

Original Article

Adult emergency department performance in the largest teaching hospital in southern Iran: a 1.5-year cross-sectional study

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Abstract

Background: Emergency department (ED) is one of the most important hospital departments, with significant effects on public health. The aim of this study was to evaluate the adult ED's performance of the largest teaching hospital in southern Iran.

Methods: In this retrospective cross-sectional study (March 2017-August 2018), the registered data in the Hospital Information System (HIS) were collected, and the ED's performance was assessed based on the Iranian emergency performance index. The slopes of the trend lines were calculated for each indicator. Moreover, 2 six-month periods were compared.

Results: The data of 104,081 patients were analyzed. The mean (\pm standard deviation) of visited patients per-month was 5,782.28 (\pm 1258.55). The slope of the trend line was negative for all indicators, except for discharge from ED with personal responsibility. The mean duration of waiting time for the first visit by physician in each triage level slightly decreased. Comparison of the two six-month periods showed a significant difference between the visited patient ($P < 0.0001$). The percentage of patients disposed within six hours ($P < 0.0001$), leaving ED within 12 hours ($P < 0.0001$), as well as the percentage of successful cardiopulmonary resuscitation ($P = 0.014$) in the six-month period of 2018 was significantly lower. The percentage of discharge with personal responsibility significantly increased ($P = 0.005$).

Conclusion: Although the number of patients visited in this ED decreased, all indicators had dropped. However, the percentage of discharge with personal responsibility was increased. Moreover, the mean duration of waiting time for the first visit by physician slightly decreased in each triage level.

Keywords: Emergency Medical Services; Emergency Service, Hospital; Emergency Treatment; Health Policy.

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Introduction

Emergency department (ED) is one of the most important hospital departments, with significant effects

on public health. This department face different problems, that the most known are overcrowding due to excess demand for emergency care and patients' long waiting

time (1, 2). Overcrowding can delay patients' care, extend the patients' waiting time, increase the risk of poor outcomes in patients, and increase patient mortality (3-5). Previous studies have shown that waiting time is significantly associated with patient satisfaction (6). Actually, longer waiting time can decline the quality of health services and lead to the patient's exit from ED with personal responsibility (7). EDs overcrowding can also increase the duration of physicians' decision-making process and consequently the patients' length of stay (LOS) (8). Studies have demonstrated that LOS is less affected by patient-related factors, and is more influenced by clinical factors, such as disease type, hospital facilities, the type of hospital, and ED's workload (9, 10).

In a US survey in 2004, the average of LOS in ED was 3.3 hours; however, 10 million patients (9.7%) stayed at ED for more than six hours (11). It was reported that only 39% of patients presenting to Iran's EDs had LOS less than four hours (12). This rate has been estimated of 72%, 96-98%, and 76% in the US, England, and Canada, respectively (13). However, EDs in Iran have reported different LOS, which can be due to differences in the studied settings, sampling methods, interventions, personnel, and management systems (10).

Considering the mentioned problems, today, there are many national and international tools and indicators, which can be used to continuously monitor the EDs' performance. These methods, which are developed based on various theories in different contexts, are used to assess the achievement of managerial goals (14, 15). However, only a few of them are correctly measured and recorded in ED. The Center for Accident and Emergency Operations of Iranian Ministry of Health has developed the national ED indicators, which are monthly assessed and recorded by emergency supervisors (16).

Considering the annual admission of 30 million critically ill patients in Iran's EDs

(17), besides the importance of monitoring EDs' performance for identifying the strengths and weaknesses, the aim of this study was to evaluate the adult ED's performance of the largest teaching hospital in southern part of Iran over an 18-month period, and compare two six-month periods in 2017 and 2018, based on five Iranian national ED performance indicators, which was introduced by Iranian Ministry of Health.

Methods

Study design and setting:

In this retrospective cross-sectional study (March 2017-August 2018), the ED's performance of the largest teaching hospital in southern Iran, with an annual admission rate of 70,000 patients was evaluated. This period was selected because of some changes in the ED's structure and management.

Participants and sample size:

The sample size included all patients who had been admitted and visited in the adult's ED during the study period, and their information was fully documented in Hospital Information System (HIS). All data were extracted from HIS. Patients who left without being visited, and whose information was not correctly registered in HIS or was omitted due to mistakes in registration were excluded from the study.

