

# Experience of Belgrade's Emergency Medical Service in the implementation of cardiopulmonary resuscitation guidelines issued in 2010

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## ABSTRACT

*Introduction.* Implementation of cardiopulmonary resuscitation (CPR) is defined by the unified 2010 Guidelines for CPR.

*Objective.* This paper presents the experience of Belgrade's Emergency Medical Services (EMS) in the implementation of out-of-hospital (OH) CPR according to the new, 2010 Guidelines.

*Methods.* A retrospective study design was used. We recorded OH CPR and analyzed four variables: patient gender and age, arrest location, bystander witnessed arrest, and arrest rhythm (shockable – group I, non-shockable – group II). The study also looked at implementation and follow-up of CPR, therapy, CPR duration, EMS reaction time, and patient outcome (Return of Spontaneous Circulation [ROSC] or death).

*Results.* Of 794 OH CPR attempts, 136 (17%) patients with field ROSC were transported to hospital admission (HA) (22% group I, 78% group II). ROSC at HA was sustained in 64 (47%), and unsustained in 72 (53%) patients. Among the patients with ROSC on HA, 47% had spontaneous breathing and 5% fully regained consciousness. The ROSC rate was higher after arrest occurring at home ( $P < 0.001$ ). No statistical significance between the groups regarding the following analyzed variables was found: patient gender, age, onset time (day or night shift), bystander witnessed arrest, ROSC, breathing and consciousness at HA. In all patients, intravenous (IV) access was established. Atropine was administered in 28 (21%) group II patients. Adrenaline was administered in 71% of patients and withheld in 29% of patients due to hospital closeness or sustained ROSC. By HA, 46% were successfully intubated. The average response time in group I was  $8.1 \pm 4.0$  minutes, in group II  $6.8 \pm 4.4$  minutes. A highly significant association ( $p < 0.01$ ) was found between CPR duration and ROSC at HA (26.23 min – ROSC vs. 14.46 min – no ROSC).

*Conclusion.* Study results indicate the significance of the new Guidelines for CPR in the everyday practice of Belgrade's EMS teams. Continual training increases the quality of administered CPR measures and the rate of patients with ROSC at HA. New studies would contribute to the disclosure of weak links in the survival chain after OH CPR in Belgrade.

**Key words:** out-of-hospital resuscitation, experience, Belgrade Emergency Medical Service, new guidelines for CPR

## Introduction

Survival rate after out-of-hospital cardiorespiratory arrest (OH CRA) differs

between individual emergency medical services (EMS). According to the data of a prospective multicentric study conducted in Serbia, immediate (Return of Spontaneous Circulation [ROSC]  $> 20$  min) survival is 12.7%, short-term (to hospital discharge) survival is 11.3%, and long-term (1 year)

survival after out-of hospital cardiopulmonary reanimation (OH CPR) is 10.0%. (1) These survival rates, after OH CRA, are similar to data recorded elsewhere in Europe. (2) Grading and synthesis of the published data has been done by a group of experts, the members of the Interna-

tional Liaison Committee on Resuscitation (ILCOR). (3) This was a continuation of the five-year cycle of the updating and changing of clinical guidelines for cardiopulmonary reanimation (CPR), by which EMS team members are informed of therapeutic procedures that can influence the outcome of CPR. A summary of these Guidelines, translated into the Serbian language and published in the scientific journal of emergency medicine "Halo 94", (4) is based on highly effective and medically based information, with the goal to help EMS physicians in the choice of the best possible diagnostic and therapeutic strategy for each individual patient with OH CRA.

However, it is inevitable, even within the boundaries of Europe, that the differences in the availability of medical personnel, equipment and medications will require certain modification of the Guidelines at the local, regional or national level. The 2010 Guidelines for CPR do not represent the only method of performing resuscitation; they represent a widely accepted opinion on the best method for safe and efficient implementation of CPR. Therefore, it is understandable that the physicians of Belgrade's EMS will apply algorithmic procedures that have been proven, through their everyday practice, to be most efficient, having contributed to the highest rate of successful CPRs.

