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Original Article

# Using Weibull model of survival analysis workflow and its relevant factors: A prospective cohort study

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## Abstract

**Objective:** One of the most important indicators used in the evaluation of emergency centers is the chronometric analysis of patients' workflow. The aim of this study was to provide a chronometric analysis of patients' workflow (patients' waiting time in the emergency department) and related factors.

**Methods:** This hospital-based prospective cohort study was carried out in Khatam al-Anbia hospital in Shoushtar in 2020. Random sampling was used and patients referred to the emergency ward in three shifts based on the ESI 5-level triage system. The research tools were the emergency workflow chronometry form and a questionnaire of determining the factors related to the speed of emergency services and using a stopwatch. In order to analyse the data, Stata software version 16 and Weibull model of survival analysis were used.

**Results:** Of 468 participants, the most common cause of referral was trauma with 21.7%. The median ± interquartile range duration of giving the final result was 6.06 ± 4.48 hours, which was more than 0.54 times shorter in clients with level 3. There was a statistically significant difference in the duration of making the final decision based on the request for testing, manner of referring and the type of initial diagnosis ($P < 0.05$).

**Conclusion:** The duration of service provision in the studied hospital is appropriate for an Iranian hospital, but it should be closer to international standards. At level 2 triage, patients stayed longer. This can be reduced by lessening the time of consultations which can help the emergency ward.

**Keywords:** Workflow, Emergency services, Hospital, Prospective studies, Survival analysis, Weibull distribution

## Introduction

In emergency wards, time is of essence to patients, and it may determine death and serious disability or a productive life (1,2). Reducing the waiting time (the time a patient waits from the moment of entering the emergency department (ED) to be examined by a doctor) in the emergency ward is a major goal in public health systems all across the world (3). Increasing patients' waiting time in the emergency ward as one of the problems in EDs has negative effects manifested in various processes within the wards and hospital (4). Studies show that there is an inverse relationship between the duration of patients' waiting time in the emergency ward and their recovery (5).

Literature shows that the long waiting time and stay of patients in the emergency ward is the result of the inefficiency of the workflow process in three stages: patient's admission, health service provision in ED and patient discharge from the ward (6). Long duration of patients' waiting time in the emergency ward means disruption in the general policies, executive orders, and current procedures within a hospital. When the patients' waiting time in the ED lasts very long, the resultant would be longer workflow inside the hospital in comparison to accepted standards (5,7,8).

In order to determine the patients' waiting time in the emergency ward, a standard questionnaire related to patients' workflow in the ED is used. Given the relationship among chronometry of services in emergency wards, the efficiency of medical measures, the rate of improvement, complications, safety and ultimately patient satisfaction, the present study was undertaken to analyze the chronometry and determine the difference of patients' workflow in rotational shifts in the emergency ward of Khatam Al-Anbia hospital in Shoushtar in 2020.

## Methods

This was a hospital-based prospective cohort study. The study was performed in the emergency ward of Khatam Al-Anbia hospital of Shoushtar faculty of Medical Sciences. The ethics code is the IR.SHOUSHTAR. REC.1398.007. This state hospital accepts the majority of patients in the geographical areas covered by Shoushtar faculty of Medical Sciences. Sampling started from October 2019 and lasted until March 2020, for 6 months. Given that patients' referrals depended on weekdays (holidays and weekends), the sampling was performed on all days of the week from patients who referred to the emergency ward and who met the inclusion criteria.

The subjects were followed up from the moment of admission to the hospital, and the exact time of each action taken against the patient (such as seeking counselling, testing, etc) was recorded. This follow-up and recording of times until making a final decision, workflow (including transfer to the ward or discharge, death, dispatch to other medical centers, personal consent of the patient for discharge and discharge with a doctor's order) were done regularly.

The target population of this study included patients who referred to the emergency ward of Khatam Al-Anbia hospital. The inclusion criteria included all patients who referred to the hospital's ED and were found to need emergency services.

The inclusion criteria were orally explained to patients at the beginning of the study, and after obtaining their consent, individuals entered the study by obtaining written consent. If they were not willing to continue at any time, they could leave the study. In addition, patients were excluded due to death, transferring to other medical centers, and personal consent for discharge.

