J Nurs Midwifery Sci. 2023 June; 10(2):e133201. https://doi.org/10.5812/jnms-133201.

Published online 2023 May 30. **Research Article**

Pre-hospital Emergency Response Time Index for Trauma Victims in Iran

Abdul Jalil Karagholi [1], Vida Shafipour [2], Jamshid Yazdani-Charati [2], Mohammad Javad Moghasemi [3], Seyede Almas Fahim Yegane [4] and Mohammad Ali Heidarigorji [2,*]

[1] Student Research Committee, Department of Nursing, Nasibeh School of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran
[2] Department of Nursing, Mazandaran University of Medical Science, Sari, Iran
[3] Medical Emergency Management Center, Golestan University of Medical Sciences, Gorgan, Iran
[4] Golestan University of Medical Sciences, Gorgan, Iran

[*] *Corresponding author*: Nasibeh School of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran. Email: heydarigorji@yahoo.com

Received 2022 November 14; **Revised** 2023 April 03; **Accepted** 2023 April 08.

Abstract

Background: The most important basis of medical care consists of emergency care, especially that of pre-hospital type, and it plays a significant role in reducing deaths rate and trauma-induced disabilities.
Objectives: This research addressed the response time index of providing pre-hospital emergency call services to trauma victims in Golestan province in 2020.
Methods: This retrospective descriptive-analytical study was conducted on all the missions performed for trauma victims in Golestan pre-hospital emergency in 2020. The sampling was done as the census. The data were collected by referring to the existing systems in the pre-hospital emergency centers using a checklist based on the mission forms of the countrywide pre-hospital emergency. The data were analyzed using descriptive statistics (frequency, mean, and standard deviation) and inferential statistics using parametric tests (such as t-test and Tukey's test to compare the two groups).
Results: Out of 9867 trauma victims transferred by Golestan pre-hospital emergency call service, 67.02% were men, 14.56% were women, and 18.43% were not registered by gender. The maximum mean age was related to the middle-aged group (38.86%) caused by traffic incidents. According to the international standard, the mean delay time was 01:11 m, the EMS response time for the central urban districts and the suburbs was 10:10 m and 12:00 m, the time of transfer to the central urban district and the suburb hospitals was 08:28 m and 17:28 m, the delivery time to the hospital was 7:14 m, the total mission time of the central urban district and the suburb bases was 1:01:25 h 1:30:20 h, and the mean response time for the trauma victims was 65.89%.
Conclusions: The time indices of pre-hospital emergency missions in Golestan province are within the normal range of the standard time, and considering the effective role of pre-hospital emergency in reducing the mortality and disability of trauma victims, more attention should be paid to the structural and functional indices and management, especially the response and scene time.

Keywords: Trauma, Emergency, Response Time, Index

1. Background

Today, trauma is one of the significant topics drawing serious attention in many developed countries. It is viewed as the fourth death-incurring cause worldwide and the first cause of death in the first four decades of life, which results in an increased burden of disease and economic and psychological damage to society (1, 2). According to the available statistics during the last seven years, around 20 - 28000 people in Iran annually die due to driving-induced accidents, and 250 - 350000 people get injured (3). Pre-hospital emergency medical service (EMS) plays a major role in reducing the mortality and disability of the injured, and through this role, time indices and trained manpower are particularly vital (4).

As the studies done in Iran reported, about 60% of deaths occurred at the incident scene or on the way to the hospital, which is part of the golden hour (5, 6). For each of the time indices, particularly the major indices, such as the response time, some limits and standards have been developed by which pre-hospital EMS can be assessed (7). Therefore, improving the time indices is one of the priorities of pre-hospital EMS (8). Several studies have been conducted to analyze the pre-hospital time intervals' effect on patient outcomes (7, 9, 10). However, there are clashes of ideas over the exact effect of the elapsed time on the patients' outcomes before reaching the hospital. The reason behind such dissensions can be attributed to the structural difference in the emergency system. In Iran, the emphasis is on the rapid transfer of the patient to the medical cen-

ter. At the same time, many countries are doctor-oriented and insist on using advanced technology and treatment at the scene, which can be the reason for the scene time interval (6). In different countries, the quick handling of pre-hospital emergencies is considered. Because it is a critical issue, it is necessary to conduct various studies to understand the relevant reasons and how to shorten the response time (11).

