BMC Emergency Medicine

RESEARCH

Open Access

Helicopter emergency medical services in Eastern Iran: a 4-year cross-sectional study of time intervals and mission profiles

Mohammad Hossein Esmaeilzadeh[1,2], Akram Nami[2], Razyeh Bajoulvand[3] and Toktam Paykani[2*]

Abstract

Background Air medical transport services play a significant role in emergency situations by providing timely transfers of critically ill patients to medical facilities. This study aimed to investigate the mission characteristics of helicopter emergency medical services (HEMS) and the associated time intervals in a geographically remote region of eastern Iran. We also compared the prehospital times of HEMS and ground transportation to determine whether dispatching a helicopter is time-efficient.

Methods This retrospective cross-sectional study was conducted at the prehospital emergency medical center in Gonabad, a remote area in eastern Iran. Data were collected using standardized electronic forms developed by the Ministry of Health and Medical Education (MOHME) in Iran. We analyzed the mission profiles and prehospital time intervals for all Gonabad HEMS missions conducted between 2021 and 2024. The mean activation time was compared to the national benchmark of three minutes, and the prehospital time intervals of air ambulances were compared to those of ground ambulances.

Results From 2021 to 2024, there were 252 HEMS missions, transporting 265 patients. Of all 252 missions, 95 (37.7%) were primary missions, and 157 (62.3%) were secondary missions. The most frequent reasons for air ambulance dispatch were trauma, acute coronary syndrome, and strokes.

The mean ± SD for HEMS activation time was 9.14 ± 3.63 min, significantly exceeding the national benchmark of three minutes. HEMS prehospital time was 49.73 ± 9.67 min. The comparison of prehospital time intervals indicated that air emergency services are more time-efficient than ground ambulances.

Conclusion This study found that the mean activation time of air ambulances exceeded the national benchmark of three minutes. When comparing prehospital times for air ambulance and ground ambulance services, HEMS was faster than both ground scenarios. The current benchmark for helicopter activation time in Iran may need clarification and revision.

Keywords Helicopter emergency medical services, HEMS, Prehospital time, Activation time, Response time, On-scene time, Transfer time

*Correspondence:
Toktam Paykani
paykani.t@gmu.ac.ir
Full list of author information is available at the end of the article

Introduction

Helicopter Emergency Medical Services (HEMS), as a component of prehospital emergency system, provide rapid medical response to patients in remote, hard-to-reach, or time-critical situations. Evidence suggests that HEMS, through safe transportation combined with prompt emergency care, is associated with a statistically significant survival benefit for patients with severe injuries [1, 2]. HEMS can improve outcomes in acute ischemic stroke and reduce disability after an ischemic stroke, thereby reducing rehabilitation costs [3]. There is also evidence that HEMS can decrease mortality and improve functional outcomes for rural patients with moderate to severe traumatic brain injury [4]. However, air medical transport services are characterized by high resource intensity, which involves constraints related to financial, technical, and temporal resources, as well as workforce availability [5], and there is ongoing debate regarding the benefits of HEMS compared to ground emergency medical services (GEMS) [1, 4, 6].

In this context, the HEMS guidelines aim to optimize the utilization of air ambulances, ensuring that critically ill or injured patients receive timely and appropriate care [2, 7]. When deciding whether to use an air ambulance for patient transportation, the following general guidelines are recommended: (a) If the patient requires transport to a trauma center or specialized care facility that is far from their current location, especially in remote areas inaccessible by ground vehicles. (b) In situations involving high-priority patients with serious illnesses or injuries who are trapped, air transport is advisable, as it can significantly reduce transport time compared to ground ambulances. (c) If ground ambulance access is obstructed or unavailable. (d) Air transport should also be considered when the air transport crew possesses specialized medical skills, supplies, or equipment that are not available with ground ambulances [2].

Theoretically, the main advantages of HEMS include reduced transport time for critically ill and time-sensitive patients to specific hospitals, as well as the presence of a team of experienced medical professionals equipped with advanced tools at the patient's bedside [8]. Therefore, assessing the efficiency of helicopter emergency medical services requires an evaluation of various performance indicators, including prehospital time intervals [4, 6, 9, 10].

Overall, as shown in Fig. 1, the prehospital time intervals for HEMS can be divided into four components: (a) activation time (the duration from the emergency call to the air ambulance take-off) (b) response time (the flight time from the helipad to the patient) (c) on-scene time, and (d) transfer time [11–13].

