Submitted: 29 January, 2024 Accepted: 17 April, 2024 Published: 08 November, 2024 DOI:10.22514/sv.2024.146

Open Access

Signa Vitae

ORIGINAL RESEARCH

Out-of-hospital cardiac arrest before and during the COVID-19 pandemic: a retrospective observational study

Radojka Jokšić-Mazinjanin[1,2], Nikolina Marić[2], Aleksandar Đuričin[1,2,*], Goran Rakić[1,3], Ilija Srdanović[1,4], Milana Maljah[5], Milena Jokšić Zelić[6], Zdravka Burinović[7], Branislav Martinović[8], Velibor Vasović[1,9]

[1]Medical faculty, University in Novi Sad, 21000 Novi Sad, Serbia
[2]Institute for Emergency Medical Services Novi Sad, 21000 Novi Sad, Serbia
[3]Clinic for Children's Surgery, Institute for Health Care of Children and Youth of Vojvodina, 21000 Novi Sad, Serbia
[4]Clinic for Cardiology, Institute for Cardiovascular Diseases of Vojvodina, 21000 Novi Sad, Serbia
[5]Health Center Novi Bečej, 23272 Novi Bečej, Serbia
[6]Health Center Bečej, 21220 Bečej, Serbia
[7]Health Center Temerin, 21235 Temerin, Serbia
[8]Health Center "Ruma", 22400 Ruma, Serbia
[9]Academy of Medical Sciences of Serbian Medical Society, 11000 Beograd, Serbia

***Correspondence**
aleksandar.djuricin@mf.uns.ac.rs
(Aleksandar Đuričin)

Abstract

The Coronavirus Disease 2019 (COVID-19) pandemic significantly impacted the management of out-of-hospital cardiac arrest (OHCA), necessitating considerable reorganization within global healthcare systems. This study aims to assess the influence of the COVID-19 pandemic on the treatment outcomes and the rate of sustained prehospital return of spontaneous circulation (ROSC) until hospital admission in patients experiencing OHCA. We conducted a retrospective observational study to evaluate the survival outcomes of OHCA patients who received cardiopulmonary resuscitation (CPR) from emergency medical services (EMS) teams before and during the COVID-19 pandemic from 11 March 2018 to 10 March 2022. The patients were categorized into two cohorts: those who suffered OHCA prior to the pandemic (Pre-pandemic group) from 11 March 2018, to 10 March 2020, and those during the pandemic (Pandemic group), from 11 March 2020, to 10 March 2022. The study included 958 patients divided into the Pre-pandemic group (n = 434 patients) and Pandemic group (n = 524 patients) ($p < 0.05$). Analysis showed no significant differences between the groups in terms of age, gender, EMS response time, initial cardiac rhythm and adrenaline administration. Endotracheal intubation was more frequently performed in the Pre-pandemic group ($\chi^2 = 8.737$; $df = 3$; $p = 0.033$), as were the administrations of amiodarone ($\chi^2 = 6.508$; $df = 1$; $p = 0.011$) and saline solution ($\chi^2 = 5.510$; $df = 1$; $p = 0.019$). Rates of prehospital ROSC until hospital admission were significantly higher in the Pre-pandemic group (18.4%) compared to the Pandemic group (12.6%) ($\chi^2 = 5.685$; $df = 1$; $p = 0.017$). During the COVID-19 pandemic, there was an increase in OHCA incidents in our study region compared to before the pandemic period. Concurrently, we observed a significant reduction in the proportion of patients achieving and maintaining ROSC prehospital until hospital admission during the pandemic.

Keywords

Coronavirus Disease 2019; Cardiopulmonary resuscitation; Sudden cardiac arrest; Survival

1. Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic precipitated widespread disruption across global healthcare systems, significantly affecting the incidence and outcomes of out-of-hospital cardiac arrest (OHCA). This impact varied by region, reflecting differences in pandemic severity and healthcare response capabilities [1]. In areas with high COVID-19 case loads, such as the Lombardy region of Italy, studies reported decreased survival rates following OHCA, characterized by reduced instances of return of spontaneous circulation (ROSC) and increased mortality rates [2]. Conversely, even in regions with comparatively lower incidence rates of COVID-19, such as Paris and its surrounding areas, a decline in OHCA survival was still evident [3].

