

Brief Communication

Survival following an out-of-hospital cardiac arrest in Japan in 2020 versus 2019 according to the cause

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Aim: The coronavirus disease (COVID-19) pandemic has led to an increase in out-of-hospital cardiac arrests (OHCAs) and mortality. However, there has been no reports in Japan using nationwide registry data. We compared survival among patients with OHCAs and detailed information on the cause during the COVID-19 pandemic (2020), and during the pre-pandemic period (2019).

Methods: Using a Japanese population-based retrospective cohort study design, we analyzed registry data on 39,324 and 39,170 patients with OHCAs in 2019 and 2020, respectively. We compared patient outcomes in 2019 and 2020 using univariable and multivariable logistic regression analyses.

Results: The proportion of OHCAs of cardiac origin increased significantly from 61.6% in 2019 to 62.7% in 2020 ($P = 0.001$). The use of bystander CPR (6.9% versus 5.7%, $P < 0.001$) and public access automated external defibrillator pads (3.7% versus 3.0%, $P < 0.001$) decreased significantly from 2019 to 2020. The 1-month survival for OHCA of cardiac origin (12.1% versus 10.7%; adjusted odds ratio [OR] 0.93, 95% confidence interval [CI] 0.87–1.00), asphyxia (10.9% versus 8.8%; adjusted OR 0.80, 95% CI 0.70–0.92), and external causes (adjusted OR 0.66; 95% CI 0.46–0.96), also decreased significantly from 2019 to 2020.

Conclusions: In Japan, the 1-month survival after OHCA of cardiac origin, or due to asphyxia or external causes, decreased significantly during the COVID-19 pandemic period.

Key words: Cardiopulmonary resuscitation, COVID-19, out-of-hospital cardiac arrest, retrospective studies, survival rate

INTRODUCTION

THE CORONAVIRUS DISEASE 2019 (COVID-19) pandemic has negatively affected access to health care and time from disease onset to starting treatment. The outcomes of out-of-hospital cardiac arrest (OHCA) have worsened since the start of the COVID-19 pandemic.^{1–4} In the prehospital setting, this has been attributed to changes in the quality of cardiopulmonary resuscitation (CPR) performed

by emergency medical services (EMS) personnel (e.g., interrupting chest compressions during potentially aerosolizing maneuvers). In hospital settings, this has been attributed to a lack of appropriate treatment due to a shortage of intensive care unit beds or human resources due to the large number of patients with COVID-19.^{1–4}

In Japan, the first case of COVID-19 was reported on January 15, 2020, and the country experienced three epidemic waves of COVID-19 in 2020. Since the start of the COVID-19 pandemic, in addition to standard precautions, EMS personnel have been required to wear N95 face masks and isolation gowns when treating patients with cardiac arrest. Since April 24, 2020, the EMS protocol has encouraged paramedics to use supraglottic airway management instead of endotracheal intubation. In addition, approximately 2 million Japanese citizens participate in community CPR programs.⁵ However, fire departments suspended CPR training for the public in 2020. Despite these changes experienced during the pandemic, there have been no reports on

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the association between OHCA and COVID-19 in Japan using nationwide registry data.

In adults, approximately 20%–40% of OHCAs are of noncardiac origin.⁶ However, the survival of patients with OHCA of noncardiac origin during the COVID-19 pandemic has not been investigated as extensively as that of patients with OHCA of cardiac origin. Therefore, in this study, after confirming the trend of OHCA survival since 2013, we focused on the specific causes, including both cardiac and noncardiac causes, and how they were affected by the COVID-19 pandemic.

METHODS

THIS OBSERVATIONAL STUDY used data from the All-Japan Utstein Registry, a nationwide prospective, population-based registry of OHCA.^{7,8} Evaluation of the detailed causes of noncardiac OHCA was introduced in 2013. Registered adult patients with a bystander-witnessed OHCA of cardiac or noncardiac origin between January 1, 2013, and December 31, 2020, in whom resuscitation was attempted, and who were transported to a medical institution, were included in the analysis. EMS witnessed and non-witnessed cases, and children were excluded because their characteristics and outcomes differ.⁹

The EMS system in Japan has been described previously.¹⁰ All EMS providers perform CPR according to the Japanese guidelines.¹¹