Time indices in pre-hospital emergencies include delay time, response time, scene time, transfer time to the hospital and delivery time to the hospital, and the total mission time, due to the differences in the resources and facilities of the pre-hospital emergency in various countries, different results have been achieved. Case studies on ambulance response times for emergency missions have been conducted for decades, particularly in developed countries, using different techniques and with distinct objectives (12). Following the countrywide pre-hospital emergency care system (ECS) regulations of 2007, the response time to patients in cities was set at less than 8 m in 80% of cases and less than 15 m in 80% of cases for pre-hospital emergency performance (9).

2. Objectives

With respect to the importance of the pre-hospital ECS role and performance in the health of society and the requirement for regular monitoring of performance, mainly the influencing indices in the process of providing services to the patients, the present study investigated the response time index of provider-hospitality EMS to the trauma victims in 2020.

3. Methods

This is a retrospective cross-sectional study based on descriptive registration data. The statistical population was all the pre-hospital emergency missions of Golestan province, with 23 urban emergency bases and 35 road emergency bases for the trauma victims who were transferred to the medical centers in 2020. Due to the existence of the emergency automation system and electronic data for the relevant data, especially the time indices surveyed in this research, the accident-prone area was selected as the research setting, and the trauma rate was considered based on the annual statistics of this center. The sampling was done by the census. Then, by the separation of different cities in Golestan province, the pre-hospital emergency time indices and the relevant factors' effect, such as the roads' traffic status at the time of an accident, and the seasons of the year, were measured and analyzed for the trauma victims during the study.

The inclusion criterion was the trauma victims transferred to affiliated medical centers by the emergency medical centers in Golestan province in 2020. The exclusion criteria were false or wrong mission, the absence of the patient at the emergency scene, cancellation by the control center, and incorrect registration of time indices.

The data were collected via the checklist of missions for the countrywide pre-hospital ECS, the first part of which is the demographic characteristics of patients, such as name, age, gender, address, and the patient's main complaint. The second part involves the mission time, which includes the call for the mission, leaving the base, arriving at the scene, leaving the scene, arriving at the hospital, delivering to the hospital, terminating the mission, and arriving at the base. The second part of the mission time includes receiving the mission, leaving the base, arriving at the scene, leaving the scene, arriving at the hospital, delivering to the hospital, terminating the mission, and arriving at the base. In the following sections, there is a list of information related to the type of mission, and finally, the mission of trauma victims and their related factors. The trauma victims' outcome in the pre-hospital emergency system includes (1) on-scene treatment, (2) transfer to the medical centers, (3) death before the ambulance arrives at the scene, (4) death during transfer to the hospital, and (5) refusal to transfer to the center.

Then, the data were analyzed using SPSS 26, descriptive statistics (frequency, frequency percentage, mean and standard deviation), and inferential statistics using parametric tests (such as Tuckey's test and *t*-test comparing two separate groups). A P = 0.05 was considered significant for this study.

4. Results

After analyzing the 9867 trauma missions performed by the pre-hospital ECS of Golestan province eligible for the study in 2020, it was discovered that 67.02% were related to men, 14.56% were women, and 18.41 were not registered by gender. The age group under one-month-old showed the lowest frequency, and middle-aged cases showed the highest frequency (Table 1). Finally, 96.88% of the trauma victims were transferred to the medical centers during the pre-hospital emergency of Golestan.

The mean response time of the pre-hospital ECS of the road base was 0:12:19 m, and that of the city base was 8:01 m (Table 2).