In the first weeks of the pandemic, two studies reported an increase in the incidence of OHCA and a decrease in survival rates [2, 3]. Although it was anticipated that subsequent research during the pandemic would reveal different outcomes, subsequent findings indicated that, compared to the pre-pandemic era, the incidence of OHCA continued to increase, while ROSC and survival rates (up to the hospital discharge) varied from region to region [4, 5].

COVID-19 infection can precipitate rapid respiratory failure and cardiac complications, potentially leading to fatal outcomes if not promptly and effectively managed in intensive care units (ICU) [6]. Following the pandemic outbreak, many patients with chronic conditions delayed or avoided the regular medical check-ups due to fears of contracting the virus in healthcare settings. Despite having high-risk health conditions, a significant number were hesitant to engage emergency medical services (EMS) or to be transported to the emergency room (ER), resulting in healthcare systems needing to adapt by reorganizing and prioritizing care for both urgent non-COVID-19 conditions and patients with COVID-19 [7]. In response, new protocols for managing OHCA were developed for both medical professionals and laypersons, placing a strong emphasis on the personal safety of the rescuer to prevent COVID-19 transmission. These included the mandatory use of personal protective equipment and, where unavailable, the recommendation to use bag-valve-mask ventilation (BVM) [8]. Misinformation, particularly prevalent social media, and shortages of personal protective equipment compounded these challenges. Fear of transmitting COVID-19 discouraged bystander initiation of cardiopulmonary resuscitation (CPR) prior to EMS arrival, and emergency operators became more reluctant to instruct bystanders to attempt CPR. These factors likely contributed to the observed impact on OHCA survival rates during the pandemic [9, 10].

Herein, we performed this study to assess the impact of the COVID-19 pandemic on the incidence, management and sustained prehospital ROSC until transfer to the admission room of patients with OHCA in our region and identify factors that might have influenced the observed outcomes.

2. Materials and methods

This retrospective observational study assessed the effects of the COVID-19 pandemic on the survival of OHCA patients, who received CPR from EMS teams. The study was conducted during a four-year period, between 11 March 2018 and 10 March 2022 and data from the pre-pandemic period (11 March 2018–10 March 2020) and the pandemic period (11 March 2020–10 March 2022) were compared. Prehospital data were collected at the Institute of Emergency Medicine Novi Sad (IEMS NS) and the Health Centers in the municipalities of Temerin, Bečej and Novi Bečej.

2.1 Source of data

The medical institutions involved in this study serve an area with a population of 455,000 inhabitants. There is a structural difference between the IEMS NS and the Health Centers at the municipal level. In Novi Sad, the EMS Call Center processes incoming calls, triaging them based on urgency. The city is served by nine prehospital EMS teams, each comprising a medical doctor (or emergency medicine specialist), a paramedic and a driver trained in basic life support (BLS). Comparatively, the municipal Health Centers, have one or two prehospital EMS teams, with similar compositions but lack dedicated Call Center personnel. Thus, doctors or paramedics in these teams directly respond to emergency calls on the 194 line. Each team is equipped with advanced life support (ALS), including a biphasic defibrillator, an intubation kit with supraglottic/subglottic airway devices, and necessary medications. CPR was conducted in accordance with the 2015 European Resuscitation Council (ERC) ALS protocol across all teams. Upon the release of the ERC COVID-19 Guidelines, adjustments were made to adhere to these recommendations based on available equipment. Notably, automated external compression devices were not employed, and manual compressions remained the standard throughout the study. During the pandemic, the EMS teams adopted droplet-precaution personal protective equipment (PPE) as a minimum standard, escalating to airborne-precaution PPE for responses to confirmed COVID-19-positive patients based on ERC guidance. Typically, teams already equipped with the necessary protective gear were dispatched. The EMS Call Center maintains a record of all calls, which are registered and recorded. Data, including personal data, vital parameters, initial rhythm, airway management, delivered shocks, medications and sustained ROSC during intervention and transport to the hospital, were extracted from prehospital medical records and were securely stored in both paper and electronic formats as classified documents.

