

Reaction times as indicators of the quality of expert work of belgrade municipal institutions for emergency medical services

Research Article

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Abstract: Introduction. Methodological Instructions for Procedures of Healthcare Institution Reports on the Indicators of the Quality of Healthcare from 2007 also involve reaction times (RTs) I, II, I+II, III and IV, as the obligatory indicator of the quality of expert work of Emergency Medical Services (EMS). Objective. Evaluation of the quality of expert work of Belgrade EMS based on RTs. Methods. A retrospective analysis of priority 1 emergency calls in September 2009 vs September 2010, and RTs from I to IV as the recommended indicators of the quality of expert work of Belgrade EMS. Results. As detected, in 2010 there has been decrease in the total number of calls for physicians, and the total number of priority 1 emergency calls. By comparing RTs, the obtained data showed that in 2010 the time elapsed from when a priority 1 call was received until it was handed to the EMS team for implementation (RT I) was on average faster by 0.1 min ($p < 0.01$), that the time elapsed from the dispatcher's receipt of the call until the EMS team arrived to the patient (RT II) was faster on average by 0.42 min ($p < 0.05$), and that the time for the team to reach the patient after the received call through the call centre (RT I+II) was faster by 0.15 min. Also, in 2010, RT III was shortened by 1.27 min and RT IV by 1.00 min. By summing RTs I, II and III, independently resolved level I emergency calls at the scene are obtained. In 2009, this time interval was, on average 38.02 min, and in 2010 it was an average of 36.23 min. By summing RTs I, II and IV, the time elapsed from the call received through the call centre until the patient's hospital admission is obtained. In 2009 this time was average 31.08 min, and in 2010 it was average 29.16 min. Conclusion. One of the major advances in emergency medicine is providing assistance to a request for emergency medical care where this is produced. Therefore, the indicator of RTs may measure the quality of care provided by pre-hospital services..

Keywords: Reaction times • Emergency medical service • Quality of work • Indicator

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1. Introduction

The Belgrade Municipal Emergency Medical Services (MIEMS) is a highly specialized healthcare institution dealing with healthcare of severely injured and critically ill individuals at the pre-hospital level on the territory of the city of Belgrade. The territory of Belgrade covers 3.222,68 km² and it is administratively divided into 17 city communities. According to the assessments of the Republican Institution of the Republic of Serbia, from 2008, there were 1,621,396 residents in the territory of Belgrade, representing 21% of the total number of the citizens of Serbia [1].

Emergency medical service (EMS) of the MIEMS includes received calls using the phone number for emergency medical interventions ("94" for Belgrade), calls triage by priority level and dispatch of calls to the out-of-hospital teams of physicians offering healthcare to patients 24 hours a day throughout the entire year. The work process of the Belgrade MIEMS is organized in five shifts, each effectively working for 12 hours. Each shift has 22 out-of-hospital medical teams (OHMT) composed of a *physician, medical technician and ambulance driver* educated as a team member. The teams are located by territory to be closer to service users. The members of OHMT are required to respect ethical

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codes, to have high levels of expertise and to provide the highest possible quality medical services.

In accordance with the Law on Healthcare (Official Paper of the Republic of Serbia, No. 107/05, article 203), the Ministry of Health of the Republic of Serbia has passed the Regulation on the Indicators on the Quality of Healthcare (Official Paper of the Republic of Serbia, No. 35/07) based on which in 2007 the Institute for Public Health of Serbia "Dr. Milan Jovanović Batut" published the Methodological Guidelines for the Procedures of Healthcare Institution Reports on Healthcare Quality. The Guidelines define the mode of collecting, follow-up, calculations and reporting on obligatory indicators of the quality of healthcare institutions. The obligatory indicators of the quality of work under follow-up in the field of EMS are RTS (I, II, I+II, III and IV).

2. Objectives

The objective of the study was to evaluate the quality of work, the quality of work, the quality of provided healthcare to Belgrade citizens by the MIEMS of Belgrade using RTs as indicators.

3. Methods

As specially designed electronic data base was used, according to the Methodological Instructions for Procedures of Belgrade MIEMS Report on the Indicators of the Quality of Healthcare from 2007. Data were obtained by dispatcher centers and physicians' reports after performed out-of-hospital interventions. A retrospective analysis was performed on the data obtained for the periods of 01.–30. September 2009 and 01.–30. September 2010. The follow-up included the total number of calls for physicians; also, a total number of level I emergency calls ("*red call*") and their rate, as well as the recommended indicators of the quality of expert work: RTs from I to IV.

