

# Out-of-hospital cardiac arrest (OHCA) in Bosnia and Herzegovina in the period 2018 -2022: current trends, usage of automated external defibrillators (AED) and bystanders' involvement

Armin Šljivo<sup>1,2\*</sup>, Tatjana Jevtić<sup>2</sup>, Iman Siručić<sup>2</sup>, Selma Terzić-Salihbašić<sup>2</sup>, Arian Abdulkhaliq<sup>2</sup>, Leopold Reiter<sup>3</sup>, Faris Salihbašić<sup>4</sup>, Ajla Bečar-Alijević<sup>2</sup>, Adin Alijević<sup>2</sup>, Ilma Dadić<sup>5</sup>, Fatima Gavrankapetanović<sup>1</sup>

<sup>1</sup>Clinical Centre of the University of Sarajevo, <sup>2</sup>Emergency Medical Service of Canton Sarajevo; Sarajevo, Bosnia and Herzegovina, <sup>3</sup>Faculty of Medicine, Iuliu Hațieganu University of Medicine and Pharmacy Cluj-Napoca, Romania, <sup>4</sup>Emergency Medical Service of Zenica, Zenica, Bosnia and Herzegovina, <sup>5</sup>Outpatient Clinic of Canton Sarajevo, Sarajevo, Bosnia and Herzegovina

## ABSTRACT

**Aim** To investigate out-of-hospital cardiac arrest (OHCA) trend, provided advanced life support (ALS) measures, automated external defibrillator (AEDs) utilization and bystanders involvement in cardiopulmonary resuscitation (CPR) during OHCA incidents.

**Methods** This cross-sectional study encompassed data pertaining to all OHCA incidents attended to by the Emergency Medical Service of Canton Sarajevo, Bosnia and Herzegovina, covering the period from January 2018 to December 2022.

**Results** Among a total of 1131 OHCA events, 236 (20.8 %) patients achieved return of spontaneous circulation (ROSC); there were 175 (74.1%) males and 61 (25.9%) females. The OHCA incidence was 54/100.000 inhabitants per year. After a 30-day period post-ROSC, 146 (61.9%) patients fully recovered, while 90 (38.1%) did not survive during this timeframe. Younger age ( $p < 0.05$ ), initial rhythm of ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) ( $p < 0.05$ ) and faster emergency medical team (EMT) response time ( $p < 0.05$ ) were significantly associated with obtaining ROSC. Only 38 (3.3%) OHCA events were assisted by bystanders, who were mostly medical professionals, 25 (65.7%), followed by close family members, 13 (34.3%). There was no report of AED usage.

**Conclusion** This follow up study showed less ROSC achievement, similar bystanders' involvement, similar factors associated with achieving ROSC (age, EMT response time) and a decline in OHCA events (especially in year 2021 and 2022) comparing to our previous study (2015-2019). There was an extremely low rate of bystander engagement and no AEDs usage. Governments and health organizations must swiftly improve public awareness, promote better practice (basic life support), and actively encourage bystander participation.

**Keywords:** cardiopulmonary resuscitation, cardiac events, resuscitation, return of spontaneous circulation

## INTRODUCTION

Out-of-hospital cardiac arrest (OHCA), positioned as the third preeminent contributor to global mortality,

manifests as the cessation of mechanical cardiac activity in settings beyond the confines of healthcare institutions. This phenomenon predominantly derives from cardiac etiologies, such as coronary artery disease (1), and non-cardiac reasons such as trauma, drowning, burns, asphyxia, or even intoxication (2). OHCA, representing a critical medical exigency, demands expeditious intervention and rigorous resuscitative endeavours aimed at optimizing survival outcomes. Noteworthy is

\* **Corresponding author:** Armin Šljivo

Emergency Medical Service of Canton Sarajevo  
Kolodvorska 14, 71 000 Sarajevo, Bosnia and Herzegovina  
Phone: +387 33 611 111; fax: +387 33 655 939;  
E-mail: [sljivo95@windowsslive.com](mailto:sljivo95@windowsslive.com)  
ORCID: <https://orcid.org/0000-0003-2865-0446>

its substantial impact, afflicting in excess of 350,000 individuals annually within the European domain (2,3). The survival rate varies across regions, with a European average of 9.0% (3).