The outcome measures were 1-month survival, prehospital return of spontaneous circulation (ROSC), and 1-month survival with favorable neurological outcomes. First, we assessed the annual trends in each outcome from 2013 to 2020 using linear trend tests. Second, we calculated crude and adjusted odds ratios (ORs) and their 95% confidence intervals (CIs) using univariable and multivariable logistic regression models in 2019 and 2020 to determine the association between COVID-19 and the primary outcome according to the cause of the OHCA. Factors considered to be associated with clinical outcomes were included in multivariable analyses.^{12,13} These variables included age (18–64/65–74/≥75 years), sex, witness status (witnessed by a family member/nonfamily member), first documented rhythm (ventricular fibrillation [VF]/pulseless ventricular tachycardia [VT]/pulseless electrical activity/asystole), use of an automated external defibrillator (AED; yes/no), bystander CPR status (chest compression only/chest compression with breathing rescue/no CPR), advanced airway management (endotracheal intubation/supraglottic airway/none), epinephrine administration (yes/no), EMS response time (call to patient

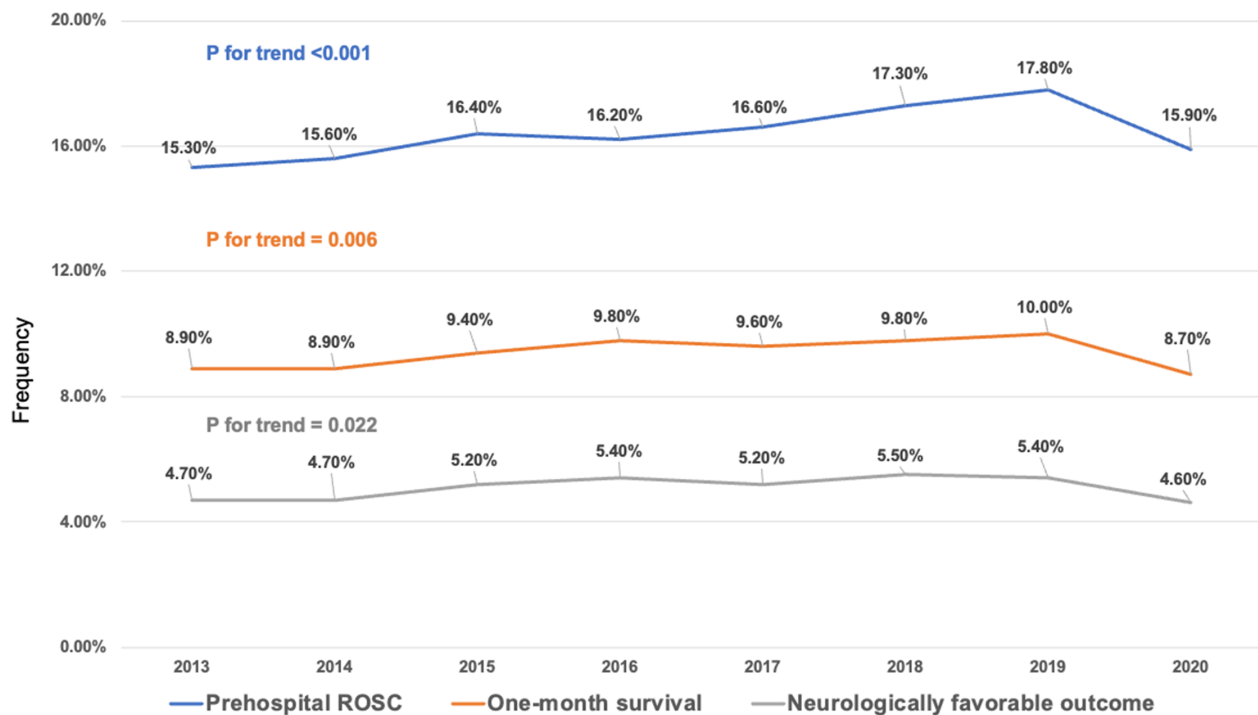


Fig. 1. Trend in the outcomes of out-of-hospital cardiac arrest by year from 2013 to 2020. The curves are based on an analysis of 314,460 patients with an out-of-hospital cardiac arrest. ROSC, return of spontaneous circulation.