2.2 Study design

In this study, we included all patients who experienced OHCA on the territories covered by the aforementioned medical institutions. Patients who underwent CPR by EMS teams were categorized into two cohorts: Pre-pandemic group, consisting of cases occurring before the COVID-19 pandemic from 11 March 2018, to 10 March 2020, and the Pandemic group, including cases during the pandemic from 11 March 2020, to 10 March 2022. The inclusion criterion was experiencing OHCA and receiving CPR from EMS teams. Exclusion criteria were patients who did not receive ALS and those who experienced sudden cardiac arrest (SCA) within hospital admission rooms.

2.3 Data analysis

In this retrospective cohort study, we evaluated 958 patients who experienced OHCA and were treated by EMS teams. They were divided into two groups: Pre-pandemic (n = 434, 45.30%) and Pandemic group (n = 524, 54.70%). Key variables for comparison included demographic data (age and gender), time to EMS arrival (measured from the call to EMS arrival at the scene) and clinical interventions (airway management, medication administration including adrenaline, amiodarone and saline solutions and the delivery Direct Current (DC) shocks). For cases where the EMS team witnessed the OHCA, the time to EMS arrival was excluded from the average arrival time calculation. The study also examined the initiation of CPR, distinguishing between immediate initiation by bystanders or the EMS team. Initial heart rhythms were identified through defibrillator monitor readings and categorized into asystole, pulseless electrical activity (PEA), ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT). An important outcome measure was the achievement of ROSC, which serves as a primary indicator of CPR effectiveness in both pre-pandemic and pandemic settings.

2.4 Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 23; IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD), or median with interquartile range (Q1–Q3) and range (minimum–maximum) based on the distribution of the data. Categorical variables are expressed as frequencies and percentages (n, %). The comparison between groups for continuous variables was performed using the Student's *t*-test or Mann-Whitney U test, contingent on the distribution's normality. Categorical variables were compared using the chi-square (χ^2) test. Variables with associated p values < 0.05 were considered statistically significant.

Results are presented in tabular format.

3. Results

Among the 958 patients analyzed, a significant difference was observed in the distribution between the Pre-pandemic group and the Pandemic group (χ^2 = 8.455; *df* = 1; p = 0.004), with fewer patients in the Pre-pandemic group. The overall sample comprised more males (660; 68.9%) than females (298; 31.1%). Although a significant difference in gender distribution was noted across the entire sample 88 (χ^2 = 136.785; *df* = 1; $p < 0.001$), there was no significant difference in gender distribution between the two groups (χ^2 = 123.785; *df* = 1; p = 0.726). The mean ages of the groups were comparable (t = 0.667; p = 0.505). No statistical difference was found in the initial heart rhythm observed between the groups (χ^2 = 1.047; *df* = 2; p = 0.592), with over 54% of cases in both groups presenting with asystole and the smallest number showing VF/pVT. OHCA was witnessed by EMS in 17.3% Pre-pandemic cases and 16.8% during the pandemic. The median time to EMS arrival was similar across groups, ranging from one to seven minutes in the Pre-pandemic group, including four patients with an arrival time of 25 minutes, and one to six minutes during the pandemic, with no significant difference (Z = −1.231; p = 0.218). Immediate CPR initiation was observed in 21.4% of Pre-pandemic and 18.5% of Pandemic cases, a difference that was not statistically significant (χ^2 = 136.785; *df* = 1; p = 0.296) (Table 1).

Regarding the ALS interventions during CPR, we observed a significantly higher frequency of endotracheal intubation in Pre-pandemic group compared to Pandemic group (χ^2 = 8.737; *df* = 3; p = 0.033). The pandemic period had an increase in the use of BVM ventilation, while the use of I-GEL airway management devices remained consistent between both groups. Before the pandemic, saline solutions were administered more frequently (χ^2 = 5.510; *df* = 1; p = 0.019). Adrenaline was used in approximately 95% of cases in both groups, but the difference was not significant (χ^2 = 0.008; *df* = 1; p = 0.929). In each group, around half of the patients received one to four ampoules of adrenaline (1 mg/1 mL). The use of amiodarone was significantly higher before the pandemic (χ^2 = 6.508; *df* = 1; p = 0.011), although the quantity of amiodarone administered (150 mg/3 mL) did not vary significantly between the groups (Table 2).

Prehospital ROSC and survival to hospital admission room were found to be significantly more frequent in the OHCA group before the pandemic (18.4%) than during the pandemic (12.6%) (χ^2 = 5.685; *df* = 1; p = 0.017) (Table 3).