Swift recognition of OHCA by both medical professionals and laypersons, followed by the immediate activation of an emergency response team, early initiation of cardiopulmonary resuscitation (CPR), timely defibrillation, proficient administration of advanced life support, and the implementation of comprehensive treatment protocols form a vital sequential approach for the successful management of this condition (4,5). The outcome of OHCA is impacted not solely by medical expertise, equipment, medications, age, sex, and the nature of rhythm (shockable or non-shockable) during resuscitation, but also by contextual factors in the field, such as bystander CPR, the utilization of automated external defibrillators (AED) before reaching the hospital, the location of the OHCA event, and the presence of witnesses at the scene of OHCA. While certain medical literature (6) places a direct association between the survival rates of OHCA and the provision of hospital care and advanced life-sustaining treatments, there is a consistent and noteworthy emphasis in the literature on the pivotal role played by bystanders (7). Specifically, the possession of basic life support (BLS) knowledge and the effective utilization of AEDs by individuals at the scene are consistently highlighted as crucial factors contributing to the enhanced survival outcomes in OHCA cases. Additionally, the role of emergency medical dispatch centres in coordinating bystander cardiopulmonary resuscitation (CPR) and AED usage is highlighted as crucial in determining the outcome, be it life or death, of OHCA incidents (7).

Our previous research (8) in Bosnia and Herzegovina (B&H) for the period 2015-2019 revealed that OHCA incidence aligned with the regional average; however, achieving return of spontaneous circulation (ROSC) in OHCA events was lower than the European average, but among the highest in the region (2). Notably, there was a lack of bystander involvement and no utilization of AEDs (8).

This study aimed to investigate potential changes since the previous study (8) of OHCA events, bystander participation in CPR, the utilization of AEDs, and observed practices in Canton Sarajevo, Bosnia and Herzegovina, between 2018 and 2022.

## PATIENTS AND METHODS

### Patients and study design

This retrospective cross-sectional study included patients and data regarding all OHCA events in Canton Sarajevo treated by the Emergency Medical Service of

Canton Sarajevo, Bosnia and Herzegovina (B&H), between January 2018 and December 2022.

The study included individuals who experienced OHCA and received care from the Emergency Medical Service of Canton Sarajevo. Exclusion criteria comprised instances with inadequate or absent medical documentation, and individuals who were solely transported from one medical institution to another without receiving treatment from the Emergency Medical Service of Canton Sarajevo.

The study received approval from the Ethical Committee of the Emergency Medical Service of Canton Sarajevo and adhered to all revisions of the Helsinki Declaration.

### Methods

The comprehensive dataset for this study was meticulously sourced from the official protocols maintained by the Emergency Medical Service of Canton Sarajevo, spanning over the extensive period from January 2018 to December 2022. This rich repository of information encapsulated a diverse array of crucial variables; the data delved into the patients' demographic details (age and gender) providing a nuanced understanding of the affected population. The data analysis encompassed a comprehensive examination of each year's dataset, revealing a detailed overview of a 5-year trend and the inherent fluctuations within all the variables under consideration. This meticulous exploration allowed for a nuanced understanding of the patterns and dynamics inherent in the presented information.

The geographical context of each OHCA event was dissected, classifying the location as either urban or rural, thereby contributing valuable insights into the potential influence of the surrounding environment on OHCA occurrences. Additionally, the temporal dimension was explored, capturing the precise time of arrival of the Emergency Medical Response Team. This temporal granularity aids in unravelling patterns and trends associated with response times. Following the 30-day period post-ROSC, patient's outcome was examined with two distinct trajectories: a noteworthy percentage experienced complete recovery, while a regrettable portion did not survive.

Bystander-related variables were also a focus in collecting data, revealing the profiles of individuals present during OHCA incidents. This encompassed factors such as bystander relationship to the victim and their level of involvement in providing assistance. Furthermore, the dataset documented details related to CPR efforts, including the initiation and duration of CPR by bystanders or medical professionals.

A crucial aspect of this study involved scrutinizing the utilization of AEDs. The data encompassed information regarding whether AEDs were deployed during the emergency response, providing valuable insights into

the prevalence and effectiveness of this life-saving technology in the context of OHCA cases.

