

DOI: 10.5455/msm.2024.36.115-119

Received: Sep 20 2024; Accepted: Oct 25, 2024

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ORIGINAL PAPER

Mater Sociomed. 2024; 36(2): 115-119

Outcomes of Out-of-Hospital Cardiac Arrest with Initial Shockable Rhythm: The Role of Bystander and Dispatch-Guided CPR in Sarajevo's Physician-Led Emergency Medical Teams

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ABSTRACT

Background: The Out-of-hospital cardiac arrest (OHCA) remains a major public health challenge worldwide, with survival outcomes heavily influenced by early intervention. The presence of an initial shockable rhythm significantly increases the likelihood of survival when combined with timely cardiopulmonary resuscitation (CPR) and defibrillation. **Objective:** To analyze patient outcomes and the incidence of bystander and dispatch-guided CPR in cases of OHCA with an initial shockable rhythm treated by physician-led emergency medical teams in Bosnia and Herzegovina. **Methods:** Data for this study were collected over a 5-year period, from January 2019 to September 2023, using the Utstein protocol. Hospital records were analyzed to determine patient outcomes, with a focus on the 30-day survival rate and favorable neurological outcomes. Instances of dispatch-guided and bystander CPR were recorded for each case based on available patient records. **Results:** In this study, 1,020 patients were included, with 151 cases (14.8%) having an initial shockable rhythm, of which 14.3% of males and 4.4% of females achieved return of spontaneous circulation (ROSC). ROSC rates varied by year, with the highest in 2019 (20.4%) and 2022 (17.9%). Thirty-day survival with a good neurological outcome was observed in a

small percentage of cases. The initial shockable rhythm was found to be statistically significant ($p < 0.001$) for achieving a good neurological outcome after 30 days. Dispatch-guided CPR was attempted in 12.9% of cases, with success in 1.9%. Bystander CPR was performed in 1.4% of cases, and only one case involved the use of an automated external defibrillator (AED). The median response time for successful resuscitations was 2 minutes, while for unsuccessful resuscitations, it was 6 minutes. The findings emphasize the role of age, initial rhythm, and response time in determining outcomes for OHCA patients. **Conclusion:** The promising survival rate of OHCA patients, despite limited bystander CPR, highlights the impact of short response times and skilled physician-led teams, underscoring the need for public education and a unified registry to address gaps and better understand OHCA epidemiology in Bosnia and Herzegovina.

Keywords: CPR; OHCA; ROSC; epidemiology; Bosnia and Herzegovina.

1. BACKGROUND

Out-of-hospital cardiac arrest (OHCA) poses a significant challenge to healthcare systems globally, with the European Resuscitation Council's EuReCa project estimating

an annual incidence of 67 to 170 cases per 100,000 inhabitants in Europe (1). The true incidence of out-of-hospital cardiac arrest remains elusive, as many cases go unrecorded due to the absence of resuscitation attempts by bystanders and the failure to activate emergency medical services (2, 3)

The management of out-of-hospital cardiac arrest primarily involves cardiopulmonary resuscitation (CPR), early defibrillation, and, when appropriate, early adrenaline administration, alongside the identification of the potential cause. The "4H&4T" acronym—hypoxia, hypovolaemia, hypo/hyperkalaemia, hypothermia, thrombosis, cardiac tamponade, toxins, and tension pneumothorax—serves as a useful guide for identifying possible causes. However, the exact etiology of many OHCA cases remains undetermined, preventing targeted interventions in prehospital settings, and while other potential causes have been identified, their relative likelihood and frequency remain unclear (4).

A strong chain of survival, including early bystander CPR, early AED use, dispatch-guided CPR, and the presence of an initial shockable rhythm (ventricular fibrillation and pulseless ventricular tachycardia), significantly enhances the chances of survival and recovery for victims of out-of-hospital cardiac arrest (5,6). Although the overall survival rate for OHCA remains low, early recognition and immediate bystander CPR, along with the use of an automated external defibrillator (AED) while awaiting emergency services, have been associated with reduced mortality (6). Education and training for the public, along with strategically placed AEDs, are essential for achieving high rates of bystander CPR and AED usage, yet only 35–50% of cardiac arrest victims worldwide receive bystander CPR before EMS arrival, prompting many healthcare systems to implement dispatcher-assisted CPR (DA-CPR) or telephone CPR (TCPR), which has been shown to positively impact patient outcomes following OHCA (7-9)

2. OBJECTIVE

This study aimed to evaluate patient outcomes and the incidence of bystander and dispatch-guided CPR in individuals treated by physician-led emergency medical teams for OHCA with an initial shockable rhythm in Bosnia and Herzegovina.