In Iran, improving HEMS is a key component of the "Health Transformation Plan" which was launched in May 2014 to facilitate the attainment of universal health coverage [14]. The program, developed by the Ministry of Health and Medical Education, aims to enhance air ambulance services [14–17], and specifies a benchmark of three minutes for activation time [14].

Several studies conducted in Iran have reported data on the characteristics of HEMS missions and prehospital time intervals. However, activation time—the only time

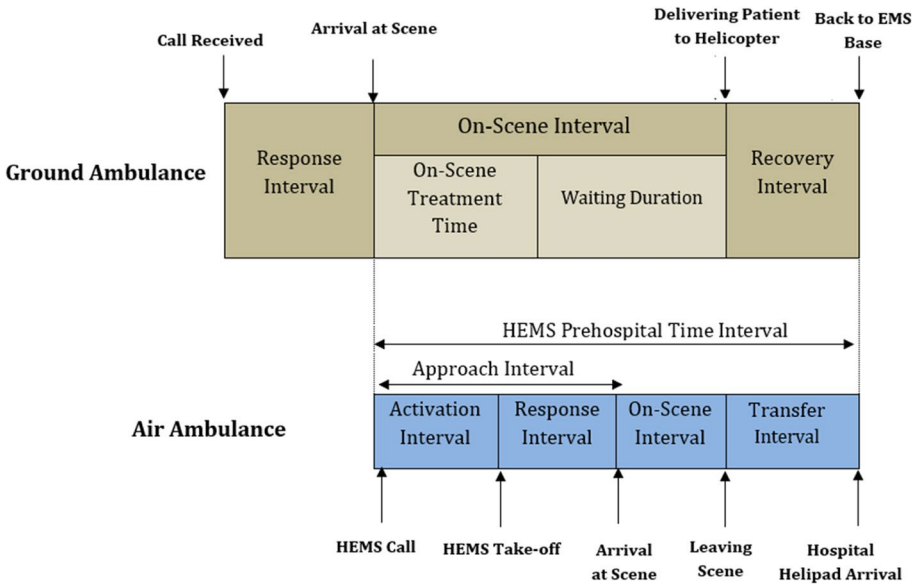

Fig. 1 Procedure for air medical transport services

interval with a national benchmark of three minutes—has not been reported separately [18–24]. Some studies have compared the prehospital times of air ambulances with those of ground ambulances, finding that HEMS are generally time-efficient [19, 21–23]. However, evidence suggests that ground ambulances may be faster than air transport in certain cities [21].

Against this background,

- Our study examines the characteristics of HEMS missions and prehospital time intervals in a geographically remote area of eastern Iran.
- We compare the mean activation time for air ambulances to the national benchmark of three minutes.
- Considering the study setting, we compare HEMS prehospital times with two ground transportation scenarios to determine whether dispatching a helicopter after receiving a call from the ground ambulance technician at the scene is time-efficient.

Methods

Study setting

Gonabad HEMS is located in the southern part of Khorasan Razavi province in eastern Iran. It serves over ten neighboring cities in both Khorasan Razavi and South Khorasan provinces, covering a population of approximately 1.5 million people. The helicopter base is located 150 m from the emergency department of Bohloul Hospital, the only hospital in Gonabad city.

Weather conditions in this region pose a significant challenge, especially during the summer months. Dust storms, known as "120-day winds" in eastern Iran, are prevalent and affect operations.

HEMS services in Iran are currently restricted to daylight hours, operating from half an hour after sunrise to half an hour before sunset.

The Medicopter used in Gonabad HEMS is a BK-117 series helicopter (BK117 C-1). Each air emergency mission is staffed by two emergency medical technicians. The types of HEMS missions in Gonabad include primary missions and secondary missions, the latter referring to inter-hospital transfers for patients requiring higher levels of care [25–27].

Procedures

In our study region, which is flat and not mountainous, helicopter emergency medical services typically operate as follows: First, ground ambulances, which are regionally distributed, are quickly dispatched to the patient's location. After assessing the scene and the patient's condition, the ambulance crew may request a helicopter to transport the patient to the hospital. The helicopter is then dispatched to the patient's location. In rare cases, the ground ambulance may transport injured individuals to the nearest suitable helipad for helicopter landing and takeoff. The HEMS model in our study employs a "scoop and run" approach, focusing on rapid response and swift transportation of patients to hospitals. Prehospital care is provided by two emergency medical technicians.

