with length-of-stay in the department was increasing. All these factors lead the staff and management to believe that a systematic approach was needed to determine the appropriate staffing and services levels, and identify other methods to improve patient flow.

A project team composed of nursing and department management, ED nurses, ED physicians, ED technicians, and management consulting was formed to investigate methods to improve these department processes. The team chose simulation as a tool to examine the current system and to test any proposed changes. MedModel™ simulation software was selected because of ease of use and the graphical interface that allows the visualization of the simulated system.

3 CURRENT SYSTEM

To build the simulation model the first task for the team, was to collect data about the operation of the ED. Data was collected from patient charts, emergency department logs, computer information systems, interviews, observations and data collection where information was not available.

Information about arrival times by hour of day were taken from a three-month sample period. The arrival pattern that the department experienced was used to distribute the patient arrivals during the day. Once this data was captured, the next step was to flowchart the patient and staff activities. The team developed detailed flows for the following nine patient types; abdominal pain, lacerations, fractures, non red and yellow trauma (non life threatening), red and yellow trauma (life threatening), medical emergencies, cardiac emergencies/chest pain, assault (sexual and physical), and minor-care. Each of these patient care categories were subdivided into five levels of increasing patient acuity.

Each flow was a compilation of detailed activities for

each patient type, and acuity, the use of consulting physicians, the use of ancillary testing i.e., laboratory, radiology, etc., the probabilities of complications, the use of discharge protocols, and other factors affecting the patient flow.

Once the flows were completed, the ED team conducted a patient chart review. Four hundred charts were chosen at random from the previous year for the review. The review captured information about each patient type; the arrival time, the mode of arrival, the patient acuity, the patient type, the number and kind of ancillary tests performed, the procedures performed, the discharge disposition, the discharge times, and other pertinent data were collected. This background information was entered into the simulation software to develop the model of the PRMC's ED. For each patient type the simulation logic was evaluated for any discrepancies to actual departmental operation. This involved taking the information from the 400 patient chart samples and determining the average patient transit time through the department and the confidence intervals using UniFitII™, a statistical analysis package. This historical information is important since it is the original pattern to decide if the simulation matches reality and it is also the baseline against which changes to the simulation are to be judged for improvements.

The model was validated using the Trace Validation function from the MedModel™ program. The team examined the trace logic for each patient type looking for errors in the time required to perform functions, errors in patient processing logic, errors in staff processing logic, and faulty processing loops. To validate the model a period of one week with a one day warmup was selected. The simulation was run a minimum of 20 replications to validate the model against the historical period.

The validation of the model against the historical information gave the team proof that the simulated model represented the operation of the ED at PRMC (see Figure 1). The more accurate times are those with the highest number of occurrences. The patient categories are ordered by the number of patients.

4 PROPOSED SYSTEM ANALYSIS

With the simulation now validated the next task before the team was to test impact of the eleven alternatives to improve patient flow. These alternatives encompassed the following areas: reduction of staff, introduction of point-of-care testing in the ED, developing and using a specialized minor care area in the departments, changing triage protocols, and changes to volume in the department. The results are summarized in the Figure 2.

The three optimal alternatives are:

First is establishing a fast track care in the minor care area. The impact of this change in the ED saves 15.5 minutes in the average patient turnaround time.

Second is placing patients in the treatment area when beds are available instead of sending them back to the waiting room. This saves 14.1 minutes on the average patient turnaround time.

The third alternative is the use of point-of-care lab testing. This saves 8.4 minutes in the average patient turnaround time. For eligible patients this translates to a savings of approximately eighty minutes. When these three alternatives are combined the resulting time saving to the average patient turnaround time is a reduction of 38 minutes.