According to similar studies conducted in Iran (1,2), and also the following formula, at the level of the first type of error (α) 5% and the second type of error (β) 20%, the sample size required to achieve the objectives of the study was estimated.

$$n = \frac{2(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 \delta_2}{(\mu_1 - \mu_2)^2}$$

Sampling was done based on the stratified random method. According to the number of patients referred on weekdays and in the morning, evening and night shifts, the sample size was allocated in the same proportion to different days and shifts. In the next step, after obtaining written consent from patients who had the eligibility criteria, randomization was done using coins. This operation was repeated every day and in every shift until the required sample volume was reached. The participants included outpatients and hospitalized patients in the ED in three shifts of morning, evening and night based on the 5-level triage system of ESI. The research instrument consisted of a dual-section form; the first section of the form included the emergency workflow chronometry designed by the hospital emergency administration (one of the administrations supervised by the Center for Supervision and Accreditation of Medical Affairs in the Ministry of Health, Treatment and Medical Education). The validity and reliability of the form were measured in the research conducted by Setoodehzadeh et al (9). Factors recorded in this questionnaire included visiting an emergency medicine specialist, sending test samples (laboratory test request), receiving test results, performing radiography, and making a final decision for patients (discharge or sending the patient to another ward or hospital) (7,8).

In order to determine the factors related to the speed of providing medical services in the emergency ward, the second part of the questionnaire addressed the demographic information of triage department personnel. In this section, 4 factors (psychological factors, work experience, scientific knowledge and economic literacy) were measured. The questions included: type of shift, marital status (psychological factor), work experience, clinical work experience and work experience in the emergency ward (experience factor), educational degree, having or not having a certificate of participation in the triage workshop (scientific literacy factor), and the type of employment (economic factor). In a sampling period of 6 months, 468 participants took part in this study.

In order to avoid interviewer bias, the sampling was performed by a nursing student who was trained for sampling. In case of missing data, the research team obtained the necessary information by checking the medical records of patients as well as calling the patient.

The obtained data were analyzed via Stata software version 16. For data analysis, first the descriptive information of participants was analyzed. By using log-rank test, the duration of making a final decision for patients was compared for different variables at $\alpha = 0.05$. This (log–rank) statistic, like many other statistics used in other kinds of chi-square tests, makes use of observed versus expected cell counts over categories of outcomes. The categories for the log–rank statistic are defined by each of the ordered failure times for the entire set of data being analyzed. The formula for the expected cell counts is shown below for each group. For group 1, this formula computes the expected number at time *f* (i.e.,$e_{1f}$) as the proportion of the total subjects in both groups who are at risk at time *f,* that is, $n_{1f}/(n_{1f}+n_{2f})$, multiplied by the total number of failures at that time for both groups (i.e.,$m_{1f}+m_{2f}$). For group 2, $e_{2f}$ is computed similarly (10)

$$e_{1f} = \left(\frac{n_{1f}}{n_{1f} + n_{2f}}\right) \times (m_{1f} + m_{2f})$$

$$e_{2f} = \left(\frac{n_{2f}}{n_{1f} + n_{2f}}\right) \times (m_{1f} + m_{2f})$$

For the two-group case, the log–rank statistic (shown below) is computed by dividing the square of the summed observed minus expected score for one of the groups — say, group i — by the variance of the summed observed minus expected score. Although the same tabular layout can be used to carry out the calculations when there are more than two groups, the test statistic is more complicated mathematically, involving both variances and covariances of summed observed minus expected scores for each group (10).

$$Log-rank.statistics=\frac{(O_i-E_i)^2}{Var(O_i-E_i)}$$

Since the purpose of this study was to analyze the time to event (patients' waiting time in the ED), the parametric methods of survival analysis were appropriate to obtain the acceleration factor. Therefore, by obtaining Akaike information criterion (AIC), exponential proportional hazard (PH), exponential accelerated failure time (AFT), Weibull PH, Weibull AFT, Gompertz PH, lognormal AFT, log-logistic AFT and generalized gamma AFT models were compared and each one that had the lowest AIC was selected as a suitable model.

The Weibull AFT model had at least AIC, so it was chosen as the appropriate model for data analysis, and then, the existence of AFT hypothesis was investigated using graphical methods such as log-log plot method (Figure 1). In using AFA Weibull model, $\alpha=0.2$ was considered in univariable analysis. Variables with a statistically significant relationship with the duration of making a final decision were included in the multivariable model with $\alpha=0.05$. The time spent to provide each of the services in the chronometry questionnaire was calculated in hours.