Compared with the international standard, the time response of ECS was in the range of 64.95 - 66.82% (Table 3)

The standard delay time is 60 to 90 s during the day and 90 to 150 s at night, and the response time of the road

Table 1. The Age Frequency of Trauma Victims of Golestan Province

Age	No. (%)
Infant-under one month old	3 (0.03)
Baby-from one month to below 5 years	252 (2.55)
Teenager-from 5 to below 18 years	1764 (17.88)
Young-from 18 to younger than 30 years	3390 (34.36)
Middle aged-from 30 to younger than 60 years	3834 (38.86)
The elderly-60 years and over	583 (5.91)
Non-registered age	41 (0.42)

Table 2. Comparison of Time Indices of Pre-hospital Emergency Care System (ECS) in Golestan Province for Trauma Victims in Urban and Road Bases in 2019

Time Index and Type of ECS	Number of Missions	Mean ± SD	SE	Mean Rank	P-Value (Parametric *t*-Test)
Emergency					
Road	5354	0:01:15 ± 0:01:38	0:00:01	5148.07	< 0.001
Delaytime					
Urban	4513	0:01:07 ± 0:01:09	0:00:01	4680.04	
Response time					< 0.001
Road	5354	0:12:19 ± 0:08:37	0:00:07	5833.11	
Urban	4513	0:08:01 ± 0:04:08	0:00:03	3867.34	
Scene time					< 0.001
Road	5354	0:12:00 ± 0:08:12	0:00:06	5307.56	
Urban	4513	0:10:10 ± 0:07:09	0:00:06	4490.82	
Transfer time to hospital					< 0.001
Road	5354	0:17:37 ± 0:15:53	0:00:13	5971.32	
Urban	4513	0:08:28 ± 0:17:59	0:00:07	3703.38	
Delivery time to emergency					< 0.168
Road	5354	0:07:19 ± 0:07:12	0:00:05	4959.50	
Urban	4513	0:07:07 ± 0:07:35	0:00:06	4903.74	
Total mission time					< 0.001
Road	5354	1:30:20 ± 1:10:21	0:00:57	5922.21	
Urban	4513	1:01:25 ± 1:05:03	0:00:58	3761.63	
Golden time					< 0.001
Road	5354	0:49:17 ± 0:24:58	0:00:20	5959.25	
Urban	4513	0:33:47 ± 0:14:12	0:00:12	3717.69	

base is less than 14 m. The urban base is less than 8 m, the scene time is less than 10 m, sometimes more than 20 m (at times when the victim is stuck inside the vehicle as the result of an accident or debris fall, and it is more consideration for the injured people with mass-casualty incidents) and in suspected stroke patients, the scene time or emergency wait time is less than 5 m.

The delivery time to the emergency was less than 15 m; the golden time is the first 60 m after the victim's injury and until the delivery to the medical center.

So that the mean emergency response time according to the cities for the trauma victims was the shortest in the suburban base of Gomishan City at 0:8:12 m, and the longest response time was related to Maraveh Tappeh City at 0:17:40 m. The urban base of Aqqala city with 0:06:01 showed the shortest, and Gorgan city with 00:09:25 m showed the longest response time (Table 4).

Comparing the response time of pre-hospital ECS with

Table 3. Comparison of Time Indices of Pre-hospital Emergency Care System (ECS) Missions in Golestan Province Compared with the International Standard for Trauma Victims

Time Indices	In Accordance with International Standard	Not in Accordance with International Standard	The Percentage of Compliance with Standard	Confidence Interval of 95% for the Percentage of Compliance with the Standard
Standard emergency delay time	8540	1327	86.55	85.88 - 87.22
Standard response time	6501	3366	65.89	64.57 - 66.82
Standard scene time	5284	4583	53.55	52.57 - 54.54
Standard emergency delivery time	5284	4583	53.55	52.57 - 54.54
Standard golden time -from the injured person's phone call to delivery to the medical center	8426	1441	85.40	84.07 - 86.09

Table 4. Frequency of Pre-hospital Emergency Response Time of Golestan Province for Trauma Victims According to Cities

City	Suburban Base			Urban Base		
	Number of Missions	Mean	SE	Number of Missions	Mean	SE
Azadshahr	391	0:12:46	0:00:26	269	0:07:07	0:00:13
Aqqala	282	0:11:20	0:00:23	138	0:06:01	0:00:12
Bandar-e-Torkman	33	0:12:06	0:00:50	45	0:07:39	0:00:30
Bandar-e-Gaz	182	0:08:32	0:00:17	56	0:05:47	0:00:17
Ramiyan	506	0:09:45	0:00:17	67	0:06:27	0:00:30
Aliabad	656	0:10:01	0:00:14	512	0:07:31	0:00:10
Kordkuy	208	0:11:33	0:00:20	191112	0:07:35	0:0:18
Kalaleh	362	0:15:46	0:00:26	177	0:06:23	0:00:12
Galikesh	290	0:11:25	0:00:24	134	0:06:14	0:00:22
Gorgan	646	0:13:12	0:00:16	1640	0:09:25	0:00:06
Gomeishan	99	0:08:12	0:00:41	84	0:06:04	0:00:25
Gonbad	1176	0:12:54	0:00:14	1008	0:07:39	0:00:06
Maraveh-Tappeh	327	0:17:40	0:01:02	68	0:07:10	0:00:47
Minudasht	196	0:13:24	0:00:32	123	0:07:22	0:00:24
Total	5354	0:12:19	0:00:07	4513	0:08:01	0:00:03

