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ORIGINAL PAPER

Wait Time in Emergency Department (ED) Processes

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Introduction: Emergency Department (ED) provides urgency clinical and Para clinical care for patients who injured in accidents and incidents. Simulation is one of the decision supporting techniques that analyze risk factors and strategies in decision-making. **Goal:** The aim of this study was to determine the waiting time in emergency department services at Ayatolahkashani Hospital to propose scenarios for reducing waiting time. **Methods:** This study was an analytical and cross-sectional in which data collected by forms and observations. Population included waiting and service time in all stations related to ED's treatment processes along with diagnostic departments (e.g. Laboratory, Radiology, Ultrasonography, and C-T Scan) over a two-week period for 663 patients. For data analysis, SPSS software and simulation technique were used. **Results:** Results show that add one intern to the Ear Nose Throat (ENT) service makes the most reduction on the waiting time from 112.19 to 99.24 minutes. In this option the mean of ENT services time will be reduced to 26.54 minutes, neurology services time will be reduced to 6.58 minutes and the mean of orthopedic services time were reduced to 5.98 minutes. **Conclusion:** Health care managers, in the ED are usually physicians who are not familiar with principals of management. Hence, they need simple tools for logical decision-making. Operation research methods such as simulation should be suitable for them. **Key Words: Emergency Department, Waiting Time, Simulation, Scenario**

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1. INTRODUCTION

Hospital with specified responsibilities is known as important health care organization. An emergency Department (ED) provides urgent clinical and Para-clinical care for patients that injured in accidents and incidents. The injured patients need urgent treatment according to their situation (1). The ED is one of the important wards in hospital. The main function of the ED is health care offering in high-risk emergency situation (2). The patients' rescue should be a high priority at the ED for acute patient situations (3). The ED provides urgent clinical and Para clinical care for patients that injured in accidents and incidents. The injured patients need urgent treatment according to their situations. These patients should receive resuscitative treatments in shortest time (4). In the ED seconds and minutes are very important for patients. These times may be determinant of the interval between death and serious disability or life (5). Patient waiting time in the ED is one of the important factors in health care management. It is one of the determinate factors on patient satisfaction, as well as indicators for evaluating quality of emergency services (6). The results of different studies have shown that patient waiting time is one of the impressive factors on patient satisfaction. In a research that titled "reasons of patient dissatisfaction at the ED", finding showed main reasons of dissatisfaction were 67% of waiting time and 19% of absence of effective relationship with patients by medical care staff (7). At recent years, patient waiting time in the emergency process has had a great increase, for instance, in England waiting time was increased to 4 hours and in Canada received to 2 hours (8). Reviewing of some research projects in health care sector in Iran showed that the average waiting time in the ED is much higher and this issue causes many problems in service processes at the EDs (9). Long waiting time of health care services illustrates weak management, no coordination and inadequate of resources (10). Several studies in recent years reveal that the number of

people that visit the ED has grown as in Canada to 14 million per year and in Britain to beyond 15 million in a year (10 & 11). This problem caused patient waiting time as well as resources for health care delivery, and other impressive factors are increasing (12).

Many factors cause difficulty for decision making, promotion and improvement such as; increasing number of referring to emergency, long length time of healthcare delivery and complexity of rendering services. Therefore, it is critical managers apply scientific decision-making tools for managing (13).

Nowadays, health care managers are using scientific methods for reducing costs and waiting time of receiving services. Health care managers, especially emergency managers are physician whom are not health processes analyzer and need to have simple and flexible tools for analyzing (14). Simulation provides different solutions for improvement current situation by examination different scenarios to reduce expenditures and risks (9). Simulation models help the managers to optimize many factors such as work expenditure, patient waiting time and number of personnel in the ED (14). Reduction of patient waiting time is the most usage of simulation in ED (15). Findings of Aeenparast at clinic of Ememkhomeini Hospital in Iran, presented one solution for reducing patient waiting time by simulation. At this solution physicians work start time has been changed and the interval between admission and examination has been reduced. The results showed that implementation of this suggestion reduced patient waiting time for physician examination from 43.73 to 67.01 percent of the previous situation (9).

In 2008, Statistics showed that Ayatolahkashani Hospital, which is affiliated, with Isfahan University of Medical Sciences (IUMS) in Iran had been operated with 10 wards, 196 active beds, an average length of stay of 2.41 days, a bed occupancy of 70% and a turnover of 1.1 days.

In addition, it's the ED has 30 beds with 74 medical staff (26 nurses, 6 general practitioners, 2 anesthesiologists, 1 secretary, etc). The annual number of admissions to the ED in 2006-8 was 29446, 31735, and 32445 respectively. The average daily admissions during the last three years were 81, 87, and 89 respectively.