4. Discussion

During the COVID-19 pandemic, the incidence of OHCA increased by 20.7% in the studied area. Similar increases in OHCA incidence were reported in other studies, although the extent of the increase varied. Lim *et al.* [11] observed a 9.38% increase in OHCA incidence, while Nickles *et al.* [12] reported a more substantial increase of 59.55% [11, 12]. Conversely, Paoli *et al.* [13] documented a 3% decrease in OHCA incidence, but this finding was noted with caution due to the study's small sample size and shorter follow-up period.

In this study, no significant differences in age and gender distribution were observed between groups. However, throughout the pandemic, we observed a tendency of the infected patients being slightly younger and comprising more females, aligning with the findings of other studies [3, 14]. The average age of patients, both before and during the pandemic was 70 years, which matches the demographic of our study. Although OHCA was more frequently reported among males, an increase in cases among females was also noted during the pandemic period [3, 14, 15].

The pandemic urged a global restructuring of healthcare systems to accommodate the new health crisis, which included the suspension of elective medical procedures and a noticeable decline in ER visits, partly due to fear of infection and partly because of restricted access to healthcare services. Prehospital EMS and ER primarily focused on patients with life-threatening conditions, with COVID-19 patients often being given priority [16–18]. These adjustments, alongside limited access to routine care, likely contributed to the deterioration of chronic patients conditions. The increase in OHCA was significantly influenced by both delayed and reduced access to healthcare services during the COVID-19 pandemic, as well as by the infection itself [2, 18, 19].

The restructured health system, aiming to accommodate the increased demand during the pandemic, inadvertently extended the response times of EMS, particularly for OHCA cases. Bielsky *et al.* [20] conducted a meta-analysis of eighteen studies reporting data from OHCA events and comparing the periods before the pandemic and after its outbreak and reported that the time for EMS arrival decreased in only three studies. In contrast to the general trend of increased EMS arrival times during the COVID-19 pandemic, a study by Nishiyama *et al.* [21] reported a reduction in arrival time by one minute. Similarly, two other studies noted a modest decrease in arrival time by 0.2 minutes [20–23]. However, most studies reported that, on average, EMS response times to OHCA cases extended by 0.2 to 3 minutes during the pandemic period [2, 20, 24]. Specifically, before the pandemic, the average EMS arrival time was recorded at 9.1 ± 2.1 minutes, whereas it increased to 9.8 ± 2.6 minutes during the pandemic [20]. Interestingly, our study observed a decrease in EMS arrival time by one minute during the pandemic.

The results of our study also differ in the initial rhythm assessment. In most studies on OHCA, there was a decrease in the frequency of shockable rhythms. Notably, a comprehensive analysis by Bielski *et al.* [20] of 31 studies examining OHCA incidents both before and throughout the pandemic revealed a decrease in the occurrence of shockable

TABLE 1. Baseline characteristics of patients with OHCA.

Characteristics	Pre-pandemic group (n = 434)	Pandemic group (n = 524)	*p*-value
Gender‡			0.726
Male, n (%)	302 (69.6%)	358 (68.3%)	**0.029**
Female, n (%)	132 (30.4%)	166 (31.7%)	**0.049**
Age (yr)#, (Mean ± SD)	67.0 ± 13.4	66.4 ± 18.8	0.505
Initial rhythm‡			0.592
Asystole	238 (54.8%)	284 (54.2%)	**0.044**
PEA	122 (28.1%)	138 (26.3%)	0.321
VF/pulseless VT	74 (17.1%)	102 (19.5%)	**0.035**
Time to EMS arrival (minute)†, median (Q1–Q3)	7 (5–9)	6 (5–9)	0.218
Min–Max	1–25	1–21	
Immediate CPR attempt‡, n (%)	93 (21.4%)	97 (18.5%)	0.296
CPR attempted by bystanders	18 (4.2%)	9 (1.7%)	0.215

‡χ^2 test; #Student's t-test; †Mann-Whitney's U test; Q1: 25%; Q3: 75%; Min: minimal value; Max: maximal value; SD: standard deviation; Numbers in boldface are statistically significant values; PEA: pulseless electrical activity; VF: ventricular fibrillation; VT: ventricular tachycardia; EMS: emergency medical services; CPR: cardiopulmonary resuscitation.

