The incidence and outcomes of out-of-hospital cardiac arrest during the COVID-19 pandemic in South Korea: a multicenter registry study

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected out-of-hospital cardiac arrest (OHCA) and disrupted the chain of survival (CoS). Even after the end of the pandemic, the risk of new variants and surges persists.

Objective: We aimed to investigate and compare the incidence, outcomes, and characteristics of OHCA during the pre-pandemic and pandemic periods using data from a nationwide multicenter registry.

Methods: We conducted a multicenter prospective observational study using data from the Korean Cardiac Arrest Resuscitation Consortium (KoCARC) registry. This study included adult patients with OHCA across three distinct one-year periods: pre-pandemic (January 2019 to December 2019), early pandemic (July 2020 to June 2021), and late pandemic (July 2021 to June 2022). We extracted and contrasted the OHCA characteristics, pre-hospital time factors and outcomes for the patients across these three periods. The primary outcomes were survival to hospital admission and survival to hospital discharge. The secondary outcome was good neurological outcome (GNO).

Results: A total of 9031 adult patients with OHCA were eligible for analysis (pre-pandemic, 2728; early pandemic, 2954; late pandemic, 3349). Witnessed arrest and arrest at home/residence were significantly more frequent during the pandemic period than during the pre-pandemic period, and automated external defibrillator use by bystanders was lower in the early phase of the pandemic than during other periods. As the pandemic advanced, the rates of the first monitored shockable rhythm and pre-hospital endotracheal intubation decreased significantly. Cardiac arrest cognition upon emergency department arrival time increased sequentially (33 min vs. 35 min vs. 36 min; P < .001). Both survival and neurological outcomes worsened as the pandemic progressed, with survival to discharge showing the largest statistical difference (14.1% vs. 12.0% vs. 11.7%, P = .011). Additionally, none of the outcomes differed significantly between the early and late pandemic phases.

Conclusions: During the pandemic, especially amidst community COVID-19 surges, the incidence of OHCA increased while survival rates and GNO at discharge decreased. Pre-hospital OHCA factors, which are directly related to OHCA prognosis, were adversely affected by the pandemic. Ongoing discussions are needed to maintain CoS in the event of a new pandemic. Clinical Trial: The project was registered at ClinicalTrials.gov with the identifier NCT03222999.

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Title: The incidence and outcomes of out-of-hospital cardiac arrest during the COVID-19 pandemic in South Korea: a multicenter registry study

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Abstract

Background

The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected out-of-hospital cardiac arrest (OHCA) and disrupted the chain of survival (CoS). Even after the end of the pandemic, the risk of new variants and surges persists. Analyzing the characteristics of OHCA during the pandemic is important to prepare for the next pandemic and to avoid repeated negative outcomes. However, previous studies have yielded somewhat varied results, depending on the healthcare system or the specific characteristics of social structures.

Objective

We aimed to investigate and compare the incidence, outcomes, and characteristics of OHCA during the pre-pandemic and pandemic periods using data from a nationwide multicenter OHCA registry.

Methods

We conducted a multicenter retrospective observational study using data from the Korean Cardiac Arrest Resuscitation Consortium (KoCARC) registry. This study included adult patients with OHCA of South Korea across three distinct one-year periods: pre-pandemic (January 2019 to December 2019), early phase pandemic (July 2020 to June 2021), and late phase pandemic (July 2021 to June 2022). We extracted and contrasted the OHCA patients characteristics, pre-hospital time factors and outcomes for the patients across these three periods. The primary outcomes were survival to hospital admission and survival to hospital discharge. The secondary outcome was good neurological outcome (GNO).

Results

From the three designated periods, a total of 9031 adult patients with OHCA were eligible for analysis (pre-pandemic, 2728; early pandemic, 2954; late pandemic, 3349). Witnessed arrest and arrest at home/residence were significantly more frequent during the pandemic period than during the pre-pandemic period, and automated external defibrillator use by bystanders was lower in the

early phase of the pandemic than during other periods. As the pandemic advanced, the rates of the first monitored shockable rhythm and pre-hospital endotracheal intubation decreased significantly. Cardiac arrest cognition upon emergency department arrival time increased sequentially (33 min vs. 35 min vs. 36 min; *P*<.001). Both survival and neurological outcomes worsened as the pandemic progressed, with survival to discharge showing the largest statistical difference (14.1% vs. 12.0% vs. 11.7%, *P*=.01). Additionally, none of the outcomes differed significantly between the early and late pandemic phases.