Data collection

A retrospective study was conducted on all Gonabad HEMS missions from January 1, 2021, to July 20, 2024. Data were collected using standard electronic forms designed by the Ministry of Health and Medical Education in Iran. The dispatch process in Iran's prehospital emergency medical services is managed and controlled through a web-based system that incorporates Global Positioning Systems (GPS) from the initial call to the completion of the mission [27]. This electronic tool offers several advantages, including national standardization, integration with GPS technology, and accurate measurement of all EMS time intervals involved in delivering prehospital emergency care in Iran.

Measurements

The time intervals for HEMS are shown in Fig. 1.

The time intervals for GEMS are measured as follows:

GEMS on-scene time: the duration from the initial physical contact with the patient until the patient is delivered to the helicopter. As shown in Fig. 1, GEMS on-scene time includes both treatment time and the waiting time for the helicopter's arrival; However, we do not have these time intervals recorded separately. Therefore, to estimate on-scene treatment time for ground ambulances, we use the mean on-scene time from GEMS missions conducted in non-urban regions during the study period. We also consider the platinum time principle for on-scene activities, which is 10 mins [2].

GEMS transport time: we obtained data on land transport times between the emergency scene and the destination hospital from the Google Maps website. In our study region, traffic is not a major issue. In addition, ambulances in Iran are allowed to exceed the speed limit by up to 20% [27]. Therefore, data on ground transportation times were collected for the time of the accident, considering low traffic conditions.

Data analysis

The data were analyzed in three parts. First, we described the characteristics of HEMS missions and the associated time intervals. Second, we conducted

a one-sample t-test to compare the HEMS activation time with the established benchmark time [14]. Third, we used a t-test to compare the mean prehospital time of HEMS with that of ground transportation (e.g., on-scene treatment time and transportation time). This comparison could help evaluate the time efficiency of dispatching an air ambulance after receiving a call from the GEMS technician at the emergency scene.

It should be noted that the ground ambulance response time is not included in this comparison. As mentioned in the procedure section, both air and ground services encompass this time interval. Therefore, we compare the HEMS prehospital time, as shown in Fig. 1, with the GEMS on-scene treatment and transportation times.

Table 1 Distribution of HEMS patients by traumatic and non-traumatic injuries ($n=265$)

Traumatic, *n* (%)		**Non-traumatic, *n* (%)**	
Road traffic injury	84 (31.7)	Acute coronary syndrome	67 (25.3)
Falls	9 (3.4)	Acute stroke	35 (13.2)
Colliding with an inanimate object	7 (2.6)	Pregnancy and childbirth	29 (10.9)
Gunshot	3 (1.1)	Decreased level of consciousness	11 (4.2)
Burn	2 (0.8)	Poisoning	5 (1.9)
Drowning	2 (0.8)	Respiratory failure	3 (1.1)
Stab wound	2 (0.8)	Insect bites	1 (0.4)
Electrocution	1 (0.4)	Others	2 (0.8)
Hanging	1 (0.4)		
Sports injuries	1 (0.4)		
Total	112 (42.3)		153 (57.7)

Results

From January 1, 2021, to July 20, 2024, the Gonabad Emergency Medical Center received a total of 192,643 calls, resulting in 44,981 dispatches. Among these, there were 252 HEMS missions that transported 265 patients.

Of the 252 HEMS missions, 95 (37.7%) were primary missions, while 157 (62.3%) were secondary missions.

Table 1 presents a detailed overview of dispatch indications and injury mechanisms. The most frequent reasons for air ambulance dispatch were trauma (42.3%), acute coronary syndrome (25.3%), and strokes (13.2%).

The median age of the patients was 46 years (IQR = 27–65), with ages ranging from under one year to 94 years. Among all the patients, 55.68% were male.

Figure 2 summarizes the distribution of patients based on the time of HEMS missions, which occurred between 5 AM and 7 PM.

During the study period, 67 missions (26.6%) were conducted in the spring, 74 missions (29.4%) in the summer, 52 missions (20.6%) in the fall, and 59 missions (23.4%) in the winter. However, the distribution of missions across the four seasons did not differ significantly at the 0.05 level.

A total of 29 primary missions (23.4%) were canceled. Figure 3 provides a breakdown of the reasons for these cancellations.

All cancellations in the"flight restrictions at night" category occurred before sunrise or at sunset. Excluding these requests, our cancellation rate drops to 20 (17.4%).

Table 2 presents the mean time intervals for HEMS and ground transport services.

