Research Paper: Time Indices of Prehospital Emergency Services in Ardabil City, Iran, 2020

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ABSTRACT

Background: The role and function of Emergency Medical Service (EMS) in people's health and the need for continuous evaluation of its function, especially delivering services to the patients, are essential. So, the present study was conducted to determine the time indices of prehospital emergency services in Ardabil City, Iran.

Materials and Methods: This study was a retrospective cross-sectional study. Out of all calls recorded in EMS centers of Ardabil in the first 6 months of 2020, 327 calls, which resulted in the patient's transfer to a hospital, were randomly selected. Then, the required data, including time indices and demographic information, were extracted from EMS forms filled by a medical emergency technician for each mission. The obtained data were analyzed using descriptive statistics, including mean, standard deviation, and inferential statistics, including 1-way analysis of variance and the Chi-square test in SPSS v. 22.

Results: In terms of time indices, the average delay time (1.01 minutes), the response time (7.87 minutes), on-scene time (13.81 minutes), transport time (12.53 minutes), the total run time (transport time, response time, and on-scene time) (35.15 minutes), and the round trip time (52.50) had been recorded. According to the Chi-square test, there was a significant relationship between the total run time (transport time, response time, and on-scene time), transport time, round trip time, and the location of the emergency base.

Conclusion: EMS time indices were at the desired level. Updating information systems, ambulances, medical equipment, and holding training courses for personnel working in this system can effectively improve time indicators.

1. Introduction

T he Emergency Medical Service (EMS) is an essential part of the health care delivery system and plays a vital role in providing prehospital services and transferring patients to medical centers. It provides appropriate treatment at the right place and time, using available resources. Prehospital care starts from the patient's bedside and ends in the hospital emergency room [1, 2]. In health care systems, the first treatment of critically-ill and emergency patients is usually performed by the pre-

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Table 1. Definition of time indices of prehospital emergency services

Indices	Definitions
Delay time	The time interval between receiving an emergency call and sending an ambulance
Response time	The time interval between receiving an emergency call and the arrival of the ambulance at the scene
On-scene time	The time interval between the arrival of the ambulance at the scene and leaving the scene
Transport time	The time interval between leaving the scene and the arrival of the ambulance to the emergency department
Total run time	The total of 3 time periods of response, presence at the scene, and transfer to the hospital
Round trip time	The time interval between dispatching an ambulance from the base and its return to the base

hospital emergency system [3]. Mainly the patients with internal medicine diseases or trauma at the scene of the accident call the EMS and use its services [4]. Proper functioning of the EMS with rapid and timely dispatch of ambulances and rescue forces can prevent the death of patients and their disability [5, 6]. The importance of prehospital emergencies in Iran becomes more critical because Iran is one of the countries with a high mortality rate, and also, the rate of road accidents is 20 times higher than the global average [7]. In Iran, the prehospital mortality rate has been reported up to 40%, which can be reduced by proper management and timely arrival of prehospital emergency on patients' beds [8]. The success of this system depends on various factors, such as the staff skills, modern medical equipment, coordination, proper communication between members, and the development of a specific program to review and improve prehospital emergency time indices [7, 9, 10].

Developing a system for evaluating and monitoring the EMS performance in recent years based on prehospital emergency indices significantly impacts its performance [11]. Prehospital indices are critical and vital factors in providing prehospital emergency services, of which time indices are more important [12]. Monitoring time indices can be a practical step to identify the strengths and weaknesses of the system and a proper way to improve the provision of clinical services to the injured cases [13, 14]. Considering the importance of time indices in prehospital emergencies and providing proper health services can significantly reduce mortality [15, 16]. Time is an essential factor in managing patients who have contacted the prehospital emergency, and despite the impact of other factors in the management of emergency patients, time is of great importance [17]. Time indices in EMS include delay times, response time, on-scene time, transfer time, and round trip time [1, 18]. Considering these indices and their periodic monitoring can be a good

solution to the challenges facing the prehospital emergency system [19].

Despite the importance of EMS, few studies have been conducted in this area. Also, due to differences in resources and facilities of EMS in different countries, different results have been obtained regarding prehospital indices. Because the number of prehospital emergency bases in Ardabil City, Iran, has increased in recent years, and no similar study has been conducted to examine time indices in Ardabil, the present study can provide significant results for health policymakers in EMS. Regarding the importance of EMS performance and their regular monitoring, especially effective factors in providing services to patients, this study aimed to determine the indices of EMS in the first six months of 2020 in Ardabil.

