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Research paper

Effect of delayed transport on clinical outcomes among patients with cardiac arrest during the coronavirus disease 2019 pandemic

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ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has prompted many changes. Revised cardiopulmonary resuscitation (CPR) recommendations were issued including increased requirement for personal protective equipment (PPE) during CPR and isolation rooms. We hypothesized that these changes might have affected transport times and distance. Accordingly, we investigated any differences in transport time and distance and their effect on patient neurologic outcomes at hospital discharge.
Methods: This retrospective study was conducted among patients who experienced cardiopulmonary arrest and were admitted to an emergency department during specific periods — pre-COVID-19 (January 1 to December 31, 2019) and COVID-19 (March 1, 2020, to February 28, 2021).
Result: The mean transport distance was 3.5 ± 2.1 km and 3.7 ± 2.3 km during the pre-COVID-19 and COVID-19 periods, respectively ($p = 0.664$). The mean total transport time was 30.3 ± 6.9 min and 35.6 ± 9.3 min during the pre-COVID-19 and COVID-19 periods, respectively ($p < 0.001$). The mean activation time was 1.5 ± 2.2 min and 2.9 ± 4.5 min during the pre-COVID-19 and COVID-19 periods, respectively ($p = 0.003$). The mean transport time was 9.3 ± 3.5 min and 11.5 ± 6 min during the pre-COVID-19 and COVID-19 periods, respectively ($p = 0.001$).
Conclusion: Total transport time, including activation time for out-of-hospital cardiac arrest patients, increased owing to increased PPE requirements. However, there was no significant difference in the neurological outcome at hospital discharge.

Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory disease coronavirus 2 (SARS-CoV-2), was initially reported in China in December 2019 and was subsequently designated a global pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. The COVID-19 pandemic is a social, economic, and public health crisis that has generated burdens on healthcare system worldwide. It has affected public health care systems, including emergency medical services (EMS). EMS can be defined as a comprehensive system which provides appropriate prehospital management, including the personnel, facilities, equipment, and transfer to emergency department (ED) for victims of sudden illness or injury [2]. EMS institutions have been forced to establish strategies for the treatment and transport of patients during the COVID-19 pandemic period. In previous studies, the overall EMS response rates decreased during the COVID-19 period, with similar or partial increases in response rates for other severe diseases, such as out-of-hospital cardiac arrest (OHCA), stroke, and ST-elevated myocardial infarction [3].

In South Korea, the first case of COVID-19 was reported on January 20, 2020. The number of confirmed cases surged after the government raised the alert level to the highest category (Level 4) on February 23, 2020 [4]. This alert level 4 (Serious, Red) indicates that the new infectious disease was spreading in the community. The government can take the active response at this level, such as a school closure order or movement restriction. Based on the experience with the Middle East respiratory syndrome-related coronavirus

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(MERS) outbreak in 2015, the South Korean government has established a prevention system for infectious diseases, including the use of an isolation rooms, additional precautionary equipment for bag-valve-mask and ventilation, mechanical compression, and enhancement of personal protective equipment (PPE) [5–7]. In addition, transport services in the public health care system were affected by the need for EMS providers to take extra precautions, such as use of PPE, to reduce the risk of infection among themselves or patients [8].

During the current COVID-19 pandemic, new resuscitation strategies for patients with OHCA are needed to protect clinicians. However, the previously published 2015 cardiopulmonary resuscitation (CPR) guidelines did not address adjustments that should be made in response to an infectious epidemic. Therefore, revised CPR recommendations were issued in March 2020 [9,10], including use of PPE during CPR, use of isolation rooms, in additional precautionary equipment for bag-valve-mask and ventilation, and mechanical compression. This management initiative profoundly impacted the prehospital and in-hospital management of patients with OHCA [11]. EMS clinicians, including paramedics and emergency medical technicians are also required to wear enhanced PPE; therefore, we hypothesized that this change may have affected the transport time in the prehospital phase. In addition, the insufficient number of available isolation room makes it exceedingly difficult to transport the nearest hospital in some cases, which could increase the transport distance.

In this study, we investigated differences in transport time and distance and their effect on neurological outcomes in patients with OHCA at hospital discharge.