The city of Belgrade covers a total area of 322,268 ha, and is administratively divided into 17 municipalities. Belgrade's EMS, as a highly specialized medical institution, provides prehospital care to severely injured and critically ill persons within the territory of 10 central municipalities that include 1,576,124 inhabitants. The workload of the EMS involves: responding to call "94"; requesting emergency medical interventions; triaging of incoming calls, according to the degree of emergency, and referring to on-field physicians' teams. The workload is organized into five day and night shifts of 12-hours duration. Each shift is covered by 22 medical teams composed of a physician, medical technician and EMS vehicle.

In the Center for Education, physicians' teams undergo regular annual training to renew previously acquired knowledge, and obtain new knowledge in accordance with new Guidelines for CPR and treatment of emergency conditions.

During regular training, the significance of team work, in the implementation of CPR measures and activities, is pointed out.

Also, the significance of endotracheal intubation, as the gold standard for airway maintenance during CPR, is pointed out to physicians' teams. Appropriate training in the application of this method is insisted on, so as to increase the number of EMS physicians capable of performing early endotracheal intubation with minimal interruptions to chest compressions. In the case of a difficult or impossible endotracheal intubation, an oropharyngeal tube is inserted. Ventilation is provided by oxygen delivery using a self-inflating Ambu bag.

Although the new Guidelines do not recommend routine administration of atropine in non-shockable arrest rhythms, some physicians have been using this drug in asystole resistant to the applied therapeutic measures in the later phase of CPR. The applications of other medications during CPR have conformed to the new Guidelines.

This paper presents the experience of Belgrade's EMS in implementing OH CPR according to the new, 2010 Guidelines.

## Methods

### Study design

A retrospective one-year study was conducted between January 1<sup>st</sup> to December 31<sup>st</sup> 2011. OH CPRs and their outcomes were followed-up. A prehospital resuscitation team (physician, nurse and driver) implemented measures of advanced life support (ALS).

### Ethics

The study was approved by the Ethics Committee of the Municipal Institution for Emergency Medical Services (Decision No.3950/12).

Construction and method of sample selection

The sample was composed of adult patients, of different ages, who developed OH CRA (unconscious, breathless, pulseless).

The study included persons over 18-years of age, with cardiac arrest regardless of etiological cause or initial electrocardiography (ECG) findings. ALS resuscitation was performed in the following events: when the attending physician diagnosed cardiac arrest upon arrival, or when a hemodynamically unstable or critical patient experienced a cardiac arrest in the presence of the ALS team. Exclusion criteria were in concordance with the Utstein style Joint Royal Colleges Ambulance Liaison Committee (JRCALC) guidelines 1996.

### Analyzed variables

The variables analyzed were classified into four categories:

1. Patient variables (gender, age);
2. Arrest location variables (public place or home), bystander witnessed arrest (yes – EMS team or no – non-witnessed arrest);
3. Arrest variables, onset time (day or night shift), initial ECG rhythm (shockable – group I or non-shockable – group II);
4. Outcome variables: ROSC at hospital admission (HA) (yes/no), breathing at HA (assisted or spontaneous), conscious at HA (yes/no) or lethal outcome after OH CPR.

Follow-up also involved response time (time interval from onset of CRA to arrival of EMS), implemented CPR measures, administered therapy and duration of CPR.

### Statistics

The data obtained from physicians' reports were coded and a PC stored database was created.

Statistical analysis was performed using SPSS 15.0 for Windows, with graphic presentation using Harvard Graphics software, while the completed paper was edited using the word processing program Microsoft Word for Windows. Data were processed by using standard descriptive statistical methods (mean value, standard deviation and rate frequency). In order to test the hypotheses of the difference between observed risk factors, the Student's t-test, non-parametric Mann-Whitney U

and  $\chi^2$ -test were used, with statistically significant values ( $p < 0.05$ ) presented.