TABLE 2. ALS data of the EMS teams.

Characteristics	Pre-pandemic group (n = 434)	Pandemic group (n = 524)	*p*-value
Airway management during CPR, n (%)‡			**0.033**
BVM	95 (22.9%)	154 (29.4%)	<**0.001**
ETI	322 (74.2%)	355 (67.4%)	0.205
I-GEL	7 (1.6%)	9 (1.7%)	0.617
NNV	10 (2.3%)	5 (1.0%)	0.197
Not ventilated	0 (0.0%)	1 (0.2%)	
DC shocks‡, n (%)	111 (25.6%)	127 (24.2%)	0.715
Number of shocks†, median (Q1–Q3)	2 (1.75–4.00)	3 (1.00–3.00)	0.921
Min–Max	1–15	1–17	
Saline solution‡, n (%)	118 (27.2%)	107 (20.4%)	**0.019**
Adrenaline‡, n (%)	411 (94.7%)	497 (95.0%)	0.929
Ampullae of adrenaline† (1 mg/1 mL), median (Q1–Q3)	4 (3–6)	4 (3–6)	0.693
Min–Max	1–10	1–16	
Amiodarone‡, n (%)	67 (15.4%)	51 (9.7%)	**0.011**
Ampullae of amiodarone† (150 mg/3 mL), median (Q1–Q3)	2 (1–2)	2 (1–2)	0.985
Min–Max	1–2	1–3	

‡χ^2 test; †Mann-Whitney U test; Numbers in boldface are statistically significant values; Q1: 25%; Q3: 75%; Min: lowest value; Max: maximal value; CPR: cardiopulmonary resuscitation; BVM: bag-valve-mask ventilation; DC: Direct Current; ETI: endotracheal intubation; NNP: no need for ventialtion.

TABLE 3. Sustained prehospital ROSC and survival of patients with OHCA during the transfer to the hospital admission room.

Characteristics	Pre-pandemic group (n = 434)	Pandemic group (n = 524)	*p*-value
ROSC[1], n (%)‡	80 (18.4%)	66 (12.6%)	**0.017**

‡χ^2 test; Numbers in boldface are statistically significant values; [1]return of spontaneous circulation. ROSC: return of spontaneous circulation.

rhythms. The meta-analysis, which included data from 21 studies, reported a 4.3% reduction in shockable rhythms during the pandemic, with only 12.4% of OHCA cases presenting with a shockable rhythm at the time of EMS intervention [20]. Our study reveals an interesting finding of increased shockable rhythms during the COVID-19 pandemic, showing a 7.1% rise compared to other investigations. This observation is particularly intriguing given the notably low incidence of bystander-initiated CPR in our region, which remains below 2.5%. Before the pandemic, bystander CPR was reported in 4.2% of OHCA cases, which decreased to 1.7% during the pandemic. This decrease contrasts with earlier data from a 2010 study in a similar setting, where bystander CPR initiation was at 11.6%, indicating a longstanding trend of low bystander intervention rates predating the pandemic [25]. In addition, this rate is significantly lower compared to international data, where bystander CPR rates varied from 25% to 73.5% before the pandemic and from 18.2% to 78.7% during the pandemic [2, 13, 26]. The potential explanations behind the increase in shockable rhythms during the pandemic in our study remain unclear, especially considering the minimal involvement of bystanders in CPR efforts, thereby urging the need for further investigations.

Regarding airway management strategies for OHCA patients during the pandemic, there was a decrease in the frequency of endotracheal intubation, paralleled by an increased reliance on BVM ventilation to support respiratory functions. Concurrently, the administration of DC shocks, saline solutions and amiodarone was reported to decrease. This pattern aligns with findings from multiple studies, which collectively highlight a significant reduction in the deployment of various prehospital interventions for OHCA management during the pandemic period. A review of related literature reveals a decrease in the rate of endotracheal intubation, with six studies documenting decreases ranging from 3.8% to 27.7% [15, 24, 26–29]. This period also had an increase in the utilization of supraglottic airway devices, with their application ranging between 5.2% and 27.2% [15, 24, 28, 29].

The administration of amiodarone during the pandemic displayed variability across different studies. Lai *et al.* [15] observed a downturn in its use, whereas an increase was noted in three other studies. Despite these variances, the overall comparative analysis of amiodarone usage before and throughout the pandemic period did not yield a statistically significant difference [2, 15, 26, 30, 31].