Materials and method

Study design

This retrospective study involved individuals who experienced OHCA and were admitted to the emergency department (ED) of an academic tertiary hospital in South Korea during specified pre-COVID-19 and COVID-19 periods. Considering seasonal variations, the pre-COVID-19 period was from January 1, 2019, to December 31, 2019, and the COVID-19 period was from March 1, 2020, to February 28, 2021. The two periods were divided at February 2020, when the South Korean government raised the alert level to the highest level [4]. All individuals brought to the ED with suspected cardiac arrest were included. Individuals who presented dead-on-arrival, patients who did not have resuscitation, patients who experienced in-hospital cardiac arrest, post-cardiac arrest patients who were transferred from other hospitals, patients who were transferred to other hospitals at ED discharge, patients with trauma-related arrest, and individuals aged < 18 years were excluded. The enrolled patients received advanced cardiovascular life support and post-resuscitation care [12,13]. Data were collected from the electronic medical records (EMR) and EMS records. This study was approved by the Institutional Review Board (IRB No. 2021–07–001) of our institution. Due the retrospective nature of the study and the use of anonymized patient data, the requirement for informed consent was waived.

Data collection and outcome measurement

All data were collected from the EMR and EMS records in accordance with the Utstein guidelines [14]. Study variables included patient demographic information, pre-arrest cerebral performance category (CPC) scale, cause of cardiac arrest, data related to the EMS (witnesses, bystander CPR, electrocardiogram [ECG] rhythm at EMS, defibrillation performed by EMS, and transfer distance), and initial hospital data (ECG rhythm and defibrillation at the ED). Time point data from EMS records were also collected and time variables were measured as follows [15].

- Downtime: From the time someone reports to EMS to ROSC
- No-flow time: From the time someone reports to EMS to the start of first CPR
- Low-flow time: From the start of the first CPR to return of spontaneous circulation (ROSC) time
- Total transport time: From the time someone reports to the EMS to the time patients arrive at the hospital
- Activation time: From the time someone reports to EMS to the time EMS departure
- Response time: From the time EMS departure to arrival at the scene
- On-scene time: From the time arrival at scene to the time of departure for hospital
- Patient access time: Arrival at scene to patient contact time
- Scene treatment and patient removal time: patient contact to departure from scene time for hospital
- Transport time: departure from scene time for hospital to the time patients arrive at the hospital

After ROSC, we collected variables including the Glasgow coma scale (GCS) score, pupillary light reflex, corneal reflex, mean arterial pressure (MAP), serum lactate levels, ECG results, targeted temperature management (TTM), duration of intensive care unit (ICU) stay, and highest Sequential Organ Failure Assessment (SOFA) score at 7 days of ICU stay were recorded.

The primary outcome was characteristics of EMS transportation, including distance and each transport time variable, during the COVID-19 period compared to those during the pre-COVID-19 period. The secondary outcome was the neurological outcomes at hospital discharge, with good neurologic outcomes defined as a CPC scale score of 1 and 2.

Statistical analysis

Categorical variables are expressed as counts and percentages, and continuous variables are expressed as mean with standard deviation (SD). The independent *t*-test or Mann –Whitney *U* test was used for continuous variables, such as age, distance, and time variables. Pearson's chi-square test or the Fisher's exact test was used for nominal variables. Continuous variables are expressed as the means ± SD or median (interquartile range [IQR]), and categorical variables are expressed as number and percentage. Univariate logistic regression was used to compare neurological prognosis in patients whom ROSC was achieved. Differences with $p < 0.05$ were considered statistically significant. All statistical analyses were performed using IBM SPSS statistics version 26.0 (IBM Corporation, Armonk, NY, USA).

Result

Baseline characteristics

Among 53,382 patients admitted to the ED during the pre-COVID-19 period, 294 were enrolled (Fig. 1), and among 39,538 admitted to the ED during the COVID-19 period, 198 were enrolled (Fig. 2). The baseline characteristics of both groups are summarized in Table 1. The mean (± SD) age of the pre-COVID-19 and COVID-19 groups was 71.2 ± 14.6 years and 68.2 ± 17.8 years, respectively ($p = 0.160$); the proportion of men was 61.2% and 64.4%, respectively ($p = 0.628$). The mean no-flow time was 4.7 ± 4.8 min during the pre-COVID-19 period and 6.5 ± 8.5 min during the COVID-19 period ($p = 0.046$).