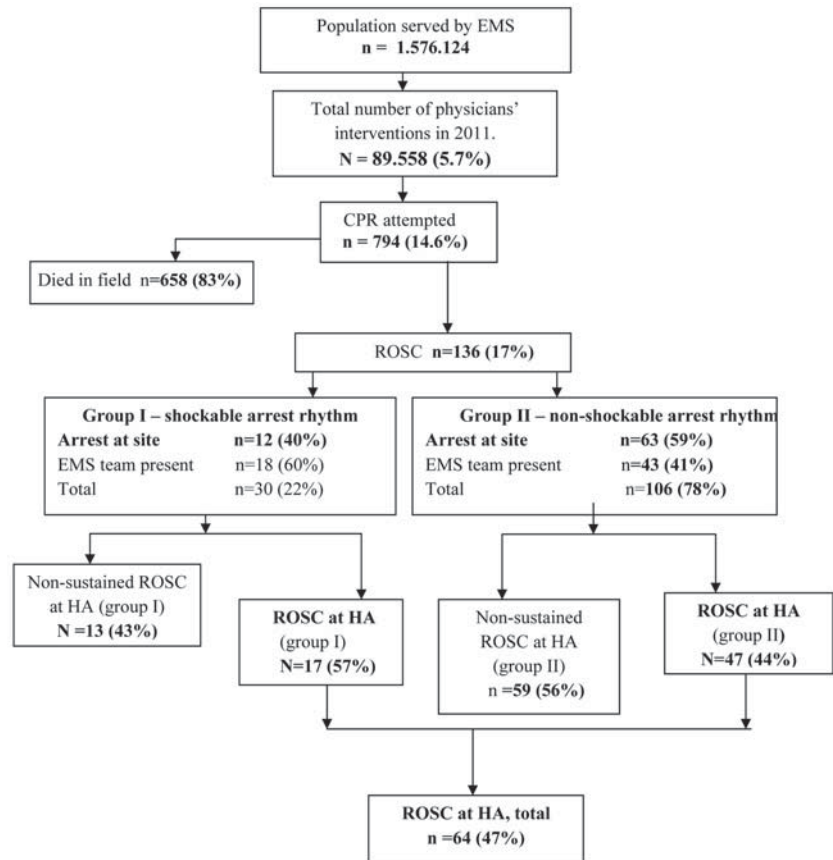
## Results

In 2011, physician teams of Belgrade's EMS performed in total 89,558 interventions, among which 794 were CPRs. In 658/794 (83%) CRAs, resuscitation was unsuccessful, with a lethal outcome on the field. After sustained ROSC was obtained on the field, 136/794 (17%) patients were transported to HA, of whom 30/136 (22%) with initially shockable - group I, and 106/136 (78%) with initially non-shockable rhythm arrest - group II. A total of 64/136 (47%) patients had sustained ROSC at HA, of whom 17 (57%) in group I and 47 (44%) in group II (figure 1). Seventy-two of 136 (53%) patients did not achieve sustained ROSC at HA.

Table 1 shows patient variables (gender, age), arrest location variables (public place or home), bystander witnessed arrest (yes - EMS team or no - non-witnessed arrest) and arrest variables, onset time (day or night shift).