During the pandemic, there was a significant decrease in the frequency of successful prehospital ROSC across multiple studies. For instance, Baldi *et al.* [22] observed a minimal decrease of 0.8%, while Nickles *et al.* [12] reported a substantial decline of 22.24%. Further analysis by Bielski *et al.* [20], covering twelve studies, highlighted a decrease in prehospital ROSC rates from 28.4% before the pandemic to 19.3% during it. Our research indicates that even before the pandemic the rates of sustained ROSC before hospital admission were quite low, aligning with findings from Italy and Switzerland [2, 22]. Notably, these rates were less than those we reported in a similar study from 2010, which found a 19.1% rate of prehospital sustained ROSC [32]. The pandemic period led to a significant decrease of 5.8% in prehospital sustained ROSC to hospital admission among OHCA patients, highlighting a critical healthcare issue, as our observed rates of sustained prehospital ROSC are considerably lower than those reported in international or European contexts.

The study has several limitations. First, it lacked data on long-term outcomes such as hospital discharge rates and neurological status at discharge, which are important for assessing the overall effectiveness of CPR by EMS teams. Additionally, the study did not account for the number of COVID-19-positive patients in the analyzed area or whether patients had pre-existing respiratory conditions before the OHCA event, thereby limiting the comprehensiveness of our findings regarding the pandemic's impact on OHCA outcomes.

5. Conclusions

The COVID-19 pandemic led to a statistically significant increase in the incidence of OHCA in the studied area. In the pandemic group, the time of arrival of the EMS teams was shorter, and the percentage of patients with an initial shockable rhythm was higher. The number of patients with endotracheal intubation by EMS teams was statistically significantly lower in the pandemic group, and the percentage of BVM ventilation use increased. The prehospital ROSC that was maintained until hospital admission was statistically significantly lower in the pandemic group than in the group before the COVID-19 pandemic.

ABBREVIATIONS

COVID-19, The Coronavirus Disease 2019; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; ICU, intensive care units; EMS, emergency medical services; ER, emergency room; CPR, cardiopulmonary resuscitation; IEMS NS, Institute of Emergency Medicine Novi Sad; BLS, basic life support; SCA, sudden cardiac arrest; ALS, advance life support; DC, Direct Current; PEA, pulseless electrical activity; VF, ventricular fibrillation; pVT, pulseless ventricular tachycardia; SD, standard deviation; Q1–Q3, interquartile range.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analyzed during the current study are not publicity available due to legal restrictions for privacy protection of susceptible populations under the regulations of Serbia, but are available from the corresponding authors on reasonable request.

AUTHOR CONTRIBUTIONS

RJM, NM, AĐ—conceptualization, design, data collection, visualization, writing original draft, literature search, methodology; MM, MJZ, ZB and BM—conceptualization, data collection, literature search; GR and IS—conceptualization, methodology, writing-review, editing; VV—edits, revision and supervision.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of the: Institute for Emergency Medical Services Novi Sad, Novi Sad (protocol code 1394, 14 July 2022); Health Centre Becej (protocol code 13/2022, 24 July 2022); Health Centre Novi Becej (protocol code 11/2022, 12 July 2022) and Health Centre Temerin (protocol code 07/2022, 18 July 2022). The Review Board waived the need for informed consent because of the retrospective nature of this study.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Husain AA, Rai U, Sarkar AK, Chandrasekhar V, Hashmi MF. Out-of-hospital cardiac arrest during the COVID-19 pandemic: a systematic review. HealthCare. 2023; 11: 189.

[2] Baldi E, Sechi GM, Mare C, Canevari F, Brancaglione A, Primi R, *et al*. Out-of-hospital cardiac arrest during the Covid-19 outbreak in Italy. The New England Journal of Medicine. 2020; 383: 496–498.

[3] Marijon E, Karam N, Jost D, Perrot D, Frattini B, Derkenne C, *et al*. Out-of-hospital cardiac arrest during the COVID-19 pandemic in Paris, France: a population-based, observational study. The Lancet Public Health. 2020; 5: e437–443.

