
Time Analysis in Emergency Medical Service Reporting Unit

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Abstract

Aim. The aim of this paper was to determine whether there are any differences in the time of mobilisation and response time of the emergency medical service (EMS) team with respect to the location of the emergency call.

Methods. The data for this paper was collected and analysed in detail using the program "e-hitna" ("e-emergency"). The sample consists of all calls received in the period between 1 January and 31 December 2019 in the Medical Reporting Unit of the Department of Emergency Medicine of Zagreb County (DEMZC; Zavod za hitnu medicinu zagrebačke županije). This paper presents the number, category, place of intervention, time of mobilisation of the emergency medical service team, and the response time of the emergency services team to emergency calls designated as priority 1 (A).

Results. A total of 47,060 calls were recorded in the "e-hitna" system. We found that out of the total number of calls received, 49% (23,235) were related to emergency interventions. In 38% (8,841) of calls, the medical dispatcher opted for priority 1 (A). According to the place of emergency, 53% (4,691) of priority 1 (A) cases take place in the apartment, while 46% (4,071) occur in a public place. The average mobilisation time of an EMS team for priority 1 (A) cases for apartments is 1.87 ± 1.27 , while for public places it is 1.92 ± 0.78 min. (Mann Whitney U test, $p < 0.001$). The average response time of an EMS team for priority 1 (A) cases for apartments is 11.02 ± 4.27 , and for public places it is 6.57 ± 3.78 min. The response

time was on average much shorter for calls related to emergencies in public places (Mann Whitney U test, $p < 0,001$).

Conclusion. The collected data showed that the Department of Emergency Medicine of the Zagreb County effectively aligns their working processes as well as resources with the needs of the population regarding emergency medical care. Creativity, imagination, and constant time analysis are the determinants of the work of a medical dispatcher.

Introduction

The activity of outpatient emergency medical services is organized as a public service with the aim of providing continuous urgent medical care to all persons whose life is directly endangered due to illness or injury. The activity of outpatient emergency medical services includes the implementation of measures and procedures for emergency medical care on the scene, as well as during the transport of affected and/or injured persons to the appropriate medical institution with the aim of maximally shortening the time from the occurrence of the emergency to the provision of medical care (1). Emergency medical services include functional connectivity and coherence, as well as cooperation at all horizontal and vertical levels with other healthcare providers, given the scale and complexity of the work and the characteristics of the area where the emergency event occurs (1). In the medical dispatch centre of emergency medical service, specific activities begin which are the basis of complete management and a prerequisite for achieving an efficient, uniform, accessible, and quality health service (2).

The main task of the medical dispatch service is to respond to an emergency medical call in as short a period of time as possible. During an emergency call, the medical dispatcher collects basic information about the location and type of the event, assesses the data according to the Croatian Emergency Call Receiving Index (CECRI; Hrvatski indeks prijema hitnog poziva), and on the basis of the collected data makes a decision on the priority and manner of intervention of the emergency medical service team. The

nearest appropriately trained and equipped team is sent to the scene (3).

Time management in the medical dispatch service is reflected in the achievement and maintenance of quality standards, as well as in taking responsibility for the outcomes of health care in the health status of patients and the population. Understanding the real conditions of the working processes, the role of participants in those processes, and efficient monitoring and evaluation of processes enables the improvement of healthcare, and therefore the existing health system (4). Tam et al. (2018) claim that the effectiveness of triage systems allows priority decisions to be made at the most favourable time given the severity of the health status of the person in need. Through a developed triage system, decisions contribute to reducing disability and mortality of a person in a life-threatening condition (5). Working time is measured using different approaches, setting its priorities and developing a plan for its use. Time is a resource which we optimize through planning and constant control. In order to optimize working time, it is important to distinguish between urgent cases and those that must be addressed without delay, and to accept the challenge of modern time management through adaptability, spontaneity, and openness to unpredictable events. The quality of the provided health service is evaluated by analysing time periods and is a fundamental indicator of the work in terms of resource planning, according to which the conditions, organization, and mode of operation of the emergency medical service are proposed, with the aim of achieving the highest quality of health care. By conducting data analysis during mobilisation and response of the emergency medical service team, we perform a series of activities that are closely related to the coordination of time of response and are crucial for the survival of patients and the provision of immediate health services (6). The team's standard mobilisation time refers to the movement of an activated emergency medical service team while responding to a priority 1 (A) intervention within 60 seconds.