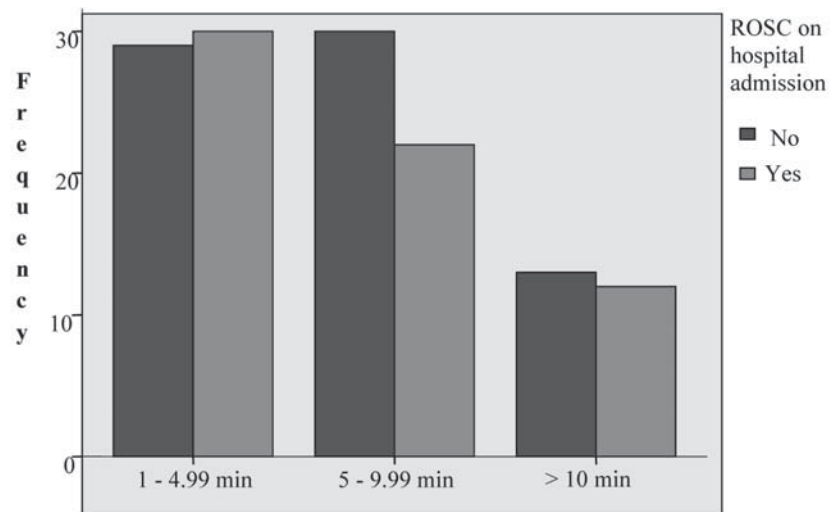
No statistically significant difference was found in the outcome of CPR (death on location or ROSC) in relation to gender difference (male vs. female,  $p > 0.05$ ), mean age (years) of patients (ROSC -  $63.11 \pm 16.17$  vs. without ROSC -  $60.78 \pm 19.23$ ,  $p > 0.05$ ), nor in the day-night variations of arrest onset ( $p = 0.89$ ). A statistically significant difference ( $p < 0.001$ ) was found in relation to arrest location with a higher rate of immediate survival (ROSC) occurring after arrest onset at home. There was a considerably higher rate of non-witnessed arrests than those that occurred with the EMS team present ( $p < 0.001$ ) (table 1).

Table 2 shows measures that were applied and table 3 therapy that was administered during CPR in group I and group II depending on the initial arrest rhythm. A statistically significant difference in the application of DC shock and amiodarone administration was found between an initially shockable arrest and initially non-shockable arrest rhythm which evolved into a shockable one during CPR. Atropine was adminis-



CPR, Cardiopulmonary resuscitation; EMS, Emergency Medical Services; HA, hospital admission; ROSC, return of spontaneous circulation.

**Figure 1. Out-of-hospital CPR from January 1st - December 31st, 2011; follow-up.**



**Figure 2. Relationship between time from the received call until arrival to the patient and return of spontaneous circulation (ROSC) on hospital admission.**

**Table 1. Factors associated with immediate survival (ROSC) or death after resuscitations performed during 2011.**

	Lethal outcome at arrest site (n=658; 100%)	Transported to hospital - ROSC (n=136; 100%)	Total (n=794; 100%)	p
Gender, n (%)				
Male	441 (67)	84 (62)	525 (66)	0.240*
Female	217 (33)	52 (38)	269 (34)	
Age (years), Mean±SD	64.8 ± 15.8	61.9 ± 17.8	64,3 ± 16,2	0.066**
Location, n (%)				
Home	527 (80)	92 (68)	619 (78)	< 0.001*
Public place (out of home)	131 (20)	44 (32)	175 (22)	
Time of event, n (%)				
Day	396 (60)	81 (60)	477 (60)	0.890*
Night	262 (40)	55 (40)	317 (40)	
Bystander CPR, n (%)				
No (unwitnessed arrest)	564 (86)	75 (55)	639 (80)	< 0.001*
Yes (during EMS intervention intervencije, n (%))	94 (14)	61 (45)	155 (20)	

CPR, Cardiopulmonary resuscitation; EMS, Emergency medical services; ROSC, Return of spontaneous circulation.

\*  $\chi^2$  test

\*\* t test

tered to 28 (21%) patients from group II, and none of the patients from group I. There was a statistically significant difference in the application of atropine between the studied groups ( $p=0.002$ ) (table 3) in the proportion of recorded cardiac rhythm.

From a total of 136 patients, 30 (22%) from group I and 106 (78%) from group II achieved ROSC during CPR at arrest location, and it was sustained at HA in 64 (47%) patients (figure 1).

No statistically significant difference was found between the groups in relation to the following variables: gender, age, arrest location, time of arrest onset (day or night), bystander witnessed arrest, ROSC, breathing and consciousness at HA ( $p>0.05$ ) (table 4).