2. Materials and Methods

This retrospective cross-sectional study was conducted after obtaining permission from the Ethics Committee and the Vice-Chancellor for Research of Ardabil University of Medical Sciences. The study population included all missions of the EMS of Ardabil, by which the patients were transferred to medical centers in the first six months of 2020. Considering the total number of missions (12000) during the first six months of 2020, the sample size was calculated to be 372 using Cochran's formula at a 95% confidence level with an error level of 5% (Formula 1):

$$1.\quad n = \frac{\frac{Z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{Z^2 pq}{d^2} - 1\right)}$$

The samples were selected by the multistage cluster sampling method. First, 5 bases were selected from 12 bases of Ardabil City, and then, the ratio of missions of each base was determined, and using the random num-

Table 2. Demographic characteristics of the patients

Variables	Subgroups	No. (%)
Gender	Male	158 (48.3)
	Female	169 (51.7)
Age, y	<20	50 (15.3)
	20-40	85 (26.0)
	40-60	86 (26.3)
	60≤	106 (32.4)
Reason for calling	Physical problems	137 (41.9)
	Traffic accidents	101 (30.9)
	Falling from a height	30 (9.2)
	Conflict and fighting	46 (14.1)
	Explosion and gas poisoning	13 (4.0)
Initial diagnosis	Disturbance of consciousness	28 (8.6)
	Cardiovascular	32 (9.8)
	Poisoning	17 (5.2)
	Respiratory	19 (5.8)
	Stroke	13 (4.0)
	Convulsions	16 (4.9)
	Trauma	161 (49.2)
	Giving birth	10 (3.1)
	Mental	3 (0.9)
	Internal medicine	28 (8.6)
Base location	North	114 (34.9)
	East	52 (15.9)
	West	50 (15.3)
	South	32 (9.8)
	Center	79 (24.2)
Time of mission	Morning	103 (31.5)
	Evening	90 (27.5)
	Night	134 (41.0)

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Table 3. Prehospital emergency time indices of Ardabil according to the studied periods

Time Indices		No. (%)
Delay time (min)	<1	322 (98.5)
	>1	5 (1.5)
	Mean±SD	1.01±0.12
Response tine (min)	8≥	268 (82)
	9-16	40 (12.2)
	>16	19 (5.8)
	Mean±SD	7.00±3.47
On-Scene time (min)	10≥	131 (40.1)
	11-20	138 (42.2)
	>20	58 (17.7)
	Mean±SD	13.81±6.51
Transport time (min)	10≥	132 (40.4)
	11-20	176 (53.8)
	>20	19 (5.8)
	Mean±SD	12.53±4.70
Total run time (min)	25≥	39 (11.9)
	26-35	144 (44)
	36-45	30 (30)
	>45	46 (14.1)
	Mean±SD	35.15±8.58
Round trip time (min)	40≥	62 (19)
	41-50	111 (33.9)
	51-60	86 (26.3)
	>60	68 (20.8)
	Mean±SD	52.50±13.02

ber table, the sample size was estimated. The instrument used was a prehospital emergency checklist consisting of two parts. The first part included the details of the mission, such as personal details, the main complaint of the patient, and location. The second part checked 8 time indices of receiving the request, departure from the base, arrival at the scene, leaving the scene, arrival at the hospital, delivery to the hospital, termination of the mission, and arrival at the base. Other information, such as the type of mission, the patient's vital signs, medication interventions, and the used equipment for the patient, was also recorded in this checklist. After selecting the desired missions, the items considered in the research objectives were extracted, which included gender, age, the reason for contact, patient's main complaint, location of the mission, and time of the mission, as well as emergency

Table 4. Relationship between time indices and the emergency base location

Time Indices		Base Location, No. (%)					P
		North	East	West	South	Center	
Delay time (min)	<1	113 (99.1)	52 (100)	49 (98)	31 (96.9)	77 (97.5)	0.68
	>1	1 (0.9)	0	1 (2.0)	1 (3.1)	2 (2.5)	
Response time (min)	≤8	93 (81.6)	41 (78.8)	43 (86.0)	24 (75.0)	67 (84.8)	0.61
	9-16	15 (13.2)	6 (11.5)	5 (10.0)	4 (12.5)	10 (12.7)	
	>16	6 (5.3)	5 (9.6)	2 (4.0)	4 (12.5)	2 (2.5)	
On-Scene time (min)	≤10	44 (38.6)	24 (46.2)	21 (42.0)	11 (34.4)	31 (39.2)	0.66
	11-20	54 (47.4)	16 (30.8)	19 (38.0)	16 (50.0)	33 (41.8)	
	>20	16 (14.0)	12 (23.1)	10 (20.0)	5 (15.6)	15 (19.0)	
Transport time (min)	≤10	16 (14.0)	16 (30.8)	11 (22.0)	15 (46.9)	74 (93.7)	<0.001
	11-20	89 (78.1)	33 (63.5)	33 (66.0)	16 (50.0)	5 (6.3)	
	>20	9 (7.9)	3 (5.8)	6 (12.0)	1 (3.1)	0 (0)	
Total run time (min)	≤25	7 (6.1)	6 (11.5)	7 (14.0)	1 (3.1)	18 (22.8)	<0.001
	26-35	44 (38.6)	23 (44.2)	20 (40.0)	16 (50.0)	41 (51.9)	
	36-45	42 (36.8)	13 (25.0)	14 (28.0)	11 (34.4)	18 (22.8)	
	>45	21 (18.4)	10 (19.2)	9 (18.0)	4 (12.5)	2 (2.5)	
Round trip time (min)	≤40	6 (5.3)	10 (19.2)	10 (20.0)	3 (9.4)	33 (71.8)	<0.001
	41-50	39 (34.2)	20 (38.5)	17 (34.0)	11 (34.4)	24 (30.4)	
	51-60	38 (33.3)	11 (21.2)	13 (26.0)	11 (34.4)	13 (16.5)	
	>60	31 (27.2)	11 (21.2)	10 (20.0)	7 (21.9)	9 (11.4)	