Table 3 indicates that the mean activation interval for HEMS exceeded the benchmark of three minute [14].

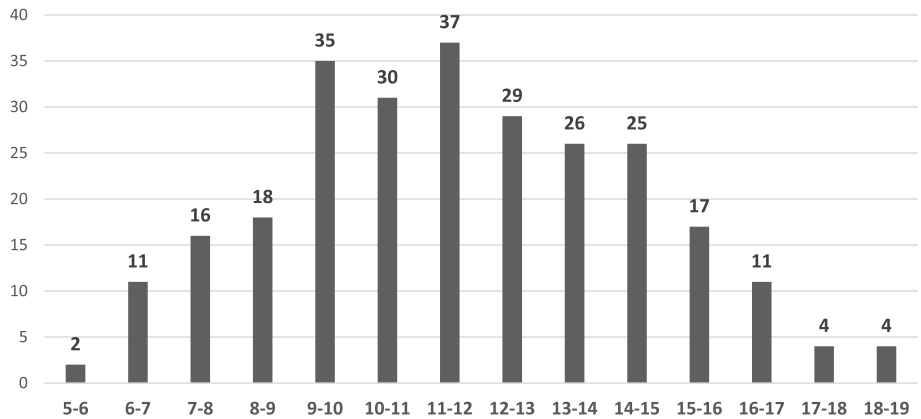

Fig. 2 Distribution of patients by time of HEMS missions ($n=265$)

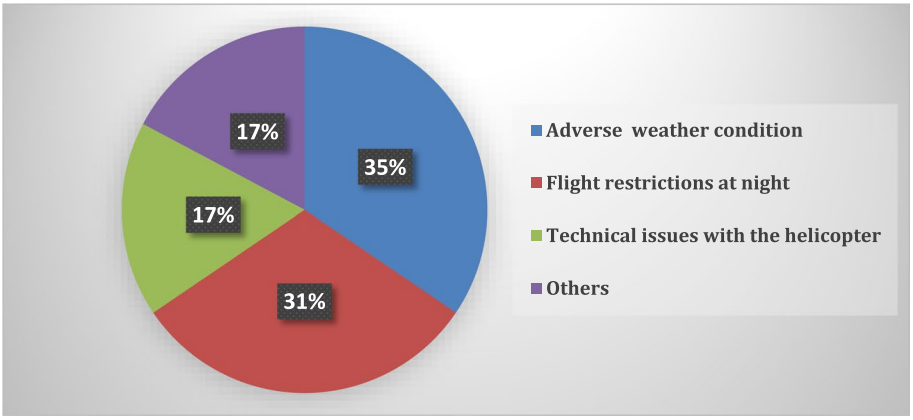

Fig. 3 Reasons for HEMS dispatch cancellation

Table 2 Time intervals for HEMS and GEMS ($n=95$)

		Mean (minute)	Std Dev (minute)
HEMS	Activation interval	9.14	3.63
	Response interval	17.38	4.17
	Approach interval	26.53	5.85
	On-Scene interval	5.76	3.74
	Transfer interval	17.45	4.15
	Prehospital time	49.73	9.67
GEMS	On-Scene interval	36.39	8.63
	On-Scene treatment time[a]	15.24	0
	On-Scene treatment time[b]	10	0
	Transfer interval	52.70	13.63
	GEMS mission time (On-Scene Treatment Time and Transfer Interval)	[a] 67.94 [b] 62.70	13.63 13.63

[a] The mean on-scene treatment time was calculated using real data from GEMS in non-urban missions during the study period

[b] The on-scene treatment time: platinum-10 min

Table 3 Comparison of helicopter activation time with national benchmark ($n=95$)

	Mean ± SD (minute)	Benchmark (minute)	*p*-value 95% CI
Activation interval	9.14 ± 3.63	3	$p=0.001$ [8.39, 9.89]

Our analysis further divided the activation interval into two phases:

(I) Preparation phase: from the emergency call until the helicopter crew is ready to take off and start the rotor;
(II) Takeoff phase: from rotor start to helicopter takeoff.

We found that the mean duration for the preparation phase was 5.51 ± 3.15 min, and the mean duration for the takeoff phase was 3.91 ± 1.42 min. Both of these durations exceed the benchmark of three minutes ($p<0.05$).

When comparing prehospital times for HEMS and ground transportation, we found a statistically significant difference in the mean prehospital times between HEMS and ground ambulance services. HEMS was faster, even when accounting for a 10-minute on-scene time as a benchmark for GEMS (Table 4).