Mean elapsed time from receiving the emergency call until arrival to the patient in group I was  $8.1 \pm 4.0$  minutes, and in group II  $6.8 \pm 4.4$  minutes ( $p>0.05$ ) (figure 2).

Mean duration of CPR in group I was  $18.8 \pm 19.7$  min (max = 85 min), and in group II  $20.2 \pm 15.9$  min (max = 63 min) (table 5). A highly statistically significant difference in the duration of CPR was

found in relation to the observed groups ( $p<0.01$ ).

## Discussion

The obtained data show that the incidence of CRA, regardless of rhythm, treated by Belgrade's EMS (50.38 per 100,000 inhabitants) is higher than the incidence recorded by the joint EMS data of 37 European countries (38 per 100,000 inhabitants). (2) The rate of our patients with shockable arrest is 22%, which is similar to two large national registries: The Cardiac Arrest Registry to Enhance Survival (CARES) (5) and Resuscitation Outcomes Consortium (ROC) group (6) of 23%. As only every fourth out-of-hospital cardiac arrest rhythm is shockable and the total rate of 23% is twice as low than that of 25 years ago, Salvucci's paper (7) considers the question "Where has v fib gone": Why are today's EMS crews seeing less ventricular fibrillation in the field? In our study, asystole was the predominating arrest rhythm (78%). In other studies, the main reason for this non-witnessed arrest rhythm is

late arrival of the EMS team. (8,9) In our study, response time was  $7.1 \pm 4.3$  min. Even the best EMS systems can be late due to heavy traffic, closed roadways, guarded buildings, large commercial complexes, out-of-order elevators, etc. This imposes the significance of trained laymen who would, as bystander witnesses of the event, apply measures of basic life support (BLS) until the arrival of the EMS team. (9) Additional variables which influence the presence of asystole as the initial arrest rhythm are older age ( $64.3 \pm 16.2$ ), night arrest (317/794) and unwitnessed arrest (639/794). Increased survival of patients with non-shockable arrest has been confirmed in Sweden (10) if six criteria are present: younger persons, bystander CPR, arrest in a public place, shorter response time of EMS and early defibrillation. Although in our study the highest number of OH CRA occurred in a private location (78%), which corresponds to the data reported in some international studies, (11) bystander witnesses of the event did not initiate BLS in any of the cases. Belgrade's EMS teams performed ALS

**Table 2. Cardiopulmonary resuscitation procedures and initial arrest rhythm.**

	Initial rhythm			p
	Group I (shockable) (n=30;100%)	Group II (non-shockable) (n=106; 100%)	Total (n=136; 100%)	
I.V. access, n (%)	30 (100)	106 (100)	136 (100)	
Establishing an Airway at arrest site, n(%)				0.930*
Oropharyngeal airway	24 (80)	84 (79)	108 (79)	
Endotracheal tube	6 (20)	22 (21)	28 (21)	
Establishing an airway until hospital admission, n (%)				0.052*
Oropharyngeal airway	21 (70)	53 (50)	74 (54)	
Endotracheal tube	9 (30)	53 (50)	62 (46)	
Ventilation, n (%)	30 (100)	106 (100)	136 (100)	
Aspiration, n (%)				0.230*
No	25 (83)	77 (73)	102 (75)	
Yes	5 (17)	29 (27)	34 (25)	
Sternum compression, n (%)	30 (100)	106 (100)	136 (100)	
Defibrillation, n (%)				< 0.001*
No	3 (10)	83 (78)	86 (63)	
Yes	27 (90)	23 (22)	50 (37)	