Patient Category	No. Hist. Patients	Historical Average	Historical Conf. Interval alpha .05	Simulation Mean	Diff.	Statistical Hypothesis Accept/ Reject ?
All Patient average LOS	320	161.2	151 - 173	165.5	4.3	Accept
All Treated & Released LOS	248	147.0	135 - 159	145.8	1.2	Accept
Minor Care T&R LOS	74	95.6	86 - 105	104.9	9.3	Accept
All Admitted LOS	72	212.8	190 - 235	216.7	3.9	Accept
Med Emerg T&R LOS	67	186.0	165 - 207	183.7	2.3	Accept
Admitted Med Emerg LOS	41	228.0	195 - 261	222.9	5.1	Accept
Abdominal Pain T&R LOS	32	157.7	127 - 188	161.2	3.5	Accept
Fractures T&R LOS	26	136.7	101 - 173	167.3	30.6	Accept
Non RY T&R LOS	21	188.0	146 - 230	184.1	3.9	Accept
Admitted Cardiac LOS	20	157.8	121 - 195	194.8	37.0	Accept
RY Admitted LOS	17	266.0	201 - 331	244.9	21.1	Accept
Lacerations T&R LOS	14	101.6	71 - 132	103.4	1.8	Accept

Figure 1: Alternative Evaluation Table for the 11 Different Scenarios.

This changes the historical patient turnaround time from 161.2 minutes to 123.2 or a reduction of 24%.

There are three alternatives that do not show any significant savings of time, but are as benchmarked "best practices" and will save time when the emergency room is quite busy. The first is the use of the internal waiting room for patients, waiting for the results of ancillary tests (Laboratory and X-ray). Rooms that are normally occupied by patients waiting for results can be used by patients who are in the waiting room. There would be no time advantages in this practice when the ED is not busy.

The second practice is having the triage nurse order lab tests and x-rays for patients based on protocols set up by physicians. This practice will cause two delays to run concurrently. One delay is the waiting time in the waiting room, and the other delay is waiting for lab results.

The last practice is to initiate bed search for admitted patients when the ED physician decides a patient needs to be admitted. The delay for bed availability will run concurrently with the wait for a staff physician to approve the admission.

5 CONCLUSION

Using simulation as an analysis tool in this project allowed the team to quantify time and staff savings that have a significant impact on the operation of the ED. Simulation provided a "laboratory setting" to test and evaluate alternatives before implementing. This prevented the disruption of the department and helped to identify the changes that would have the greatest impact for the services in the department.

As a part of the project the team also conducted a Plus and Delta analysis which is used to delineate improvements and failures for other teams on the use of the tools and processes. On the plus side the team identified six key points:

- The project made the department staff examine what happens to a patient when they are treated in the ED.
- The staff focused on resources being used by the system.
- The need to have a multi-disciplinary team work on the project and have experts provide information on how the system "works."
- Having Nursing management support the project.
- Simulation and project requirements taught the team how successfully deal with massive amounts of data.
- Simulation gives the team the ability to experiment with future "what-if" questions safely.

On the delta side the team identified three key points that they would like to change:

- The large time commitment required by the team members to do the simulation.
- The staffing of the department during team meetings.
- The lack of knowledge about simulation as a tool.

In retrospect taking on a large simulation project like this **"is as much fun as a ...", but the information and results are well worth the effort.**

Alternative Summary	LOS(min)	Impact (min)
Base	165.5	
1. Set up a Fast track system in minor care area.	150.0	saves 15.5
2. Use I-Stat machines for in ED testing of laboratory samples to reduced lab test turnaround times.	157.1	saves 8.4
3. Reducing the number of technicians by 4.5 FTE's	176.1	adds 11.6
4. Reducing number of Registered Nurses by 6.7 FTE's	167.0	no real change
5. Take the patient back to an open treatment rooms. Do not let patients wait in the waiting room until the staff is less busy.	151.4	saves 14.1
6. Initiate admission room search for an inpatient as soon as ESA_MD determines the need to admit patient, rather than wait until the staff physician approves the admission order.	164.0	no real change
7. Use of an internal waiting room (when ED is busy) for patients waiting on the results of laboratory tests an other tests.	163.6	no real change
8. Set up triage protocols that direct the triage nurse to orders certain tests (such as EKGs, lab tests and x-rays) and the patient waiting for results of tests before being taken back to room (if ED is busy).	161.9	saves 3.6
9. Change intermediate care rooms 21, 22 and 23 for use in place of 9, 10 and 11.	163.8	no real change
10. Reduced RN staff (6.7) plus 5% additional volume	174.0	adds 8.5
11. Less 5% volume	162.9	saves 2.6

Figure 2: Results of Alternatives Tested in the Simulation

AUTHOR BIOGRAPHIES

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