Table 1. Comparison of the characteristics of adults with of out-of-hospital cardiac arrests in Japan in 2019 and 2020

	Total N = 78,494	2019 N = 39,324	2020 N = 39,170	P-value	
Sex					
Male, n (%)	47,278 (60.2)	23,593 (60.0)	23,685 (60.5)	0.18	
Age (years), median (IQR)	79 (69–87)	79 (69–87)	79 (69–87)	0.43	
Age group, n (%)					
18–64	14,576 (18.6)	7,300 (18.6)	7,276 (18.6)	0.37	
65–74	14,372 (18.3)	7,275 (18.5)	7,097 (18.1)		
75–	49,546 (63.1)	24,749 (62.9)	24,797 (63.3)		
Type of bystander-witnessed status, n (%)					
Family member	46,240 (58.9)	22,836 (58.1)	23,404 (59.7)	<0.001	
Origin of arrest, n (%)					
Cardiac origin	48,802 (62.2)	24,234 (61.6)	24,568 (62.7)	<0.001	
Cerebrovascular disease	1,880 (2.4)	1,004 (2.6)	876 (2.2)		
Asphyxia	9,723 (12.4)	4,958 (12.6)	4,765 (12.2)		
Malignant tumors	2,655 (3.4)	1,248 (3.2)	1,407 (3.6)		
External causes	2,731 (3.5)	1,367 (3.5)	1,364 (3.5)		
Drug overuse	40 (0.1)	24 (0.1)	16 (0.0)		
Drowning	433 (0.6)	234 (0.6)	199 (0.5)		
Traffic injury	2,077 (2.6)	1,093 (2.8)	984 (2.5)		
Accidental hypothermia	36 (0.0)	18 (0.0)	18 (0.0)		
Anaphylaxis	32 (0.0)	15 (0.0)	17 (0.0)		
Other	10,085 (12.8)	5,129 (13.0)	4,956 (12.7)		
Holiday, n (%)	26,699 (34.0)	13,521 (34.4)	13,178 (33.6)		0.029
Daytime, n (%)	31,759 (40.5)	15,884 (40.4)	15,875 (40.5)		0.70
Region, n (%)					
Hokkaido–Tohoku	9,779 (12.5)	4,932 (12.5)	4,847 (12.4)		0.007
Kanto	27,174 (34.6)	13,454 (34.2)	13,720 (35.0)		
Tokai–Hokuriku	14,843 (18.9)	7,594 (19.3)	7,249 (18.5)		
Kinki	12,693 (16.2)	6,311 (16.0)	6,382 (16.3)		
Chugoku	3,940 (5.0)	2,041 (5.2)	1,899 (4.8)		
Shikoku	2,252 (2.9)	1,130 (2.9)	1,122 (2.9)		
Kyushu–Okinawa	7,813 (10.0)	3,862 (9.8)	3,951 (10.1)		
Dispatcher instruction, n (%)	45,040 (57.4)	22,102 (56.2)	22,938 (58.6)	<0.001	
Initial rhythm, n (%)					
VF/pVT	11,529 (14.7)	5,882 (15.0)	5,647 (14.4)	0.089	
PEA	29,240 (37.3)	14,635 (37.2)	14,605 (37.3)		
Asystole	37,725 (48.1)	18,807 (47.8)	18,918 (48.3)		
Type of bystander-initiated CPR, n (%)					
Chest compression–only CPR	38,578 (49.1)	19,030 (48.4)	19,548 (49.9)	<0.001	
Conventional CPR with rescue breathing	4,949 (6.3)	2,709 (6.9)	2,240 (5.7)		
None	34,967 (44.5)	17,585 (44.7)	17,382 (44.4)		
Shocks by public-access AEDs, n (%)	2,613 (3.3)	1,436 (3.7)	1,177 (3.0)	<0.001	
Advanced airway management, n (%)					
Endotracheal intubation	7,105 (9.1)	3,540 (9.0)	3,565 (9.1)	<0.001	
Supraglottic airway	28,954 (36.9)	13,964 (35.5)	14,990 (38.3)		
Non	42,435 (54.1)	21,820 (55.5)	20,615 (52.6)		
Epinephrine, n (%)	27,710 (35.3)	13,669 (34.8)	14,041 (35.8)	0.001	
Minimum response time, median (IQR)	9 (7–11)	9 (7–11)	9 (7–11)	<0.001	
Minimum hospital arrival time median (IQR)	33 (27–40)	33 (27–40)	33 (27–41)	<0.001	

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; IQR, interquartile range; PEA, pulseless electrical activity; pVT, pulseless ventricular tachycardia; VF, ventricular fibrillation.