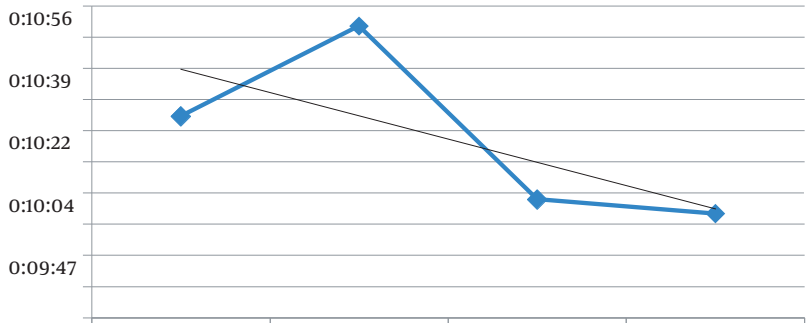
the seasons of the year, the shortest was gained for the winter and the longest for the summer (Figure 1).

Regarding the work shift of the pre-hospital ECS personnel, the morning shift showed a longer response time compared to that of the afternoon and evening shifts (Figure 2).

The results of the present study regarding trauma victims were as follows: Death before the arrival of emergency technicians: 0.1%, on-scene treatment and recommendation to the medical centers: 0.15%, delivery to another ambulance: 0.29%, transfer during resuscitation: 0.09%, non-cooperation and acquiring signature: 2.37%, and transfer by personal vehicle: 0.11%.

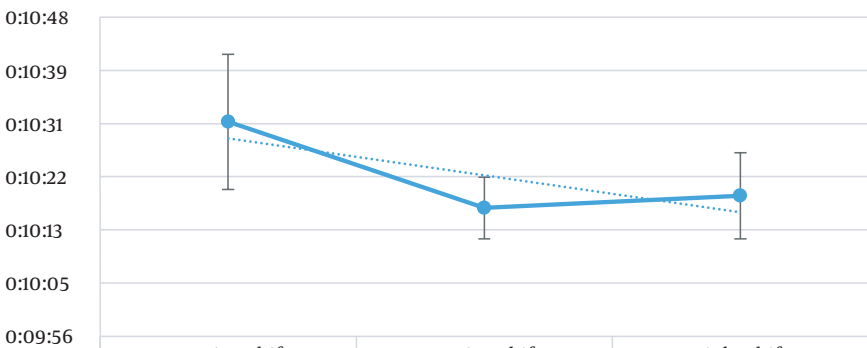
5. Discussion

The pre-hospital emergency response time refers to the time difference between receiving the emergency call from the victim and the on-scene time. According to the results, the average pre-hospital emergency response time in Golestan province in some cities has been higher than the provincial average in the suburbs, which is due to the population density of the areas covered by the emergency centers, the lack of roads and mountain emergencies, and the impassable axis of the roads. Therefore, the mean response time in all cities of Golestan province, except for Gorgan city, was shorter than the provincial mean in the urban area, which is probably due to the lack of road traf-



	Spring	Summer	Autumn	winter
The average emergency response time in Golestan province using Tukey's test to the seasonal factor in 2020	0:10:26	0:10:51	0:10:03	0:09:59

Figure 1. Comparison of the response time of the pre-hospital emergency response time in Golestan province for trauma victims according to the season



	Morning shift	Evening shift	Night shift
The average response time using Tukey's test to compare shift factor in Golestan Province in 2020	0:10:31	0:10:17	0:10:19