Conclusions

During the pandemic, especially amidst community COVID-19 surges, the incidence of OHCA increased while survival rates and GNO at discharge decreased. Pre-hospital OHCA factors, which are directly related to OHCA prognosis, were adversely affected by the pandemic. Ongoing discussions are needed to maintain CoS in the event of a new pandemic.

Keywords: heart arrest, cardiopulmonary resuscitation, SARS-CoV-2, mortality

Introduction

At the end of December 2019, the outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in Wuhan, China, leading to the global pandemic of coronavirus disease 2019 (COVID-19) [1,2]. As of Aug 2023, more than 769 million confirmed cases and almost 7 million cumulative fatalities have been attributed to COVID-19 [3]. The emergence of SARS-CoV-2 variants and mutations has played a significant role in the pandemic's persistence, [4] and, even after the end of the global pandemic, the risk of new variants and surges remains [5].

According to the current out-of-hospital cardiac arrest (OHCA) guidelines, the chain of survival (CoS) has been constantly emphasized to improve outcomes for OHCA patients [6]. The OHCA CoS includes rapid recognition and activation of emergency response, early high-quality cardiopulmonary resuscitation (CPR) and defibrillation, and effective advanced life support (ALS) interventions [6]. Each pre-hospital step experienced concurrent disruptions during the COVID-19 pandemic, resulting in a disruption of the OHCA CoS worldwide [7-9]. Notably, there was an increase in the incidence of OHCA, while rates of bystander CPR and automated external defibrillator (AED) usage rate declined, especially during periods of heightened community transmission [10,11]. Additionally, a study using emergency medical services (EMS) data of South Korea reported the proportion of prehospital return of spontaneous circulation (ROSC) was decreased during the pandemic period [12].

During the pandemic era, outcomes of OHCA, including survival and neurological outcomes, deteriorated [9,13,14]. A previous meta-analysis reported that ROSC rate, survival to hospital admission, and hospital discharge with good neurologic outcome (GNO) were significantly lower during the pandemic compared to the pre-pandemic period [13]. One recent registry-based cohort-study reported the survival rate was significantly decreased while the bystander CPR rate was stable [15]. Another study reported higher incidence of OHCA and decreased bystander CPR in regions with a high burden of pandemic [16]. A population-based nationwide study in Japan also reported

pandemic is related with poorer neurologic outcomes and less AED use in OHCA patients [17]. These poor outcomes could be closely related to changes in the pre-hospital phase during the pandemic, especially when considering the nature of OHCA.

Previous research has explored the impact of the COVID-19 pandemic on OHCA incidence, outcomes, and pre-hospital factors [10,18-20]. Analyzing the characteristics of OHCA during the pandemic is important to prepare for the next pandemic and to avoid repeated negative outcomes. However, previous studies have yielded somewhat varied results, depending on the healthcare system or the specific characteristics of social structures. Here, we aimed to investigate and compare the incidence, outcomes, and characteristics of OHCA between the pre-pandemic and pandemic periods, using data from a nationwide multicenter registry.

Methods

Study design

We conducted a multicenter retrospective observational study using data from the Korean Cardiac Arrest Resuscitation Consortium (KoCARC) registry. This nationwide registry collates OHCA cases of South Korea in alignment with the Utstein templates and involves a collaborative research network among multiple hospitals. The study included patients with OHCA who were transported to the emergency department by emergency medical services and underwent resuscitation. Inclusion was limited to patients diagnosed with a medical cause identified by emergency physicians. Meanwhile, individuals with terminal illnesses, in hospice care, pregnant, or with a 'Do Not Resuscitate' card were excluded. Patients with OHCA resulting from non-medical causes, such as trauma, poisoning, burns, drowning, asphyxia, or hanging, were also excluded. Data were collected using a standardized registry form and uploaded to a web-based electronic database. The quality of the registry was monitored using a quality management committee to improve its reliability and integrity.

Ethical considerations

The project was registered at ClinicalTrials.gov with the identifier NCT03222999 and received ethical approval from the institutional review boards (IRB) of the 62 participating hospitals. Given the nature of this study, the requirement for informed consent was waived by the IRB. All personal information of OHCA patients enrolled in the registry was anonymized. There are no direct compensations for included patients.

Study population

This study included OHCA cases of South Korea registered in the KoCARC database in three distinct one-year periods: pre-pandemic, early phase of the pandemic, and late phase of the pandemic. KoCARC releases a year's worth of datasets annually, with the period starting in July and ending in June of the following year. The pre-pandemic period was defined as the year leading up to the reporting of the first COVID-19 case (from January 1, 2019 to December 31). The early phase of the pandemic period corresponds to the first dataset released after the declaration of the pandemic (from July 1, 2020 to June 30, 2021). The late phase of the pandemic encompasses the most recent dataset (from July 1, 2021 to June 30, 2022). Patients aged <18 years were excluded.