In this study, all participants were followed up for 48 hours after admission to the hospital and were considered as censored if not making a final decision (right censored).

## Results

Figure 1 is an example of checking AFT hypothesis, which shows that this assumption is valid and the shape parameter is less than 1, so the hazard function decreases over time.

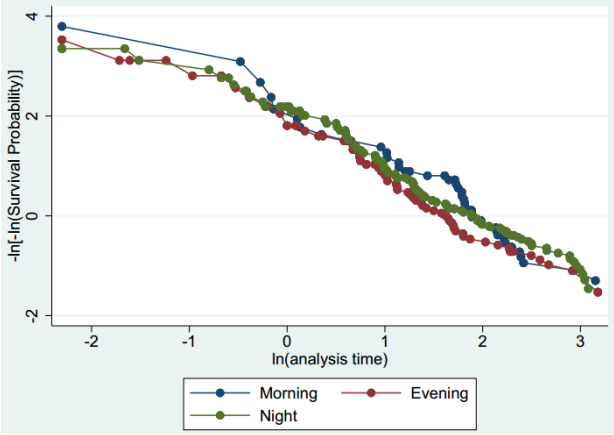


**Figure 1.** Result for plot of ln [-ln S(t)] against ln(t) by referral shift

In this study, from 468 cases, in 374 participants a final decision was decided and 94 persons were censored. Of all participants, 40.2% were women, and 50.9% referred to the hospital during the night shift. The most prevalent reason for referring was trauma (21.7%) and the least frequent cause of referral was gastroenteritis (inflammatory bowel disease) (3.1%). In addition, after referring to the emergency ward, 90.6% of the patients requested a diagnostic test and 81.7% requested counselling. The median time from the moment of arrival to making a final decision was $6.06\pm4.48$ (Table 1).

There was a statistically significant difference in making a final decision based on the laboratory test request, how people referred and the type of initial diagnosis made (Table 2).

Based on the adjusted time ratios, the length of time until final decision making for level 3 patients was equal to 0.54 of the length of time until final decision making for level 2 patients.

In addition, the duration of making a final decision for individuals with initial diagnosis of abdominal pain, weakness and fatigue and seizures were respectively 0.49, 0.39 and 0.50 times shorter than the duration of making a final decision for individuals with initial diagnosis of trauma. In addition, the decision making duration for those who sought neurological counselling was 0.37 times shorter compared to those who sought cardiology counselling (Table 3).

## Discussion

This cohort study was carried out to analyze the chronometry and to determine the difference of patients' workflow in rotational shifts in the emergency ward of Khatam Al-Anbia hospital in Shoushtar from October 2019 to March 2020. This specialized and sub-specialized hospital is the main referral center for patients. Emergency medicine specialists work in this hospital. The participants were followed up from the moment of admission to the hospital until a final decision was made for them (whether transfer to the ward or discharge, death, referral to other medical centers, personal consent of the patient for discharge and discharge order by the doctor). The results showed that the patients with three triage levels, the type of counselling specialty and the type of initial diagnosis were the factors that affected the duration of making a decision for the patients.

In our study, the workflow timing method was performed by using a stopwatch (the presence of the person measuring was invisible). The findings obtained were consistent with the results of studies conducted by Basir Ghafouri et al (11), Khazaei et al (1), Jadidi et al (12) and Jabbari et al (7). Conversely, our findings were

**Table 1**. Baseline characteristics, clinical information and treatment measures in the patients who referred to the emergency ward of Khatam Al-Anbia hospital