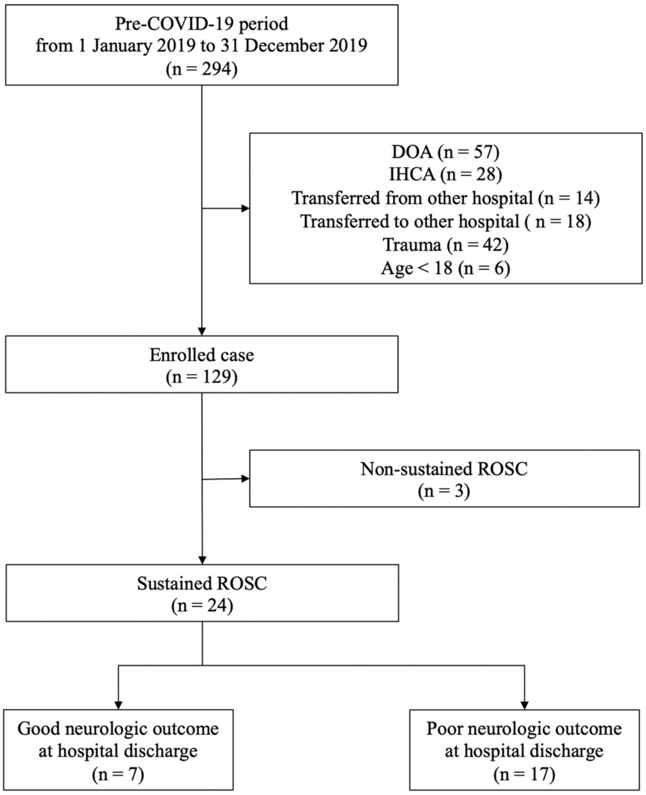

Fig. 1. Pre-COVID-19 period Flow chart.

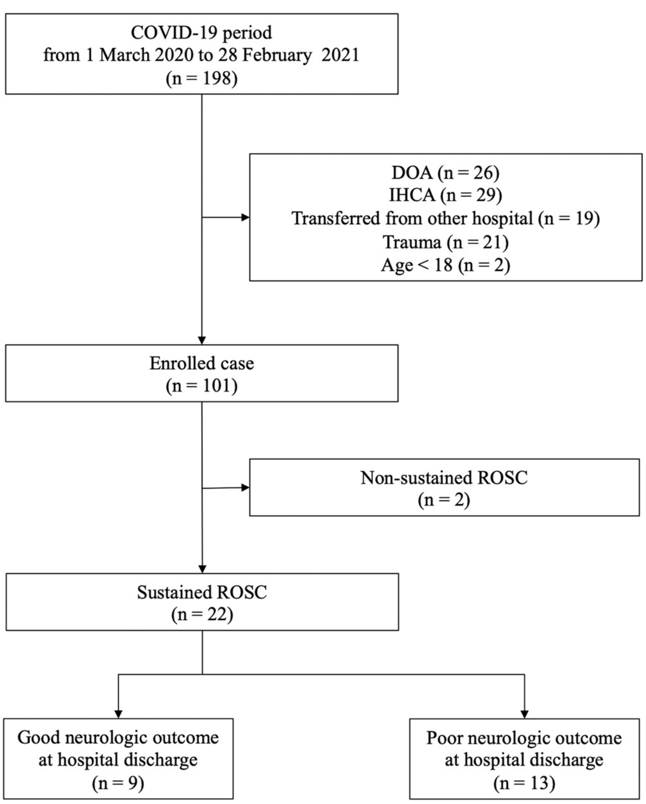

Fig. 2. COVID-19 period Flow chart.

Table 1
Baseline characteristics of the enrolled patients.