Table 2. Comparison of the outcomes among adults with out-of-hospital cardiac arrests of in Japan in 2019 and 2020 according to the cause

One-month survival		2019	2020	P-value
Cardiac origin	<i>n/N</i> (%)	2,936/24,234 (12.1)	2,638/24,568 (10.7)	
	Crude OR (95% CI)	Reference	0.87 (0.83–0.92)	<0.001
	Adjusted OR (95% CI)	Reference	0.93 (0.87–1.00)	0.038
Cerebrovascular disease	<i>n/N</i> (%)	75/1,004 (7.5)	63/876 (7.2)	
	Crude OR (95% CI)	Reference	0.96 (0.68–1.36)	0.817
	Adjusted OR (95% CI)	Reference	0.90 (0.62–1.31)	0.583
Respiratory disease	<i>n/N</i> (%)	539/4,958(10.9)	419/4,765 (8.8)	
	Crude OR (95% CI)	Reference	0.79 (0.69–0.90)	0.001
	Adjusted OR (95% CI)	Reference	0.80 (0.70–0.92)	0.002
Malignant tumors	<i>n/N</i> (%)	19/1,248 (1.5)	17/1,407 (1.2)	
	Crude OR (95% CI)	Reference	0.79 (0.41–1.53)	0.486
	Adjusted OR (95% CI)	Reference	0.81 (0.41–1.60)	0.542
External causes	<i>n/N</i> (%)	83/1,367 (6.1)	53/1,364(3.9)	
	Crude OR (95% CI)	Reference	0.63 (0.44–0.89)	0.009
	Adjusted OR (95% CI)	Reference	0.66 (0.46–0.96)	0.029
Drug overuse	<i>n/N</i> (%)	3/24 (12.5)	2/16 (12.5)	
	Crude OR (95% CI)	Reference	1.00 (0.15–6.77)	>0.99
	Adjusted OR (95% CI)	Reference	N/A	N/A
Drowning	<i>n/N</i> (%)	9/234 (3.85)	8/199 (4.0)	
	Crude OR (95% CI)	Reference	1.05 (0.40–2.77)	0.926
	Adjusted OR (95% CI)	Reference	0.86 (0.26–2.85)	0.81
Traffic injury	<i>n/N</i> (%)	16/1,093 (1.5)	13/984 (1.3)	
	Crude OR (95% CI)	Reference	0.90 (0.43–1.88)	0.782
	Adjusted OR (95% CI)	Reference	0.78 (0.36–1.69)	0.525
Accidental hypothermia	<i>n/N</i> (%)	3/18 (16.7)	2/18 (11.1)	
	Crude OR (95% CI)	Reference	0.63 (0.09–4.28)	0.632
	Adjusted OR (95% CI)	Reference	N/A	N/A
Anaphylaxis	<i>n/N</i> (%)	5/15 (33.3)	3/17 (17.7)	
	Crude OR (95% CI)	Reference	0.43 (0.08–2.22)	0.313
	Adjusted OR (95% CI)	Reference	N/A	N/A
Other	<i>n/N</i> (%)	244/5,129 (4.8)	207/4,956 (4.2)	
	Crude OR (95% CI)	Reference	0.87 (0.72–1.05)	0.159
	Adjusted OR (95% CI)	Reference	0.92 (0.75–1.11)	0.374

CI, confidence interval; OR, odds ratio.

contact), daytime (9:00–16:59; yes/no), weekend/holiday (yes/no), region (Hokkaido–Tohoku, Kanto, Tokai–Hokuriku, Kinki, Chugoku, Shikoku, or Kyushu–Okinawa), and dispatcher instruction (yes/no). All statistical analyses were conducted using Stata, version 16 (StataCorp LP, College Station, TX, USA). Two-tailed *P*-values of <0.05 were considered statistically significant.