\*  $\chi^2$  test**Table 3. Arrest rhythm-appropriate medications.**

	Group I (shockable) (n=30;100%)	Group II (non-shockable) (n=106; 100%)	Total (n=136; 100%)	p
Adrenaline, n (%)				0.120*
No	12 (40)	27 (25)	39 (29)	
Yes	18 (60)	79 (75)	97 (71)	
Atropine, n (%)				0.002*
No	30 (100)	78 (74)	108 (79)	
Yes	0 (0)	28 (26)	28 (21)	
Dopamine, n (%)				0.880*
No	26 (87)	93 (88)	119 (87)	
Yes	4 (13)	13 (12)	17 (13)	
Amiodarone, n (%)				< 0.001*
No	17 (57)	97 (91)	114 (84)	
Yes	13 (43)	9 (9)	22 (16)	
I.V. infusion, n (%)				0.300*
No	13 (43)	35 (33)	48 (35)	
Yes	17 (57)	71 (67)	88 (65)	
Oxygen therapy, n (%)				0.430*
No	4 (13)	9 (8)	13 (10)	
Yes	26 (87)	97 (92)	123 (90)	

\*  $\chi^2$  test

**Table 4. Transported to hospital.**

	Group I (n=30;100%)	Group II (n=106; 100%)	Total (n=136; 100%)	p
Gender, n (%)				
Male	18 (60)	66 (62)	84 (62)	0.820*
Female	12 (40)	40 (38)	52 (38)	
Age (years), Mean±SD	62.2 ± 17.0	61.8 ± 17.8	64,3 ± 16,2	0.911**
Location, n (%)				
Home	24 (80)	63 (59)	87 (64)	
Public place	6 (20)	43 (41)	49 (36)	0.040*
Time of arrest onset, n (%)				
Day	18 (60)	63 (59)	81 (60)	
Night	12 (40)	43 (41)	55 (40)	0.960*
Bystander witness, n (%)				
Yes – EMS team	18 (60)	43 (41)	61 (45)	
No – unwitnessed arrest	12 (40)	63 (59)	75 (55)	0.060*
ROSC at HA, n (%)				
No	13 (43)	59 (56)	72 (53)	
Yes	17 (57)	47 (44)	64 (47)	0.230*
Breathing at HA, n (%)				
Assisted	19 (63)	81 (76)	100 (73)	
Spontaneous	11 (37)	25 (24)	36 (27)	0.150*
Conscious at HA, n (%)				
No	26 (87)	103 (97)	129 (95)	
Yes	4 (13)	3 (3)	7 (5)	0.020*
Time elapsed until arrival to patient (minutes), Mean ± SD	8.1 ± 4.0	6.8 ± 4.4	7.1 ± 4,3	0.070***
Duration of CPR (minutes), Mean ± SD	18.8 ± 19.7	20.2 ± 15.9	19.9 ± 16,8	0.334***

CPR, Cardiopulmonary resuscitation; EMS, Emergency Medical Services; HA, hospital admission; ROSC, Return of spontaneous circulation.

\*  $\chi^2$  test

\*\* t test

\*\*\* Mann – Whitney U test

according to the 2010 Guidelines for CPR. (2) As the Guidelines underline the significance of correctly performed and uninterrupted chest compressions, such procedure was implemented by our teams in all patients. Although tracheal intubation is no longer the priority of OH CPR, the interesting information in our study is that 21% (28/136) of patients were successfully intubated at arrest location, another 25% (34/136) during transport, so that

at HA 46% (62/136) of patients were, in total, intubated. The Berlin study (12) has demonstrated the problems associated with intubation under prehospital conditions. It should also be noted that defibrillation was not applied in three (10%) shockable arrests, occurring during EMS team presence, that were caused by rhythm change into non-shockable during defibrillator preparation. Also, during CPR, almost a quarter of all initially non-shockable rhythms

(22%) changed into shockable; in these cases defibrillation was applied due to the change of algorithm.

