Role of Waiting Line Model in Reducing the Patient's Waiting Time In The Emergency Department

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Abstract
Timely health aid affects the prospects of patient life. In critical cases waiting for the patient will definitely ruin the opportunity of the life.

Many previous studies elaborate occurrences of the patient's waiting time in the Emergency Department all over the world which directly affects the patient satisfaction level and finally reducing the performance of the hospital. Total five types of patient waiting time are observed by the researcher. These patient's waiting times stop the patient flow at various steps.

To optimize the performance of the emergency department in terms of time and other variables, there are various management techniques, such as LEAN, Six Sigma, Simulation modeling, Waiting line model, Application of Rapid Assessment team, Continuous Quality Improvement techniques.

We designed randomized observational cross sectional time study in the emergency department of a multi spatiality hospital located in central India over a period of 6 months.

Results: From time study, waiting times are observed which are of five types such as waiting for Ward boy, Casualty Medical Officer, Intensivist,diagnostic procedure and for Bed in ICCU or ICU or Ward.

Waiting time for Intensivist and for bed in ICCU / ICU / Ward are of having high value for the patients of priority level I, II and III. For patients of priority level-I and II, time is very important.

Introduction

For the patients, especially critical in condition, entering in the hospital, time is very crucial. It decides the scope for the life of the patients. Timely health aid affects the prospects of patient life. Therefore, in such critical cases, occurrence of the waiting for the patient will definitely ruin the opportunity of the life. This patient's waiting time at various stages in the Emergency Department is a worldwide problem.

Patient's waiting time in the ED is generally occurring due to unavailability of the different resources of the ED. Many previous studies elaborate occurrences of the patient's waiting time

in the ED in all over the world which directly affects the patient satisfaction level and finally reducing the performance of the hospital.

In the Emergency Department of the multi speciality hospital located in central India, the researcher found the patient waiting time at various stages. Total five types of patient waiting time are observed by the researcher. These patient's waiting times stop the patient flow at various steps.

As this emergency department has a very important role for the critical patients, analysis of the activities carried to stabilize the patient in the emergency department is very necessary. To optimize the performance of the emergency department in terms of time and other variables, there are various management techniques, such as LEAN, Six Sigma, Simulation modeling, Waiting line model, Application of Rapid Assessment team, Continuous Quality Improvement techniques.

Here we are interested in the study of the status of role of waiting line model in reducing the patient waiting time in the emergency department of the multispciality hospital

Emergency Department

An Emergency Department (ED) is a facility, which specializes in the critical care of patients who report without a prior appointment. Patients either arrive by their private transport or ambulance. An emergency department has a great influence on the performance of the hospital.

The Emergency Department (ED) is known to be one of the most congested units in any hospital that faces greater pressure in terms of patient load and health care resources as compared to other departments of the health care system.

The Emergency Department's function is to receive, triage, stabilize and provide emergency management to patients who report with a wide variety of critical, urgent and semi urgent conditions. The emergency department to provide the treatment to the patients in case of natural calamity like an earthquake. Emergency

department for the reception and management of disaster patients as part of its role within the disaster plan of each region. The aspect of speed, accuracy and sympathy are important in the emergency department.

Every Multi specialty hospital or Government Hospital has emergency department where critical patients whose lives are under threat or accidental cases which requires prompt emergency treatment are admitted. Emergency department admits the patient and treats him till he gets out of danger and stabilizes. Then the patient is shifted to ICC/ Ward.

The Emergency department has to give treatment for critical patients because the time factor plays a very important role to save the life of the patient. Every minute decides the scope for life of the critical patient. Following are the objectives of the emergency department

1) To start the treatment in between the arrival of patient and stabilization of his health condition.

2) The time required to stabilize the patient should be minimum. And it governs the performance of of the emergency department and the hospital as a whole

Literature Review For Waiting Line (Queuing) Model

Queuing theory was first analyzed by A.K Erlang in 1913 in the context of telephone facilities. The field of telephone traffic was further developed by Molins (1927) and Thornton D-Fry (1928). It is extensively practiced or utilized in the industrial settings or retail sector, operations management.