[4] Lim SL, Kumar L, Saffari SE, Shahidah N, Al-Araji R, Ng QX, *et al*. Management of out-of-hospital cardiac arrest during COVID-19: a tale of two cities. Journal of Clinical Medicine. 2022; 11: 5177.

[5] Ristau P, Wnent J, Gräsner JT, Fischer M, Bohn A, Bein B, *et al*. Impact of COVID-19 on out-of-hospital cardiac arrest: a registry-based cohort-study from the German Resuscitation Registry. PLOS ONE. 2022; 17: e0274314.

[6] Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, *et al*. Risk factors associated with acute respiratory distress syndrome and death in patients with Coronavirus Disease 2019 pneumonia in Wuhan, China. JAMA Internal Medicine. 2020; 180: 934.

[7] Xiao H, Dai X, Wagenaar BH, Liu F, Augusto O, Guo Y, *et al*. The impact of the COVID-19 pandemic on health services utilization in China: time-series analyses for 2016–2020. The Lancet Regional Health. Western Pacific. 2021; 9: 100122.

[8] Nolan JP, Monsieurs KG, Bossaert L, Böttiger BW, Greif R, Lott C, *et al*; European Resuscitation Council COVID-Guideline Writing Groups. European resuscitation council COVID-19 guidelines executive summary. Resuscitation. 2020; 153: 45–55.

[9] Scquizzato T, Olasveengen TM, Ristagno G, Semeraro F. The other side of novel coronavirus outbreak: fear of performing cardiopulmonary resuscitation. Resuscitation. 2020; 150: 92–93.

[10] Scquizzato T, Landoni G, Paoli A, Lembo R, Fominskiy E, Kuzovlev A, *et al*. Effects of COVID-19 pandemic on out-of-hospital cardiac arrests: a systematic review. Resuscitation. 2020; 157: 241–247.

[11] Lim SL, Shahidah N, Saffari SE, Ng QX, Ho AFW, Leong BSH, *et al*. Impact of COVID-19 on out-of-hospital cardiac arrest in Singapore. International Journal of Environmental Research and Public Health. 2021; 18: 3646.

[12] Nickles AV, Oostema A, Allen J, O'Brien SL, Demel SL, Reeves MJ. Comparison of out-of-hospital cardiac arrests and fatalities in the metro Detroit area during the COVID-19 pandemic with previous-year events. JAMA Network Open. 2021; 4: e2032331.

[13] Paoli A, Brischigliaro L, Scquizzato T, Favaretto A, Spagna A. Out-of-hospital cardiac arrest during the COVID-19 pandemic in the province of Padua, Northeast Italy. Resuscitation. 2020; 154: 47–49.

[14] Liu JZ, Counts CR, Drucker CJ, Emert JM, Murphy DL, Schwarcz L, *et al*. Acute SARS-CoV-2 infection and incidence and outcomes of out-of-hospital cardiac arrest. JAMA Network Open. 2023; 6: e2336992.

[15] Lai PH, Lancet EA, Weiden MD, Webber MP, Zeig-Owens R, Hall CB, *et al*. Characteristics associated with out-of-hospital cardiac arrests and resuscitations during the novel Coronavirus Disease 2019 pandemic in New York City. JAMA Cardiology. 2020; 5: 1154–1163.

[16] Jaehn P, Holmberg C, Uhlenbrock G, Pohl A, Finkenzeller T, Pawlik MT, *et al*. Differential trends of admissions in accident and emergency departments during the COVID-19 pandemic in Germany. BMC Emergency Medicine. 2021; 21: 42.

[17] Schwarz V, Mahfoud F, Lauder L, Reith W, Behnke S, Smola S, *et al.* Decline of emergency admissions for cardiovascular and cerebrovascular events after the outbreak of COVID-19. Clinical Research in Cardiology. 2020; 109: 1500–1506.

[18] Lazzerini M, Barbi E, Apicella A, Marchetti F, Cardinale F, Trobia G. Delayed access or provision of care in Italy resulting from fear of COVID-19. The Lancet Child & Adolescent Health. 2020; 4: e10–11.

[19] Santi L, Golinelli D, Tampieri A, Farina G, Greco M, Rosa S, *et al*. Non-COVID-19 patients in times of pandemic: emergency department visits, hospitalizations and cause-specific mortality in northern Italy. PLOS ONE. 2021; 16: e0248995.

