Improving Patient Cycle Time Hospital Emergency Department

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Abstract: Hospital Emergency Departments (EDs) play an important role to the patient's treatment cycle. They are expected to provide the care for any patients, at any given time, 24 hours a day. The increasing problem of crowding has strained the EDs to a breaking point. The major cause of ED crowding is holding patients waiting in the emergency department. In most cases, the capacity of the ED cannot be increased due to lack of space in the building, so other solutions have to be found in order for it to function efficiently. This study looks at ways to eliminate bottle necks from the patient treatment process. According to staff the main problem is the time that a patient has to wait at the ED before treatment and the time spend waiting after treatment is finished. Also another problem is the distribution of available resources (e.g. nurse and doctors) in a proper way. In order to improve the patient treatment cycle time in the ED system, the study uses lean manufacturing principles to eliminate wasted time. It also uses design of experiments (mixed factorial design method) to figure out sensitive variable interactions in the system.

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In data analysis, simulations (contour plot and response surface plot) were used. The analysis using statistical tool (e.g. Minitab) shows significant improvement in the patient cycle time. It also shows reduced waiting time and better allocation of resources in the ED. The ED system is an ongoing study to maintain sustainability for future generation in our communities.

I*ntroduction:* The research work was done in hospital in Baltimore, Maryland. Due to privacy corner, the hospital will not be identified in this paper. This Emergency Department specializes in acute care of patients who present themselves without prior appointment, either by their own means or by ambulance. Due to the unplanned nature of patient attendance, the department provides initial treatment for a broad spectrum of illness and injuries. Some of which maybe life threatening and require immediate attention.

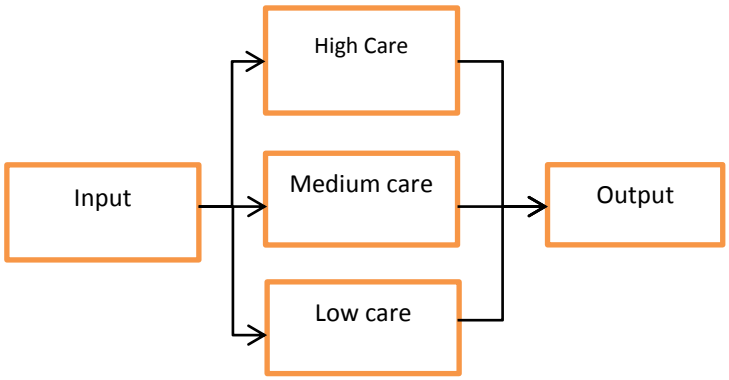
Emergency Departments (ED)s play an important role to patient's treatment cycle. For decades the EDs have provided communities with emergency care and access to health care services, creating a first line of defense for the health care system and 24 hours a day option for patients. The EDs provide the only universally guaranteed right to health care in the United States. In 1986 the Emergency Medical Treatment and Labor Act mandated that all patients who present to an ED have the right to a screening examination and emergency care. EDs are expected to provide care for any patient, at any time and they are also being

used for public health surveillance, disaster preparedness, observation and procedural care (e.g. blood transfusions), occupational care, employee health, and, in many cases, primary health care. The unique role of the ED has prompted many to see the EDs as a safety net for the health care system. The increasing problem of crowding has strained this safety net to the "breaking point," according to a recent report by the Institute of Medicine.

Background: It is very important for EDs to have a good and clear plan of patient flow in order to deal with predictable daily, seasonal variations and the unpredictable situations (e.g. mass casualty event). Overcrowding of our nation`s emergency departments was an intermitted, geographically isolated phenomenon in the 1980s, but it has reemerged as a wide spread, chronic and debilitating situation today (National policy perspective). Overcrowding has a negative impact on patient care, the mission of any medical center and on the health of a community. Many factors contribute to emergency department overcrowding. Nationwide, the number of emergency departments and hospital beds has decreased through the downsizing, closing and merging of health care institutions. According to the 2004 report by the Center for Disease Control (CDC), from 1994 to 2004, annual ED visits were up by 18%, while the number of emergency departments was down by 15%. A community with the same population, the same primary care provider but fewer hospitals and emergency department beds will have more crowded emergency departments. The current nationwide nursing shortage has caused many hospitals to close available beds. Having fewer inpatient beds means there are fewer places for admitted emergency department patients to be transferred to. Also the growing number of uninsured and under insured patients results in more use of the emergency department delays in seeking needed attention and a worse health status when patients do seek treatment.