Variable	Pre-COVID-19 period (n = 129)	COVID-19 period (n = 101)	*P*-value
Age	71.2 ± 14.6	68.2 ± 17.8	0.160
Sex			0.628
Male	79 (61.2)	65 (64.4)	
Female	50 (38.8)	36 (35.6)	
Pre-arrest CPC			0.398
CPC1	52 (40.3)	44 (43.6)	
CPC2	59 (45.7)	38 (37.6)	
CPC3	17 (13.2)	19 (18.8)	
CPC4	1 (0.8)	0	
Cause of arrest			0.476
Cardiac origin	90 (69.8)	66 (65.3)	
Non-cardiac origin	39 (30.2)	35 (34.7)	
Witness			0.507
Yes	71 (55.0)	60 (59.4)	
No	58 (45.5)	41 (40.6)	
Bystander CPR			0.803
Yes	66 (51.2)	50 (49.5)	
No	63 (48.8)	51 (50.5)	
ECG rhythm in EMS			0.170
Shockable	18 (14.0)	21 (20.8)	
Non-shockable	111 (86.0)	80 (79.2)	
EMS defibrillation			0.193
Yes	24 (18.6)	26 (25.7)	
No	105 (81.4)	75 (74.3)	
ECG rhythm in the ED			0.400
Shockable	11 (8.5)	12 (11.9)	
Non-shockable	118 (91.5)	89 (88.1)	
Prehospital ROSC			0.084
Yes	9 (7.0)	14 (13.9)	
No	120 (93.0)	87 (86.1)	
ED defibrillation			0.573
Yes	13 (10.1)	8 (7.9)	
No	116 (89.9)	93 (92.1)	
No-flow time (min)	4.7 ± 4.8	6.5 ± 8.5	**0.046**
Return of spontaneous circulation	24 (18.6)	22 (21.8)	0.550
Down-time (min)	32.6 ± 16.8	37.1 ± 33.1	0.570
Low-flow time (min)	29.8 ± 16.8	31.3 ± 32.9	0.846
GCS score after ROSC			0.425
≤ 8	16 (66.7)	17 (77.3)	
> 8	8 (33.3)	5 (22.7)	
Pupillary light reflex			0.958
Yes	10 (41.7)	9 (40.9	
No	14 (58.3)	13 (59.1)	
Corneal reflex			0.655
Yes	8 (33.3)	6 (27.3)	
No	16 (66.7)	16 (72.7)	
ECG result after ROSC			0.608
ST elevation	6 (25.0)	7 (31.8)	
Non-ST elevation	18 (75.0)	15 (68.2)	
Lactate (mg/dL)	98.3 ± 54.5	91.2 ± 38.8	0.614
MAP after ROSC (mmHg)	92.3 ± 26.9	96.1 ± 34.8	0.675
TTM			0.113
Yes	3 (12.5)	7 (31.8)	
No	21 (87.5)	15 (68.2)	
Highest SOFA score in 7days	7.7 ± 2.5	9.0 ± 4.2	0.217
Neurological outcome at hospital discharge			0.404
Good (CPC 1–2)	7 (29.2)	9 (40.9)	
Poor (CPC 3–5)	17 (70.8)	13 (59.1)	

Continuous values are given as mean ± standard deviation.
Categorical values are given as number (%).

Comparison of transport distance and time

The mean transport distance was 3.5 ± 2.1 km and 3.7 ± 2.3 km during the pre-COVID-19 and COVID-19 periods, respectively; the difference, however, was not statistically significant differences ($p = 0.664$). The mean total transport time was 30.3 ± 6.9 min during the pre-COVID-19 period and 35.6 ± 9.3 min during the COVID-19

Table 2
The comparison of distance and time between pre-COVID-19 and COVID-19 period.

Variable	Pre-COVID-19 period (n = 98)	COVID-19 period (n = 65)	*P*-value
Distance of transport (Straight) (km)	3.5 ± 2.1	3.7 ± 2.3	0.664
Total transportation time (Min)	30.3 ± 6.9	35.6 ± 9.3	**< 0.001**
Activation time (Min)	1.5 ± 2.2	2.9 ± 4.5	**0.003**
Response time (Min)	5.4 ± 2.6	5.9 ± 2.5	0.127
On-Scene time (Min)	14 ± 5.4	15.2 ± 6.7	0.146
Patient access time (Min)	1.5 ± 2.3	2.3 ± 4.2	0.085
Scene treatment & patient removal time (Min)	12.5 ± 5	12.9 ± 5.9	0.570
Transport time (Min)	9.3 ± 3.5	11.5 ± 6	**0.001**

Continuous values are given as mean ± standard deviation.

period; this difference was statistically significant difference ($p < 0.001$). The mean activation time was 1.5 ± 2.2 min during the pre-COVID-19 period and 2.9 ± 4.5 min during the COVID-19 period; this difference was statistically significant difference ($p = 0.003$). The mean transport time was 9.3 ± 3.5 min during the pre-COVID-19 period and 11.5 ± 6 min during the COVID-19 period; this difference was a statistically significant difference ($p = 0.001$). However, when comparing detailed transport times by EMS, no statistical differences were observed in response time ($p = 0.127$), on-scene time ($p = 0.146$), patient access time ($p = 0.085$), and scene treatment and patient removal time (p = 0.570) (Table 2).