Figure 2. Comparison of pre-hospital emergency response time in Golestan province for trauma victims according to work shift of emergency personnel

fic, fewer incidents, or the medical centers accessible to the emergency call stations (Table 4). However, according to the standard response time, the suburban response time was 14 m, and that of the urban area was 12 m in the metropolitan cities and 8 m in the cities, and the time obtained in the present study was normal. In the same context, it was 5.53 m in Dezful (2015), which is less than the response time in the current study (13). In a study done in Guilan (2015), the mean response time for suburban missions was 7.5 ± 5 m, and that of the urban missions was 4.4 ± 4.5 m, which is less than that of the present study (14). In a study conducted in Zanjan (2017), the response time was 8 m (15). In research performed in Shahrekord (2018), this time was 7 m (9), which is less than that of the current study. In a study done in Shiraz (2013), in 49.9% of the missions, the response time was 8 - 10 m, which is longer than that of the standard one (16). A study carried out in Tehran (2019) reported this time as 7.87 m (17). A study in Kermanshah (2014) reported this time as more than 7 m (18). In a study done in Tabriz (2022), the mean ambulance response time was 11.58 ± 5.69 m, which is more than that of the current research (19). In a study performed in Isfahan (2017) indicated the response time was longer than that of the global standard (20). In a study in Tabriz (2016), the mean response time was more than 10 m (21). The difference in response time between the present study and the previous studies can be attributed to the specialized workforce trained in the pre-hospital emergency course, the number of missions in each point of the out-of-town missions, the technical preparation of the ambulance, traffic conditions, the time of the accident, and the education of the personnel.

Moreover, in the present study, the highest frequency ratio of the victims was 67.02% for men and 38.86% for middle-aged people (Table 1). This signifies that the trauma mostly occurs in men and young people, which increases handicapped and physically disabled individuals in society. Therefore, it is necessary to develop the required infrastructure to prevent trauma injuries.

Response time is a significant quantitative index for evaluating the performance of the pre-hospital EMS (15). Some studies in Iran also indicated that the response time is longer than the international standard (22). In some studies, the response time was reported consistent with the standard of this time interval (23, 24). In the present study, 69.89% of the response time was congruent with the international standard (Table 3). The differences between the existing times and the international standard can be justified by the factors such as traffic, construction density, population density, insufficient number of ambulances, and in some cases, no intervention can be performed. Spatial dispersion of emergency stations, the geographic extent of the area, dispersion of emergency stations, and the distance of emergency contact stations from the accident site, especially in road stations, can be considered reasons for an increase in response time. Meizoso et al. stated that to reduce the response time, there is a need to increase the number of available pre-hospital ECSs and strategies to cover the area (25). In a study performed in Brazil during 2007-2017 by reviewing the English articles on pre-hospital EMS, the response time was 6.1 m in the United States (Seattle), 7 m in South Korea (Seoul), 7.8 m in Sweden (Stockholm), 10 m in the United States (Chicago), and 9 m in Portugal (11). Lack of a sufficient number of ambulances, traffic, misdiagnosis, and poor management were the main reasons for the response time increase (26). The region's climatic conditions, traffic routes, the site of the incident, the race and ethnicity of the patients, as well as the clinical condition of the patients, are the most critical factors during emergency response time (13). This issue is noteworthy not only in Iran but also in other countries. As reported by a study done in Brazil (2018), in different countries, the pre-hospital EMS is arranged to arrive quickly on the scene, and due to the importance of this issue, various studies are required to indicate the reasons and how to shorten the response time (11).

A study performed in Singapore (2019) showed that of precipitation, traffic incidents are significantly more in winter than in other seasons (13). The fact that most of these incidents occur outside the city can explain the increase in the total mission time. A study conducted in Chinese Taipei (2015) also stated that traffic incidents and trauma patients get more in late fall and winter (27). This can affect the pre-hospital emergency performance and time indices. A study done in Ohio (2013) also revealed the highest number of trauma patients in winter while raining, particularly during the day after rain, which can affect the time indices considering the road conditions (28). In our study, the scene time in winter was more than that of other seasons. The scene time was 53.55% as prescribed by the international standard (Table 3), so that the emergency response time was longer in summer than in other seasons (Figure 1). A study conducted by Birjand (2019) declared that training has a significant effect on reducing the on-scene time (6). A study conducted in Tabriz (2022) reported that the time of the incident and heavy traffic in the afternoon highly affected the response time of the ambulance (19). While in the present research, the comparison of the incident time or personnel shift and the pre-hospital ESC response time in the morning shift showed that it is relatively higher than other shifts (Figure 2).