Regarding the particular situation of the hospital, due the high rate of emergency patients and their need to be admitted urgently, delay in servicing the patients not only increases dissatisfaction of health care render in hospital, but also causes delay in reception of new patients.

Due to the long patient waiting times in the ED and importance of minimizing costs and maximizing hospital resources productivity, it was felt necessary to study patient waiting time in ED at the Ayatolahkashani Hospital in Isfahan, Iran.

2. MATERIALS AND METHODS

This study was an analytical and cross-sectional study in which data were collected by forms, observation, and study of documentations. Isfahan city with a population of approximately 3,000,000 has 22 hospitals. However, Alzahra Hospital and Ayatolahkashani Hospitals are the biggest emergency centers in the Isfahan province. Because of overcrowded and limitation of space and Medical personnel, researchers chose this hospital. Study population included the patients who received services in the Ayatolahkashani ED in May 2008. Researchers took permission from hospital administrators who encouraged personnel for cooperation. Research team interviewed with managers and Medical personnel to know the working stations, number of personnel and their service times in stations in the ED along with diagnostic wards (e.g. Laboratory, Radiology, Ultrasonography, and C-T Scan). Then, the research team has drawn the flow work of patients' treatment process to receive diagnostic and care services in the ED.

For measuring waiting and service time, research team settled down in all stations related to the ED's treatment process along with diagnostic wards (e.g. Laboratory, Radiology, Ultrasonography, and C-T Scan) during a two-week period in the spring 2008, when the patient arrival pattern remains stable. Patients tracked by patient number wristband were worn after entering through ED door and research team recorded waiting and service time to measure their information in each station. Data included; current process, patients' wristband numbers, name of stations and duration of rendered service, time of arrival to and departure from stations in the Ayatolahkashani Hospital ED. SPSS(Statistical Package for Social Science), has been applied to examine the patients' arrival and service time distributions in different work stations, via One-Sample Kolmogorov-Smirnov Test. Sample size of patients was based on number of patients who were treated in the previous year at the same time. Finally, the required data of patients in different stations for 663 patients during two weeks has been collected. Then, by using SPSS, distribution of patient arrival time and patient service along with related parameter in all stations were designed. After that, a simulation model for the ED has been designed by simul8. Results from base model running and alternatives running were also analyzed for more discussion. The validity of model has been verified via comparison between actual data and the result of the simulation model. At the end, 20 alternative scenarios for reducing patient waiting time were suggested.

3. RESULTS

Results showed the stations that deliver services including screen physician visit, admission, primary nurse, specialist visits (ENT, Orthopedic, and Neurosurgical), secondary nurse, Para-clinical (CT- Scan, Ultrasonography, Radiology, Laboratory), and tertiary nurse services at the ED of the Ayatolahkashani Hospital. Distribution of arriving time to the ED was exponential with mean about 8.34 indicated averagely seven people refer to the ED.

According to findings, there were three type patients in the ED; Patient's type 1: These patients have life-threatening but treatable injuries requiring rapid medical attention that put on the first priority than other types (Red or immediate). They use screen services, medical specialty services, nurses, para-clinics and CPR (Cardio Pulmonary Resuscitation) services. Patients' type 2: They

Number of Samples	Distribution	Mean in Minute	Standard Deviation	Stations of Services' Delivery
635	Normal	4.73	2.45	Admission
663	Normal	2.88	2.26	Screen Physician Visit
293	Normal	3.39	1.89	Primary nurses' services
291	Normal	12.13	11.04	Orthopedic Intern Visit
269	Normal	16.19	13.12	Orthopedic Resident Visit
227	Normal	13.21	11.43	Neurosurgical Intern Visit
157	Normal	16.31	14.11	Neurosurgical Resident Visit
62	Exponential	38.89	-	ENT Intern Visit
35	Exponential	49.60	-	**ENT Resident Visit**
293	Normal	5.77	4.92	Secondary Nurse Services
1221	Normal	9.43	4.33	CT- Scan Services
589	Normal	13.62	1.92	Ultrasonography Services
972	Exponential	12.31	-	Radiology Services
2905	Normal	21.15	13.33	Laboratory Services
293	Normal	6.02	8.04	Tertiary Nurse Services

Table 1. Statistical Distribution of Services' Delivery in Different Stations

potentially have serious injuries, but are stable enough to wait a short while for medical treatment (Yellow or delay). They move on similar path than type 1, except use of CPR service. The patients' type 3: They have minor injuries that can wait for longer periods of time for treatment and only uses nurse services and screen services (Green or minor).