Data extraction and definition

Previously published literature has provided comprehensive details regarding the KoCARC database, including information on data elements and quality assurance [21]. We extracted the following data from the KoCARC database: 1) patient characteristics: age, sex, witnessed arrest, arrest location at home or residence, bystander response (CPR and AED), first monitored shockable rhythm, and pre-hospital management (defibrillation, adrenaline use, advanced airway [supraglottic airway or endotracheal intubation]); 2) pre-hospital time factors: cardiac arrest recognition to emergency department (ED) arrival, EMS call to EMS arrival, arrest place arrival to departure, arrest place departure to ED arrival, and cardiac arrest recognition to pre-hospital ROSC.

Outcome variables

Primary outcomes were survival until hospital admission and survival to hospital discharge. We compared survival rates between the pre-pandemic period and the early and late pandemic periods, and investigated the factors affecting survival rates. The secondary outcome was a good neurological outcome (GNO), which was defined as a Cerebral Performance Category (CPC) score of 1 or 2 at the time of hospital discharge. A CPC score of 1 denotes good cerebral performance, meaning patients are conscious, alert, and capable of functioning with only minor neurological or psychological deficits. A CPC score of 2 indicates moderate cerebral disability, with patients being conscious, possessing adequate cerebral function for independent daily activities, and having the ability to work in sheltered environments. A CPC score of five corresponds to mortality, specifically defined as death or brain death.

Statistical analysis

This study used data from the KoCARC registry, which were meticulously compiled and organized using a spreadsheet application (Excel 365; Microsoft, Redmond, USA). Continuous baseline variables were presented as median and interquartile range, and their normal distribution was assessed using the Shapiro-Wilk test. In instances where the data deviated from the normality assumptions, the Kruskal-Wallis test was used to compare the groups and the Mann-Whitney test was used for post hoc test. Categorical variables were expressed as absolute counts and percentages and analyzed using the chi-square test. A significance threshold of $P<.05$ was adopted to establish statistical significance.

To ascertain the independent association between variables and neurological and survival outcomes, multivariate analysis was performed using logistic regression. Furthermore, to validate the calibration of the logistic model, the Hosmer-Lemeshow test was applied. The statistical software packages SPSS (version 27.0 for Windows; IBM, Armonk, NY, USA) and MedCalc (version 17.2; MedCalc Software, Ostend, Belgium) were used to perform all statistical computations.

Results

From the three designated periods, a total of 9209 OHCA patients were registered. After excluding patients aged under 19, 9031 OHCA patients were deemed eligible. The number of patients included in each period was as follows: 2728 in the pre-pandemic phase, 2954 in the early phase of the pandemic, and 3349 in the late phase of the pandemic (Fig. 1; Fig. 2). There was a sequential increase in the incidence of OHCA at the participating hospitals throughout the pandemic.

The baseline and pre-hospital OHCA characteristics from the three periods, along with inter-group comparisons are summarized in Table 1. Age was significantly higher in the late phase pandemic group compared to the pre-pandemic or early phase pandemic groups (72 vs. 72 vs. 73; *P*=.01). However, there was no significant difference in the sex distribution across the periods. Witnessed arrests and arrests at home/residence were significantly higher during the pandemic compared to the pre-pandemic period. Although bystander CPR was not statistically different among the three periods, AED use by bystanders was lower in the early phase of the pandemic compared to the other periods. The rate of the first monitored shockable rhythm and pre-hospital defibrillation decreased sequentially throughout the study period. The pre-hospital endotracheal intubation rate significantly decreased as the pandemic progressed (9.0% vs. 5.2% vs. 3.5%; *P*<.001), resulting in a significant increase in supraglottic airway use (61.9% vs. 73.3% vs. 72.6%; *P*<.001).

During the pandemic, pre-hospital phase time factors were extended compared to the pre-pandemic period. The time from cardiac arrest recognition to ED arrival increased sequentially (33 min vs. 35 min vs. 36 min; *P*<.001). Other time-related factors also worsened during the pandemic, including EMS call to arrival, arrest place arrival to departure, and arrest place departure to ED arrival.

Primary and secondary outcomes are summarized in Table 2. As the pandemic progressed, both survival and neurological outcomes worsened. The survival to discharge rate exhibited the most pronounced statistical variation (14.1% vs. 12.0% vs. 11.7%, *P*=.01). The survival to hospital

admission rate was 24.3% in the late phase of the pandemic, which was significantly lower than that in the pre-pandemic period. However, there was no statistically significant difference between the pre-pandemic and early-phase pandemic period (26.9% vs. 24.8%; *P*= .08). Both the survival to discharge and good neurological rates were significantly lower in the early- and late-phase pandemics than in the pre-pandemic period. Additionally, none of the outcomes differed significantly between early- and late-phase pandemics.