[20] Bielski K, Szarpak A, Jaguszewski MJ, Kopiec T, Smereka J, Gasecka A, *et al*. The influence of COVID-19 on out-hospital cardiac arrest survival outcomes: an updated systematic review and meta-analysis. Journal of Clinical Medicine. 2021; 10: 5573.

[21] Nishiyama C, Kiyohara K, Iwami T, Hayashida S, Kiguchi T, Matsuyama T, *et al*. Influence of COVID-19 pandemic on bystander interventions, emergency medical service activities, and patient outcomes in out-of-hospital cardiac arrest in Osaka City, Japan. Resuscitation Plus. 2021; 5: 100088.

[22] Baldi E, Auricchio A, Klersy C, Burkart R, Benvenuti C, Vanetta C, *et al*; SWISSRECA researchers. Out-of-hospital cardiac arrests and mortality in Swiss Cantons with high and low COVID-19 incidence: a nationwide analysis. Resuscitation Plus. 2021; 6: 100105.

[23] Semeraro F, Gamberini L, Tartaglione M, Iarussi B, Descovich C, Picoco C, *et al*. Out-of-hospital cardiac arrest during the COVID-19 era in Bologna: system response to preserve performances. Resuscitation. 2020; 157: 1–2.

[24] Glober NK, Supples M, Faris G, Arkins T, Christopher S, Fulks T, *et al*. Out-of-hospital cardiac arrest volumes and characteristics during the COVID-19 pandemic. American Journal of Emergency Medicine. 2021; 48: 191–197.

[25] Jokšić-Mazinjanin R, Jokšić M, Vasović V, Mikov M, Saravolac S, Djuričin A, *et al*. Location of out-of-hospital cardiac arrest as a determinant in the survival of patients. Serbian Archives of Medicine. 2016; 144: 485–489.

[26] Ball J, Nehme Z, Bernard S, Stub D, Stephenson M, Smith K. Collateral damage: hidden impact of the COVID-19 pandemic on the out-of-hospital cardiac arrest system-of-care. Resuscitation. 2020; 156: 157–163.

[27] Cho JW, Jung H, Lee MJ, Lee SH, Lee SH, Mun YH, *et al*; WinCOVID-19 consortium. Preparedness of personal protective equipment and implementation of new CPR strategies for patients with out-of-hospital cardiac arrest in the COVID-19 era. Resuscitation Plus. 2020; 3: 100015.

[28] Rosell Ortiz F, Fernández Del Valle P, Knox EC, Jiménez Fábrega X, Navalpotro Pascual JM, Mateo Rodríguez I, *et al*. Influence of the COVID-19 pandemic on out-of-hospital cardiac arrest. A Spanish nationwide prospective cohort study. Resuscitation. 2020; 157: 230–240.

[29] Elmer J, Okubo M, Guyette FX, Martin-Gill C. Indirect effects of COVID-19 on OHCA in a low prevalence region. Resuscitation. 2020; 156: 282–283.

[30] Masuda Y, Teoh SE, Yeo JW, Tan DJH, Jimian DL, Lim SL, *et al*. Variation in community and ambulance care processes for out-of-hospital cardiac arrest during the COVID-19 pandemic: a systematic review and meta-analysis. Scientific Reports. 2022; 12: 800.

[31] Sultanian P, Lundgren P, Strömsöe A, Aune S, Bergström G, Hagberg E, *et al*. Cardiac arrest in COVID-19: characteristics and outcomes of in- and out-of-hospital cardiac arrest. A report from the Swedish Registry for Cardiopulmonary Resuscitation. European Heart Journal. 2021; 42: 1094–1106.

[32] Jokšić-Mazinjanin R, Đuričin A, Jokšić-Zelić M, Šaponja P, Saravolac S, Gojković Z, *et al*. Analysis of the emergency medical service call centre actions in patients with cardiac arrest. Scripta Medica. 2021; 52: 230–234.

How to cite this article: Radojka Jokšić-Mazinjanin, Nikolina Marić, Aleksandar Đuričin, Goran Rakić, Ilija Srdanović, Milana Maljah, *et al*. Out-of-hospital cardiac arrest before and during the COVID-19 pandemic: a retrospective observational study. Signa Vitae. 2024; 20(11): 68-74. doi: 10.22514/sv.2024.146.