The researched index:

In this study, five emergency performance index (EPIs) which were developed by the Center for Accident and Emergency Operations of Iranian Ministry of Health, were selected:

- 1) Percentage of patient disposition within six hours: The proportion of patients hospitalized in the ED and disposed within six hours to the total number of patients hospitalized in the ED over a certain period of time. Disposition means the first physicians' order about discharge from ED.

- 2) Percentage of patients leaving ED within 12 hours: The proportion of patients hospitalized in the ED and being disposed by the ED's physicians, they have not physically leave ED within 12 hours to the total number of patients hospitalized in the ED over a certain period of time.
- 3) Percentage of discharge with personal responsibility: The proportion of patients who are discharged from the ED with personal responsibility despite medical advice to the total number of patients hospitalized in the ED over a certain period of time.
- 4) Percentage of successful cardiopulmonary resuscitation (CPR): The proportion of successful CPR in the ED to the total CPR over a certain period of time. A successful CPR is a CPR after which the patient's blood flow is restored, with no need for another resuscitation at least for 20 minutes. In the previous version of the standard protocol, the percentage of unsuccessful CPR was considered as a performance indicator. For evaluation of this indicator according to the new protocol, the number of unsuccessful CPRs was subtracted from 100.
- 5) Mean duration of waiting time for the first visit by physician in each level of triage.

Based on the emergency severity index (ESI), ED's patients are categorized into five groups from level one (most urgent) to level five (least urgent) (16).

Study protocol:

Firstly, the registered data in the HIS were collected, and EPI was assessed. Then, slope of the trend lines were calculated and drawn for the number of patient visits, both in general and for each level, as well as all the studied indicators. Moreover, two six-month periods (March 2017-August 2017 and March 2018-August 2018) (the first six months of the year in Persian calendar) were compared in 2017 and 2018. This period was selected considering the changes in this hospital's adult ED, including changes in ED's management.

Statistical analysis:

Using the SPSS IBM statistics software (IBM Corp., New York, USA) for Windows version 22.0 and MedCalc Statistical Software version 13.3.3 (MedCalc Software bvba, Ostend, Belgium; <http://www.medcalc.org>; 2014), data were analyzed. Descriptive and analytical tests, such as *Chi-square* test were employed for the categorical variables, and independent student *t* as well as *Mann-Whitney U* tests were utilized for the continuous ones. For calculating and drawing the trend lines for each indicator and their slopes, Graph Pad Prism software version 6.0 and Microsoft Office Excel software version 2013 for Windows were used. Results are presented as mean±standard deviation (SD) for continuous variables, and summarized in number (percentage) for categorical ones. Two-sided P-value<0.05 and Confidence Interval (CI) of 95% were considered as statistically significant.

Results

The data of 104,081 patients were analyzed in this study. The mean±SD of the patient visits per month was 5,782.28± 1258.55. As shown in Table 1, the highest number of admitted patients was reported in March 2017 (7,954), while the lowest was reported in August 2018 (4,344). The highest number of visits was attributed to triage level 4 (4,100), while the lowest number was related to triage level 5 (40). Figure 1 shows the trend of visited patients in ED. In general, the number of ED's visited patients decreased, significantly (slope = -194.7±33.22, 95%CI =-265.2, -124.3, P<0.0001*). This trend was significantly decreased in level 4 (P<0.0001) and level 5 (P=0.0169), but it was increased in level 2 (P=0.0048).