Multivariate analyses of the factors related to survival and neurological outcomes were performed to adjust for confounders that could affect the primary outcome (Table 3). Significant independent effects on all outcomes were observed for age, witnessed arrest, arrest at home or residence, first monitored shockable rhythm, pre-hospital adrenal use, and supraglottic airway. Cardiac arrest cognition at ED arrival significantly affected GNO after adjusting for confounders (aOR, 1.001; 95% CI, 1.000-1.002; *P*=.04). The difference in period (pre-pandemic, early-phase, or late-phase) did not independently affect any of the three outcomes.

Discussion

Principal Findings

In this study, we aimed to investigate changes in OHCA characteristics and outcomes during the SARS-CoV-2 pandemic using multicenter registry-based data. The incidence of OHCA increased and neurologic/survival outcomes were worse during the pandemic era compared to the pre-pandemic era. Outcomes were particularly poor in the late phase when the number of SARS-CoV-2 infection cases spiked due to the spread of the delta/omicron variants [22].

During the pandemic, a significant increase in the global incidence of OHCA was observed compared to the pre-pandemic period. In cities such as New York, Detroit, and London, the number of OHCAs increased proportionally with the number of COVID-19 cases during the initial surge [18-20]. In South Korea, the number of out-of-hospital sudden cardiac arrests increased by

approximately 8%, from 60 to 64.7 per 100,000 population, in 2021 when compared with 2019, the year preceding the COVID-19 [23]. One meta-analysis reported early in the pandemic, which included 10 studies with a total of 35,000 participants published before October 2020, found that the incidence of OHCA increased by approximately 2.2-fold compared to the pre-pandemic period [10].

Globally, the outcomes of OHCA during the pandemic have consistently been reported to be less favorable than those observed pre-pandemic [14]. For instance, in two regions of the United States, the survival-to-discharge rate decreased from 14.7% in 2019 to 7.9% in 2020 [24]. Meanwhile, in Singapore, while the incidence of OHCA increased during the pandemic, pre-hospital ROSC decreased [25]. In South Korea, the survival-to-discharge rate of OHCA, which had been steadily increasing for more than a decade before the pandemic, dropped from 8.7% in 2019 to 7.5% in 2020 and 7.3% in 2021. Moreover, the brain function recovery at discharge rate reached 5.4% in 2019 but dropped to 4.9% in 2020 and 4.4% in 2021 [23]. In addition, a previous meta-analysis reported that the outcomes of OHCA were significantly poorer than before the pandemic in most of the included studies. The meta-analysis also showed a significant increase in mortality [10,26].

The characteristics of OHCA shifted during the pandemic periods in this study. Instances of witnessed OHCA and arrests at home/residence became more frequent in the pandemic era. This change has been observed in previous studies and can be attributed to the increased time spent at home during the pandemic due to quarantine and social distancing [10,27]. These results may also reflect the number of patients who progressed to OHCA due to being unable to visit a hospital in a timely manner as a result of reduced access to hospitals. Although bystander CPR decreased slightly during the pandemic, the difference was not statistically significant. This study also found that bystander use of AEDs decreased in the early phase of the pandemic but returned to pre-pandemic levels in the late phase of the pandemic. This is likely a reflection of bystander fears of COVID-19 transmission in the early phase of the pandemic [28]. A previous meta-analysis reported a decreased OHCA with shockable rhythms during the pandemic [10,26]. In our research, the frequency of the

first monitored shockable rhythm decreased progressively. The rise in respiratory arrests due to respiratory failure due to COVID-19 may have contributed to the diminished proportion of OHCA with shockable rhythms. Such cases would likely have a more unfavorable prognosis than OHCAs of shockable rhythm with an etiology of cardiac origin [29]. Notably, the age demographic skewed older in the late phase of the pandemic, suggesting a possible increase in OHCAs among older patients, who are more vulnerable to COVID-19.

Pre-hospital airway management has also been affected by the pandemic. An updated meta-analysis reported an increase in the use of both endotracheal intubation and supraglottic airway devices during the pandemic [26]. However, in this study, the supraglottic airway was favored, while endotracheal intubation progressively decreased during the pandemic. This is likely due to the EMS personnel's fear of contracting COVID-19 during endotracheal intubation and the physical restrictions imposed by wearing protective clothing, face shields, and goggles. The sum of supraglottic airway and endotracheal intubation was higher than that before the pandemic, suggesting that more advanced resuscitation was performed in the pre-hospital setting.