In the methodological instructions mentioned above, the term "level I emergency calls" refers to conditions with acute onset that directly or indirectly endanger vital function, and which require the initiation of urgent medical intervention within the shortest possible time period, e.g. cardiac arrest, ceased breathing, loss of consciousness, stroke, severe chest pain, respiratory obstruction, drowning, hanging, electric shock and lightning stroke, burns of large body surfaces, wounds inflicted by gunshots and physical abuse, massive bleeding from external orifices, extremity lacerations with profuse bleeding, traumatic extremity amputations, open fracture of long

bones, call from a public place reporting an unconscious person that stopped breathing or blue in face, fall from height, allergic reaction with breathing difficulties or unconscious, coma of unknown cause, convulsions and suffocation in children, first epileptic attack, onset of labor, traffic accidents, etc.

During the research the already-existing information-communication system of the admission-distribution center consisting of several subsystems was of great help. The software part of the system covers the needs of the call center, dispatcher service and administration sector of MIEMS. The application is based on the applied Extensible Markup Language (XML) technology that facilitates the preparations of protocols and their transfer into the electronic format. Telecommunication surroundings based on the Voice over Internet Protocol (VoIP) technology also form a significant part of the system, while the real-time Global Positioning System (GPS) mobile team tracking uses special software.

This modern technology in electronic form contains the complete process of providing emergency medical help through locating the patient by tracking the phone number of the call, determining the location of the nearest EMC ambulance, its dispatch for intervention and collecting data about the intervention at the site (2).

Statistical analysis was performed using SPSS version 9.0 statistical software package for Windows. Descriptive analysis on various pre-hospital time intervals including: response time I, II, I+II, III, IV were investigated, using mean and standard deviation (mean $\pm$ SD), maximum, minimum and median. Moreover, bivariate analyses were conducted to detect significant association and differences ($p < 0.05$) in distribution between categorical and continuous variables, respectively using Mann-Whitney U test and Chi-Square Tests.

4. Results

Table 1 shows the increasing trend of the total number of calls for physician from 6.353 in 2009 to 6.413 in 2010. Concurrently, the change in total number of priority 1 calls from 500 (7.9%) in 2009 to 479 (7.5%) in 2010 is not significant (Chi-Square Tests = 0.725, DF = 1, $p = 0.394$).

Figure 1 gives a parallel presentation of RTs (in minutes and seconds) in 2009 and 2010 with a statistically significant difference for RT I ($p < 0.01$, Mann Whitney U test) and RT II ($p < 0.05$, Mann Whitney U test). By comparing the RTs I, II, I+II, III and IV, it was noted that in 2010, the period for the level I emergency call to be dispatched to the EMS team for implementation was 0.1 min faster (RT I), the time elapsed from EMS team

receiving the call from the dispatcher to arrival at the scene was 0.42 min faster (RT I+II), and the time for the team to reach the patient after having received the call from the call centre was 0.15 min faster (RT II) (Figure 1). Also, in 2010 as compared to 2009, the time interval from the team's arrival to the patient until the finalization of out-of-hospital medical intervention was shortened by 1.27 min (RT III), as well as the time interval from team's arrival to the patient until the time of patient's hospital admission for further care was shortened by 1.00 min (RT IV) (Table 1).

The sum of RTs I, II and III represents the time interval from the time the call was received by the call center until treatment of the patient at the scene without transport to hospital. These are independently solved level I emergency calls by OHMT of physicians. In September 2009 this time interval was 38.02 min, while in September 2010 it was slightly shorter, i.e. 36.23 min.

By adding RTs I, II and IV, the time elapsed from the call received by the call centre until the patient's hospital admission for further treatment is obtained. In 2009 this time interval was 31.08 min, and in 2010 it was slightly shorter, i.e. 29.16 min.

5. Discussion

The priority of the Belgrade EMS is the implementation of level I emergency calls as compared to the calls of lower emergency levels (II and III) [2]. Of the total number of answered calls by the call center of the Belgrade MIEMS (on average 2500 daily), 12% are received for implementation as level I and II emergency calls, while others are completed by giving advice [3].

The operator at the call center receives the call based on the electronic protocol programmed with triage algorithms from the Emergency Care Index [4]. Under the section "problem", by the principle of descending menu one of 39 options can be selected (Figure 1). By following the triage instructions from the Emergency Care Index, all operators' conversations on phone call "94" are standardized. The receipt of phone calls is simplified and time-shortened. In this research the rate of level I emergency calls was 7.9% in 2009 and 7.5% in 2010. Such a sensitivity increase of correct categorization of emergency level by 0.4% is the result of regular call center operators training to recognize the "true" level I emergency calls. Also, as the statistical report of Belgrade MIEMS for 2010 gives data that harassment and false "94" calls subtract a total of 110,000,000 sec per year or 21 days of operator's time [5], extensive education of citizens has been conducted under the slogan "Emergent when Urgent" to indicate the significance of calling EMS only in true emergencies only.