The standard of response time is the time for a medical emergency team to arrive on the scene, measured from the moment the medical dispatcher responds to an emergency call. This standard depends on network configuration and team availability. The standard varies for urban and rural areas as well as for individual periods throughout the day (3). Cabral's

(2018) literature review presented response times for emergency medical services in several parts of the world, claiming that response times are basic indicators of the quality of emergency medical services (7). Blackwell (2002) claims that a less than 5-minute emergency response time contributes to a higher percentage of survival than calls that have a response time of more than 5 minutes (8). Mell et al. have shown that medical dispatchers in the United States respond to 37 million calls per year (9).

The demand for a highly efficient, accessible, and effective emergency medical service is an essential precondition for reducing disability and sustaining human life, so it poses a particular challenge for emergency medical service. A review of existing literature showed no similar studies conducted in the Republic of Croatia, leading us to believe that this paper would represent a significant contribution to the improvement of the work of emergency medical service. The aim of this paper is to present the number of calls, the category of calls, the place of intervention, the time of mobilisation of the EMS team, and the response time of the emergency call team to calls indicated as priority 1 (A) in the period from 1 January 2019 to 31 December 2019. Furthermore, the study aims to determine whether there is a difference in the time of mobilisation and response of the EMS team between emergency calls of priority 1 (A) made in apartments versus those made in public places.

Methods

Retrospectively, all calls received in the information communication system "e -hitna" of the Department of Emergency Medicine of Zagreb County were analysed in the period from 1 January 2019 to 31 December 2019. The sample consists of all calls received in the period from 1 January 2019 to 31 December 2019 by the medical dispatch service of the DEMZC. For each call marked with priority 1 (A), the mobilisation time and response time of the EMS team were analysed. The interventions are divided into those that take place in apartments and those that take place in an open public space. The average mobilisation time of the EMS team (the time from receiving an emergency call to the submission of a call to

an EMS team) and the response time (the time from the medical dispatcher's call to the EMS team to the team's arrival on the scene) were also investigated.

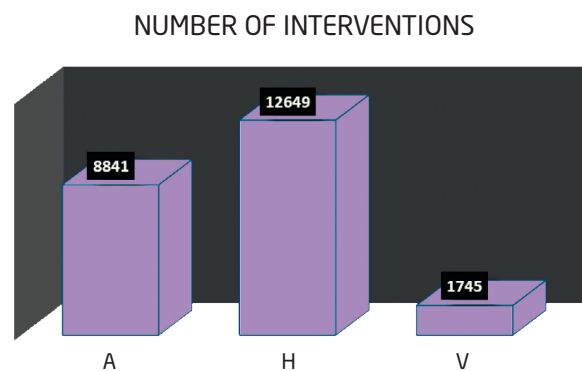
Descriptive statistical methods were used to describe the distribution of frequencies of variables. Mean values are expressed by arithmetic mean and median, measures of variability by standard deviation and range, and structure indicators are presented as percentages. The nonparametric Mann Whitney U test was used to determine the differences between dependent, mobilisation, and response times in comparison with independent variables. Significance was set at $p=0.05$. The IBM SPSS 25 system was used to process the data.

Ethics

The study was conducted according to the Helsinki Declaration with ethical principles and human rights in research. Prior to the study, the approval of the director of DEMZC was obtained, as well as the approval of the ethics committee of DEMZC.

Results

A total of 47,060 calls were received from 1 January 2019 to 31 December 2019. Each call received is triaged according to CECRI, and placed in one of the following categories: intervention, advice, other, or disturbance.