3. MATERIAL AND METHODS

This retrospective, observational study assessed all OHCA events treated by the Institute for Emergency Medical Assistance of Canton Sarajevo, either in stationary ambulances or in the field, over a 5-year period from January 1st, 2019 to September 31st, 2023, with data collected according to the Utstein protocol, specifically for this study, due to the lack of a unified OHCA registry in Bosnia and Herzegovina. Ethical approval for the study was granted by the Ethical Committee of the Institution for Emergency Medical Assistance of Canton Sarajevo (approval number 3085), with data

confidentiality maintained for all enrolled cases.

Data collection and patients

The study included data on OHCA from both traumatic and non-traumatic causes, encompassing adult and pediatric patients treated by emergency medical services within the geographic and administrative boundaries of Canton Sarajevo. Patients were excluded if medical documentation was absent or incomplete, or if resuscitation was not attempted for any reason.

Demographic data, including age and sex, were collected for all patients, along with information on the time and location of the OHCA, whether it was witnessed, the interventions provided by bystanders (including both medical personnel and laypersons), the use of AEDs, the time interval from the emergency call to EMS arrival, the initial cardiac rhythm, the number of defibrillation attempts, medications administered, and whether return of spontaneous circulation (ROSC) was achieved. Patient outcomes were derived from hospital records using the integrated electronic healthcare system in Canton Sarajevo, with a focus on the 30-day survival rate and favorable neurological outcomes, assessed using the Cerebral Performance Category (CPC) scale (10). Additionally, dispatch-guided CPR was recorded for each case based on data from the dispatch center.

Statistical analysis

The analysis was conducted using IBM SPSS Statistics v23.0, with descriptive statistical models applied to evaluate the incidence of OHCA, bystander CPR measures, and ROSC outcomes, while the distribution of numerical variables was assessed using the Kolmogorov-Smirnov test, and mean with standard deviation (SD) or median with interquartile range (IQR) were used for numerical data based on normality, with frequency and percentage used for categorical data. The incidence was calculated based on the population served and extrapolated to rates per 100,000 individuals per year. The T-test and Mann-Whitney U test were used to compare the means and mean ranks of numerical variables, while the Chi-square test and Fisher's exact test were employed to assess the association between categorical variables.

4. RESULTS

In this study, a total of 1,020 patients were included, with data collected from 2019 to 2023. The overall rate of ROSC was 14.3% for males and 4.4% for females, with a significant difference between the sexes ($p < 0.001$). The rate of unsuccessful resuscitation was 55% for males and 26.2% for females. ROSC outcomes showed that 12.6% of patients experienced a complete recovery, while 6% of patients died. ROSC rates varied by year, with the highest observed in 2019 (20.4%) and 2022 (17.9%). Regarding age groups, the majority of successful resuscitations occurred in patients aged 46–65 years (8.7%), followed by those aged >65 years (7.9%). The rates of unsuccessful resuscitation were highest in patients aged >65 years, accounting for 42.6% of cases. The median response time for suc-