As shown in Table 2 and Figure 2, the slopes of the trend lines for all indicators were negative, except for the percentage of discharge with personal responsibility (slope =0.288±0.088, 95%CI =0.101, 0.475, P =0.0049). Furthermore, the mean

Table 1. Frequency of visited patients in the adult’s emergency department of the biggest teaching hospital in southern Iran (March 2017-August 2018)

Months	Visited Patients in each triage levels (numbers)					Total
	Level 1	Level 2	Level 3	Level 4	Level 5	
March 2017	699	719	1,688	4,100	748	7,954
April 2017	540	972	2,098	3,404	560	7,574
May 2017	410	792	3,278	2,325	495	7,300
June 2017	375	754	2,273	3,299	613	7,314
July 2017	410	725	2,260	3,542	240	7,177
August 2017	425	715	2,180	2,897	538	6,755
September 2017	341	780	2,290	1,490	198	5,099
October 2017	337	736	1,622	1,583	159	4,437
November 2017	389	692	1,627	1,680	215	4,603
December 2017	406	780	2,150	2,150	521	6,007
January 2018	396	795	1,986	1,986	515	5,678
February 2018	394	698	1,503	1,503	429	4,527
March 2018	425	878	2,264	1,472	890	5,929
April 2018	400	1,010	2,527	1,344	204	5,485
May 2018	478	926	2,270	901	120	4,695
June 2018	328	1,004	2,760	523	40	4,655
July 2018	342	1,022	2,800	310	74	4,548
August 2018	417	1,053	2,549	257	68	4,344
Total	7,512	15,051	40,125	34,766	6,627	104,081
Trend line Slope (mean±SD)	-7.562±3.601	15.11±4.614	19.68±20.81	-195.6±21.34	-26.34±9.877	-194.7±33.22
95%CI	-15.20, 0.07235	5.323, 24.89	-24.44, 63.80	-240.9, -150.4	-47.28, -5.395	-265.2, -124.3
P value	0.0519	0.0048*	0.3583	<0.0001*	0.0169*	<0.0001*

* Statistically significant, SD =Standard Deviation, CI = Confidence interval

Table 2. Performance of the adult's emergency department of the biggest teaching hospital in southern Iran (March 2017-August 2018) based on Iranian national emergency performance index

Months	Patient disposition within six hours (%)		Patients leaving ED within 12 hours (%)		Discharge with personal responsibility (%)		Successful CPR (%)		Mean duration of waiting time for the first visit by physician (minute)				
	Level 1	Level 2	Level 3	Level 4	Level 5								
March 2017	94	88	5	79	0	5	8	10	12				
April 2017	96	85	6.5	74	0	5.5	7	9	11				
May 2017	93	79.5	5.8	84	0	4.2	6	8	11				
June 2017	94	65.5	6	84	0	5	6.5	8	10				
July 2017	94.7	87.5	6.7	88.7	0	4.5	6.6	7.5	10				
August 2017	95.5	88.9	6	58.8	0	5	6.5	10	11.5				
September 2017	94	85	4.7	25	0	8.5	10	12	13.5				
October 2017	86	87	9	77.6	0	5.2	6	8	9.5				
November 2017	87.5	79.9	5.9	80	0	4.8	6.2	7.5	8.3				
December 2017	81	76	5.8	67.9	0	10	13	15	15				
January 2018	82	78	5	67	0	6.5	8	10	11.5				
February 2018	83.8	82.9	5.8	69	0	6	7.5	9	11				
March 2018	86	57.9	4.6	74	0	4	8	9.5	11				
April 2018	79	68	8.6	55	0	6.5	7.5	9	11				
May 2018	88	46	11	56	0	4.8	6.2	8.5	11				
June 2018	87.26	46.4	12.88	56.6	0	4.9	6.4	8.6	11				
July 2018	87.2	37.7	10.40	57.8	0	4.5	6.3	8.5	11				
August 2018	88.3	37.2	9.27	50	0	5.9	7.2	9	13				
Trend line Slope (mean±SD)	-0.668±0.185	-2.737±0.503	0.288±0.088	-1.466±0.634	-	0.015±0.071	-0.003±0.081	-	0.003±0.084	0.035±0.07			
95%CI	-1.06, -0.275	-3.803, -1.671	0.101, 0.475	-2.810, -0.123	-	-0.136, 0.167	-0.175, 0.168	-	-0.18, 0.176	-0.113, 0.183			
P value	0.0024*	<0.0001*	0.0049*	0.0343*	-	0.833	0.967	-	0.974	0.625			

* Statistically significant, CPR = Cardiopulmonary resuscitation, SD =Standard Deviation, CI = Confidence interval

Table 3. Comparison the performance of two six-month periods (March-August 2017 and March-August 2018) of the adult's emergency department of the biggest teaching hospital in southern Iran based on Iranian national emergency performance index