Queuing theory was later developed to study the queuing phenomena in the banking sector, industrial servicing systems, telephone traffic, transportation, variable reservoirs etc. In the health sector, Queuing Theory is mainly used in Emergency Department wait line and staffing studies, analysis of queues in outpatient and ambulatory care settings and for disaster management. However, it can be applied in inpatient, outpatient, physician office, public

health facility as well as in any public health setting where there exist wait lines.

Queuing theory is a very efficient mathematical approach to the analysis of waiting lines performance parameters in health care systems [1]. It has already become a common management tool for decision making in the developed world.

Review of existing literature, stated the use of queuing theory and modeling in improving waiting time in various hospital settings. [2,3,4]. It was also used in minimizing costs relating to various aspects of health care [5] and improved performance of hospital systems. [6]

One of the major fundamentals in improving efficiency in the delivery of health care services is patient flow. Meaning of Good patient flow is that patient queuing is minimized and improper patient flow means that patients suffer considerable queuing delays [7]. Effective resource allocation and capacity planning are determined by patient flow because it informs the demand for health care services [8]. Queuing theory provides exact or approximate estimation of performance measures for such systems based upon specific probability assumptions. In a hospital, these assumptions are rarely held, and so results are approximated [9].

Application of queuing theory to model hospital settings has been extensively published [10,11,12]. Also, the use of queuing analysis and simulation to enhance performance at various hospital departments has been broadly researched [13] as well as emergency department also [14]. McQuarrie [15] explained how to minimize waiting times by giving priority to patients who required shorter service times. Green L. V. et. al. [16] also explained models for queue disciplines while Siddhartan K. et. al.[17] investigated the effect on patient waiting times when primary care patients used the Emergency Department. They recommend a priority discipline for different categories of patients and then a first-in-first-out discipline for each category.

Obamiro J. K.[17,20] also applied the queuing theory in a study and determined the optimum number of nurses required in an antenatal clinic to reduce the time spent by pregnant women in the queue and the system.

Agrawal G. et. al.[18] critically analyzed the use of queuing theory in health care center of IIT-K and stated the benefits obtained from the same. The authors developed an appointment system in which customers who are about to enter in the service may have a probability of not being served and may rejoin the queue. In their investigation, they found that the capacity utilization is 76%, average number of people waiting in the queue is 2.57 calculated by the Poisson distribution method Mehandiratta R. [19] examined Queuing models with rapid change and alignment of health care system. Author used Queuing models and achieved a balance or trade off between capacity and service delays.

Queuing theory and modeling can thus be said to be useful modern tools for decision making on issues of capacity and resourcing. But this waiting line model is used in the western countries, to reduce patient's waiting time in the Emergency Department

Time Study In The Emergency Department

To understand the activities and time require for these, time study is decided to carry in the ED. We designed randomized observational cross sectional time study in the emergency department of multi spatiality hospital located in central India over a period of 6 months.

Ethical permission was taken from hospital authority. Total 300 patients were observed in ED from their entry in the Emergency Department to shifting to ICCU / ICU / Ward.

Following parameters and procedure were observed during time study in the ED.

1)Shifting of patient to bed in the emergency department:

Shifting of patient from the ambulance or vehicle to stretcher if wad boy was available on time. This stretcher was carried to ED and the patient was shifted to bed in the ED.

2) Attending of the Patient by nursing staff

Patient attending by Nursing Staff carried dressing of the injuries, measured the blood pressure and checked the pulse rate of the patient and reported to the Casualty medical officer (C. M. O.).

3)Attending and treatment of the patient by C.M.O.:

C. M. O. completed physical examination of the patients such as checking the vital signs and gave the instructions to nursing staff for E.C.G., I. V. and Injections. Simultaneously C. M. O. took the previous history of the patient. Thus, according to the patient's condition, initial treatment was given to the patient by the C. M. O. If the condition of the patient was critical then C. M. O. made contact by telephone call to the Intensivist and shortly explained the position of the serious patient.

4) Patient's waiting time for the intensivist

As the Intensivist was not arrived on time, patient had to wait at the Emergency Department, Intensivist arrived and examined the patient. Then he gave necessary direction to the C. M. O. about X-ray, pathological tests, C.T. Scan according to severity of the patient.