The ethics committee of Osaka University Graduate School of Medicine approved the study (approval number: 14147) and waived the requirement for informed consent. The study results were reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.¹⁴

RESULTS

A TOTAL OF 992,614 cases of adult OHCA were registered from 2013 to 2020. After excluding patients with no resuscitation attempts (*n* = 23,873), EMS witness (*n* = 77,368), arrest not witnessed (*n* = 566,082), witness unknown (*n* = 3,780), origin unknown (*n* = 2), outcome unknown (*n* = 4), bystander CPR unknown (*n* = 234), and first rhythm unknown (*n* = 6,811), 314,460 patients were eligible for inclusion (235,966 patients in 2005–2018, 39,324 in 2019, and 39,170 in 2020). The 1-month survival, prehospital ROSC, and 1-month survival with favorable neurological outcomes improved annually from 2013 to

2020, before the COVID-19 pandemic ($P_{\text{trend}} < 0.001$, $P_{\text{trend}} = 0.006$, and $P_{\text{trend}} = 0.022$, respectively; Fig. 1).

The characteristics of patients with an OHCA in 2019 and 2020 are shown in Table 1. The proportion of OHCA of cardiac origin was significantly higher in 2020 than in 2019 (62.7% versus 61.6%, $P < 0.001$). The proportion of shock by public-access AED was lower in 2020 than in 2019 (3.7% versus 3.0%; $P < 0.001$), while the proportion of OHCA witnessed by a family member was significantly higher in 2020 (58.1% versus 69.7%; $P < 0.001$). The proportion of conventional CPR with rescue breathing decreased from 6.9% to 5.7%, while the rate of supraglottic airway management use increased from 35.5% to 38.3%. The response time and time until hospital arrival were significantly longer in 2020 than in 2019 ($P < 0.001$). The proportion of patients with 1-month survival after OHCA decreased in 2020 in patients with OHCA of cardiac origin (12.1% versus 10.7% for cardiac origin; adjusted OR 0.93, 95% CI 0.87–1.00); OHCA due to asphyxia (10.9% versus 8.8% for asphyxia; adjusted OR 0.80, 95% CI 0.70–0.92); and OHCA due to external causes such as hanging and falls (6.1% versus 3.9%; adjusted OR 0.66, 95% CI 0.46–0.96; Table 2).

DISCUSSION

USING THE NATIONWIDE OHCA registry, our study revealed that, since the start of the COVID-19 pandemic, the decrease of survival rates in people with OHCA in Japan depends on the cause. After adjusting for variables related to prehospital factors, ORs were significantly lower in 2020 than in 2019, suggesting that unmeasured factors such as hospital circumstances or the direct impact of COVID-19 may have affected the outcome. To the best of our knowledge, this study is the first to report how COVID-19 has impacted the specific causes of OHCA using nationwide registry data. Considering the reasons for decreased survival, more than 20% of percutaneous coronary intervention (PCI) institutions in Japan were either closed or restricted during the state of emergency in 2020,⁴ so patients with OHCA of cardiac origin did not undergo primary PCI in a timely manner. The suicide rate in Japan increased during the COVID-19 pandemic.¹⁵ Social distancing measuring might have delayed their detection; however, we cannot explain the reason for the increase in OHCA due to external causes. Although relieving foreign body airway obstructions in the prehospital setting reportedly improves survival outcomes,¹⁶ citizen or Emergency Medical Teams teams might have hesitated to observe or remove foreign bodies in the larynx or pharynx, fearing infection.

This study had some limitations. The registry did not provide data on whether patients had COVID-19 before the occurrence of the OHCA, and did not provide information about in-hospital treatments. Second, our results might not be fully applicable to other countries, which have different EMS and medical systems, spread of infection, and policy. Finally, as with all retrospective studies, data integrity, validity, and ascertainment bias are potential limitations.

This study revealed that the COVID-19 pandemic was associated with an increase in OHCA of multiple causes. Careful monitoring of OHCA according to the cause is warranted to assess the true impact of the COVID-19 pandemic.

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DISCLOSURE

APPROVAL OF THE research protocol with approval No. and committee Name: This study was approved by the ethics committee of Osaka University Graduate School of Medicine (approval number: 14147).

Informed Consent: The data were deidentified; thus, the requirement for obtaining informed consent was waived.

Conflicts of Interest: The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

SH AND TK designed the study and wrote the manuscript. SH, LZ, KK, and TK performed statistical analyses. TI, HO and JO critically revised the manuscript for intellectual content. All authors have read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

THE DATA THAT support the findings of this study are available from the All-Japan Utstein Registry. Restrictions apply to the availability of these data, which were used under license for the current study and are, therefore, not publicly available. However, the data are available from the

authors upon reasonable request and with permission from the All-Japan Utstein Registry.

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