Ambulance response time is a fundamental variable in evaluating the quality of these services. Pursuant to the aforementioned studies, time is an important factor in de-

termining the outcome of the patients transferred to the hospital emergency through the pre-hospital EMS. Considering that the response time is one of the most critical factors affecting the quality of pre-hospital EMS, there is no doubt that the lower the operation time in the emergency, the better the response time (21).

The limitations of this study were incomplete information about the trauma victims, the lack of clarity about the outcomes of death and disability of trauma victims after being delivered to the hospital, and not accurate examining the remoteness of the scene from the emergency centers due to the differences in the roads of each region and comparing the response time of the ambulance according to the climatic conditions. Therefore, it is suggested to perform more studies at the countrywide pre-hospital emergency level.

5.1. Conclusions

In order to reduce the response time and the on-scene time of pre-hospital emergency missions for trauma victims, the Ministry of Health and Medical Affairs and the countrywide emergency organization should increase the EMS in the accident-prone areas by training the personnel and extra-organizational co-working forces and hiring more specialized forces in this field. As the results displayed, reducing the pre-hospital emergency time indices requires physical agility and taking action quickly, and also, there is a need for a scientific approach to provide trauma victims with medical care. Regarding the electronic forms for pre-hospital emergency missions, it is necessary to extract the data in order to analyze the related studies to solve the pre-hospital emergency problems as the frontline of the healthcare system in the country.

The time response of pre-hospital emergency is a significant factor in mitigating the injuries imposed on trauma-induced victims. As the present research findings demonstrated, the mean response time in some cities of Golestan province was longer compared to the mean provincial one in the suburban area, which can be attributed to the population density of the areas covered by the bases, the paucity of road and mountainous emergency bases, and the impassability of the road axes. Therefore, the treatment personnel working in this department can help the patients on time through punctual planning and team cooperation with other medical team members.

Pursuant to the current study, the time indices of pre-hospital emergency missions in Golestan province are within the normal range of standard time. Besides, a significant relationship was spotted between the seasons of the year, mission time, and response time. The mission time, whether in the morning or at night, the season of the mission, and the climatic conditions also affect the time of dispatching and performing the mission and considering the role of pre-hospital emergency in cutting down the mortality and disability of the trauma victims, there is a need to focus more on the structural, functional, and management indices, especially the response time and the on-scene time. Considering the results of the standard response time and the on-scene time, they were shorter than other time indices. Therefore, considering the role of time and the importance of appropriate clinical decision-making in the golden hour and its consequences on trauma patients and the available scientific evidence, it is necessary for the authorities to pay more attention to identifying appropriate strategies to reduce time indices of pre-hospital emergency.

Acknowledgments

Hereby, we would like to express our gratitude to the Honorable Deputy of Technology and Development of Mazandaran University of Medical Sciences for financially supporting the project and the dutiful fellows of the Medical Emergency and Management Center of Golestan Province for paving the ground for this research as the research project of the Emergency Nursing Master's Thesis with the ethics code IR.MAZUMS.REC.1399.906 at the Mazandaran University of Medical Sciences.

Footnotes

Authors' Contribution: M-AH and VS designed the study, provided important suggestions for the improvement of the study, and supervised it. A-Jk wrote the first draft proposal and manuscript, also collected the data, wrote and contributed to the translation procedure. JY-C analyzed the data. MM and S-AFY collaboration in data collection. M-AH, VS, and A-Jk cooperated in the process of accepting the manuscript. All authors read and approved the manuscript.

Clinical Trial Registration Code: There is no clinical trial code due to descriptive analytical study

Conflict of Interests: The authors have declared no conflicts of interest.

Data Reproducibility: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

Ethical Approval: This study was approved by the Mazandaran University of Medical Sciences IR.MAZUMS.REC.1399.906.

Funding/Support: This study was financially supported by grant number 8800.

Informed Consent: There is no informed consent in this study.

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