We discuss these findings in detail in the next section.

Discussion

This study investigated the time intervals of helicopter emergency medical services (HEMS) and the characteristics of missions in Gonabad, a remote region in eastern Iran. We analyzed 252 HEMS missions involving 265 patients. Our findings revealed that the mean helicopter activation time exceeded the national benchmark of three minutes. Furthermore, a comparison between HEMS and ground transport scenarios demonstrated that HEMS is more time-efficient.

We found that the number of secondary missions (62.3%) was greater than the number of primary missions. This finding is consistent with a study in Tehran, which reported that 63% of missions were inter-hospital missions [28]. In contrast, a study in Sweden reported that 84.7% of missions were primary [29]. These variations may be attributed to several factors, including differences in EMS systems. Specifically, Iran's EMS model follows the Anglo-American approach, where prehospital care is typically provided by emergency medical technicians rather than physicians [30]. A previous study conducted in Iran showed that when a physician was added to the

Table 4 Comparison of prehospital times for HEMS and GEMS ($n=95$)

	Air ambulance	Ground ambulance	*p*-value 95% CI
Prehospital time interval (mean ± SD in minutes)	49.73 ± 9.67	67.94 ± 13.63[a]	$p=0.001$ [16.34, 20.06]
		62.70 ± 13.63[b]	$p=0.001$ [11.10, 14.82]

[a] The mean on-scene treatment time was calculated using real data from GEMS in non-urban missions during the study period

[b] The on-scene treatment time: platinum-10 min

decision-making team, the number of cases transferred by air ambulance increased by more than two times [21].

Air emergency missions showed variability between 6:00 AM and 19:00, with the highest number of missions occurring between 11:00 AM and 12:00 PM (Fig. 2). A study in Tehran found that the peak number of missions took place between 1:00 PM and 3:00 PM [28]. Another study in Tehran reported the highest number of missions occurring between 12:00 PM and 2:00 PM, as well as between 6:00 PM and 7:00 PM [20]. These differences may be attributed to factors such as geographical location, sunrise and sunset times, population density, and traffic conditions. It is important to note that in many countries, HEMS flight operations are conducted at night [30]; however, in Iran, night operations are restricted due to infrastructure limitations. This restriction poses challenges in providing timely assistance, especially during peak accident hours between 4:00 PM and 8:00 PM [31].

In this study, trauma, acute coronary syndrome, and acute stroke were identified as the main reasons for HEMS dispatches. Since these conditions are the leading causes of death in Iran [32], our findings, which are consistent with previous studies [19, 22, 24], underscore the importance of targeted interventions to enhance emergency medical services in the country.

Our study found that 23.4% of primary missions were canceled due to adverse weather conditions, night-time flight restrictions, technical issues with the helicopter, and other reasons (e.g., lack of a landing pad, patient death, and simultaneous requests). When excluding night-time requests from the cancellation count, the cancellation rate drops to 17.4%. A previous study in Tehran reported a lower cancellation rate of 12.6% for HEMS missions. Reasons for cancellation included the helicopter's inability to land at the event scene, adverse weather conditions, and patient death prior to the emergency team's arrival [20].

In the following, we will discuss the time intervals in more detail.

Activation time

The mean activation time for HEMS in our study was 9.14 ± 3.63 min, significantly exceeding the national standard of three minutes [14]. This duration, from the emergency call to helicopter takeoff, is also longer than the activation time reported in a previous study conducted in Tehran, which was 7.38 ± 2.50 min [28].

There appears to be ambiguity in the definition of the current benchmark for the activation interval, which requires clarification [14, 33]. Our findings indicate that the mean interval between rotor start and helicopter takeoff (3.91 ± 1.42 min) is significantly longer than the current benchmark. Furthermore, the interval from the receipt of an emergency call to the helicopter crew being ready for takeoff exceeds three minutes (5.51 ± 3.15 min), which is also statistically significant at the 0.05 level. This delay may be partially attributed to the military backgrounds of the flight crews in our study, who lack EMS training. Consequently, their limited medical knowledge may hinder their understanding of the risks and implications associated with emergency situations [8]. To address this issue, it is recommended that flight crews receive EMS training that includes both safety and medical topics [2, 8]. However, in Iran, there is currently no standardized level of training required for HEMS operations [8].