Graph 1. Number of emergency calls according to priority

Table 1. Number of calls for priority A interventions to the scene

Place of intervention	Call number	Percentage
Apartment	4,691	53
Public place	4,071	46
Unmarked	79	1
Total	8,841	100

Table 2. Number of calls for priority A in a public place

Place of intervention	Number of calls	Percentage
Sports facility	14	0.3
Educational institution	24	0.5
Closed public place	146	4
Open public place	814	20
Primary health care centre	542	13
Police	21	0.5
Prison	11	0.2
Retirement home	754	19
Emergency room	1,184	29
Hospital	44	1
Place of work	83	2
Field	6	0.1
Mountain	4	0.1
River	4	0.1
Highway	54	1
Road	366	9
Total	4,071	100

According to results medical dispatcher received 11,454 calls (24%) categorised into advice. 23,235 calls (49%) were recorded as an intervention. 307 (1%) calls were categorized as harassment. 12,064 (26%) calls were categorised as "other" and were related to providing general information.

Graph 1 shows the number of emergency calls according to their priority levels. For priority 1, or red answer, the letter A is used as the initial character - "AKKUT" (acute), for a total of 8,841 (38%) calls. For priority 2, or yellow answer, the letter H is used as the initial character - "HASTER" (urgently), for a total of 12,649 (55%) calls. For priority 3, or green answer,

Table 3. Total mobilisation time of EMS teams for priority A calls

Time in minutes	Number of calls	Percentage
< 1 min	3,011	34
2	4,131	47
3	1,524	17
4	35	0.3
5	19	0.2
6	16	0.1
7	2	0.02
8	2	0.02
9	2	0.02
10	2	0.02
11	2	0.02
12	4	0.04
13	1	0.01
14	1	0.01
15	1	0.01
16	1	0.01
17	1	0.01
18	2	0.02
19	2	0.02
20	1	0.01
33	2	0.02
Unmarked	79	0.8
Total	8,841	100

the letter V is used as the initial character - "VANLIG" (regular), for a total of 1,745 (7%) calls.

Table 1 shows the number of priority 1 calls (A) with regard to the place of intervention. A total of 4,691 (53%) interventions took place in apartments, 4,071 (46%) interventions took place in public places, while the total number of unmarked calls in the "e-hitna" IT system was 79 (1%).

Table 2 shows the number of calls for priority 1 (A) in public places according to specific venues. More significant is the fact that the majority of calls for public places came from the EMS infirmary, i.e., the resuscitation area. The total number of such calls was 1,184 and 29, respectively. Fewest emergency calls for priority 1 (A) were made from fields and rivers, a total of 4 (0.1%) for each location.

Table 3 shows the total time in minutes for a medical dispatcher to mobilise an EMS team for priority 1 (A)

Table 4. **The time for the mobilisation of EMS teams in minutes for priority 1 (A) calls made in apartments and public places**

Time	Apartment		Public place	
	Number of calls	Percentage	Number of calls	Percentage
<1 min	1,783	38	1,228	30
2	2,088	45	2,043	50
3	756	16	768	19
4	23	0.49	12	0.29
5	9	0.19	10	0.24
6	12	0.25	4	0.09
7	1	0.02	1	0.02
8	1	0.02	1	0.02
9	1	0.02	1	0.02
10	1	0.02	1	0.02
11	1	0.02	1	0.02
12	3	0.06	1	0.02
13	1	0.02	0	0
14	1	0.02	0	0
15	1	0.02	0	0
16	1	0.02	0	0
17	1	0.02	0	0
18	2	0.04	0	0
19	2	0.04	0	0
20	1	0.02	0	0
33	2	0.04	0	0
Total	4,691	100	4,071	100

calls. 4,131 (47%) emergency calls were forwarded to an EMS team in 2 minutes from the start of the call and 3,011 (34%) in less than one minute.

Table 4 shows the mobilisation time for EMS teams in minutes for priority 1 (A) calls made in apartments. 2,088 (45%) emergency calls were forwarded within 2 minutes of the start of the call. 1,783 (34%) calls were forwarded to an EMS team in less than one minute, while 756 (16%) emergency calls were submitted within 3 minutes. 2,043 (50%) emergency calls were forwarded within 2 minutes of the start of the

call, 1,228 (30%) calls were forwarded in less than one minute, and 768 (19%) emergency calls were forwarded within 3 minutes.