| Variable | | Number (%) |
|---|---|---|
| **Baseline characteristics** | | |
| Gender | Male | 280 (59.8) |
| | Female | 188 (40.2) |
| 5-level triage system ESI | Level 2 | 434 (95.6) |
| | Level 3 | 20 (4.4) |
| Referral shift | Morning | 90 (19.4) |
| | Evening | 138 (29.7) |
| | Night | 236 (50.9) |
| Referral method | Ambulance | 24 (5.2) |
| | Patient himself/herself | 208 (45) |
| | With company | 230 (49.8) |
| **Clinical information** | | |
| Type of initial diagnosis | Weakness and fatigue | 28 (8.7) |
| | Shortness of breath | 36 (11.2) |
| | Abdominal pain | 24 (7.5) |
| | Fever and shivering | 44 (13.7) |
| | Trauma | 70 (21.7) |
| | Pneumonia | 16 (5) |
| | Hypertension | 14 (4.3) |
| | Appendicitis | 8 (2.5) |
| | Scorpion stings | 24 (7.5) |
| | CVA | 10 (3.1) |
| | Seizure | 22 (6.8) |
| | GE | 10 (3.1) |
| | Other diagnoses | 16 (5) |
| Counselling request | Yes | 384 (81.6) |
| | No | 86 (18.3) |
| Laboratory test request | Yes | 424 (90.6) |
| | No | 44 (9.4) |
| The unit requesting counselling | Acute emergency | 182 (47.6) |
| | Sub-acute emergency | 200 (52.4) |
| Counselling specialty | Cardiology | 80 (21.3) |
| | Surgery | 46 (12.2) |
| | Internal medicine | 112 (29.8) |
| | Neurology | 38 (10.1) |
| | Pediatrics | 70 (18.6) |
| | CCU | 24 (6.4) |
| | Other specialties | 6 (1.6) |
| **Treatment cares (median ± interquartile range) (h)** | | |
| The time interval between arrival and the initial visit | | 1.21 ± 0.26 |
| The interval between arrival and the start of initial treatment | | 2.47 ± 0.53 |
| The interval between the request and the consultation | | 2.04 ± 0.53 |
| The time interval between performing the test and determining the test result | | 1.72 ± 1.54 |
| The time interval between arrival and making a final decision (workflow) | | 6.06 ± 4.48 |

CVA, cerebral vascular accident; GE, Gastroesophageal

not in line with the study method by Zare Mehrjardi et al (13), using the discrete simulation method, and the study of Firouzi Jahantigh and Aghajannejad (14), using the Queuing theory.

It should be noted that the discrete event simulation method is used as a tool to predict the impact of changes in existing systems and also a design tool to predict the performance of new systems. The use of this technique in the health sector is much less in comparison to industrial areas (13). The mathematical model (Queuing theory) can also be a valuable tool to study patient capacity, resources, and flow time. In the health care system, queuing theory is used to assess the required capacity, and reduce delays (patient service process may be interrupted or delayed) (14). One of the simplest methods is to use the hospital health information system (HIS). However, it has a defect in recording the time of patients' arrival and departure (2). It should be noted that chronometer timing is one of the methods of direct observation and is the most common and widely used workflow timing technique (15). Therefore, it was decided to collect data in the field by chronometer.

The findings indicate that, as for the referral shift, 50.9% of the participants referred to the hospital emergency ward during the night shift (the most frequent shift). These results were consistent with the findings of studies by Jabbari et al (7), Basir Ghafouri et al (11) and Safari et al (16). However, in studies conducted by Chong et al (17) and Füchtbauer et al (18), evening shift visits were the most frequent shift. In a study by Ay et al (19), the most frequent referral shift was between evening and night (16:00 to midnight). The most common ways of referral were patients themselves (49.8%), with a company (45%), and finally by an ambulance (5.2%). These results are consistent with the findings of studies by Mahsanlar et al (4), Basir Ghafouri et al (11) and Chong et al (17).

The most frequent cause of referral was trauma with 21.7% and the least frequent cause of referral was non-traumatic reasons with 3.1%. In addition, the findings of the studies by Khazaei et al (1), Movahednia et al (5) and Jafakesh Mogadam et al (20) are consistent with the findings of our study. However, the results of a research by Tabibi et al (21), are inconsistent with this part of our study and the rate of non-trauma patients was higher than trauma patients (about 4 times). It can be stated that the type of hospital (in terms of having or not having a trauma center) may be one of the factors affecting the number of non-trauma patients referring to the emergency ward.