In the care of patients with critical conditions, beside airway maintenance and adequate ventilation and respiration, ensuring vascular access is of key significance. Although in critically ill patients, even under hospital conditions (13) it is not always possible to secure intravenous (IV) access, our medical teams succeeded in secu-



**Table 5. Duration of CPR.**

	ROSC on admission to hospital		
	Yes	No	Total
N	64	72	136
Mean	26.23	14.46	20.00
Std. Deviation	18.44	12.93	16.77
Median	22.00	10.50	18.00
Minimum	1	1	1
Maximum	85	63	85
Range	84	62	84
% of Total N	47.1	52.9	100.0

CPR, Cardiopulmonary resuscitation; ROSC, Return of spontaneous circulation.

ring venous access during CPR. In the 2010 Guidelines, intraosseal needle placement provides the best alternative to venous access for the administration of drugs and fluids; however, our Service is currently not supplied with the necessary equipment for its application.

One of the basic drugs administered during CPR is adrenaline. In 97 (71%) CPRs, our teams administered adrenaline. In 29% of CPRs adrenaline was not given; reasons that have also been reported by other studies are closeness of hospital admission and sustained ROSC obtained before the sequence recommended for adrenaline application. (14) A big disappointment were the results of the first randomized placebo controlled study, conducted at the pre-hospital level, reporting that adrenaline was still controversial both in regard to efficacy and safety of application. (15) Although 2010 Guidelines for CPR do not recommend the application of atropine for routine use in asystole or pulseless electrical activity (PEA), our teams administered the drug in 28 (26%) cases of asystole resistant to administered measures, in the later

phase of CPR. Amiodarone was given in a total of 22 (16%) arrests (13 with unwitnessed shockable rhythm and 9 with initially non-shockable which changed into shockable rhythm during CPR). A randomized controlled study by Olasveengen et al. (16) has reported that IV application of adrenaline, atropine and/or amiodarone during ALS is not related to increased long-term survival after OH CRA.

The incidence of ROSC during OH CPR ranges from 35.0-61.0%, however, not all of these patients survive at hospital admission or discharge. (17,18) In our study ROSC was obtained at the arrest location in 136 patients and it was sustained during transport until HA in 64 (47%) patients independent of the initial rhythm arrest. In this group of patients, 36 (47%) had spontaneous breathing and seven (5%) fully recovered consciousness at HA. Seventy-two (53%) patients had unsustained ROSC.

Mean duration of CPR was 20 min (26.23 min in patients with ROSC at HA vs. 14.46 in those without ROSC on HA), while maximal duration for shockable arrest was 85 min and 63 min for non-shockable arrest.

Study limitations - observed problems  
 First, our citizens are not sufficiently educated in regard to the recognition of CRA symptoms. They panic and do not follow EMS dispatcher's instructions on the method of applying BLS until the arrival of the EMS team; as bystander witnesses they did not apply BLS, before EMS arrival, in any of the patients. Automated external defibrillators (AED) are unavailable in public places, although first-line security workers (police, firefighters, security guard etc.) are trained in its use in practice.  
 Second, Belgrade's EMS teams do not use the Utstein templates for uniform CPR registration. Third, hospital medical documentation is not available to EMS teams so that they are not informed of the final outcome after HA.

## Conclusion

The results of our study indicate the significance of the implementation of the new CPR Guidelines in the everyday practice of Belgrade's EMS teams. Continuous and regular training can increase the quality of implemented CPR measures and the rate of patients with ROSC at HA. This imposes the significance of team-work and experience of EMS teams in the successful application of every single therapeutic measure (eg. endotracheal intubation and IV route placement). Our study results indicate that our physicians apply atropine in the later phase of CPR, with asystoles resistant to the applied CPR measures.

It is evident that by educating the inhabitants, the number of bystander CPRs would be increased and the time until the first defibrillation shortened by the implementation of the Public Access Defibrillation Program at the level of the city of Belgrade. Negative trends associated with poor survival rate are older age of patients with CRA, non-shockable arrest rhythm on arrival and response time of over 5 min. The introduction of the Utstein template in the work of Belgrade's EMS and new studies would contribute to the disclosure of weak links in the survival chain after OH CRA.

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