time indices, like delay time, response time, on-scene time, transport time, and round trip time. Time indices were recorded based on GPS by emergency medical technicians. The definitions of different time indices for providing prehospital emergency services based on the study by Altintas and Bilir [20] are presented in Table 1.

3. Results

Out of 372 patients transferred to medical centers by Ardabil prehospital emergency, 169 (51.7%) were women and 106 were over 60 years old. The most common reason for calling the prehospital emergency center was related to physical problems (137, 41.9%), and also the main complaint was trauma (161, 49.2%). Most missions (114, 34.9%) were recorded in the northern part of the city, and 134 missions (41%) were recorded at night shifts (Table 2).

The results of EMS time indices showed that the delay time in 322 missions (98.5%) was less than one minute. Response time in 190 missions (58.1%) was less than 8 minutes. On-scene time in 138 missions (42.2%) was 11-20 minutes, transfer time in 176 missions (53.8%) was between 11 and 20 minutes, and the round trip time in 111 missions (33.9%) was 41-50 minutes (Table 3).

According to the Chi-square test, there was a significant relationship between total run time (response time, on-scene time, and transfer time), transfer time to the hospital, the round trip time, and the base location (P<0.05) (Table 4).

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4. Discussion

The study results showed that the time indices of EMS in the studied missions are acceptable. We aimed to determine the indices of EMS in the first six months of 2020 in Ardabil Medical Emergency and Accident Center.

In the present study, nearly one-third of all emergency calls were made for the elderly aged 60 and older. Zeraat-chi et al. reported that most emergency calls were related to 15-30 years old cases [1]. Alipour et al. reported that the maximum age of people who called EMS was under 40 years [5]. Ranjbar et al. reported that the average age of those who called EMS was 30 years [6]. Yadollahi et al. reported that the most users of EMS were people over 60 years old [4]. The high number of calls by the elderly in the present study can indicate their need to use the health services of the EMS and the high rate of chronic diseases in this age group. However, differences in various reports can be due to age groups in studies, economic status of indi-viduals, level of education and their awareness of the use of pre-hospital emergency services and the level of awareness and knowledge of people to use EMS.

In terms of the frequency of diseases, trauma accounted for nearly half of EMS missions. According to Zeraatchi et al., trauma was the most common reason for calling the emergency medical centers [1]. Alipour et al. reported that the most common reason for calling the air rescue emergency was traffic accidents and trauma [5]. Haj Nabi et al. reported that the most common reasons for calling the emergency medical centers were internal medicine cases, followed by trauma [18]. Seyed Nozadi et al. de-clared that the most common reason for calling the EMS was related to traffic accidents [9]. Regarding the loca-tion of the base, most of the phone calls were made from the north part of the city. The lifestyle of the residents of the northern part of the city, their socioeconomic situa-tion, their familiarity with prehospital emergency servic-es, and their level of awareness can affect these results. Meanwhile, according to the results, more than one-third of the emergency missions in Ardabil had been recorded at night (between 8 PM and 8 AM).

In terms of time indices, the delay time in most missions was less than one minute, which is a good time to provide prehospital emergency services. In most studies, this time was less than one minute, which was consistent with the present study results [1, 10]. Improving the quality of pre-hospital emergency services, highlighting the importance of prehospital emergency time indices during the last few years, compiling evaluation checklists of emergency bases, regular visiting of all bases, the proper functioning of the

quality improvement department, and providing periodic feedback from the evaluation results to the base technicians to improve the identified weaknesses during periodic visits can be reasons for the obtained results in Ardabil.