Diagnostic tests were requested for 90.6% of the patients and counselling was requested for 81.6%. In the study by Bukhari et al (22), the diagnostic tests and counselling request were 58.28% and 77.43%, respectively. These findings are close to the results of our study in terms of counselling request. In the study by Jafakesh Mogadam et al (20), the total figure for the requested counselling was

**Table 2**. Investigating the relationship between different variables and the duration of making a final decision of the subjects under study from the arrival to emergency ward of Khatam Al-Anbia hospital

| Variable | | Number of observed events | Number of expected events | Chi-square statistics | *P* value* |
|---|---|---|---|---|---|
| Referral method | Ambulance | 20 | 10.81 | 12.23 | **0.002** |
| | Patient himself/herself | 187 | 209.71 | | |
| | Sick companions | 161 | 147.48 | | |
| Type of initial diagnosis | Weakness and fatigue | 20 | 22.24 | 79.96 | **<0.001** |
| | dyspnea | 26 | 33.9 | | |
| | Abdominal pain | 19 | 9.69 | | |
| | Fever and shivering | 38 | 42.56 | | |
| | Trauma | 58 | 33.06 | | |
| | Pneumonia | 12 | 9.23 | | |
| | Hypertension | 12 | 21.93 | | |
| | Appendicitis | 8 | 13.35 | | |
| | Scorpion stings | 16 | 26.56 | | |
| | CVA | 10 | 4.53 | | |
| | Seizure | 20 | 7.78 | | |
| | GE | 8 | 12.55 | | |
| | Other diagnoses | 12 | 21.64 | | |
| Laboratory test request | Yes | 354 | 362.06 | 7.04 | **<0.001** |
| | No | 18 | 9.94 | | |
| Counselling request | Yes | 332 | 340.03 | 2.3 | 0.129 |
| | No | 40 | 31.97 | | |
| Counselling specialty | Cardiology | 61 | 67 | 11.96 | 0.06 |
| | Surgery | 44 | 35.11 | | |
| | Internal medicine | 101 | 121.41 | | |
| | Neurology | 32 | 32.8 | | |
| | Pediatrics | 64 | 51.14 | | |
| | CCU | 22 | 16.27 | | |
| | Other specialties | 4 | 4.27 | | |

CVA, cerebral vascular accident; GE, Gastroesophageal
*Log-rank test.

55%, which is different from our study. The reason for this difference can be related to the fact that the most frequent referrals were for patients with level-three triage, and the treatment measures included visits and medication without paraclinical procedures. It should be noted that, among the possible causes of a long stay in the emergency room are: request for unnecessary tests and counselling in the emergency room and delays in sample delivery to the laboratory. As a result, the patient's working time in the ED of the hospital will increase.

According to adapted time ratio in this study, the duration of making a final decision for the patients with level-3 triage was 0.54 the patients with level-2 triage. Prolongation need for treatment of the patients with level-2 triage, can be due to the prolongation of counseling, the need for treatment by another service, the lack of an empty bed in the wards, the wider evaluations required and the wider relationship these services have with other services, and finally the delay in making a decision for the patient by other hospital service providers. This issue has been repeated in the findings of in a study by Nasr Esfahani et al (23) and is consistent with the results of this part of our study. However, in the findings of several studies (1, 4) that those with level one (vital) and two (urgent) have a higher priority in receiving the required facilities and resources. This is not consistent with our findings.

The findings of the present study indicate that the duration of making a final decision for patients with the initial diagnosis of weakness and fatigue, scorpion sting, seizures and abdominal pain (causes of non-traumatic referral) was respectively 3.37, 3.31, 2.64 and 2.14 times longer in comparison to the patients initially diagnosed with trauma. This indicates the experience of longer hospitalization in the emergency ward. The information obtained from this study was consistent with the study conducted by Nasr-Esfahani et al (23).

In one study, the waiting time of emergency ward patients was divided into five components, including the waiting time from triage to the start of treatment, for diagnostic procedures, from the end of diagnostic

**Table 3**. Findings of AFT Weibull model, and the relationship between different variables and the duration of making a final decision for the patients who referred to the emergency ward of Khatam Al-Anbia hospital