From results, total percent of patient's type 1, 2 and 3 were 7, 50 and 43 respectively. Percent of patients' orthopedics, neurosurgical and ENT (Eye, Nose & Throat) services were 38, 30, and 11 respectively. Percent of patients whose didn't use any of these services and only use Para-clinics and screen services were 21. On the other hand, percent of patients in Laboratory, Radiology, CT-Scan and Ultrasonography services were 73, 65, 47 and 17 respectively. Distribution of services time in Radiology, ENT Intern and Resident were exponential and in other services were normal. Bottlenecks are stations which have maximum waiting time.

Mean waiting Time in Minute	Stations of Services' Delivery
0.25	Admission Process
1.06	Screen Physician Visit
2.33	Primary nurses' services
14.88	Orthopedic Visit
11.37	Neurosurgical Visit
36.04	ENT Visit
5.57	Secondary Nurse Services
1.06	CT- Scan Services
.78	Ultrasonography Services
5.85	Radiology Services
20.17	Laboratory Services
11.30	Tertiary Nurse Services
112.19	Total Mean of Patient Waiting Time in System

Table 2. Mean of Patient Waiting Time on Base Model

As it can be seen from table 1, Laboratory Services, ENT Visit, and Orthopedic Visit were bottlenecks respectively. There were many factors corresponding to these delays and long waiting time but the most significant related to lack of efficient communications among different resident specialists.

Percent of Manpower Idle Time	Stations of Services' Delivery
63.84	Admission
60.48	Screen Physician
54.54	First Nurses Activity
45.16	Orthopedics' Intern
42.66	Orthopedics' Resident
50.5	Neurosurgical Intern
45.66	Neurosurgical Resident
46.94	ENT Intern
48.28	ENT Resident
42.73	Second nurses activity
79.98	CT-Scan
87.19	Ultrasonography
64.51	Radiology
38.22	Lab
33.24	Third Nurses activity

Table 3. Percent of Manpower Idle Time in Stations of Services' Delivery

After designing model and running 1000 times, mean of waiting time and idle time was earned (table 2 and 3). Table 2 illustrates that total mean of patient waiting time was 112.19 minutes in ED. The most and the least patient waiting times were 36.04 and 0.25 minutes in ENT and Admission services respectively.

As the table 3 shows, mean of idle time of manpower in Para-clinical units (CT-Scan, Ultrasonography and Radiology) and admission unit were more than other. The least manpower idle time related to third nurse activity with 33.24 percent. After designing of base model and running it, mean waiting time and manpower idle time were obtained. Then 20 alternative solutions were suggested for reducing patients waiting time. According to stakeholder's viewpoint and hospital situations, alternative solutions were designed. These mainly related to improvement of processes' emergency care delivery and change number of manpower. After implementing alternatives, manpower idle time was designed.

Then, in order to select the best alternative in the ED and implement it successfully, researchers compared the results from running of any alternative in model with base model. Scenarios denote that we can reduce mean of care services time and waiting time for receiving care services with small changes

Alternatives	Descriptive
2	Number of admission staff decreased to one staff
3	One intern was added to orthopedic services and orthopedic services done by two interns and one resident
5	One intern was added to ENT services and ENT services done by two interns and one resident
6	Orthopedic intern service time reduced from 12.13 minute to 5.98 minute, neurology intern service time reduced from 13.21 to 6.58 and ENT intern service time reduced from 38.89 to 26.54
10	Triage service process was considered for emergency process and 2 minutes supposed as triage service time
13	This is accumulated of 3 and 6 alternatives
14	This alternative was a combination of alternatives 4 and 6
15	This alternative was a mixture of alternatives 5 and 6
16	Nurse service time in tertiary nurses activity reduced from 6.02 minutes to 5.45 minutes

Table 4. Alternatives for solving problem at ED of Ayatolahkashani Hospital

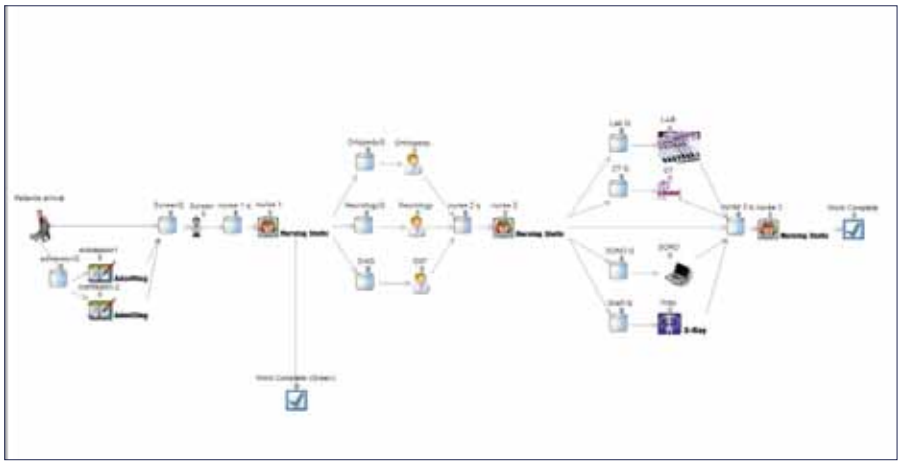

Figure 1. Model of flow work at Ayatolahkashani Hospital ED

in some stations.