Variable	Year (No of patients)					Total (1020)	p	
	2019 (225)	2020 (246)	2021 (159)	2022 (217)	2023 (173)			
Male/Female (No; %)								
ROSC	46 (20.4)/10 (4.4%)	28 (11.3)/ 10 (4.0)	23 (14.4)/ 5 (3.1)	39 (17.9)/ 12 (5.5)	10(5.7)/ 8(4.6)	146(14.3)/ 45(4.4)	<0.001	
Unsuccessful resuscitation	119 (52.8)/50 (22.4)	142 (57.7)/ 66 (27.0)	94 (59.1)/ 37 (23.4)	119 (54.8)/ 47 (21.6)	87(50.3)/ 68(39.3)	561 (55.0)/ 268 (26.2)		
ROSC outcomes (No, %)								
Complete recovery	39 (17.3)	30 (12.1)	26 (16.3)	19 (8.7)	15 (8.6)	129 (12.6)	N/A	
Death	17 (7.5)	8 (3.2)	2 (1.2)	32 (14.7)	3 (1.7)	62 (6.0)		
Age groups (No; %) (years)								
ROSC	<25 years	0 (0.0)	0 (0.0)	1 (0.9)	1 (0.4)	0 (0.0)	2 (0.2)	0.241
	25-45 years	5 (2.2)	4 (1.6)	3 (1.8)	4 (2.5)	3 (1.7)	19 (1.8)	
	46-65 years	27 (12.0)	21 (8.6)	7 (4.4)	27 (16.9)	7 (4.0)	89 (8.7)	
	>65 years	24 (10.6)	13 (5.2)	17 (10.7)	19 (11.9)	8 (4.6)	81 (7.9)	
Unsuccessful resuscitation	<25 years	5 (2.2)	2 (0.8)	4 (2.5)	2 (0.8)	3 (1.7)	16 (1.5)	
	25-45 years	10 (4.4)	19 (7.7)	10 (6.2)	10 (4.6)	14 (8.0)	63 (6.1)	
	46-65 years	71 (31.5)	80 (32.5)	50 (31.4)	60 (27.6)	54 (3.1)	315 (30.9)	
	>65 years	83 (37.1)	107 (43.4)	67 (42.1)	94 (35.3)	84 (48.5)	435 (42.6)	
Response time (median, 25th,75th percentile) (minutes)								
ROSC	3.0 (0.0; 5.0)	1.0 (0.0; 5.0)	2.0 (0.0; 6.0)	2.0 (1.0; 4.0)	2.0 (1.0; 3.5)	2.0 (0.0; 5.0)	<0.001	
Unsuccessful resuscitation	4.0 (2.0; 7.0)	6.0 (3.0; 7.0)	5.0 (3.0, 8.0)	6.0 (3.0; 7.0)	5.0 (3.0; 7.0)	6.0 (3.0;7.0)		
Initial rhythm (No, %)								
ROSC	Asystole/PEA	9 (4.0)	10 (4.0)	8 (5.0)	6 (2.7)	11 (6.3)	44 (4.3)	<0.001
	VF/VT	38 (16.8)	31 (12.6)	26 (16.3)	49 (22.5)	7 (8.0)	151 (14.8)	
Unsuccessful resuscitation	Asystole/PEA	135 (60.0)	153 (62.1)	81 (50.9)	107 (49.3)	105 (60.7)	581 (56.9)	
	VF/VT	43 (19.2)	52 (21.3)	44 (27.8)	55 (25.5)	50 (28.9)	244 (23.9)	
Bystander involvement (No; %)								
ROSC	5 (2.2)	2 (0.8)	4 (2.5)	2 (0.9)	2 (1.1)	15 (1.4)	0.985	
Unsuccessful resuscitation	8 (3.5)	4 (1.6)	5 (3.1)	2 (0.9)	3 (1.7)	22 (2.1)		

Table 1. Patient Demographics, Resuscitation Outcomes, and Factors Associated with ROSC in OHCA Cases (2019–2023)

Successful resuscitations was 2 minutes, with a statistically significant difference between years ($p < 0.001$). For unsuccessful resuscitations, the median response time was 6 minutes.

The initial rhythm most commonly associated with ROSC was VF/pulseless VT (14.8%), while asystole/PEA was more frequently observed in unsuccessful resuscitations (56.9%). A significant difference was found in initial rhythm between the ROSC and unsuccessful resuscitation groups ($p < 0.001$). Bystander involvement was minimal, with only 1.4% of ROSC patients receiving bystander CPR, and 2.1% of those with unsuccessful resuscitation having bystander intervention. These findings highlight the impact of age, initial rhythm, and response time on outcomes for patients experiencing out-of-hospital cardiac arrest (OHCA).

During the observed period, a total of 151 cases (14.8%) with an initial shockable rhythm achieved ROSC in Canton Sarajevo. The initial shockable rhythm ($X^2=20.5, p<0.001$) was found to be statistically significant for achieving a good neurological outcome after 30 days. Dispatch-guided CPR was attempted in 132 (12.9%) cases and successful in 20 (1.9%) cases. Bystander CPR was performed in 15 (1.4%) cases. Only one case involved the use of an AED. A comprehensive overview of all remaining data related to OHCA cases during the period from 2019 to 2023 is provided in Table 1 and depicted graphically in Figure 1.