| Variable | Crude Model | | Adjusted Model | |
|---|---|---|---|---|
| | TR (80% CI) | *P* value[a] | TR (95% CI) | *P* value[b] |
| Triage level | | | | |
| Level 2 (reference) | 1 | | 1 | |
| Level 3 | 0.63 (0.44-0.88) | 0.084 | 0.54 (0.29, 1.02) | 0.058 |
| ln P | 0.101 (0.05, 0.15) | **<0.001** | | |
| Referral shift | | | | |
| Morning (reference) | 1 | | 1 | |
| Evening | 0.81 (0.69-0.97) | 0.134 | 1.04 (0.73-1.49) | 0.811 |
| Night | 0.99 (0.84-1.16) | 0.951 | 0.95 (0.67-1.35) | 0.817 |
| ln P | 0.089 (0.04, 0.14) | **0.021** | | |
| Referral method | | | | |
| Ambulance (reference) | 1 | | 1 | |
| Patient himself/herself | 2.01 (1.54, 2.63) | **0.001** | 1.85 (0.91, 3.74) | 0.087 |
| Sick companions | 1.63 (1.25, 2.14) | **0.019** | 1.47 (0.71, 2.95) | 0.296 |
| ln P | 0.12 (0.06, 0.17) | **0.002** | | |
| Type of initial diagnosis | | | | |
| Trauma (reference) | 1 | | 1 | |
| Shortness of breath | 1.18 (0.86, 1.62) | 0.490 | 0.68 (0.34, 1.37) | 0.271 |
| Abdominal pain | 0.53(0.37, 0.75) | **0.042** | 0.49 (0.26, 0.92) | **0.027** |
| Fever and shivering | 1.14 (0.85, 1.54) | 0.540 | 1.11 (0.65, 1.90) | 0.732 |
| Weakness and fatigue | 0.63 (0.47, 0.83) | **0.034** | 0.39 (0.21, 0.71) | **0.002** |
| Pneumonia | 0.87 (0.59, 1.30) | 0.670 | 0.77 (0.36, 1.65) | 0.475 |
| Hypertension | 1.61 (1.09, 2.38) | 0.115 | 1.31 (0.66, 2.61) | 0.470 |
| Appendicitis | 1.59 (1.02, 2.50) | 0.179 | 0.71 (0.31, 1.63) | 0.407 |
| Scorpion sting | 1.43 (1.002, 2.05) | 0.197 | 0.91 (0.50, 1.68) | 0.747 |
| CVA | 0.48 (0.31, 0.72) | **0.024** | 0.44 (0.21, 0.92) | **0.030** |
| Seizure | 0.43 (0.31, 0.61) | **0.002** | 0.50 (0.26, 0.97) | **0.043** |
| GE | 1.60 (1.02, 2.50) | 0.175 | 2.36 (0.90, 6.18) | 0.079 |
| Other diagnoses | 1.53 (1.03, 2.26) | 0.159 | 1.12 (0.59, 2.09) | 0.744 |
| ln P | 0.182 (0.12, 0.24) | **<0.001** | | |
| Laboratory test request | | | | |
| No (reference) | 1 | | 1 | |
| Yes | 1.75 (1.32, 2.32) | **0.010** | 1.28 (0.67, 2.43) | 0.443 |
| ln P | 0.108(0.058,0.16) | **0.004** | | |
| Counselling request | | | | |
| No (reference) | 1 | | 1 | |
| Yes | 1.28 (1.05,1.56) | 0.096 | 1 (0.99-1.01) | 0.99 |
| ln P | 0.101 (0.05, 0.15) | **0.008** | | |
| The unit requesting counselling | | | | |
| Acute emergency (reference) | 1 | | 1 | |
| Sub-acute emergency | 0.88 (0.77, 1.009) | 0.234 | 0.86 (0.59, 1.23) | 0.419 |
| ln P | 0.09 (0.03, 0.14) | **0.029** | | |
| Counseling specialty | | | | |
| Cardiology (reference) | 1 | | 1 | |
| Surgery | 0.75 (0.60, 0.95) | 0.121 | 1.18 (0.52, 2.69) | 0.684 |
| Internal medicine | 1.04 (0.86, 1.26) | 0.755 | 0.74 (0.38, 1.42) | 0.366 |
| Neurology | 0.90 (0.70, 1.17) | 0.630 | 0.37 (0.18, 0.77) | **0.008** |
| Pediatrics | 0.74 (0.60, 0.91) | **0.064** | 0.57 (0.29, 1.10) | 0.096 |
| CCU | 0.69 (0.52, 0.93) | 0.113 | 0.33 (0.09, 1.17) | 0.087 |
| Other specialties | 0.93 (0.51, 1.69) | 0.879 | 1.05 (0.23, 4.75) | 0.994 |
| ln P | 0.098 (0.04, 0.15) | **0.02** | | |
| ln P (total)[c] | | | 0.23 (0.12, 0.34) | **<0.001** |