Transport time, including the time from cardiac arrest diagnosis to ED arrival, significantly increased during the pandemic era. During the surge in COVID-19 patients, the lack of medical resources, poor access to hospitals, requirements for ambulance disinfection, and the need to wear protective equipment may have contributed to the increase in transportation time [30]. Difficulties in hospital selection led to prolonged unnecessary pre-hospital treatment, and the frequency of adrenaline use increased during the pandemic. Further, prolonged transport time may have directly contributed to poorer outcomes in OHCA patients during the pandemic. Furthermore, it emerged as an independent factor for poorer neurological outcomes in the multivariate analysis of this study. Such delays could compromise the continuity and quality of ALS from pre-hospital settings to hospitals, as underscored in the CoS, ultimately leading to suboptimal patient outcomes.

The pre-hospital factors consistently emphasized in the CoS, which play a key role in OHCA

outcomes, were also heavily impacted by the pandemic. Maintaining a CoS in the event of future outbreaks and the emergence of new variants should be an ongoing discussion.

Limitations

This study has several limitations. First, depending on the country and region, the impact of the COVID pandemic on OHCA may vary. Our findings were derived using only OHCA patients in South Korea and extending globally can be limiting. Second, although the KoCARC registry was prospectively collected using established protocols and methods, the aim to examine the impact of the pandemic on OHCA was not predetermined before the initiation of the registry. Third, we were unable to investigate whether SARS-COV-2 infection was the direct cause of cardiac arrest in the enrolled OHCA patients. However, the main contribution of this study was to investigate the impact of prehospital factors associated with CoS during the pandemic. Forth, despite the comprehensive data collection employing Utstein-style templates within the registry, the potential remains for latent confounders to influence the results. Lastly, long-term prognoses were not included in this analysis due to the limited observation period.

Conclusions

The incidence of OHCA increased during the pandemic, while both the survival rate and GNO at discharge decreased, especially during community COVID-19 surges. Pre-hospital OHCA factors, which directly influence OHCA prognosis, were adversely affected by the pandemic. Ongoing discussions are needed to maintain the CoS in anticipation of future pandemics.

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Abbreviations

OHCA, out-of-hospital cardiac arrest; CoS, the chain of survival; KoCARC, Korean Cardiac Arrest Resuscitation Consortium; GNO, good neurologic outcome; SARS-CoV-2, the severe acute respiratory syndrome coronavirus 2; COVID-19, coronavirus disease 2019; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; ALS, advanced life support; ROSC, return of spontaneous circulation; IRB, the institutional review board; ED, emergency department; EMS, emergency medical services; CPC, Cerebral Performance Category; aOR, adjusted odds ratio; OR,

odds ratio; CI, confidence interval

Figures

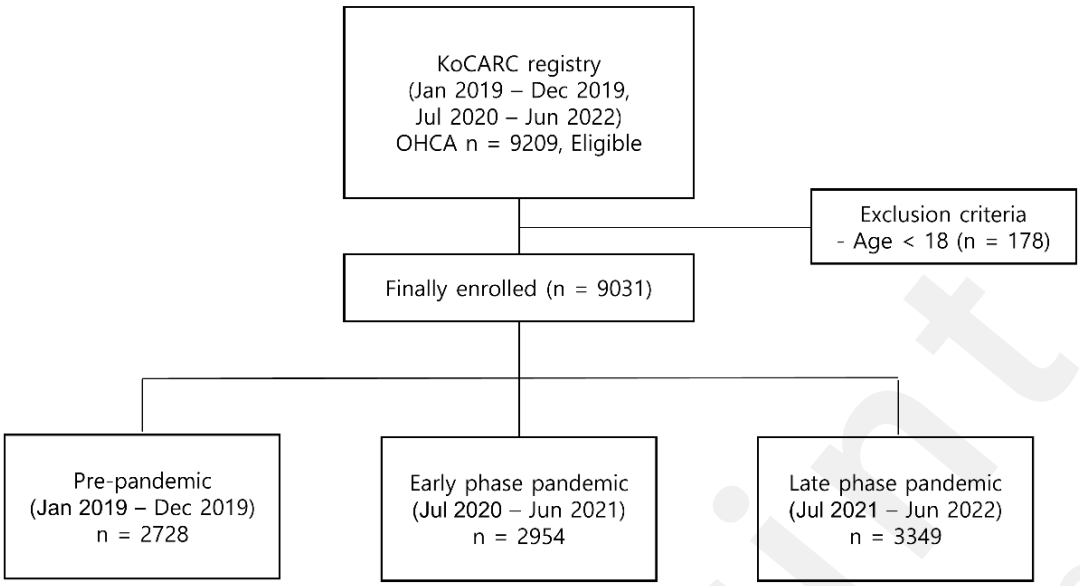


Figure 1. Flowchart of the study. KoCARC, the Korean Cardiac Arrest Research Consortium; OHCA, out-of-hospital cardiac arrest