6) Diagnostic procedure

After the necessity of diagnostic tests for patients, nursing staff checked the availability for the same. After the availability in the diagnostic center nursing staff shifted the patient from the bed on the stretcher. Ward boy along with nurse moved the patient to the diagnostic center.

7) Waiting time for bed

After the diagnostic procedure, nursing staff checked the availability of bed in the ICCU by contacting the personal relation officer (P. R. A.) by telephone. Then the patient was shifted to the Emergency Department if the ward was not available.

8) After the availability of bed, the patient was shifted to ICCU / ICU / Ward.

All above activities were tried to include in the time study sheet so that the time required for every small activity could be recorded.

Thus, this time study sheet was developed to record time accurately for every activity which is explained above and given in the time study sheet.

Sr. No.	NAME OF ACTIVITY	Pt. No 1	Pt. No 2	Pt. No 3	Pt. No 4	Pt. No 5
	TIME STUDY SHEET					
1	Waiting time for availability of Ward boy (Wt – 1)					
2	Patient shifting on the bed					
3	Patient Attending by the Nursing staff					
4	Time for attending and checking of patient by Casualty Medical Officer (Wt-2)					
5	Attending and checking of Patient by the C. M.					
6	Waiting time for availability of Intensivist (Wt-3)					
7	Checking and treating of Patient by the					
8	Waiting time for diagnostic procedure (Wt- 4)					
9	Shifting of patient to diagnostic centre					
10	Tests at Diagnostic centre					
11	Shifting of patient to Emergency department					
12	Waiting time for availability of bed in ICCU / ICU / Ward (Wt- 5)					
13	Shifting of patient to ICCU / ICU /Ward					
	Total Service Time					
	Total Wait Time					
	TOTAL TIME					

Patients enters in the Emergency Department were categorized according to their severity as given bellow.

Level I (Resuscitation): Conditions of the patient that are threaten to life or imminent risk of worsening, requiring immediate aggressive interventions (e.g. cardiac arrest, major trauma or shock states, severe head injury).

Level II (Emergent): Conditions of the patient that are potential threat to life or limb function requiring rapid medical intervention or delegated acts (e.g., chest pain, gastrointestinal bleeding, abdominal pain with visceral symptoms, neonates with hyperbilirubinemia).
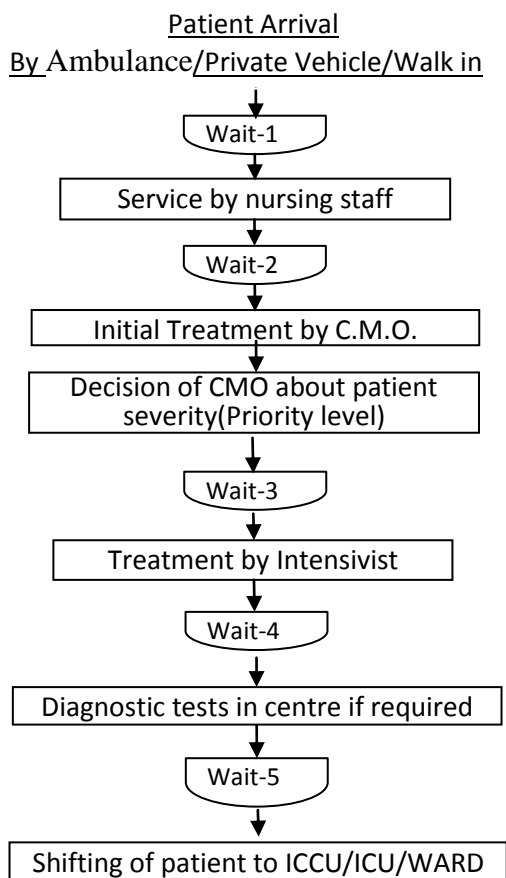
Level III (less Urgent): Conditions of the patient that could potentially progress to a serious problem requiring emergency intervention (e.g. mild moderate asthma or dyspnea, moderate trauma, vomiting and diarrhea in patients younger than age 2).Conditions related to patient age, distress or potential for deterioration or complications that would benefit from intervention or reassurance within 1 to 2 hours (e.g. urinary symptoms, mild abdominal pain, earache).