Table 5 shows the mobilisation time of the EMS team for priority 1 (A) calls for apartments in relation to priority 1 (A) calls for public places. The mobilisation time of an EMS team for priority 1 (A) calls for apartments ranges from 1 minute to 33 minutes (min=1, max=33), while the time for priority 1 (A) calls for public places ranges from 1 minute to 12 minutes (min=1, max=12). The average mobilisation time for

Table 5. **Mobilisation time of EMS teams for priority 1 (A) calls for apartments in relation to priority 1 (A) calls for public places**

Place of intervention	n	Σ (sd)	Mean	(min; max)	Mann Whitney
Apartment	4,691	1.87 (1.27)	(1.83; 1.86)	(1.00;33.00)	< 0.015
Public place	4,071	1.92 (0.78)	(1.89; 1.95)	(1.00;12.00)	< 0.015

Table 6. **Total response time of EMS teams for priority 1 (A) calls**

Time in minutes	Number of calls	Percentage
1-5 min	932	11
6-10 min	3,643	41
11-15 min	3,525	40
16-20 min	460	5
21-30 min	87	1
> 30 min	109	1
Unmarked	79	1
Total	8,841	100

priority 1 (A) calls for apartments is 1.87 ± 1.27 and for public places it is 1.92 ± 0.78 min. (Mann Whitney U test, $p < 0.001$).

Table 6 shows the total response time of the EMS team for priority 1 (A) calls. For 3,643 (41%) calls, the average time the EMS team took to arrive at the emergency call intervention site was between 6 and 10 minutes. 932 (11%) calls received assistance within 1-5 minutes, and 11 to 15 minutes were needed for 3,525 (40%) calls.

Table 7 shows the response time of the EMS team for priority 1 (A) calls in apartments and public places. The EMS team usually arrived at the apartment as the emergency call intervention site in 11 to 15 minutes for a total of 2,304 (49%) calls. 403 (9%) calls received assistance within 1 to 5 minutes, and 6 to 10 minutes were needed for 1,404 (30%) calls.

Table 7. **The EMS team response time for priority 1 (A) calls for apartments and public places**

Time in minutes	Apartment		Public place	
	Number of calls	Percentage	Number of calls	Percentage
1-5 min	403	9	529	13
6-10 min	1,404	30	2,239	55
11-15 min	2,304	49	1,221	30
16-20 min	402	9	58	1
21-30 min	75	1	18	1
> 30 min	103	2	6	1
Total	4,691	100	4,071	100

Table 8. Response time of the EMS team for priority 1 (A) calls for apartments in relation to priority 1 (A) calls for public places

Place of intervention	n	Σ (sd)	Mean	(min; max)	Mann Whitney
Apartment	4,691	11.02 (4.27)	(10.58; 11.86)	(1.00;93.00)	< 0.001
Public place	4,071	6.57 (3.78)	(6.50; 6.95)	(1.00;32.00)	< 0.001

The EMS team usually arrives in a public place as an emergency call intervention site in 6 to 10 minutes in 2,239 (55%) calls. 529 (13%) calls received assistance within 1 to 5 minutes, and 11 to 15 minutes were required for 1,221 (30%) calls.

Table 8 shows the response time of the EMS team for priority 1 (A) calls for apartments and public places. The response time of EMS teams for priority 1 (A) calls made in apartments ranges from 1 minute to more than 93 minutes (min=1, max=93), while the response time for priority 1 (A) calls made in public places ranges from 1 minute to 32 minutes (min=1, max=32). The average response time for priority 1 (A) calls for apartments is 11.02 ± 4.27 , and for public places it is 6.57 ± 3.78 min. The response time for public places was on average much shorter than for calls to a public place (Mann Whitney U test, $p < 0.001$).

Discussion

The aim of this paper was to determine whether there is a difference in mobilisation and response between emergency calls of priority 1 (A) for apartments and public places. The statistical processing of data contained in tables 5 and 8 shows that there is no significant difference between the time of mobilisation and the response time of EMS teams for priority 1 (A) calls made from apartments in comparison with calls made from public places. The average mobilisation time of EMS teams for priority 1 (A) calls for apartments is 1.87 ± 1.27 , while for public places it is 1.92 ± 0.78 (Mann Whitney U test, $p < 0.001$). The average response time of EMS teams for priority 1 (A)

calls for apartments is 11.02 ± 4.27 , and for public places it is 6.57 ± 3.78 .