Comparison of neurological outcomes at hospital discharge

The result of univariate analysis of neurological outcomes at hospital discharge during the pre-COVID-19 and COVID-19 periods are summarized in Table 3.

During the pre-COVID-19 period, ROSC was achieved in 24 patients, seven of whom experienced good neurological outcomes; the remaining 17 patients had poor neurological outcomes at hospital discharge. The transport distance and time variables associated with resuscitation and EMS transport did not differ significantly according to neurological outcomes. Patients with good neurological outcomes had high GCS scores after ROSC ($p < 0.001$), more pupillary light reflex ($p = 0.005$), more corneal reflex ($p < 0.001$), and lower SOFA score during 7 days of ICU stay than those with poor neurological outcomes.

During the COVID-19 period, ROSC was achieved in 21 patients, nine of whom were discharged from the hospital with good neurological outcomes; however, the remaining 13 patients were discharged with poor neurological outcomes. There was no statistically significant difference in transport distance between patients with good and poor neurological outcomes. No-flow time was increased in patients with poor neurological outcomes, from 3.9 ± 6.1 min to 7.2 ± 4.7 min, but without statistical differences ($p = 0.170$). Patients with good neurological outcomes had a shorter down-time and low-flow time, with statistically significant differences ($p = 0.003$ and $p = 0.007$, respectively). Nine (100%) patients with good neurological outcomes experienced prehospital ROSC, while four (30.8%) patients with poor neurological outcomes experienced prehospital ROSC ($p = 0.001$). The good neurological outcome group had a higher GCS score after ROSC ($p = 0.002$) and more pupillary light reflex ($p < 0.001$) than the poor neurological outcome group. Furthermore, the highest SOFA score during ICU stay was lower in patients with good neurological outcomes than in those with poor neurological outcomes ($p < 0.001$).

Discussion

There was no statistical difference in the transfer distance between the two periods; however, statistical differences were identified in the transfer time. In particular, the increase in activation time and transfer time was statistically significant. In this study, we compared the characteristics of patients with OHCA during the pre-COVID-19 and COVID-19 periods. Several previous studies have compared the general characteristics, such as incidence and prognosis of OHCA patients between the pre-COVID-19 and COVID-19 period. In the COVID-19 periods, OHCA mortality increased with a high incidence of infection in Switzerland, and there was a transient two-fold increase in the incidence of OHCA with decreased survival in France [16,17]. We focused on examining changes in the transport process in patients with OHCA using data from EMS records. We hypothesized increased transport distances and times because of limited medical personnel and isolation rooms, making it difficult to transport patients with OHCA to suitable nearest hospitals.

Cho et al. [7]. reported that 5.9% of the 171 cases of CPR performed included in the study were confirmed to be COVID-19-positive; however, this was known in only in two cases before CPR. Moreover, the prevalence of asymptomatic COVID-19 is very high, and the rate of SARS-CoV-2 transmission far exceeds that of previous viral pathogens [18–20]. Therefore, it is exceedingly difficult to determine the risk for infection before performing CPR for OHCA events [21]. For example, in Daegu, which was the South Korean epicenter city of COVID-19, several patients were confirmed to be infected after resuscitation at the beginning of the outbreak, and exposed healthcare workers and EMS personnel placed themselves in self- quarantine [11,22]. This situation raised the problem of increased risk for infection among healthcare workers and EMS personnel, and the increase in the number of quarantined personnel led to overwork among the remaining personnel. As a result, during the COVID-19 period, standards for at least level D PPE were recommended when in contact with a patient with OHCA with an unknown COVID-19 status. In our study groups, two of 101 patients were confirmed to have COVID-19. The first patient visited the ED during the early pandemic stage, and preparation was not appropriate, and one medical staff member was exposed to aerosols and quarantined for 2 weeks. In the second case, as the experience was accumulated, no one was exposed to infection.