Index	March 2017-August 2017	March 2018-August 2018	P value
Total number of visited patients	44,074	29,656	
Number of visited patients (per month)	Mean±SD	7,345.67±400.66	4,942.67±620.52
	Minimum	6,755	4,344
	Maximum	7,954	5,929
Number of visited patients in each level Mean±SD	Triage level 1	476.50±122.75	398.33±55.73
	Triage level 2	779.50±98.64	982.17±66.12
	Triage level 3	2,296±526.97	2,528±230.0
	Triage level 4	3,261.17±603.22	801.17±523.33
	Triage level 5	532.33±167.73	232.67±327.11
Patient disposition within six hours (%) Mean±SD	94.53±1.10	85.96±3.50	<0.0001*
Patients leaving ED within 12 hours (%) Mean±SD	82.40±8.95	48.87±12.02	<0.0001*
Discharge with personal responsibility (%) Mean±SD	6±0.6	9.45±2.81	0.014*
Successful CPR attempts (%) Mean±SD	78.08±10.69	58.23±8.18	0.005*
Duration of waiting time for the first visit by physician in each triage level (minutes) Mean±SD	Triage level 1	0.0	0.0
	Triage level 2	4.87±0.46	5.1±0.93
	Triage level 3	6.77±0.68	6.93± 0.74
	Triage level 4	8.75±1.08	8.85±0.39
	Triage level 5	10.92±0.80	11.33±0.82

* Statistically significant, SD =Standard deviation, CPR =Cardiopulmonary resuscitation

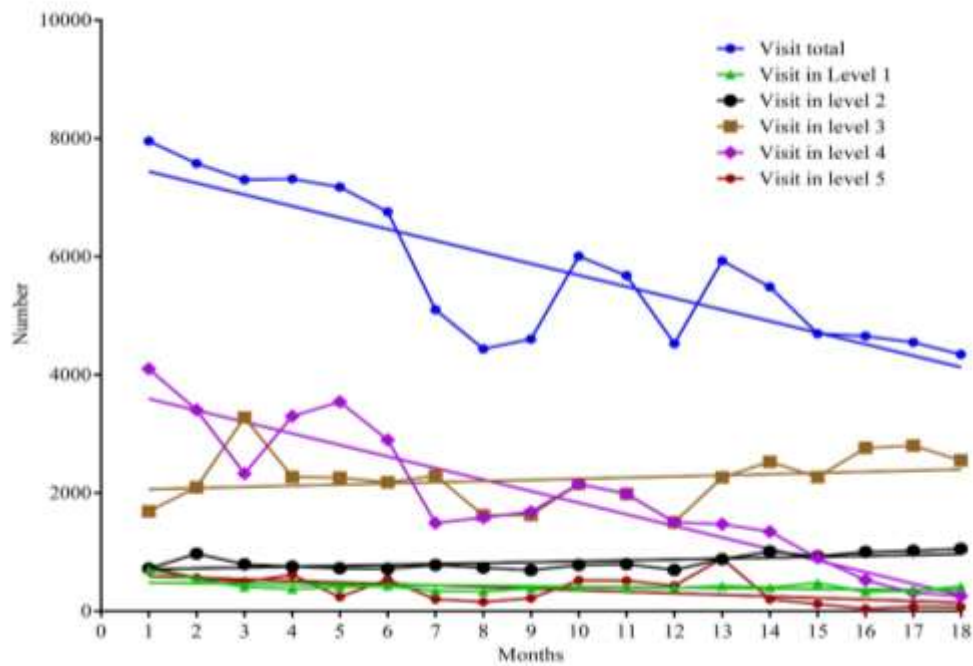


Figure 1. The trend of visited patients in the emergency department.