Mell et al. claim that emergency medical services teams operate effectively in their area regardless of the scene of emergency and recognize that telephone instructions to the caller located at the emergency scene have a positive effect on the outcomes of treatment for people in life-threatening conditions (9).

Graph 1 shows that 49% of calls relate to emergency interventions, 24% to advice provided to the caller, while the rest are categorized as "other" or "disturbance", and are related to providing general information.

According to graph 2, emergency calls of priority 1 (A) received and triaged according to CECRI represent a total of 38% (8,841). Most calls, 55% of them, were triaged as priority 2 (H) (12,649), while only 7% (1,745) were triaged as priority 3 (V). Bogunović (2018) claims that during one calendar year, 10.26% of all emergency calls were triaged as priority 1 (A) (10). A total of 19% of all calls were triaged as priority 1 (A) in DEMZC. A survey conducted in Italy suggests that 78% of calls were categorized as priority 1 (A), indicating that medical dispatchers did not work according to the guidelines (11). In total, 49% of priority 1 (A) calls were categorized in the Department MRU, which confirms that all medical dispatchers are trained and educated for work.

Tam et al. conclude that different triage systems help the medical dispatcher make decisions (5). A timely and accurate decision reduces the frequency of undesirable events. The results show that the application of the triage system reliably recognises the gravity of the emergency call and the life-threatening situation. Tam et al. claim that greater precision of triage represents better quality of emergency services (12).

Blanchard and Christophin (2002) claim that in Canada 31% (7,760) of calls were categorized as priority 1 (A), while in Iran 52% (11,961) of calls were of priority 1 (A) (13-15). On the basis of existing literature mentioned above, the number of calls of priority 1 (A) in the DEMZC is acceptable if we take into consideration various factors that directly affect the organization of work, such as the population number, the emergency medicine network, and the education and qualifications of medical dispatchers.

In 53% (4,691) of cases, the number of emergency interventions marked as priority 1 (A) take place in apartments, while the other 46% (4,071) occur in public places. 1% (79) of calls have an unmarked location. Compared to the survey conducted by Bogunović, the DEMZC has a lower percentage of interventions in public places by 6.2%. Bogunović lists a total of 52.2% of interventions in public places, with the remaining 47.8% representing priority 1 interventions that took place in apartments (10).

Further analysis of the calls visible from table 2 shows that most emergency interventions in public places for priority 1 (A) calls, as much as 29% (1,184), take place in EMS clinics, followed by interventions in the open (814, or 20%), interventions in retirement homes (754, or 19%), and in primary care clinics (542, or 13%).

Table 5 shows the mobilisation time of the DEMZC ranging from 2 minutes to 33 minutes for interventions marked as priority 1 (A). The EMS team was mobilised within 2 minutes in 47% (4,131) of cases, while in 34% (3,011) of cases it was mobilised within 1 minute. The timing of the EMS team's mobilisation is affected by its availability. Intervals that have a longer period of time in the range testify to the unavailability of an EMS team due to another pre-existing intervention (12). Bogunović claims that the mobilisation time in Serbia is less than 1 minute in 55.7% of cases and 1-5 minutes in 35.5% of cases (10). The same survey shows the results of an Israeli survey claiming that the mobilisation time for Camel County is 2.50 minutes and The Lakish District 2.40 minutes. In Ankara, the mobilisation time is 2.49 minutes, while in Ireland 41% of calls the HMS team is mobilized in less than 3 minutes (10). By comparing these results, we can see that the DEMZC mobilizes an EMS team within 3 minutes in 98% of calls for interventions of priority 1 (A), which enables the achievement of standard times and efficiency of the emergency medical service system.