If assessed as a level I emergency call or a "red call", it is automatically transferred on the relation operator-dispatcher. The dispatcher, if possible, immediately proceeds it to the first available and territorially nearest OHMT for implementation. This means, that MIEMS have operators who exclusively answer emergency calls, and dispatchers who are exclusively responsible for alarming and coordination of the OHMT. The dispatcher uses two monitors, one with the city map and GPRS system follow-up of OHMT and the other for distribution "red calls" to the first available team. By activating the implementation call, in addition to identifying the location of the caller, the monitor also shows positions of the nearest available OHMT. By respecting

Table 1. Comparative analysis of total number of physician calls, total number of priority I emergency calls and response time I to IV in September 2009 vs September 2010

Total Calls		Total priority I calls	Reaction time I			Reaction time II			Reaction time I + II			Reaction time III			Reaction time IV		
September	N	N (%)	Range min to max	X±SD	M	Range min to max	X±SD	M	Range min to max	X±SD	M	Range min to max	X±SD	M	Range min to max	X±SD	M
2009	6353	500 (7.9)	0.02 to 27.57	1.26 ± 2.22	0.47	0.02 to 69.20	8.31 ± 6.34	7.21	0.08 to 69.46	9.37 ± 6.53	8.10	6.16 to 109.18	33.35 ± 17.19	30.34	2.00 to 66.00	23.54 ± 11.12	23.00
2010	6413	479 (7.5)	0.00 to 9.59	1.06 ± 1.20	0.37	0.01 to 35.29	7.39 ± 5.20	6.39	0.08 to 42.04	9.05 ± 6.11	7.55	3.15 to 137.29	32.35 ± 19.18	29.07	4.00 to 62.00	23.02 ± 10.54	22.00
p-value*			p < 0.01 p = 0.007			p < 0.05 p = 0.047			NS p = 0.229			NS p = 0.114			NS p = 0.319		

* Mann Whitney U test; N.S. - not significant; X- mean; SD - standard deviation, M - median

Legend:

Reaction time I - The time elapsed from received level I emergency call by the call center until it was handed to the EMS team for implementation

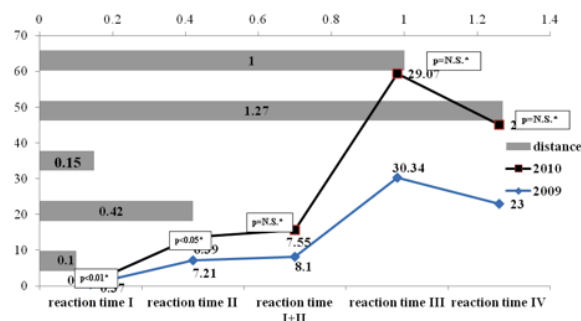
Reaction time II - The time elapsed from EMS team receiving the call from the dispatcher to arrival at the scene

Reaction time I + II - The time elapsed from received level I emergency call by the call centre until arrival of the EMS team at the scene

Reaction time III - The time elapsed from the EMS team reaching the patient until the moment of team's finalization of intervention

Reaction time IV - The time elapsed from the moment of EMS team arrival at the out-of-hospital site with the patient until the moment of patient's hospital admission for further care

Notification - All reaction times are recorded in minutes and seconds (min.sec)

Figure 1. Comparison of response times (I-IV) between September 2009 and September 2010

* Mann Whitney U test; NS – not significant

the level of priority calls, the dispatcher dispatches the nearest available OHMT for intervention. This is an internationally recognizable system of dispatcher relaying calls received at the call center by level of priority that has been already accepted by numerous countries [6-10]. Level II emergency calls or “yellow calls” indicate that the condition is assessed as being able to wait for a shorter or longer time. Level III emergency calls involve requests for transportation, which are executed by a separate service unit, a driver and a medical technician. The head of the shift that controls the work of MIEMS dispatchers also uses a monitor, responds to patients’ emergencies and gives instructions to the caller until the arrival of the team [11].

All segments of call receipt and distribution are automatically recorded, including: time of incoming call to the operator, call duration, time of forwarding call to the dispatcher center, time of call distribution to the nearest available team of physicians for implementation, the time of team leaving and the time of OHMT arrival at the scene of intervention, transport time of the patient from the scene to hospital, time of the hospital admission of the patient, as well as the time of completion of intervention, i.e. when the team becomes available for the next call [5].