### Statistical analysis

The gathered data underwent summarization, and descriptive statistics were applied for analysis. For normally distributed data, frequencies and percentages were utilized, with mean and standard deviation (mean±SD) presented. Non-normally distributed data were expressed using the median and interquartile range (25<sup>th</sup>, 75<sup>th</sup> percentile). To examine the relationships between different variables and specific phenomena, independent samples t-test, Mann-Whitney U test, or  $\chi^2$  test, as deemed appropriate, were conducted. The statistical significance level was established at  $p < 0.05$  (two-sided), ensuring a robust assessment of the findings.

## RESULTS

During the period from January 2018 to December 2022, a total of 1131 OHCA events occurred in Canton Sarajevo of which 236 (20.8 %) obtained ROSC, whereas 895 (79.2 %) had unsuccessful resuscitation: 175 (15.4%) males and 61 (5.3%) females and 615 (54.3%) males and 280 (25.0%) females, respectively. After a 30-day period following the ROSC a complete recovery was noticed in 146 (12.9%) patients; 90 (7.9%) patients did not survive during this period. An examination over a span of five years revealed consistent yearly prevalence of OHCA with respect to gender, age, emergency medical team (EMT) response time, and bystander involvement (Table 1).

Patients undergoing OHCA resuscitations were predominantly males, 790 (69.8 %), of which 175 (15.4 %) for ROSC and 615 (54.3 %) for unsuccessful resuscitations ( $p > 0.05$ ).

Most patients were in the >65 years age group, 582 (51.4%), of which 107 (9.4%) for ROSC and 475 (43.7%) for unsuccessful resuscitation, and 45-65 years age group, 442 (39.0%) of which 103 (9.1%) for ROSC and 339 (29.9%) for unsuccessful resuscitation (Table 1). However, <65 years age group was significantly associated with obtaining ROSC, comparing to age group >65 years ( $p = 0.03$ ).

After initial contact with dispatch of the Emergency Medical Department of Canton Sarajevo, only 38 (3.3%) of 1311 OHCA events were assisted by bystanders, who were mostly medical professionals (medical doctors, medical technicians and emergency medical technicians), 25 (65.7%), followed by close family members, 13 (34.3%).

No AED usage was observed from January 2018 to December 2022 in OHCA events in Canton Sarajevo.

The median response time for EMT was 4.0 (25<sup>th</sup>; 75<sup>th</sup> percentile: 3.0; 7.0). For cases resulting in ROSC, the

median response time was 2.0 (25<sup>th</sup>; 75<sup>th</sup> percentile: 0.0; 5.0), while for unsuccessful resuscitations, it was 6.0 (25<sup>th</sup>; 75<sup>th</sup> percentile; 3.0; 7.0). A faster response time was significantly associated with achieving ROSC compared to unsuccessful resuscitations ( $p < 0.05$ ).

All 1311 OHCA events during the observed period took place in the urban part of Canton Sarajevo.

The predominant initial rhythms in OHCA were mostly asystole or pulseless electrical activity (PEA) accounting for 716 (54.6%), 55 (4.8%) for ROSC and 661 (58.4%) for unsuccessful resuscitation. Only 415 (45.6%) instances of OHCA events, 181 (16.0%) for ROSC and 234 (20.8%) for unsuccessful resuscitation, occurred with an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia without a pulse (VT). Patients whose initial rhythm was VF or VT, demonstrated a significantly higher likelihood ( $p < 0.001$ ) of achieving ROSC.

During the observed period, the treatment of OHCA, included direct current cardioversion (DC shock) in 394 (34.8%) patients, 166 (14.6%) for ROSC and 228 (20.1%) for unsuccessful resuscitation. Epinephrine was administered in all OHCA events (100.0%), with 236 (20.8%) patients achieving ROSC and 895 (79.2%) experiencing unsuccessful resuscitation ( $p < 0.05$ ). More epinephrine was administered in the group where resuscitation efforts were not successful ( $p < 0.05$ ). Amiodarone was used in 251 (22.1%) patients, leading to ROSC in 131 (11.6%) and unsuccessful resuscitation in 120 (10.6%). Endotracheal intubation was performed in 401 (35.4%) patients, resulting in ROSC in 94 (8.3%) and unsuccessful resuscitation in 307 (27.1%) (Table 2).