The total response time of EMS teams for priority 1 (A) calls was investigated. According to table 6, an EMS team of the DEMZC usually arrives at the place of emergency within 6 to 10 minutes in 41% (3,643) of cases. In 40% (3,525) of cases, the EMS response time is between 11 and 15 minutes. Ankara has an average response time of 9 minutes, Malaysia 11 minutes, Long Island 7 minutes, while in Belgrade the average is 9 minutes (10). In Canada, according to Blanchard and Christoph (2002), in 24% (1,865) of interventions of the EMS team, the response time is more than 8 minutes, and less than 7 minutes in 6.4% (497) of interventions (15). In Iran, 81% of EMS interventions for priority 1 (A) calls have a response time of within 8 minutes. In North America, 90% of priority 1 (A) response times of EMS teams range within 9 minutes (16). According to a study conducted in Virginia, USA (2004), the average response time of EMS teams for priority 1 (A) calls is 12 minutes (17). Olive and Kobusingye (2004) state that in Monterrey, Mexico, the average response time of EMS teams is 10 minutes, while in Hanoi, Vietnam, the average response time of EMS teams is 30 minutes (18). Blackwell (2002) claims that a response time of less than 5 minutes contributes to a higher percentage of survival than calls that have a response time of more than 5 minutes. The mortality risk was 1.58% for patients whose response time exceeded 5 minutes and 0.51% for those whose response time was less than 5 minutes (8). Taking into consideration the number of EMS teams in the EMS network and the geographical layout of the Zagreb County, the response times of the EMS teams in the DEMZC meet the EMS standards and are approximately similar to such departments in other countries. One limitation of this study was the fact that the data were collected retrospectively and it would be good to conduct a study with a prospective longitudinal design.

Conclusion

The continuous strategic development of the DEMZC ensures effective, accessible, uniform, and quality healthcare that meets the needs of all citizens. The aim of this study was to determine whether there are any differences in the time of mobilisation and re-

sponse of EMS teams with respect to the place of intervention. The median value of team mobilisation time is 2 minutes. The median response time value of EMS teams is 6 to 10 minutes. We can conclude that a regular analysis of response time improves the quality of workflow while taking into account the prescribed standards and the real needs for health care in the system of emergency medicine.

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ANALIZA VREMENA U PRIJAVNO-DOJAVNOJ JEDINICI HITNE MEDICINSKE SLUŽBE

Sažetak

Cilj. Cilj je ovog rada utvrditi postoji li razlika u vremenu mobilizacije i vremenu odziva tima hitne medicinske službe s obzirom na mjesto odvijanja hitnog poziva.

Metode. Podaci za izradu ovog rada prikupljeni su i detaljno analizirani iz informatičkog programa „e-hitne“. Uzorak čine svi pozivi koji su zaprimljeni u periodu od 1. siječnja do 31. prosinca 2019. u Medicinskoj prijavno-dojavnoj jedinici Zavoda za hitnu medicinu Zagrebačke županije. Ovim su radom prikazani broj, kategorija, mjesto intervencije, vrijeme mobiliziranja tima hitne medicinske službe te vrijeme odziva tima hitne medicinske službe za hitne pozive koji su označeni I. prioritetom (A).

Rezultati. Ukupno je u sustavu „e-hitne“ zabilježeno 47 060 poziva. Dobivenim rezultatima utvrdili smo kako se od ukupnog broja zaprimljenih poziva 49 % (23 235) odnosi na hitne intervencije. Medicinski dispečer u 38 % (8841) poziva odlučio se za I. prioritet (A). Prema mjestu događaja, I. prioritet (A) u 53 % (4691) slučajeva odvija se u stanu, dok se 46 % (4071) događa na javnom mjestu. Prosječno vrijeme mobilizacije tima HMS-a za I. prioritete (A) za stan iznosi $1,87 \pm 1,27$ min, a za javno mjesto $1,92 \pm 0,78$ min, Mann-Whitneyjev U-test ($p < 0,001$). Prosječno vrijeme odziva tima HMS-a za I. prioritete (A) za stan iznosi $11,02 \pm 4,27$ min, a za javno mjesto $6,57 \pm 3,78$ min. Vrijeme odziva za javno mjesto prosječno je bilo znatno kraće za pozive na javnom mjestu, Mann-Whitneyjev U-test ($p < 0,001$).

Zaključak. Iz istraživanja je vidljivo da Zavod za hitnu medicinu Zagrebačke županije učinkovito usklađuje radne procese, kao i resurse u odnosu na potrebe populacije za hitnom medicinskom pomoći. Kreativnost, imaginacija te neprestano analiziranje vremena odrednica su procesa rada medicinskog dispečera.

Ključne riječi: hitni poziv, medicinski dispečer, menadžment, vrijeme mobilizacije, vrijeme odziva