Then, in order to select the best alternative in the ED and implement it successfully, researchers compared the results from running of any alternative in model with base model. The Figure 1 shows model of flow work at Ayatolahkashani Hospital ED.

Except alternatives 2, 9, 10, and 12, others were reduced the patient waiting time. In addition, for base model, patient waiting time was 112.19 minutes that in alternatives 6, 13, 14 and 15 were 90.24, 90.42, 90.53 and 90.52 minutes respectively. Mean of intern services in alternative 6 was reduced and supposed that some no essential activities' intern had better eliminate to increase interns' times for caring.

Thus, mean services time of orthopedic, neurosurgical and ENT interns reduced from 12.13 to 5.98, 13.21 to 6.58 and 38.89 to 26.54 minutes respectively. Alternative 13 was a mixture of alternatives 3 and 6.

This means, when we added one intern to Orthopedic service, it cause mean of services time in Orthopedics service, Neurological and ENT reduce from 12.13 to 5.98, 13.31 to 6.58 and 38.89 to 26.54 minutes respectively.

Alternative 14 was a mixture of alternatives 4 and 6. Moreover, when we added one intern to neurological service, it caused mean of services time in neurological service, orthopedics and ENT reduce from 13.31 to 6.58, 12.31 to 5.98 and 38.89 to 26.54 minutes respectively.

Alternative 15 was a mixture of alternatives 5 and 6. Moreover, when we added one intern to ENT service, it caused mean of services time in ENT, Orthopedics and Neurological reduce from 38.89 to 26.54, 13.31 to 6.58 and 12.13 to 5.98 minutes.

4. DISCUSSION

Scenarios denote that we can reduce mean of care services time and waiting time for receiving care services with small changes in some stations. Findings of research that entitled "simulation in outpatient's services systems in Tehran educational and general hospitals" showed changing of physicians' visit-start-time in clinics can reduce patients' waiting time from 67.01 to 44.73 percent in minutes (9).

Many solutions have also been sought from operational changes by many researchers. The focus has been on patient flows, waiting times and throughput time in the ED. Some of them focused, for their part, on fast-track solution or bed occupancy has been under examination (16).

Miller and colleagues proposed Grouping scenarios in the following hierarchy will be instrumental when executing scenarios and finding the best alternatives as follows: 1. Arrival volumes, 2. Inpatient beds, 3. Ratio of main ED and fast track beds, 4. Process improvements (17). Some solutions emphasized on number of manpower and equipments and some others on changing and improvement of processes and else on all factors (9, 17).

Most of times, we can only improve processes and decrease waiting time without spending additional cost for human resources or institute new ward in the ED.

Findings in a study at Lancaster University in United Kingdom on ED performance using simulation showed patients were actually triaged by 3 categories ("Minor", "Major" and "Life threatening"). The aim of triaging is to prioritize patients so that more severe cases are treated before less severe ones. One of the significant characteristics of the Accident and Emergency environment is that medical staff multi-task. Sometimes medical staff treat more than one patient at a time, especially when the system is congested (18).

In this research, also the results showed that general practitioners, interns, residents and specialists have multi-tasks in several places at Ayatolahkashani Hospital such as in operation room, different wards, and clinics that obviously decrease quality of care in ED. Research findings indicate that, in fact, unfortunately, doctors do not have tendency to do verity tasks and prefer to give more attention to their patients. In the other words, from our results, low experienced interns and residents were spending more time with patients and request more investigations and tests to make decisions for them. It is the opposite for experienced doctors that they are rapid in decision making. From our model, scenarios revealed that inexperienced doctors order more X-Ray and stem high congestion in Para-clinic departments. Because of mixing urgent patients with less severe patients to get Para-clinical services, severe patients have to wait to get their Para-clinical services (e.g. in CT-Scan).

5. CONCLUSION

Managers should learn scientific and simple methods to control and planning better. They should set up meetings to study and review flow works in ED at regular period.

In order to decrease waiting time in Para-clinical services, they should get to their services out of turn. Intern replace with general physician to decrease waiting time in ED. Hospital emergency Managers should inform online "Emergency Medical Services Center" about available bed that can better steer and distribute severe patients among other hospitals.

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