Response time

The mean flight time from the helipad to the emergency site was 17.38 ± 4.17 min. Most HEMS studies in Iran have reported approach time, defined as the interval from the emergency call to arrival at the scene [18, 24, 34]. In other words, their reported approach interval includes both the activation interval and the response time interval (Fig. 1). However, since activation time is the only interval with a national benchmark, it would be more beneficial to report activation time and response time separately.

We found that our response time exceeds the approach time reported in previous HEMS studies in Tehran and Qom City [18, 34]. This finding is somewhat unexpected, and additional details, such as travel distance, type of

helicopters, and the experience and training of the flight crew, are needed to potentially explain these differences.

When comparing our approach time (26.53 ± 5.85), it exceeds that of the study conducted in Kurdistan Province (21.46 ± 14.12) [24], but is similar to the approach time reported in another study in Tehran (26.95 ± 10.78) [28].

On-scene time

The mean on-scene time for HEMS was 5.76 ± 3.74 min, which is lower than findings from other studies conducted in Iran, where this interval ranged from 7.85 to 12.68 min [18, 24, 28, 34, 35]. The longer on-scene times reported in these studies may be partly attributed to the type of helicopter used. Since most of the patients transported in these studies were trauma cases, it is likely that multiple patients were transported by helicopter during each mission. This could result in longer on-scene times compared to our HEMS, which utilized a Medicopter and, in the majority of missions, transported only one patient.

Overall, these short on-scene intervals in Iranian studies can be attributed to the EMS delivery model in Iran, which follows the Anglo-American approach. In our HEMS system, emergency medical technicians provide limited care at the scene and aim to transfer patients to a physician at the hospital as quickly as possible. Furthermore, operating at night can increase on-scene time; however, emergency operations in Iran are conducted only during the day.

Transport time

The mean transport time for HEMS in our study was 17.45 ± 4.15 min. This time can be influenced by factors such as the distance from the emergency site to the destination medical center, the type of helicopter, weather conditions and wind direction [36]. We also obtained data on ground ambulance transfer times, which had a mean of 52.70 ± 13.63 min.

It is not surprising that air ambulances transport patients faster than ground ambulances. In the following section, we will compare the total prehospital time for HEMS and GEMS, excluding the ground ambulance's waiting time at the scene for the helicopter's arrival (see Fig. 1).

Prehospital time

The total mission duration for HEMS, from the emergency call to landing at the hospital helipad, was calculated to be 49.73 ± 9.67 min. This prehospital time is shorter than those reported in studies from different regions of Iran, which ranged from 52.33 to 93.72 min [24, 28, 35].

When comparing the prehospital times of HEMS with ground transportation, our findings align with previous studies conducted in Iran [18, 19], which indicate that air emergency services are more time-efficient than ground services. However, evidence suggests that in certain cities within Iran's Fars province, helicopter dispatch may be less effective, as the rescue times for HEMS were longer than those for ground ambulances. This indicates that while air ambulances typically provide shorter prehospital times, local factors can significantly influence their efficiency [21].

Limitations

The major limitation of our study is the lack of detailed records for the on-scene time of ground ambulances. As shown in Fig. 1, the on-scene time for ground ambulances consists of two components: treatment time and waiting time for the helicopter. While we have the total on-scene time interval, we do not have data for these specific components. To estimate the on-scene treatment time for GEMS, we utilized the mean on-scene time from ground ambulance dispatches during the study period in non-urban areas.

Conclusion

This study shows that the activation time, a modifiable component of the HEMS prehospital interval, exceeds the national benchmark of three minutes. Our analysis of HEMS prehospital times compared to ground transportation indicates that HEMS is faster than ground ambulances, suggesting that dispatching a helicopter is more time-efficient.

Future research could explore the factors contributing to delays in activation time and evaluate the effectiveness of providing basic EMS training for flight crews to optimize HEMS efficiency and potentially enhance patient outcomes.

Furthermore, the current national benchmark for helicopter activation time may require clarification and revision, as its definition contains ambiguities that should be addressed in future guidelines.

Acknowledgements

We would like to thank the anonymous reviewers for their insightful comments and Mr. Mojtaba Chamani, head of the HEMS medical team, for his collaboration with our research team.

Authors' contributions

MH.E. and T.P. conceptualized and designed the study, analyzed and interpreted the data, and wrote the manuscript. A.N. collected the data and contributed to the initial draft. R.B. wrote the initial version of the manuscript. All authors reviewed and approved the final manuscript.

Funding

Not applicable.