## DISCUSSION

In the period from January 2018 to December 2022 in Canton Sarajevo, our research revealed successful resuscitations with ROSC for 236 (20.8%) patients, while 895 resuscitation attempts were unsuccessful. Factors associated with achieving ROSC in OHCA incidents included younger age, quicker EMT response times, and an initial rhythm of ventricular fibrillation or pulseless ventricular tachycardia. The study also documented a significantly low rate of bystander involvement and the absence of AED usage in OHCA events. Advanced life support measures in accordance with the current European Resuscitation Council guidelines (9) were implemented, involving interventions such as DC shocks, administration of epinephrine and/or amiodarone, and endotracheal intubation.

Compared to our previous study (8), this follow up study showed less ROSC achievement, similar bystanders' involvement, similar factors associated with achieving ROSC (age, EMT response time) and a decline in OHCA events, especially in year 2021 and 2022.

Table 1. Gender, return of spontaneous circulation (ROSC) outcome, age, emergency medical team (EMT) response time, initial rhythm and bystanders' involvement in out-of-hospital cardiac arrest (OHCA) events in Canton Sarajevo in the period January 2018 to December 2022 in comparison to return of spontaneous circulation (ROSC) group and unsuccessful resuscitations

Variable	Year (No of patients)					Total (1131)	P
	2018 (284)	2019 (225)	2020 (246)	2021 (159)	2022 (217)		
<b>Male/Female (No; %)</b>							
ROSC	39 (13.7)/24 (8.4)	46 (20.4)/10 (4.4)	28 (11.3)/10 (4.0)	23 (14.4)/5 (3.1)	39 (17.9)/12 (5.5)	175 (15.4)/61 (5.3)	
Unsuccessful resuscitation	141(49.6)/80 (28.3)	119 (52.8)/50 (22.4)	142 (57.7)/66 (27.0)	94 (59.1)/37 (23.4)	119 (54.8)/47 (21.6)	615 (54.3)/280 (25.0)	>0.05
<b>ROSC outcomes (No, %)</b>							
Complete recovery	32 (11.2)	39 (17.3)	30 (12.1)	26 (16.3)	19 (8.7)	146 (12.9)	N/A
Death	31 (11.1)	17 (7.5)	8 (3.2)	2 (1.2)	32 (14.7)	90 (7.9)	
<b>Age groups (No; %) (years)</b>							
<25 years	0	0	0	1 (0.9)	1 (0.4)	2 (0.2)	
25-45 years	8 (2.8)	5 (2.2)	4 (1.6)	3 (1.8)	4 (2.5)	24 (2.1)	
46-65 years	21 (7.4)	27 (12.0)	21 (8.6)	7 (4.4)	27 (16.9)	103 (9.1)	
>65 years	34 (11.9)	24 (10.6)	13 (5.2)	17 (10.7)	19 (11.9)	107 (9.4)	
<25 years	4 (1.4)	5 (2.2)	2 (0.8)	4 (2.5)	2 (0.8)	17 (1.5)	>0.05
25-45 years	15 (5.2)	10 (4.4)	19 (7.7)	10 (6.2)	10 (4.6)	64 (5.6)	
46-65 years	78 (27.4)	71 (31.5)	80 (32.5)	50 (31.4)	60 (27.6)	339 (29.9)	
>65 years	124 (43.9)	83 (37.1)	107 (43.4)	67 (42.1)	94 (35.3)	475 (43.7)	
<b>Response time (median, 25<sup>th</sup>, 75<sup>th</sup> percentile) (minutes)</b>							
ROSC	3.0 (0.0; 6.0)	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 (0.0; 5.0)	<0.05
Unsuccessful resuscitation	6.0 (3.0, 9.0)	4.0 (2.0; 7.0)	6.0 (3.0; 7.0)	5.0 (3.0, 8.0)	6.0 (3.0; 7.0)	6.0 (3.0;7.0)	
<b>Initial rhythm (No, %)</b>							
ROSC	22 (7.7)	9 (4.0)	10 (4.0)	8 (5.0)	6 (2.7)	55 (4.8)	
Asystole/PEA	37 (13.0)	38 (16.8)	31 (12.6)	26 (16.3)	49 (22.5)	181 (16.0)	<0.001
VF/VT	185 (65.1)	135 (60.0)	153 (62.1)	81 (50.9)	107 (49.3)	661 (58.4)	
Unsuccessful resuscitation	40 (14.2)	43 (19.2)	52 (21.3)	44 (27.8)	55 (25.5)	234 (20.8)	
Asystole/PEA							
VF/VT							
<b>Bystander involvement (No; %)</b>							
ROSC	3 (1.0)	5 (2.2)	2 (0.8)	4 (2.5)	2 (0.9)	16 (1.4)	N/A
Unsuccessful resuscitation	3 (1.0)	8 (3.5)	4 (1.6)	5 (3.1)	2 (0.9)	22 (1.9)	