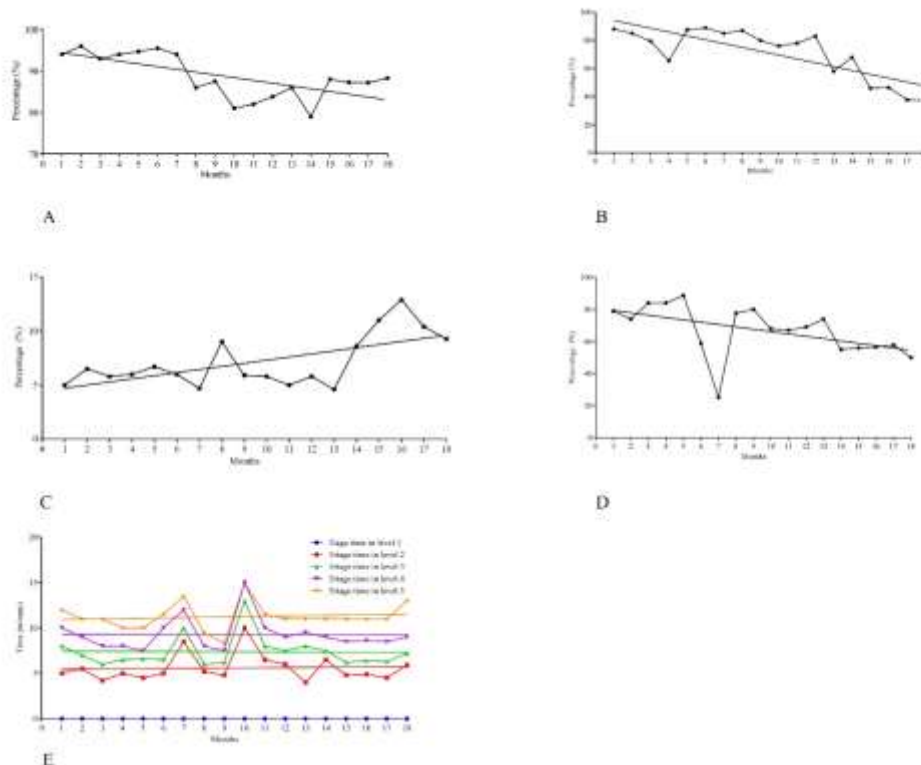


Figure 2. The trend of emergency performance index (EPI).

- A) Percentage of patient disposition within six hours, B) Percentage of patients leaving ED within 12 hours, C) Percentage of discharge with personal responsibility, D) Percentage of successful cardiopulmonary resuscitation, E) Mean duration of waiting time for the first visit by physician in each level of triage.

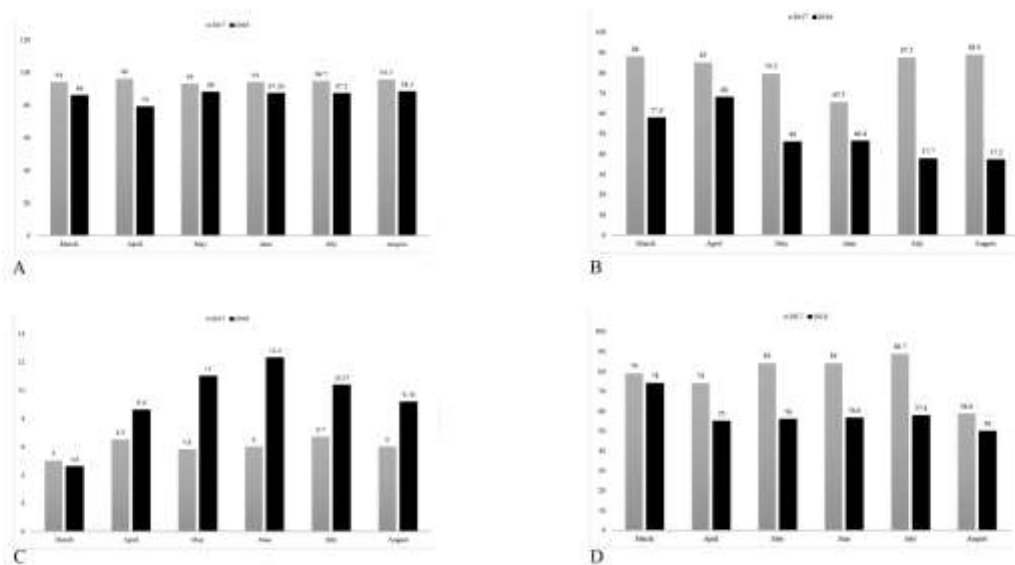


Figure 3. Comparison of the performance of two six-month periods. A) Percentage of patient disposition within six hours, B) Percentage of patients leaving ED within 12 hours, C) Percentage of discharge with personal responsibility, D) Percentage of successful cardiopulmonary resuscitation.

waiting time of patients for the first visit by physician decreased in each triage level, but it was not significant statistically in any triage level. Figure 1 shows the trend of visited patients in the ED.