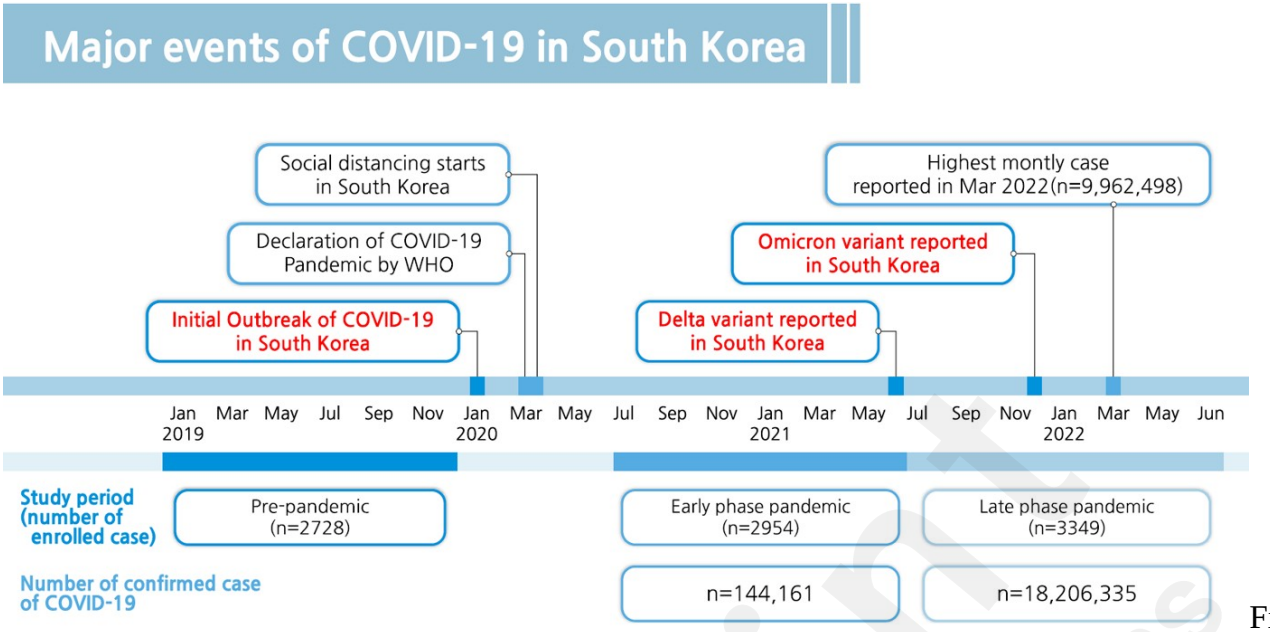


Figure 2. Major events and number of confirmed cases of COVID-19 in South Korea during the study periods (from January 2019 to June 2022). COVID-19, coronavirus disease 2019; WHO, World Health Organization

Table 1. Baseline and pre-hospital characteristics of out-of-hospital cardiac arrest patients enrolled in the nationwide multicenter registry of South Korea

Variables	Pre-pandemic (n = 2728)	Early phase pandemic (n = 2954)	Late phase pandemic (n = 3349)	*P*-value[a] Pre vs. early	*P*-value[a] Pre vs. late	*P*-value[a] Early vs. late	*P*-value[b]
Age, years, median (IQR)	72 (59-81)	72 (59-81)	73 (60-82)	.45	.06	.005	.02
Sex, male (%)	1780 (65.2)	1950 (66.0)	2230 (66.6)	.56	.28	.63	.55
Witnessed arrest (%)	1580 (58.0)	1860 (63.1)	2086 (62.9)	<.001	<.001	.92	<.001
Arrest location							
Home/residence (%)	1625 (59.6)	1899 (64.4)	2066 (62.3)	<.001	.03	.09	.001
Bystander response							
Bystander CPR (%)	1443 (56.1)	1572 (54.5)	1798 (55.8)	.23	.80	.31	.43
AED use by bystander (%)	43 (1.7)	26 (0.9)	54 (1.7)	.01	.98	.008	.02
First monitored rhythm							
Shockable rhythm (%)	496 (19.1)	518 (18.1)	538 (16.9)	.38	.03	.21	.10
Pre-hospital defibrillation (%)	621 (23.5)	665 (23.0)	726 (22.3)	.67	.27	.51	.54
Pre-hospital adrenaline use (%)	505 (19.6)	720 (25.1)	656 (20.3)	<.001	.52	<.001	<.001
Pre-hospital airway							
Supraglottic airway (%)	1685 (61.9)	2158 (73.3)	2408 (72.6)	<.001	<.001	.56	<.001
Endotracheal intubation (%)	246 (9.0)	154 (5.2)	116 (3.5)	<.001	<.001	<.001	<.001
Cardiac arrest cognition to ED arrival, min	33 (26-44)	35 (29-45)	36 (28-46)	<.001	<.001	.39	<.001
EMS Call to EMS arrival, min	7 (5-10)	9 (7-12)	9 (7-13)	.001	<.001	<.001	<.001
Arrest place arrival to departure, min	13 (9-18)	15 (11-19)	15 (11-19)	<.001	<.001	.45	<.001
Arrest place departure to ED arrival, min	9 (6-13)	10 (7-14)	10 (7-15)	<.001	<.001	.31	<.001
Cardiac arrest cognition to pre-hospital ROSC, min	16 (11-25)	20 (12-28)	19 (13-26)	.003	.03	.29	.008