We found that the total transport times increased during the COVID-19 period than before. A previous study investigated prolonged response times for EMS during the COVID-19 period. However, the response time was defined and analyzed as the call to EMS to EMS arrival at the scene time, which includes activation time [23]. To analyze the time interval in more detail, we subdivided response time into activation time and response time. The activation time increased during the COVID-19 period compared to that during the pre-COVID-19 period (Table 2), indicating that the transport time to the reporting site was not increased; however, the time for EMS rescuers to prepare for the dispatch increased. We believe that the activation time increased due to the increased use of PPE by EMS rescuers and taking more time to deploy ambulances due to limited resources.

We found that the no-flow time increased during the COVID-19 pandemic period. SARS-CoV-2 is known to have a high rate of human-to-human transmission, which may have led to hesitation in bystander CPR. Furthermore, a previous survey study reported that the threat of COVID-19 reduced the willingness of bystanders to perform CPR [24]. However, some studies reported no change in the rates of bystander CPR during the COVID-19 pandemic period [25,26]. In this study, bystander CPR was lower during the COVID-19 period than during the pre-COVID-19 period, although the difference was not statistically significant. ($p = 0.803$). Therefore, we believe that the increase in no-flow time led to an increase in transport time.

Table 3
Univariate analysis for neurological outcomes at hospital discharge.