Comparison of the two six-month periods in 2017 and 2018 showed that from March to August 2017, a total of 44,074 patients were visited in this ED, with a mean±SD of 7,345.67±400.66. During the same period in 2018, a total of 29,656 patients were visited, with a mean±SD of 4,942.67±620.52; there was a significant difference between these two periods (P<0.0001). As shown in Table 3 and Figure 3, in two six-month periods of 2017 and 2018, 94.53% and 85.96% of patients were disposed within six hours, respectively; this reduction was statistically significant (P<0.0001). Furthermore, there was a significant reduction in the percentage of patients leaving ED within 12 hours (P<0.0001), and the percentage of successful CPR (P=0.014). The mean percentage of discharge with personal responsibility in the six-month period of 2018 compared to the same period in 2017 significantly increased (P=0.005).

However, the average waiting time for the first visit was not significant in any of the triage level (Figure 3). The average waiting time in level I was zero in both periods.

Discussion

The results of the present study showed that although the number of patients visited in this ED decreased, all indicators evaluated in this study had dropped. However, the percentage of discharge with personal responsibility was increased. Moreover, the mean duration of waiting time for the first visit by physician slightly decreased in each triage level, which shows the speed of ED's specialists in visiting patients, but these changes were not significant. In the present study, two similar six-month periods were compared in 2017 and 2018, too. This period was selected considering the changes in the hospital's ED, including changes in ED's structure and management. The results showed that the number of patients admitted March-August 2017 significantly decreased (>12,000 cases), compared with the same period in 2018.

In the present study, two indicators (percentage of patient disposition within six

hours and percentage of patients leaving ED within 12 hours) were decreased, which showed the increase of LOS. Studies showed that lack of patient disposition within six hours is related to higher LOS and ED's overcrowding (3, 6). Also, it can lead to higher ED's bed occupancy and overcrowding. Theoretically, when the emergency capacity is low, the waiting time for services, and consequently, LOS increases, leading to greater ED's overcrowding (6). As mentioned earlier, overcrowding influences the length of physicians' decision-making process (8). Also, the large volume of patients and the necessity of disposition acceleration, increase in demand for para clinical and imaging services, which lead to a delay in reporting the results. Hence, the patients' disposition is delayed and the quality of service provision reduce.

A study showed that ED's overcrowding is associated with 28-day mortality in patients with community-acquired pneumonia (4). Also, ED's overcrowding leads to a significant increase in LOS during sepsis treatment (18), as well as increases the risk of side effects during hospitalization (19). ED's overcrowding can be caused by inefficiency in three stages: admission to ED (input), receiving emergency care (throughput), and discharge from ED (output). LOS can be decreased by appropriate planning for patients' immediate and effective treatment, besides making attempts to reduce overcrowding (10)

Among other possible causes of increased LOS is lack of proper interaction between ED and different departments of the hospital (e.g., radiology and laboratory departments), which indicates throughput inefficiency. Therefore, ED's administrators should note that ED is not a desirable setting for patient hospitalization and recovery. During the patient's stay in ED, the disease should be immediately diagnosed, and the treatments' plans should be determined. Moreover, physicians

should make necessary disposition decisions for diagnosis, admission, or discharge of patients in order to decrease ED's crowding.

Changes in the ED's management, managers' unfamiliarity with updated ED's management methods, lack of proper interaction between ED and other hospital departments for transferring the patients from ED and admitting them, as well as poor bed management and removal of extra beds, which can increase the emergency bed capacity in overcrowding situations were another reason. Another major reason is the increase of economic sanctions against Iran, which leads to the shortage of medicines and medical facilities for diagnosis and treatment of patients (20, 21). These sanctions, which can affect public health, have more adverse effects on high-risk groups and patients with chronic diseases, such as cancer. Therefore, international societies, especially scientific communities, are required to take the necessary actions (19).