In the Regulation on the Indicators of Healthcare Quality (Official Paper of the Republic of Serbia, No. 35/07) these times are termed response times, and are recognized as the criteria for the assessing the performance of the Belgrade MIEMS. There is no official State standard for RTs in Serbia. Approach to a high quality healthcare is the basic human right that is recognized and respected by the European Union, as well as the citizens of Europe. Therefore, patients have the right to expect that all efforts are made to secure their safety as users of healthcare services (Luxembourg Declaration on Patient Safety, European Commission, April 2005).

The most critical component in the chain-link of early approach is the quickest possible dispatch of the team

to the intervention scene after the received call, which, according to EMS principles must be below 1 min [12]. In our study, this time, known as the RT I, is close to the Arnold ideal time [13] reaching 1.26 min (median 0.47 min) in 2009, and 1.06 (median 0.37 min) in 2010 ($p < 0.01$). By comparing RT I, it was disclosed that in 2010 level I emergency calls were dispatched to the team for implementation by 0.1 min faster. The reason for this was the increase in the number of physician teams from 20 in 2009 to 22 in 2010, and a lower number of level I emergency calls.

Reaction time II is the time elapsed from the dispatcher’s receipt of the call until the EMS team arrived to the patient. After receiving the call, the OHMT must arrive at the scene as soon as possible. The survival potential of critically ill and severely injured persons is increased if the OHMT arrives faster, which, unfortunately is not always possible. The reaction time II is similar (14 min) in France and New York (10 min), while in some communities in California it is 15 min [14]. It is generally accepted within the field that an ‘ideal’ reaction time for emergency calls would be within 8 min ninety-percent of the time, but this objective is rarely achieved, and current research results question the validity of that international standard [15]. In our study the average RT II was average 8.10 min in 2009 and average 7.55 min in 2010 ($p < 0.05$), which is according to the international standard.

Although the RT II shows that in 2010 MIEMS teams reached the patient after the received call from the dispatcher faster by 0.42 min and that they reached the patient from the time of the received call at the call centre faster by 0.15 min (RT I+II); Belgrade MIEMS teams like teams in other main cities worldwide are faced with the present problems: high buildings, traffic rush-hours, traffic jams, large shopping malls, unmarked streets, etc. [16].

Although in 2010 compared to 2009 the shortened time interval from the arrival of the team to the patient until the finalization of medical intervention at the scene was shortened by 1.27 min, this RT III rated average 29.07 min in 2010. Despite being seemingly long, this is the time during which the physicians’ team, under at home conditions fully stabilized the patient’s condition by performed diagnostic and therapeutic measures, thus representing independently solved out-of-hospital cases. A higher rate of resolved cases at site decreases the unnecessary patient transport to hospital, additional hospital analyses and treatment. Today, when MIEMS vehicles are equipped, according to the European and international standards, with the most modern equipment, diagnostics and therapy, when EMS teams are trained according to the latest protocols in healthcare

Table 2. Possible problems in the work of Belgrade MIEMS

Call center	Dispatcher	Out-of-hospital team	Admission in hospital
1. false calls	1. electricity failure	1. citizens that obstruct EMS	1. insufficient number of hospital stretchers
2. harassment	2. interrupted communication by radio-connection	2. ambulance passage regardless of rotation lights and audible signal	2. insufficient number of hospital triage personnel
3. threats	3. computer system failure	2. distant destination (driving lasting mostly up to 35 min in one way)	3. busy observation, reanimation or intensive care units
4. irregularly given data on patient	4. insufficient number of out-of-hospital teams	3. EMS ambulance collision	4. out-of-order medical equipment (CT; NMR; RTG and other)
5. wrong address, etc.	5. higher number of concurrent emergency I calls	4. mechanical problem of EMS ambulance	5. decision of hospital physician for the patient to be transported to another hospital, etc.
	6. higher number of emergency I calls in the same territory, etc.	5. reconstruction of roads and bridges in Belgrade	
		6. inability to find the scene of event	
		7. traffic jams	
		8. high buildings with lift failure	
		9. unmarked streets and building numbers	
		10. failed connection by telephone and radio	
		11. out-of-order medical equipment	
		12. poor internal communication	
		13. verbal of physical attack of ESM team, etc.	

of emergent condition, a strategy for the permanent improvement of the quality of healthcare has been developed.

Reaction time IV represents the time interval from the arrival of the team to the patient, transport and hospital admission of the patient for further healthcare. In our study it rated an average of 23.00 min in 2009 and an average 22.00 min in 2010. Although the RT III and RT IV are not in accordance with the international standard due to possible working problems (Table 2)

similar to other emergency medical services, we can be satisfied with the achieved results [17].

6. Conclusion

One of the major advances in emergency medicine is providing assistance to a request for emergency medical care. Therefore, the indicator of RTs may control the quality of care provided by pre-hospital services.

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