Study periods: Pre-pandemic (from January 2019 to December 2019); Early phase pandemic (from July 2020 to June 2021); Late phase pandemic (from July 2021 to June 2022)

Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ED, emergency department; EMS, emergency medical services; IQR, interquartile range; ROSC, return of spontaneous circulation

Continuous variables are presented as the median (Q1, Q3) and tested by using [a]the Mann-Whitney or [b]Kruskal-Wallis test, and categorical variables are presented as N (%) and tested by using the chi-squared test.

*$P < 0.05$ was significant.

Table 2. Comparison of primary and secondary outcomes between pre-pandemic and pandemic eras using nationwide multicenter out-of-hospital cardiac arrest registry of South Korea

Outcomes	Pre-pandemic (n = 2728)	Early phase pandemic (n = 2954)	Late phase pandemic (n = 3349)	*P*-value Pre vs. early	*P*-value Pre vs. late	*P*-value Early vs. late	*P*-value
Survival to hospital admission (%)	734 (26.9)	734 (24.8)	815 (24.3)	.08	.02	.64	.06
Survival to discharge (%)	385 (14.1)	355 (12.0)	392 (11.7)	.02	.005	.70	.01
Good neurologic outcome (%)	260 (9.5)	234 (7.9)	265 (7.9)	.03	.03	.99	.04

Study periods: Pre-pandemic (from January 2019 to December 2019); Early phase pandemic (from July 2020 to June 2021); Late phase pandemic (from July 2021 to June 2022)

Variables are presented as N (%) and tested by using the chi-squared test.

Table 3. Multivariate analysis of factors affecting survival and neurological outcomes using nationwide multicenter out-of-hospital cardiac arrest registry of South Korea