One of the main signs of ED's overcrowding is patient leaving without physicians' visits (6). The results of this study showed that, in general, the slope of trend line of discharge with personal responsibility was increasing. Moreover, comparison of two six-month periods in the present study showed that the percentage of discharge with personal responsibility significantly increased from March to August 2018, compared with the same period in 2017 (6% vs. 9.45%), meaning that more patients were leaved ED without completing their treatment process. This rate were reported 4.57% by Ghavidel et al. (22). Hashemi et al. also showed that the percentage of discharge with personal responsibility decreased after the presence of EM residents; however, the difference was not statistically significant (17). Our previous research showed that this indicator was not reduced after the implementation of senior early assessment model of care in ED. Moreover, a lower LOS decreased the

number of patients leaving ED before physicians' visits (6).

Another factor which affects patient satisfaction is waiting time (6). Hing and Bhuiya stated that the mean of triage time in the US is 28 minutes. They also showed that the mean of waiting time for a visit by a healthcare provider can increase the mean of annual ED's visits (23). In addition, the quality of services decreases with an increase in patients' LOS in ED (24). The results of the present study showed that the mean duration of waiting time for the first visit by physician in any triage level, slightly decreased within 18 months, which indicates the efficiency of EM specialists in visiting patients. Furthermore, comparison of the two periods showed no statistically significant difference in any level. Since this indicator shows the immediate performance of EM specialists, it is recommended that other EDs use EM specialists.

The percentage of successful CPR was reported as 36.64% by Ghavidel et al. (22) and 30% by Hashemi et al. (17). In another study, this percentage was less than 20% (24). Although in the present study, ED's performance was much more favorable than many other EDs in terms of successful CPR, this indicator had decreasing trend over 1.5 years, totally. Comparison of the two six-month periods showed that the percentage of successful CPR significantly decreased from March-August 2018, compared with the same period in 2017 (a decrease of approximately 20%), which indicates the weaknesses of ED's performance in patients' resuscitation. Also, ED's overcrowding can cause delays in the resuscitation process and subsequently increase mortality among patients in need of CPR (25).

Manual recording and calculation of EPIs is one of this study's limitations. Also, mismatch between some of the manually recorded data and HIS data persuaded us to conduct a more detailed review in order to match the data. On the other hand, although

the results indicated that changes in ED's management have been effective in emergency performance, the status of all patients were not similar during the study period, as well as in both six-month periods, and all factors were generally assessed, while changes in physicians, residents, and personnel could not be assessable. Therefore, use of electronic medical recording is recommended for a more accurate and reliable recording of data in order to monitor ED's performance.

Conclusion

The results of the present study showed that although the number of patients visited in this ED decreased, all indicators evaluated in this study had dropped. However, the percentage of discharge with personal responsibility was increased. Moreover, the mean duration of waiting time for the first visit by physician slightly decreased in each triage level, which shows the speed of ED's specialists in visiting patients, but these changes were not significant.

The results can indicate some weaknesses in ED's management. In addition to long-term studies for identifying the weaknesses, strengths, and effectiveness of different models for better ED management, it is suggested that health administrators use updated methods and utilize the capacity of emergency medicine specialists for ED's management.

Authors' contributions

Study concept and design: AD, RSM, BZ, MS; Data gathering: MM, RSM, SEA; Data analysis: MM, RSM; Writing manuscript: AD, MM, RSM; Revise manuscript: all authors; Approve manuscript: all authors.

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Ethical consideration

The current study was supported by Shiraz University of Medical Sciences, which was approved by the vice-chancellor of research and technology, as well as the local ethics committee of Shiraz University of Medical Sciences (IR.sums.med.rec.1397.345). To consider ethical issue, the collected data were not revealed to anyone, except for the researchers; hence, patients' names were kept confidential.

Conflict of interest

All authors declared that they have no conflict of interest.

Informed consent

The informed consent was not needed in this study, because the patients' data were extracted from Hospital Information System (HIS), and to consider ethical issue, the collected data were not revealed to anyone, except for the researchers; hence, patients' names were kept confidential.

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