Process Description: This emergency department is divided into three main zones. High care zone, medium care zone and low care zone. The high care zone (Red zone), deals with critically ill patients and patients who need immediate care. The medium care zone (Yellow zone), deals with patients that need urgent care but can wait no more than 60 min. The Low care zone (Green zone), deal with patients with minor issues and they can afford to wait. It is also called fast track care.

	Urgency Level	Time (Min)
Red Zone	Emergent	0-10
Yellow Zone	Urgent	30-60
Green Zone	Normal	90-120



This work concentrates on the medium care and the low care as the scope.

Registration:

There are two reception clerks in the front desk. Patients are registered by the desk employee at the front desk when they arrive. Ambulance arrivals are immediately placed in a room, while the patients´ attendance is reported at the front desk by one of the ambulance nurses. Non-ambulance arrivals register their presence themselves at the front desk. The desk employee registers the patient, and meanwhile estimates the urgency of the patients care need. If she estimates that immediate care is needed, she calls a nurse and the patient is immediately taken to a treatment room. If the patient is not perceived being in an immediate care need, the patient is asked to take a seat in the waiting room.

Triage:

Triage is a management tool to control patients waiting to be seen by a doctor by prioritizing patients on the urgency of their care need at arrival. Waiting is a non-value adding activity and disliked by patients and triage in itself is neither a value adding activity for the patients, so both the waiting time to triage and the service time of the triage activity in itself should be as short as possible.

Physician Evaluation:

The physician will read the nurse notes and also perform his own diagnosis to determine what condition is causing the patient's signs and symptoms. Usually the physician will ask questions about the history of a patient and also request for tests if needed to determine the correct diagnosis. Depending on the number of tests being performed, the patient can stay waiting for diagnosis from 30 min to 120 in medium and 20 min to 45 min in low care.

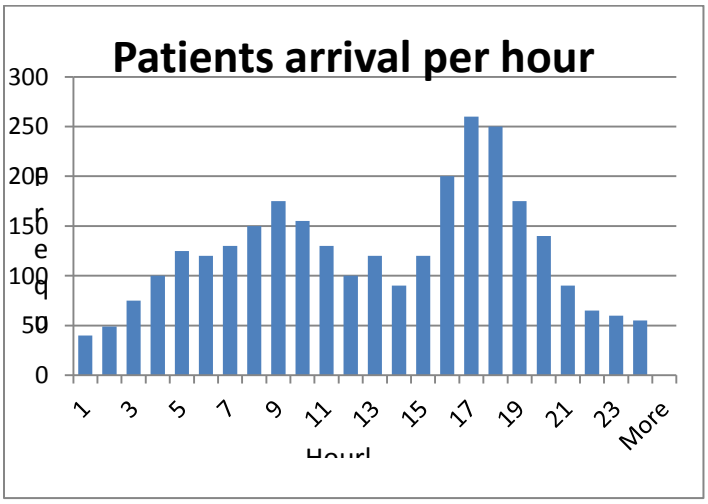
Departure:

The final step for patients is either released from the hospital or admitted into the hospital for further care.

Patient Volume:

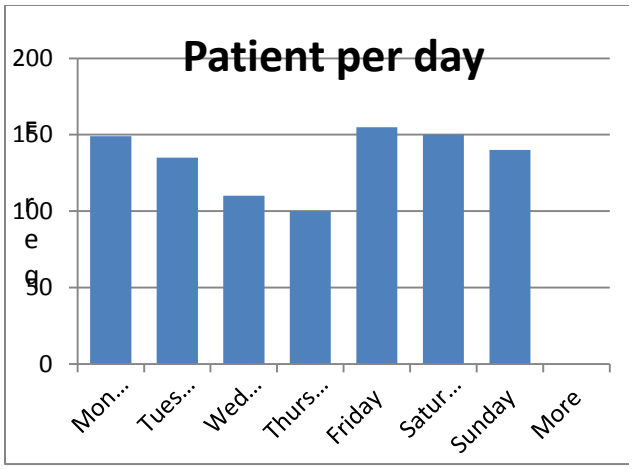
Number of patients per hour

The number of patients attending the ED during the day is characterized by a clear pattern. The figure below shows the time varying demand pattern. These are the average number of patients attending the ED per hour of the day. Looking at the figure below we see that most patients attend the ED between 0800 to 1000 and then between 1600 to 1900 with the peak being between 1700.