N/A, not applicable; PEA, pulseless electrical activity; VF, ventricular fibrillation, VT, ventricular tachycardia without pulse

**Table 2. Treatment modalities in out-of-hospital cardiac arrest (OHCA) events in Canton Sarajevo in the period January 2018 to December 2022 in comparison to return of spontaneous circulation (ROSC) group and unsuccessful resuscitations**

Variable	Year (No of patients)					Total (1131)	p
	2018 (284)	2019 (225)	2020 (246)	2021 (159)	2022 (217)		
<b>DC shock YES/NO (No; %)</b>							
ROSC	36 (12.6)/ 1 (0.3)	35 (15.5)/ 3 (1.3)	31 (100.0)/0	20 (12.5)/ 6 (3.0)	44 (20.2)/ 5 (2.3)	166 (14.6)/ 15 (1.3)	N/A
Unsuccessful resuscitation	37 (13.0)/ 3 (0.9)	43 (100)/0	52 (100.0)/0	41 (25.0)/ 3 (1.5)	55 (100.0)/0	228 (20.1)/ 6 (0.5)	
<b>Epinephrine usage (No, %)</b>							
ROSC	0	18 (8.0)	3 (1.2)	2 (1.2)	4 (1.8)	27 (2.3)	<0.05
(ampule)	2	7 (3.1)	2 (0.8)	3 (1.8)	6 (2.7)	44 (3.8)	
	3	3 (1.3)	3 (1.2)	5 (3.0)	5 (2.3)	27 (2.3)	
	>3	19 (8.4)	33(13.4)	24 (15.0)	40 (18.4)	138 (12.2)	
Unsuccessful resuscitation	1	31 (13.7)	9 (3.6)	10 (6.2)	13 (5.9)	67 (6.3)	
(ampule)	2	7 (3.1)	4 (1.6)	14 (8.8)	17 (7.8)	55 (4.8)	
	3	32 (13.8)	15 (6.0)	13 (8.1)	33 (15.2)	123 (10.8)	
	>3	108 (48.0)	177 (72.2)	88 (55.9)	99 (45.6)	650 (57.5)	
<b>Amiodarone usage (No, %)</b>							
ROSC (mg)	150	13 (5.7)	9 (3.6)	5 (3.1)	10 (4.6)	46 (4.0)	>0.05
	300	8 (3.5)	4 (1.6)	7 (4.4)	12 (5.5)	42 (3.7)	
	450	9 (4.0)	6 (2.4)	8 (5.0)	15 (6.9)	43 (3.8)	
Unsuccessful resuscitation	150	9 (4.0)	4 (1.6)	9 (5.6)	14 (6.4)	44 (3.8)	
(mg)	300	7 (3.1)	7 (2.8)	8 (5.0)	11 (5.0)	34 (3.0)	
	450	4 (1.8)	2 (0.8)	11 (6.9)	15 (6.9)	42 (3.7)	
<b>Endotracheal intubation Yes/No (No, %)</b>							
ROSC	27 (9.5)	18 (8.0)	10 (4.0)	14 (8.8)	25 (11.5)	94 (8.3)	N/A
Unsuccessful resuscitation	46 (16.1)	106 (47.1)	58 (23.5)	43 (27.0)	54 (24.8)	307 (27.1)	

DC shock, direct current cardioversion shock; N/A-non applicable

The difference observed in comparison to the previous study, concerning the reduced attainment of ROSC, may be linked to changes in the root causes of cardiac arrest incidents (10); factors like respiratory failure stemming from COVID-19 infections could have influenced the decline in ROSC rates (11,12). Similarly, these factors might also account for the decreased occurrences of OHCA events in the years 2021 and 2022. It is plausible that individuals refrained from seeking appropriate medical attention during this period due to COVID-19 restrictions, fear of getting infected or contracting the disease (13,14), contributing to the overall decrease in OHCA cases.