Findings of Time study

From time study, patient's waiting times are observed which are of five types such as

- Waiting for Ward boy,
- Waiting for Casualty Medical Officer,
- Waiting for Intensivist,
- Waiting for Diagnostic procedure and
- Waiting for Bed in ICCU or ICU or Ward.

Waiting time for Intensivist and for bed in ICCU / ICU / Ward are of having high value for the

Patient Arrival
By Ambulance/Private Vehicle/Walk in

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          ↓
      [ Wait-1 ]
          ↓
 [ Service by nursing staff ]
          ↓
      [ Wait-2 ]
          ↓
 [ Initial Treatment by C.M.O. ]
 [ Decision of CMO about patient
    severity(Priority level) ]
          ↓
      [ Wait-3 ]
          ↓
 [ Treatment by Intensivist ]
          ↓
      [ Wait-4 ]
          ↓
 [ Diagnostic tests in centre if required ]
          ↓
      [ Wait-5 ]
          ↓
 [ Shifting of patient to ICCU/ICU/WARD ]
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Patient flow diagram

Findings of the time study sheet are described below

1st activity was waiting for a ward boy, which occurred due to non availability of ward boy .

2nd activity included shifting patient from Ambulance to bed in the Emergency Department

After shifting of patient on bed nursing staff responded to the patient as per 3rd step.

There was not any waiting time for nursing staff.

Generally nursing staff was used to respond the patient arrived in the Emergency Department

patients of priority level I, II and III. For patients of priority level-I and II, time is very important.

For Priority- I patients every second are very important and it is most important to provide such patients timely service without a wait. Extra consumption of time will lead to many problems to the patient and finally death also.

Time study helped to draw detailed patient flow diagram from patient arrival to patient shifted to ICU / ICCU / Ward as follows

(4th step). Therefore time to start treatment by Casualty medical officer was introduced as waiting time (5th step) for Casualty medical officer.

After contacting the intensivist about severity of patient, intensivist was not readily available as he was also involved in another important work or in the other hospital. Patient had to wait for some minutes for intensivist as per 6th step.

After arrival, Intensivist gave the treatment to the patient as in 7th step.

After starting treatment by intensivist if diagnostic tests were required, the patient had to send to the diagnostic center(8th step). For that availability of diagnostic centre was checked by nursing staff. If diagnostic centre was not available patient had to wait for that in the Emergency Department(9th step). After diagnostic tests, patient had to shift to ICCU / ICU /Ward as per availability of the bed (13^{th}step). But if bed was not available patient had to wait for some minutes in the casualty bed(12^{th}step).

When we decided to apply the waiting line model by studying the result of the time study, we have faced many problems. First, there was only one service provider at every stage of the activities in the ED. Second, there was no queue of the patients for any service. Third, inter arrival time for the patients was 19.24 minutes. Therefore, there was enough time in between the arrival of two or more patients, i.e. two or more patient's arrival at a time in the ED were rare occasions.

Limitations Of Queuing Models

As discussed at several places earlier, queuing models have several limitations and are used in conjunction with the other decision analysis methods like simulation and regression. Most of these limitations are the basic assumptions for application of queuing models. Some of the limitations of queuing models are enumerated below:

1. The mean of all variables are used than the real numbers itself.
2. Steady state is assumed.
3. Based on the assumption that service time is known.
4. Service times are independent from one another.
5. Service rate is known.

Waiting line model is used to reduce patient's waiting time in the Emergency Department at all over the world, especially in the western countries. In India this model is not used up till now. Author studied that there are limitations in the implementation of the waiting line model in the Emergency Department. These limitations are given bellow

1) In private hospitals, in India there is no problem of patient's crowd except government hospitals. Therefore, there is no question of the queue of the patients for the different resources

2) Human touch is embedded in the health care service, therefore, first aid is given to the patients without forcing the patients or relatives for the registration. This is a simple example that how in India health care procedures are carried in the parallel manner rather than in series manner in western countries.

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