Variable	Pre-COVID-19 period Good outcomes (CPC1-2) (n = 7)	Pre-COVID-19 period Poor outcomes (CPC3-5) (n = 17)	*P*-value	COVID-19 period Good outcomes (CPC1-2) (n = 9)	COVID-19 period Poor outcomes (CPC3-5) (n = 13)	*P*-value
Distance of transport (Straight) (km)	5.6 ± 4.4	3.4 ± 1.8	0.087	4.0 ± 2.2	2.6 ± 1.7	0.116
Activation time (min)	1.1 ± 0.4	1.3 ± 0.7	0.591	2.7 ± 3.0	2.5 ± 1.3	0.890
Response time (min)	8.9 ± 4.6	4.7 ± 1.8	0.053	5.6 ± 1.4	5.4 ± 2.5	0.171
On-Scene time (min)	11.3 ± 4.7	12.5 ± 7.5	0.691	11.3 ± 4.6	14.2 ± 7.4	0.311
Transport time (min)	11.6 ± 5.7	9.5 ± 3.2	0.276	11.3 ± 4.0	10.5 ± 5.3	0.679
No-flow time (min)	2.4 ± 3.8	2.9 ± 2.8	0.714	3.9 ± 6.1	7.2 ± 4.7	0.170
Down-time (min)	24.0 ± 12.9	36.2 ± 17.3	0.108	15.6 ± 10.0	52.1 ± 35.5	**0.003**
Low-flow time (min)	21.6 ± 14.7	33.2 ± 16.9	0.125	11.7 ± 7.3	44.9 ± 37.0	**0.007**
Age	62.3 ± 8.0	62.8 ± 18.5	0.922	51.7 ± 12.9	54.0 ± 17.1	0.733
Sex			0.204			0.323
Male	6 (85.7)	10 (58.8)		6 (66.7)	11 (84.6)	
Female	1 (14.3)	7 (41.2)		3 (33.3)	2 (15.4)	
Pre-arrest CPC			0.554			0.421
CPC1	5 (71.4)	9 (52.9)		7 (77.8)	8 (61.5)	
CPC2	2 (28.6)	6 (35.3)		2 (22.2)	5 (38.5)	
CPC3	0 (0)	2 (11.8)		0 (0)	0 (0)	
CPC4	0 (0)	0 (0)		0 (0)	0 (0)	
Cause of arrest			0.081			**0.030**
Cardiac origin	6 (85.7)	8 (47.1)		7 (77.8)	4 (30.8)	
Non-cardiac origin	1 (14.3)	9 (52.9)		2 (22.2)	9 (69.2)	
Witness			0.107			0.279
Yes	7 (100.0)	12 (70.6)		8 (88.9)	9 (69.2)	
No	0 (0)	5 (29.4)		1 (11.1)	4 (30.8)	
Bystander CPR			0.303			**0.030**
Yes	6 (85.7)	11 (64.7)		7 (77.8)	4 (30.8)	
No	1 (14.3)	6 (35.3)		2 (22.2)	9 (69.2)	
ECG rhythm in EMS			0.058			**0.030**
Shockable	5 (71.4)	5 (29.4)		7 (77.8)	4 (30.8)	
Non-shockable	2 (28.6)	12 (70.6)		2 (22.2)	9 (69.2)	
EMS defibrillation			**0.028**			0.193
Yes	5 (71.4)	4 (23.5)		6 (66.7)	5 (38.5)	
No	2 (28.6)	13 (76.5)		3 (33.3)	8 (61.5)	
ECG rhythm in the ED			**0.003**			0.119
Shockable	5 (71.4)	2 (11.8)		5 (55.6)	3 (23.1)	
Non-shockable	2 (28.6)	15 (88.2)		4 (44.4)	10 (76.9)	
Prehospital ROSC			0.112			**0.001**
Yes	4 (57.1)	4 (23.5)		9 (100.0)	4 (30.8)	
No	3 (42.9)	13 (76.5)		0 (0)	9 (69.2)	
ED defibrillation			0.343			0.394
Yes	0 (0)	2 (11.8)		0 (0)	1 (7.7)	
No	7 (100.0)	15 (88.2)		9 (100.0)	12 (92.3)	
GCS score after ROSC			**< 0.001**			**0.002**
≤ 8	1 (14.3)	15 (88.2)		4 (44.4)	13 (100.0)	
> 8	6 (85.7)	2 (11.8)		5 (55.6)	0 (0)	
Pupillary light reflex			**0.005**			**< 0.001**
Yes	6 (85.7)	4 (23.5)		8 (88.9)	1 (7.7)	
No	1 (14.3)	13 (76.5)		1 (11.1)	12 (92.3)	
Corneal reflex			**< 0.001**			**0.013**
Yes	6 (85.7)	2 (11.8)		5 (55.6)	1 (7.7)	
No	1 (14.3)	15 (88.2)		4 (44.4)	12 (92.3)	
ECG result after ROSC			0.795			0.290
ST elevation	2 (28.6)	4 (23.5)		4 (44.4)	3 (23.1)	
Non-ST elevation	5 (71.4)	13 (76.5)		5 (55.6)	10 (76.9)	
Lactate after ROSC (mg/dL)	79.7 ± 45.3	106.0 ± 57.3	0.293	80.6 ± 37.9	98.5 ± 39.1	0.296
MAP after ROSC (mmHg)	95.9 ± 27.1	90.8 ± 27.5	0.686	102.6 ± 22.4	91.7 ± 41.6	0.485
TTM			0.865			0.421
Yes	1 (14.3)	2 (11.8)		2 (22.2)	5 (38.5)	
No	6 (85.7)	15 (88.2)		7 (77.8)	8 (61.5)	
Highest SOFA score in 7days	5.4 ± 2.3	8.6 ± 2.0	**0.003**	5.1 ± 1.9	11.6 ± 3.0	**< 0.001**

Continuous values are given as mean ± standard deviation.
Categorical values are given as number (%).

As a result, there were no significant differences in the total distance of transport between the two periods. However, in the prehospital phase, EMS transport time increased for patients with OHCA during the COVID-19 period. According to univariable analysis, there was no significant difference in patient neurological outcomes at hospital discharge between the two periods (Table 3).

There are limitations to the present study, the first of which was its retrospective, single-center design. Although we compared the characteristics of patients with OHCA 1 year after the COVID-19 pandemic to the previous year, the COVID-19 strategy may have changed in that time frame. We conducted the study by obtaining CPR data from EMS records. However, granular information related to the quality of CPR (e.g., chest compression quality, airway management, and intravenous epinephrine were administered) was unknown, and the resulting outcomes were not reflected. It was difficult to perform multivariate analysis of neurological outcomes at hospital discharge during both periods due to the small number of patients.

Conclusion

During the COVID-19 period, the total transport time, especially the activation time for patients with OHCA, increased due to increased requirements for PPE compared to those in the pre-COVID-19 period. However, there was no significant difference in neurological outcomes of patients with OHCA at hospital discharge between the periods.

Conflict of interest

The authors declare that they have no competing interests.

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