Note: AFT, accelerated failure time; TR, time ratio.
[a] Crude AFA Weibull model (α=0.2); [b] Multiple AFA Weibull model (α=0.05); [c] ln P in Multiple AFA Weibull model.

procedures to re-visit, from the end of the re-visit to the beginning of secondary treatment and from the end of secondary treatment to discharge from the emergency ward (21). The results of our study also showed that the mean time from the moment of admission to making a final decision for patients was approximately 320 minutes (discharge or transfer was 5.36 ± 5.16 hours). However, in a study by Jadidi et al (12), the mean length of stay of patients from the time of admission to making a final decision was 3.3 ± 6.9 hours. Furthermore, in a study by Jabbari et al, this was 249.2 ± 353.1 minutes, less than 240 minutes for 39% of patients and more than 240 minutes for 61% of them (7). There was a statistically significant difference in the duration of making the final decision based on the request for testing, way of referring and the type of initial diagnosis in our study. This difference was consistent with the study conducted by Nasr-Esfahani et al (23) and Ay et al (19). In study of Gaughan et al (24) in the Turkey, confirmed the direct relationship between the patients' length of stay in the ED and the number of counselling required to make a final decision and the need for treatment by other hospital services. Also, they showed that the increase in hospital bed occupancy is related to the patients' length of stay in the emergency ward.

The comparison of the results of the present study with previous studies shows that the time of providing services in the emergency ward (workflow) of the studied hospital is in an appropriate condition in Iran, yet it should be closer to international standards.

## Conclusion

The information obtained from this study provided accurate data about the causes of referral, busy hours, gender of patients, number of patients and emergency ward readiness. Accordingly, the authorities can prevent the occurrence of crises in emergency wards by creating special facilities and equipment.

It should be noted that one of the reasons for frequent visits to the hospital ED during night shifts and holidays is the closure of clinics and offices. It is necessary to consider the appropriate distribution of staff in the EDs in proportion to the number of clients and workflow in emergency work shifts (morning, evening and night). Paying particular attention to this issue can lead to better services to clients in the ED in different work shifts (morning, evening and night). The resultant would be client satisfaction and an increase in the efficiency of staff.

There is a relationship between the levels of triage and the duration of patients' hospitalization in the emergency ward, which in some cases is longer than the level of triage - level two. Proper triage reduces the patients' workflow and costs. Also it increases satisfaction, lessens waiting and stay time, decreases mortality rate, and increases the efficiency and effectiveness of emergency wards. Accordingly, it is necessary to update and establish a standard and scientific system of triage. Solutions such as providing essential counselling, preventing unnecessary services, the presence of an emergency specialist in the outpatient emergency ward, and finally faster treatment measures can be used to decrease the length of stay in the emergency ward. Given that there is a huge interval between the request for medical counselling and the result of medical counselling in the emergency ward, the authorities should take the necessary measures to facilitate the provision of services. Such measures include the proper use of information technologies such as ED information systems, counselling and telemedicine systems.

It is important to mention that factors such as workflow and waiting time should not cause the neglect of quality and efficiency of providing services in emergency wards. Managers and staff of ED should take necessary measures in accordance with the standards and satisfy patients in order to improve the quality and efficiency of emergency wards.

Therefore, the following suggestions are made to improve the quality of services provided in emergency wards, and as a result reduce the workflow:

Development of national standard indicators for waiting times for patients to receive diagnostic and treatment services (workflow), parallel and systematic development of operational process for patients to achieve the required care in the shortest possible time in the ED, development of shared guidelines for the ED and paraclinical units to provide services to patients in the shortest possible time, taking into account the patients' priorities, using the HIS for coordinating the ED and the laboratory, radiology, CT scan and sonography for the admission of patients as soon as possible, and presentation of the patient's paraclinical results to the emergency ward.

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### Authors' Contribution

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## Ethical Approval

It is a part of a dissertation approved by the ethics committee of the same school, registered under the ethics code of IR.SHOUSHTAR.REC.1398.007 in Shoushtar Faculty of Medical Sciences.

## Competing Interests

None.

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