Number of patients per day of the week:

Considering the days of the week individually, we determine that Mondays, Fridays and Saturdays are the most crowding days of the week. See the figure below. On these days the number of patients attending the ED is significantly higher compared to the other days of the week.



Design of experiments

In order to determine the significance of the resources in the system's behavior, a design of experiments was performed. The experiment considered a fixed two level, with five factors, physicians, nurses, beds, receptionist and patients/day.

Factor Level

Variable	Name	Low Level (-)	High Level (+)
A	Nurses	5	8
B	Physicians	3	5
C	Beds	20	30
D	Patients/day	90	140
E	Receptionist	1	2

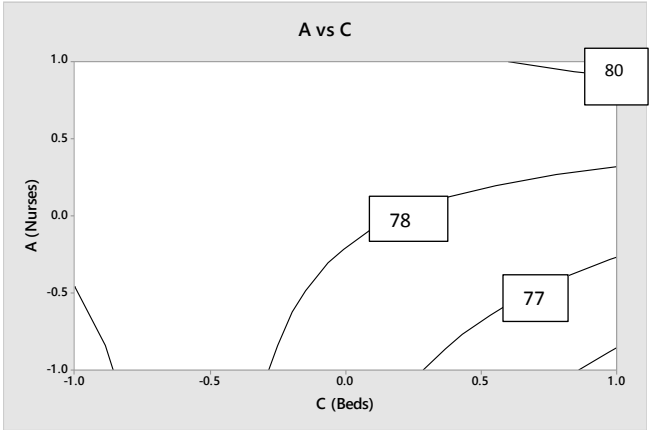
A fractional factorial design with resolution IV was conducted. This requires a total of $2^{5-1} = 16$ simulation scenarios. With this resolution it is possible to determine the significance of the main effects.

After the completion of the experiment, we analyzed the collected data using minitab-17 software and then drew conclusions from the analysis.

From Figure-1 (on attached page) which shows significant factors, we can determine that patients per day are not significant but the rest are significant. That means there is minimal effect by patients per day on the system.

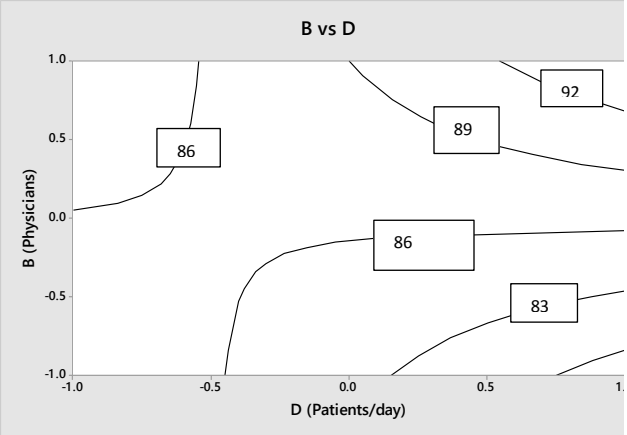
From figure- 2 (on attached page) which shows interaction factors, we determine that there is interaction between A (Nurses) and C (Beds), B (Physicians) and D (patients/day). This can be seen from the non-parallel lines by the significant factors. That means that we should look more careful into what kind of affects these are and how they affect the system. They are described in more details in the contour plots.

Contour Plot Nurses VS Beds



The contour plot above shows that for the system to improve we have to set both number of beds and number of nurses to operate on high.

Physician's VS Patients per day



The contour plot shows that, if there are increased patients per day then more physicians need to operate on high.

Conclusion:

The system was then run with the following factors on high, number of nurses and number of beds. The system was also run by increasing the number of number of physicians during the days when there are most patients. Significant improvement was observed in the system.

Figure-1 (Significant factors)