When comparing data with the EuReCA ONE study (15), the average incidence of OHCA was 54/100,000 inhabitants, demonstrating a lower rate than in neighbouring countries, such as Croatia (62/100,000), Serbia (183/100,000), and Slovenia (69/100,000). This decrease in OHCA events may be attributed to the impact of the COVID-19 pandemic and the socio-epidemiological measures implemented, which hindered proper responses from bystanders, particularly family members. The rate of ROSC among OHCA cases was lower compared to the overall European average (20.8% vs. 28.6%) (15). However, within the region, it stands among the highest, albeit lower than Slovenia, similar to Croatia, and lower than Serbia. This discrepancy could be elucidated by the significantly low or absent involvement of bystanders in OHCA events, limited knowledge, lack of prior training in administering basic life support (BLS) measures

among bystanders, and insufficient availability and distribution of AEDs in the region (8,15).

One of the variables that exhibited notable variability and had a substantial impact on the outcome of OHCA was the EMT response time. In our patients with ROSC, the EMT reaction time was quicker than the established optimal response time threshold, 6.2 minutes (16). This swift EMT response time could potentially be a decisive factor contributing to a favourable overall survival rate for OHCA in our study.

Our research showed a concerning pattern characterized by a notably low level of involvement in cardiopulmonary resuscitation (CPR) by bystanders, coupled with an infrequent utilization of AEDs. This figure stands in stark contrast to the European average AED usage rate of 50.0% (15). The factors contributing to this alarming trend include insufficient knowledge about BLS, uncertainty among individuals regarding the appropriate circumstances for administering CPR, a lack of prior training in both BLS measures and AED usage, and an inadequately developed AED network with suboptimal distribution (8,17). A noteworthy observation from our study is that the majority of bystanders who did engage in OHCA events were medical professionals. While their involvement is valuable, it underscores the critical necessity for a broader educational initiative targeting the general population (18,19). Additionally, there is a clear need for the expansion and enhancement of the AED network. By implementing these measures, we anticipate a substantial improvement in the overall sur-



vival rate of OHCA events, moving us closer to achieving parity with the European average (20). This underlines the importance of comprehensive efforts in public education and infrastructure development to foster a more resilient and responsive community in emergency situations.

Our research encountered several limitations. Firstly, the cross-sectional nature of the study impedes our ability to establish causality. Secondly, information extracted from Emergency Medical Service Protocols lacked details regarding bystanders' educational backgrounds and actions taken during the EMT response to the OHCA event. To address these shortcomings, future studies should be conducted prospectively, incorporating a more comprehensive dataset.

In conclusion, our investigation indicates that the incidence/prevalence of OHCA events in Bosnia and Herzegovina aligns with regional trends. While the attainment of ROSC in OHCA cases was below the European average, it ranked among the highest in the region. The factors influencing the outcomes of OHCA in our population were found to be comparable to those observed in the European context. However, there was a concerning lack of bystander involvement and minimal utilization of AEDs during the studied period. Urgent intervention by governmental institutions and health agencies is imperative to significantly enhance public knowledge, thereby promoting better practices and ultimately elevating the overall survival rate for OHCA in Bosnia and Herzegovina.