Data availability
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Research Ethics Committee of Gonabad University of Medical Sciences, IR.GMU.REC.1401.103. The study was approved by the Internal Review Board (IRB# 1120), which did not require explicit consent from the participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Health in Disasters and Emergencies, School of Health Management and Information Sciences, Iran University of Medical Sciences, Tehran, Iran. [2]Social Development and Health Promotion Research Center, Gonabad University of Medical Sciences, Gonabad, Iran. [3]Student Research Committee, Iran University of Medical Sciences, Tehran, Iran.

Received: 7 July 2024 Accepted: 4 December 2024
Published online: 05 January 2025

References

1. Fritz CL, Thomas SA, Galvagno SM Jr, Thomas SH. Survival benefit of helicopter scene response for patients with an Injury Severity score of at least nine: a systematic review and meta-analysis. Prehospital Emerg Care. 2024;28(6):841–50.
2. Mistovich JJ, Karren KJ, Werman HA, Hafen BQ. Prehospital emergency care. 11th ed. NY: Pearson; 2018.
3. Florez-Perdomo WA, Garcia-Ballestas E, Konar SK, Ramos-Gomez L, Al-Mufti F, Sursal T, et al. Effect of helicopter transportation of acute ischemic stroke patients on mortality and functional outcomes: a systematic review and meta-analysis. Air Med J. 2022;41(5):476–83.
4. Penner K. Fly or drive to stay alive? A systematic review evaluating outcomes following ground versus helicopter prehospital transport in rural patients with moderate to severe traumatic brain injury. Air Med J. 2022;41(1):34.
5. Röper J, Krohn M, Fleßa S, Thies K-C. Costing of helicopter emergency services-a strategic simulation based on the example of a German rural region. Health Econ Rev. 2020;10:1–15.
6. Butler DP, Anwar I, Willett K. Is it the H or the EMS in HEMS that has an impact on trauma patient mortality? A systematic review of the evidence. Emerg Med J. 2010;27(9):692–701.
7. Lenz TJ, Kossyreva EA, Colella MR. HEMS guidelines utilization. Air Med J. 2018;37(5):293–4.
8. Sorani M, Tourani S, Khankeh HR, Panahi S. Challenges of helicopter emergency medical service: A qualitative content analysis in Iranian context. Health Policy Technol. 2018;7(4):374–8.
9. Colnaric J, Bachir R, El Sayed M. Association between mode of transportation and outcomes in penetrating trauma across different prehospital time intervals: a matched cohort study. J Emerg Med. 2021;60(4):460–70.
10. Pham H, Puckett Y, Dissanaike S. Faster on-scene times associated with decreased mortality in Helicopter Emergency Medical Services (HEMS) transported trauma patients. Trauma Surg Acute Care Open. 2017;2(1):e000122.
11. Tomazin I, Vegnuti M, Ellerton J, Reisten O, Sumann G, Kersnik J. Factors impacting on the activation and approach times of helicopter emergency medical services in four Alpine countries. Scand J Trauma Resusc Emerg Med. 2012;20:1–11.
12. Fuchs A, Huber M, Riva T, Becker S, Albrecht R, Greif R, et al. Factors influencing on-scene time in a physician-staffed helicopter emergency medical service (HEMS): a retrospective observational study. Scand J Trauma Resusc Emerg Med. 2023;31(1):20.
13. Meuli L, Zimmermann A, Menges A-L, Tissi M, Becker S, Albrecht R, et al. Helicopter emergency medical service for time critical interfacility transfers of patients with cardiovascular emergencies. Scand J Trauma Resusc Emerg Med. 2021;29:1–9.
14. MOHME. Ministry of Health and Medical Education (Iran). Health Transformation Plan. Developing pre-hospital emergency services in type of merians and helicopters; 2015.
15. Abdi Z, Majdzadeh R, Ahmadnezhad E. Developing a framework for the monitoring and evaluation of the Health Transformation Plan in the Islamic Republic of Iran: lessons learned. East Mediterr Health J. 2019;25(6).
16. Moradi-Lakeh M, Vosoogh-Moghaddam A. Health sector evolution plan in Iran; equity and sustainability concerns. Int J Health Policy Manag. 2015;4(10):637.