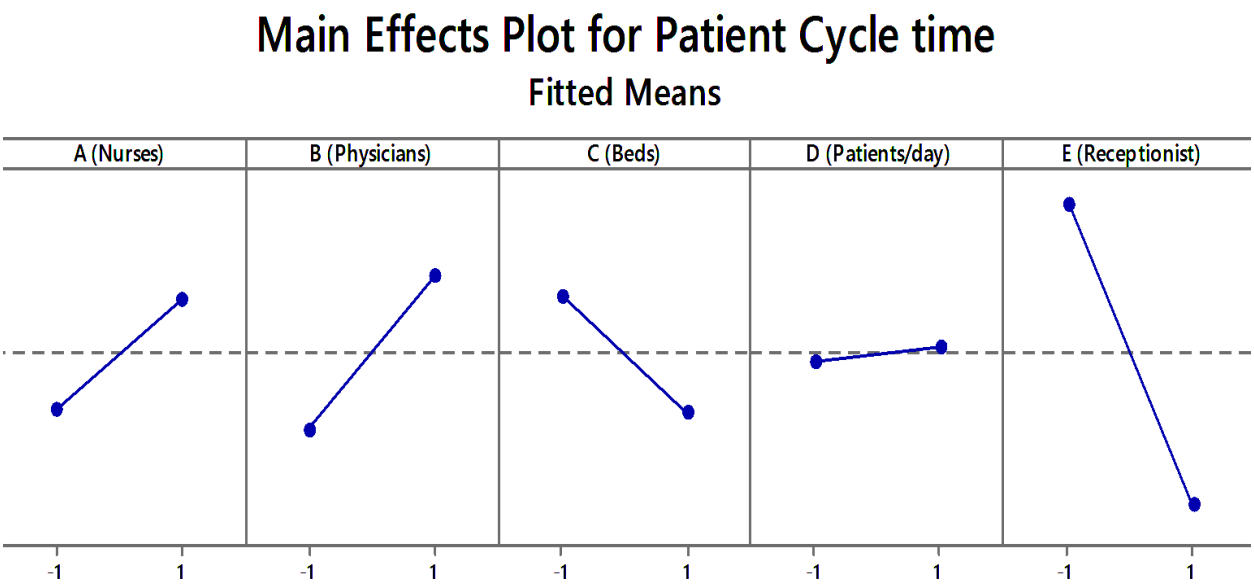
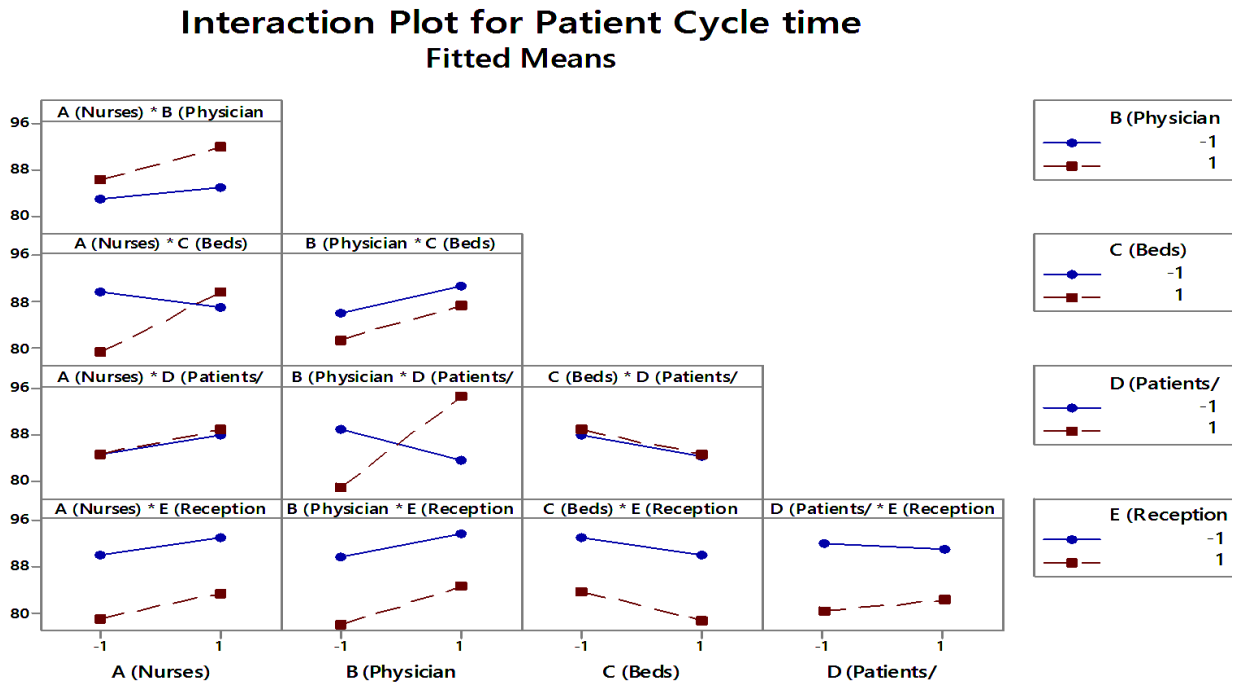


Figure- 2 (Interaction factors)



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