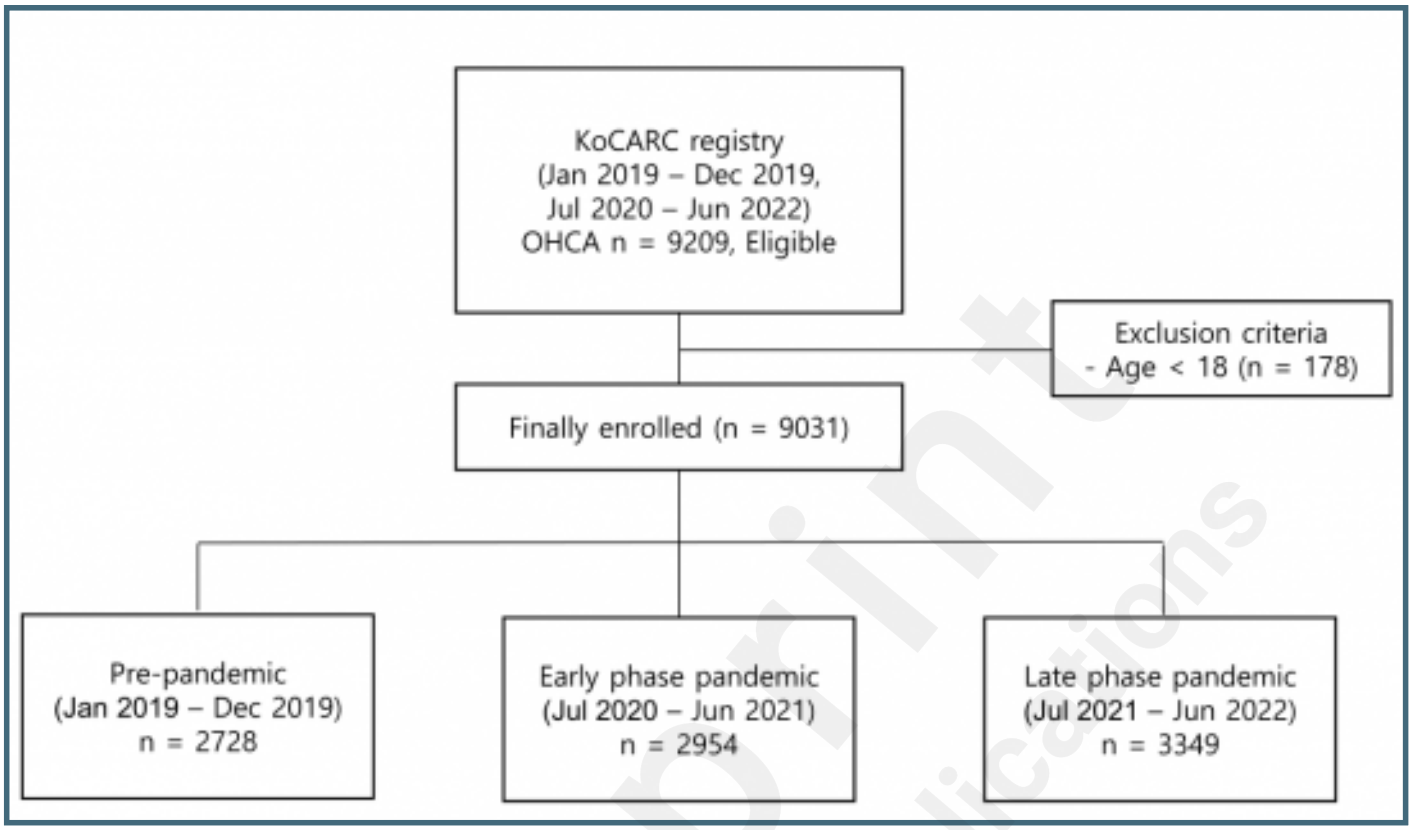
	Survival to hospital admission			Survival to discharge			Good neurologic outcome		
	Adjusted OR	95% CI for the OR	*P*-value	Adjusted OR	95% CI for the OR	*P*-value	Adjusted OR	95% CI for the OR	*P*-value
Age (per year)	0.971	0.967-0.974	<0.001	0.965	0.960-0.970	<.001	0.961	0.955-0.967	<.001
Witnessed arrest (Yes/No)	1.993	1.747-2.275	<0.001	2.122	1.732-2.600	<.001	1.952	1.517-2.513	<.001
Arrest at home/residence (Yes/No)	0.709	0.628-0.799	<0.001	0.599	0.507-0.708	<.001	0.634	0.519-0.776	<.001
AED use by bystander (Yes/No)	0.845	0.513-1.396	0.510	1.530	0.861-2.717	.147	1.740	0.918-3.298	.090
First monitored rhythm (Shockable/Non-shockable)	4.667	4.080-5.338	<0.001	9.061	7.662-10.716	<.001	13.945	11.282-17.236	<.001
Pre-hospital adrenaline (Used/Not used)	0.756	0.651-0.877	<0.001	0.723	0.583-0.896	.003	0.553	0.423-0.723	<.001
Pre-hospital supraglottic airway (Performed/Not performed)	0.750	0.654-0.861	<0.001	0.455	0.380-0.545	<.001	0.416	0.336-0.514	<.001
Pre-hospital endotracheal intubation (Performed/Not Performed)	0.867	0.657-1.145	0.315	0.556	0.374-0.826	.004	0.519	0.319-0.844	.008
Cardiac arrest cognition to ED arrival (per min)	1.000	1.000-1.001	0.484	1.001	1.000-1.002	.052	1.001	1.000-1.002	.036
Period of OHCA occurred									
Pre-pandemic	Reference	-	-	Reference	-	-	Reference	-	-
The early phase pandemic	0.961	0.867-1.065	0.450	0.995	0.861-1.150	.946	0.993	0.835-1.179	.932
The late phase pandemic	1.015	0.918-1.123	0.770	0.962	0.836-1.107	.589	1.026	0.866-1.216	.763

Abbreviations: AED, automated external defibrillator; CI, confidence interval; ED, emergency department; OHCA, out-of-hospital cardiac arrest; OR, odds ratio

Supplementary Files

Figures

Flowchart of the study.



Major events and number of confirmed cases of COVID-19 in South Korea during the study periods (from January 2019 to June 2022).