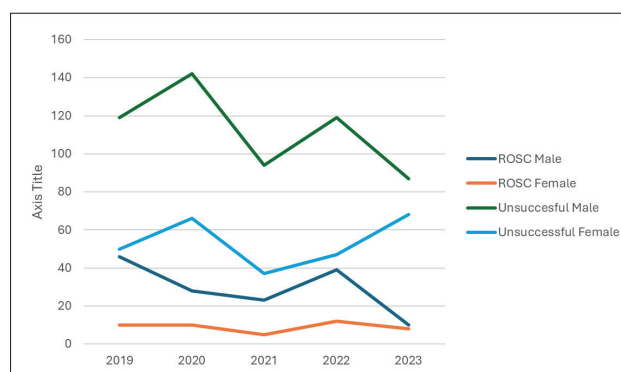


Figure 1. The number of patients achieving return of spontaneous circulation (ROSC) and those with unsuccessful resuscitation during the period 2019–2022

5. DISCUSSION

In this study, a total of 1,020 patients with OHCA were examined. The overall rate of ROSC was 14.8%. A significant association was found between initial shockable rhythm and achieving ROSC, with patients experiencing VF/pulseless VT more likely to survive compared to those with asystole/PEA. The use of bystander CPR was minimal, occurring in only 1.4% of ROSC cases. Dispatch-guided CPR was attempted in 12.9% of cases, but only 1.9% were successful. These findings emphasize the importance of early intervention, especially for cases with shockable rhythms, and highlight the limited role of bystander and dispatch-guided CPR in improving OHCA outcomes in Sarajevo.

Data on OHCA incidence in Europe varies widely, with the EuReCa Two study reporting rates between 28 and 244 per 100,000 inhabitants, and the European Resuscitation Council's 2021 Guidelines citing a range of 67 to 170 per 100,000, while this study reports an annual incidence of 54 per 100,000 in Canton Sarajevo, Bosnia and Herzegovina, with variability in incidence likely influenced by factors such as the COVID-19 pandemic in 2021 and 2022, which may have caused delays in seeking medical help due to restrictions and fears of contagion. (1, 11, 12) Variability in incidence may be influenced by factors such as the COVID-19 pandemic, which likely delayed patient care due to restrictions and fears of contagion. Additionally, differences in prehospital EMS organization, where physicians can pronounce death on-site and withhold resuscitation, may contribute to these variations. (11, 12)

This study also demonstrated that the dispatchers at the Institute for Emergency Medical Assistance of Canton Sarajevo recognized OHCA with a very high accuracy, most notably in the group of patients with the best odds of survival – witnessed OHCA with an initial shockable rhythm. However, it was clearly noted that efforts of dispatch guided CPR by EMS personnel working in dispatch were, although substantial, in a very high percentage of cases - to no effect, given that the rate of bystander CPR resulting from these efforts was very low. Dispatch guided CPR has proven to be a crucial tool in aiding laymen during CPR, with the systematic review by Nikolau et al in 2019, showing that dispatcher-assisted CPR was associated with a beneficial effect on patient outcomes following OHCA. (9) When comparing dispatcher assisted CPR to no CPR, analysis show that dispatcher assisted CPR provides better results in terms of survival with ROSC, survival to hospital discharge and favorable neurologic outcome (9).

For dispatch assisted CPR to be successful, bystander CPR needs to be carried out. Bystander CPR, mainly the timely start of chest compressions, are essential for enhancing OHCA survival.

In Canton Sarajevo, bystander CPR rates were lower than the European average, with most bystanders being medical professionals (1). Barriers to CPR included lack of training and emotional factors such as anxiety and fear of legal or medical consequences. A recent review confirmed that psychological factors affect CPR initiation, but proper training can help overcome these challenges. Additionally, AED use was low, likely due to an underdeveloped AED network in the region compared to the European average (13-17).

Survival outcomes vary according to the initial rhythm, and ventricular fibrillation or pulseless ventricular tachycardia is a strong predictor of favorable OHCA outcomes (18,19). For example, survival rates of up to 30% have been reported for OHCA patients in VF/pVT (20). Patients with OHCA and an initial VF/pVT rhythm should promptly receive an electrical shock that is immediately followed by chest compressions. Individuals with refractory VF (VF/pVT) who do not

respond to conventional defibrillation have a high rate of death and poor neurological sequelae.

This study's limitations include its observational design, lack of detailed bystander data, and incomplete information on dispatch-guided CPR execution.

6. CONCLUSION

Despite the lack of bystander CPR, the number of patients surviving OHCA is encouraging and could be attributed to an initial shockable rhythm, short response times and well-trained physician led teams. Additional education of the public, as well as improving the AED network could lead to a higher incidence of OHCA with an initial shockable rhythm and therefore better survival rates. A quality registry with a unified system of data gathering is essential for identifying shortcomings and understanding the epidemiology of OHCA in Bosnia and Herzegovina.

- **Author's contribution:** Every author participated in every stage of preparing this article. The initial author conducted the final proofreading.
- **Conflict of interest:** None to declare.
- **Financial support and sponsorship:** None.

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