In the present study, in more than two-thirds of the mis-sions, the response time was less than 8 minutes, and the Mean±SD response time was 7.00 (3.47) minutes, which is a good response time. Yadollahi et al. reported that in 76.66% of prehospital emergency missions, the response time was less than 8 minutes [4]. Zeraatchi et al. declared that in more than two-thirds of the missions, the response time was less than 8 minutes [1]. In another study, the response time for half of the missions was less than 10 minutes [20]. One of the most influential factors in EMS is the response time, which should not exceed 10 minutes in urban areas [20]. In Iran, the average response time is 8 minutes [10]. In most parts of North America, the standard response time is 9 minutes [13]. The distance from the base to each accepted mission, the familiarity of technicians with the location of the scene, time of the mission, type of mission, and more importantly, the qualification of the technicians in each base are influential factors when arriving at the patient's bedside.

In the present study, the Mean±SD on-scene time was 13.81 (6.51) minutes. Altintas reported an average on-scene time of 9.36 minutes [20]. Zeraatchi et al. reported that in more than half of the missions, the mean on-scene time was less than 10 minutes [1]. Also, Dadashzadeh et al. declared the average on-scene time of 8.11 minutes [16]. Yadollahi et al. reported that in more than two-thirds of the missions, the on-scene time was less than 10 minutes [4]. Differences in the results of studies can be due to factors, such as the num-ber of injured people, the severity of injuries, and the need for primary care by patients, the type of accident, patients' inability to pay for hospital services, lack of companion support to stay in the hospital, or distrust of medical cen-ters leading to home care and treatment. Also, the qualifica-tion and technical, communication, and scene management skill of the emergency technicians and their ability to make quick decisions affect the on-scene time.

The average transfer time to the hospital in the present study for more than half of the missions was 11-20 minutes, and the average transfer time was 12.53 minutes. Altintas et al. reported an average transfer time of 13.28 minutes [20]. Panahi et al. also reported an average transfer time of 19.2 minutes [4]. In the other two studies, the transfer time was less than 18 minutes in more than half of the missions [1, 10]. In the present study, in one-third of the missions, round trip time was 50-41 minutes. Yadollahi reported a total run time of 50 minutes [10]. Altintas declared a round trip time of 32.31 minutes [20]. Zaraatchi et al. reported a round trip

time of 94 minutes [1]. Differences in the obtained results can be due to the base location, the type of mission, the distance from the base to the hospital, the time of the mission, and the emergency technician skills in deriving.

The present study results showed that the response time in more than two-thirds of prehospital emergency missions in Ardabil was less than 8 minutes, which showed that this index was at a desirable level. Regarding the transfer time, the results showed a statistically significant relationship between transfer time and base location. The results showed that bases that are close to the hospitals spend less time transferring the patient to the hospital. Accordingly, for bases that are located in the city center and are near hospitals, the transfer time is less than ten minutes in more than two-thirds of the missions. This factor is crucial because if patients arrive at the hospital on time, they will receive treatment more quickly, preventing adverse health consequences. These results indicate the importance of the appropriate location for the construction of hospitals. The location of hospitals in specific areas of the city can significantly impact the transfer of patients to hospitals.

Time indices are very important in evaluating health services in the EMS. In general, time is one of the most critical issues affecting EMS. In studies on assessing time in providing services to patients and the injured people, this factor has been the most vital index in patients' chances of survival. Therefore, prehospital emergency indices and considering their importance by the personnel working in this system are the most effective components in prehospital emergencies. Accurate recording of time indices and planning to improve these indices are requirements of the prehospital emergency [7, 10, 16]. Improving the quality of prehospital emergency services and the quality of time indices can significantly increase the survival of the injured people and reduce mortality and morbidity. Improving hospital indices can reduce hospital stay as well as the recovery process. This study had some limitations. First, the findings cannot be generalized because EMS technicians might not record the time indices accurately or forgot them and recorded them at another time. The second limitation of the study was the lack of analysis of time indices considering days of the week, level of education, and experience of emergency medical technicians. Therefore, it is recommended that the following studies be performed in other cities of Iran by considering the limitations of the present study to comprehensively and completely examine time indices by the EMS. It is suggested that in addition to conducting similar studies in Iran, some studies be conducted on the factors affecting the time indices as well as the effect of the performance of emergency medical personnel on EMS time indices.

5. Conclusion

The prehospital emergency is the first line of health care, and time indices significantly impact the quality of service. Considering many missions of the EMS staff, especially from trauma patients in the present study, it is expected that prehospital emergency officials take steps to improve time indices. They accomplish this task by updating information systems, ambulances, and medical equipment to reach patients' bedsides faster and holding relevant training courses for personnel to improve the quality of services for patients. To improve the prehospital emergency services, the Ministry of Health and Medical Education should establish a standard to control the quality of services of prehospital emergency technicians and the prehospital emergency time indices.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Student Research Committee, School of Nursing and Midwifery, Ardabil University of Medical Sciences (Code: IR.ARUMS.REC.1398.471). In addition, the Student Research Committee of Ardabil University of Medical Sciences supported this study.

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