17. Doshmangir L, Moshiri E, Mostafavi H, Sakha MA, Assan A. Policy analysis of the Iranian Health Transformation Plan in primary healthcare. BMC Health Serv Res. 2019;19:1–8.
18. Azadeh MR, Parvaresh Massoud M, Gaini M, Hemta A. Comparative study of road traffic accident victims transferred by air and ground emergency to Shahid Beheshti Medical Center in Qom City, Iran, 2015–2018. Health Emerg Disasters Q. 2021;6(4):225–34.
19. Ghaffarzad A, Ghalandarzadeh A, Rahmani F, Ghafouri RR, Dorosti F, Morteza-Bagi HR. Helicopter emergency medical services in East Azerbaijan province: assessment of patients' outcome. Turkish J Trauma Emerg Surg. 2021;27(4):427.
20. Hassani SA, Moharari RS, Sarvar M, Nejati A, Khashayar P. Helicopter emergency medical service in Tehran, Iran: a descriptive study. Air Med J. 2012;31(6):294–7.
21. Moradian M, Rastegarfar B, Salahi R, Abbasi H, Paydar S, Rastegar M, et al. Helicopter emergency medical service in fars province: the referral trauma center of South of Iran. Iran Red Crescent Med J. 2012;14(5):300.
22. Sajjadi SM, Koushkaki FR, Mousavi-Roknabadi RS, Farahmand F, Dehbozorgi A, Hamrah H, et al. Transferred patients by Fars Province's Helicopter Emergency Medical Service (HEMS); a 2-years cross-sectional study in Southern Iran. Bull Emerg Trauma. 2021;9(1):21.
23. Salimi J, Khaji A, Khashayar P. Helicopter emergency medical system in a region lacking trauma coordination (experience from Tehran). Emerg Med J. 2009;26(5):361–4.
24. Abdi K, Ghaderi S, Nuri B, Karimian A. Dispatcher Criteria and Therapeutic Measurement by Air Emergency Ambulance of Kurdistan Province, Iran, 2017. Health Emerg Disasters Q. 2019;4(2):63–70.
25. Østerås Ø, Brattebø G, Heltne JK. Helicopter-based emergency medical services for a sparsely populated region: a study of 42,500 dispatches. Acta Anaesthesiol Scand. 2016;60(5):659–67.
26. Taylor CB, Stevenson M, Jan S, Liu B, Tall G, Middleton PM, et al. An investigation into the cost, coverage and activities of Helicopter Emergency Medical Services in the state of New South Wales, Australia. Injury. 2011;42(10):1088–94.
27. Noori Sari H, Erfani H, Ghaderi-far M. Processes of Pre-hospital Emergency operations. Ministry of Health and Medical Education. Emergency medical services in Iran; 2016.
28. Alipour M-R, Nasiripour AA. Time Indicators of Pre-hospital Emergency Care Services to patients transported by emergency helicopter to Imam Khomeini Hospital of Tehran in 2014. J Police Med. 2015;3(4):269–76.
29. Kornhall D, Näslund R, Klingberg C, Schiborr R, Gellerfors M. The mission characteristics of a newly implemented rural helicopter emergency medical service. BMC Emerg Med. 2018;18(1):1–9.
30. Jones A, Donald MJ, Jansen JO. Evaluation of the provision of helicopter emergency medical services in Europe. Emerg Med J. 2018;35(12):720–5.
31. Yadollahi M, Zakipour M, Zolghadrasli Y, Kalantari Meibodi M. Time distribution of traffic accidents in Shiraz, Iran during 2017–2018. Health Manag Inform Sci. 2019;6(4):156–62.
32. WHO. Health data overview for the Islamic Republic of Iran 2019. Available from: https://data.who.int/countries/364.
33. Jafari H, Ranjbar M, Mozaffari AR, Sadeghi A, Fallah Aliabadi S. Assessing the status of Yazd province medical emergency and accident management center in terms of necessary standards for air emergencies. Health Emerg Disasters Q. 2020;6(1):47–56.

34. Shojamoradi M, Alavi E, Zarrabi B, Pilehvari Z, Kaviani A. Evaluation of the patients transported by Tehran Helicopter Emergency Medical Service: the necessity of using appropriate triage criteria. Razi J Med Sci. 2008;15:99–106.
35. Eghbali A, Pashaei Sabet F, Momenyan S, Abbasi M. The comparison of indicators of air and ground emergency with international standards in trauma resulting from accidents patients in Qom in 2016. Iran J Nurs Res. 2019;14(3):19–23.
36. Chen X, Gestring ML, Rosengart MR, Peitzman AB, Billiar TR, Sperry JL, et al. Logistics of air medical transport: when and where does helicopter transport reduce prehospital time for trauma? J Trauma Acute Care Surg. 2018;85(1):174–81.

Publisher's Note