## FUNDING

No specific funding was received for this study

## TRANSPARENCY DECLARATION

Conflicts of interest: None to declare

## REFERENCES

- 1 Geri G, Passouant O, Dumas F, Bougouin W, Champigneulle B, Arnaut M, et al. Etiological diagnoses of out-of-hospital cardiac arrest survivors admitted to the intensive care unit: Insights from a French registry. *Resuscitation* 2017;117:66–72. doi: 10.1016/j.resuscitation.2017.06.006.
- 2 European Registry of Cardiac Arrest-Study TWO (EuReCa TWO) 2022 <https://cms.erc.edu/news/european-registry-of-cardiac-arrest-study-two-eure-ca-two> (accessed January 18, 2022).
- 3 Berdowski J, Berg RA, Tijssen JGP, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. *Resuscitation* 2010;81(11):1479–87. doi: 10.1016/j.resuscitation.2010.08.006.
- 4 Semeraro F, Greif R, Böttiger BW, Burkart R, Cimpoesu D, Georgiou M, et al. European Resuscitation Council Guidelines 2021: Systems saving lives. *Resuscitation* 2021;161:80–97. doi: 10.1016/j.resuscitation.2021.02.008.
- 5 Ahn JY, Ryoo HW, Moon S, Jung H, Park J, Lee WK, et al. Prehospital factors associated with out-of-hospital cardiac arrest outcomes in a metropolitan city: a 4-year multicenter study. *BMC Emerg Med* 2023;23(1):125. doi: 10.1186/s12873-023-00899-3.
- 6 Larribau R, Deham H, Niquille M, Sarasin FP. Improvement of out-of-hospital cardiac arrest survival rate after implementation of the 2010 resuscitation guidelines. *PloS One* 2018;13(9):e0204169. doi: 10.1371/journal.pone.0204169.
- 7 Shinozaki K, Nonogi H, Nagao K, Becker LB. Strategies to improve cardiac arrest survival: a time to act. *Acute Med Surg* 2016;3(2):61–4. doi: 10.1002/ams2.192.
- 8 Zalihić A, Šljivo A, Ribić E, Gavranović A, Brigić L. Bystanders' cardiopulmonary resuscitation involvement in the treatment of out-of-hospital cardiac arrest events and educational status regarding basic life support measures and automated external defibrillator usage among residents in Canton Sarajevo, Bosnia and Herzegovina. *Med Glas Off Publ Med Assoc Zenica-Doboj Cant Bosnia Herzeg* 2022;19(2). doi: 10.17392/1472-22.
- 9 Soar J, Böttiger BW, Carli P, Couper K, Deakin CD, Djäv T, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. *Resuscitation* 2021;161:115–51. doi: 10.1016/j.resuscitation.2021.02.010.
- 10 Teoh SE, Masuda Y, Tan DJH, Liu N, Morrison LJ, Ong MEH, et al. Impact of the COVID-19 pandemic on the epidemiology of out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Ann Intensive Care* 2021;11(1):169. doi: 10.1186/s13613-021-00957-8.
- 11 Šljivo A, Kačamaković M, Quraishi I, Džubur Kulenović A. Fear and Depression among Residents of Bosnia and Herzegovina during COVID-19 Outbreak - Internet Survey. *Psychiatr Danub* 2020; 32(2):266–72. doi: 10.24869/psyd.2020.266.
- 12 Šljivo A, Kulenović AD. Fear, Anxiety and Depression among Bosnia and Herzegovina Citizens during the Third Wave of COVID-19. *Iran J Psychiatry* 2023;18(1):1–10. doi: 10.18502/ijps.v18i1.11407.
- 13 Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet Lond Engl* 2020;395(10229):1054–62. doi: 10.1016/S0140-6736(20)30566-3.
- 14 Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet Lond Engl* 2020;395(10223):507–13. doi: 10.1016/S0140-6736(20)30211-7.

- 15 Gräsner J-T, Lefering R, Koster RW, Masterson S, Böttiger BW, Herlitz J, et al. EuReCa ONE-27 Nations, ONE Europe, ONE Registry: A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe. *Resuscitation* 2016;105:188–95. doi: 10.1016/j.resuscitation.2016.06.004.
- 16 Huang LH, Ho Y-N, Tsai M-T, Wu W-T, Cheng F-J. Response Time Threshold for Predicting Outcomes of Patients with Out-of-Hospital Cardiac Arrest. *Emerg Med Int* 2021;2021:5564885. doi: 10.1155/2021/5564885.
- 17 Jarrah S, Judeh M, AbuRuz ME. Evaluation of public awareness, knowledge and attitudes towards basic life support: a cross-sectional study. *BMC Emerg Med* 2018;18;(1):37. doi: 10.1186/s12873-018-0190-5.
- 18 Mawani M, Kadir MM, Azam I, Mehmood A, McNally B, Stevens K, et al. Epidemiology and outcomes of out-of-hospital cardiac arrest in a developing country—a multicenter cohort study. *BMC Emerg Med* 2016;16;(1):28. doi: 10.1186/s12873-016-0093-2.
- 19 Khan UR, Khudadad U, Baig N, Ahmed F, Raheem A, Hisam B, et al. Out of hospital cardiac arrest: experience of a bystander CPR training program in Karachi, Pakistan. *BMC Emerg Med* 2022;22;(1):93. doi: 10.1186/s12873-022-00652-2.
- 20 Simmons KM, McIsaac SM, Ohle R. Impact of community-based interventions on out-of-hospital cardiac arrest outcomes: a systematic review and meta-analysis. *Sci Rep* 2023;13;(1):10231. doi: 10.1038/s41598-023-35735-y.

**Publisher's Note** Publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations