


ORIGINAL RESEARCH



Reasons for the termination of resuscitation in out-of-hospital cardiac arrests before and after the COVID-19 pandemic in Korea

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Abstract

The incidence of out-of-hospital cardiac arrest (OHCA) gradually increased during the coronavirus disease 2019 (COVID-19) pandemic, and the number of cases requiring termination of resuscitation (TOR) also rose. This study aimed to analyze the reasons for TOR of OHCA cases over 2 years (2019–2020). This retrospective observational study was conducted using data gathered from prehospital emergency medical service (EMS) care reports generated in Seoul between 01 January 2019, and 31 December 2020. We included OHCA cases reported to the EMS system in this study. Patients who experienced cardiac arrest for a non-medical cause and received cardiopulmonary resuscitation (CPR) from EMS paramedics at the scene were excluded. The variables of demographics and comorbidities, arrest location, identity of the bystander, cause of cardiac arrest, first monitored electrocardiographic (ECG) rhythm, and reason for TOR were investigated. We compared data for 1 year before and after the start of the COVID-19 pandemic. A total of 10,872 OHCA cases with TOR were included in this study; of these, 6238 cardiac arrest cases were terminated without resuscitation attempts during the COVID-19 period compared to 4634 during the pre-COVID-19 period. During the COVID-19 period, the proportion of women in the total population decreased, while the median age increased ($p < 0.001$). Patients with comorbidities, the frequency of asystole rhythm at first monitoring, and the number of witnessed cardiac arrests significantly increased ($p < 0.001$). The proportion of TOR cases due to decisions made by a medical director and refusal of CPR by family members also significantly increased, while that due to clear evidence of death decreased ($p < 0.001$). In conclusion, there was a significant change in the reason for TOR before and after the COVID-19 pandemic in Korea.

Keywords

Cardiac arrest; Cardiopulmonary resuscitation; COVID-19; Emergency medical services; Termination of resuscitation

1. Introduction

The incidence of out-of-hospital cardiac arrest (OHCA) has been gradually increasing because of the high prevalence of cardiovascular diseases and aging of the population, leading to increased interest in cardiopulmonary resuscitation (CPR) among the public [1]. To improve the survival of OHCA patients, CPR should be performed immediately by any bystander at the scene, and the patient should be transported thereafter to the hospital while receiving prehospital care [2].

Recently, not only basic life support but also advanced life support has been performed at scenes of OHCA; to do this, a multi-tiered ambulance service system, involving the dispatch of two or more ambulances to the scene of cardiac arrest, has been expanded and implemented [3]. In Korea, a two-tiered ambulance service system has been in play since 2016,

in which two ambulances are simultaneously dispatched to the emergency scene, including that of OHCA, to improve the survival rate of cardiac arrest patients. The two-tiered ambulance service system enhances the quality of prehospital patient care by allowing team resuscitation to be performed, with several paramedics arriving at the scene of an OHCA [4]. However, as two ambulances are simultaneously dispatched to the scene of cardiac arrest, the number of ambulance dispatches increases, aggravating the burden of fieldwork for paramedics. Therefore, an efficient dispatch system should be established to minimize unnecessary dispatches to the scene of OHCA [5, 6].

Previous studies on termination of resuscitation (TOR) guidelines for OHCA have actively investigated sorting patients with cardiac arrest who do not have or have little possibility of survival to reduce unnecessary transport of

patients to hospitals [7–9]. It is widely applicable to activities of prehospital patient care worldwide. Notably, the use rate of medical institutions was reduced during the coronavirus disease 2019 (COVID-19) pandemic due to various barriers [10]. However, the number of ambulance dispatches during the COVID-19 pandemic gradually increased [11]. As the number of patients with cardiac arrest in residential areas rose, the number of cases of TOR at the scene of cardiac arrest also gradually increased [12–14]. It appears that emergency medical service (EMS) is not used efficiently. Therefore, as one of the methods for efficient EMS operation, it is necessary to analyze the size and reason for TOR. However, systematic studies on cases in which paramedics withheld hospital transfers at the scene of an OHCA remain lacking in Korea. Therefore, this study aimed to analyze the reasons for TOR in prehospital cardiac arrest patients and compare them between before and after the COVID-19 pandemic.

2. Participants and methods

2.1 Data collection

This study was conducted using data from prehospital care reports in Seoul for 2 years (01 January 2019–31 December 2020). The data from patients' prehospital care reports were collected using the "Fire and Emergency Rescue Activity Information Management Reporting System" established at the Seoul Metropolitan Fire and Disaster Headquarters. The following data were collected: demographics and comorbidities, arrest location, the identity of a bystander, cause of cardiac arrest, first monitored electrocardiographic (ECG) rhythm, the reason for TOR, witnessed arrest, and transport to the hospital. OHCA cases with TOR reported to the EMS were included in the study. Patients who experienced cardiac arrest of a non-medical cause and received CPR from EMS paramedics at the scene were excluded from the analysis.

2.2 Control group

In Korea, the incidence of COVID-19 has gradually increased since the first case was confirmed in January 2020. As quarantine measures were gradually strengthened, full-scale social distancing has been implemented since March 2020. In this study, 01 January–31 December 2019, was defined as the pre-COVID-19 period (control group), while 01 January–31 December 2020, was defined as the COVID-19 period (comparative group), and an analysis was conducted to compare data from these periods.

2.3 Statistical analysis

Categorical variables are presented as frequencies and percentages, while continuous variables are presented as medians and interquartile ranges. After the normality test, parametric (independent *t*-test or chi-square test) or non-parametric (Mann-Whitney U test) methods were used for comparison. All statistical analyses were performed using SPSS Statistics version 18.0 (SPSS Inc., Chicago, IL, USA). $p < 0.05$ was considered to be statistically significant.

3. Results

3.1 Study participants

During the study period, 22,300 ambulances were dispatched for OHCA in Seoul. Among them, 3801 patients who experienced OHCA due to a non-medical cause and 7627 patients who received CPR from paramedics at the scene were excluded. Overall, only 10,872 cardiac arrest patients whose resuscitation was terminated were included in the analysis (58.8% of 18,499 non-traumatic OHCA cases) (Fig. 1).

The numbers of non-traumatic OHCA patients in Seoul were 8466 in 2019 and 10,033 in 2020; thus, it is apparent that cases increased significantly during the COVID-19 period. Among them, 4634 (54.7%) patients with TOR were enrolled from the pre-COVID-19 period, and a statistically significant increase to 6238 (62.2%) patients was noted in the COVID-19 period ($p < 0.001$, Fig. 2).

3.2 Comparison of characteristics for TOR cases

During the COVID-19 period, the proportion of women decreased (53.1% vs. 37.3%, $p < 0.001$), but the median age of patients during the COVID-19 period was higher than that of patients during the pre-COVID-19 period (77.0 vs. 75.0, $p < 0.001$, Table 1).

A total of 6415 (59.0%) patients had comorbidities, and hypertension, diabetes, and cancer were the most common comorbidities in descending order. The numbers of patients with hypertension, diabetes, cancer, and neurovascular diseases were increased significantly in the COVID-19 period (Table 1).

The most frequently observed first monitored ECG rhythm was asystole (9232 cases, 84.9%); the number of patients with asystole significantly increased from 3889 (83.9%) during the pre-COVID-19 period to 5343 (85.7%) during the COVID-19 period ($p < 0.001$, Table 1).

Most of the cardiac arrests occurred at home (10,160 cases, 93.5%); however, there was no significant difference in cardiac arrest location between before and after the start of the COVID-19 pandemic. A total of 1718 witnessed OHCA cases (15.8%) were documented during the study period, with a significant increase from 671 (14.5%) during the pre-COVID-19 period to 1047 (16.8%) during the COVID-19 period ($p < 0.001$, Table 1). The most common bystanders were family members (7595 cases, 69.6%), whose presence during OHCA significantly increased from 3152 (68.0%) cases during the pre-COVID-19 period to 4443 (71.2%) cases during the COVID-19 period ($p = 0.002$, Table 1).

3.3 Comparison of the reasons for TOR

The reasons for TOR reported by the paramedics included clear evidence of death, refusal of CPR by family members, decision by the medical director, and the presence of a do-not-resuscitate (DNR) order in advance directives. During the COVID-19 period, the proportion of TOR cases due to decisions by medical directors and refusal of CPR by family members significantly increased, whereas that due to clear

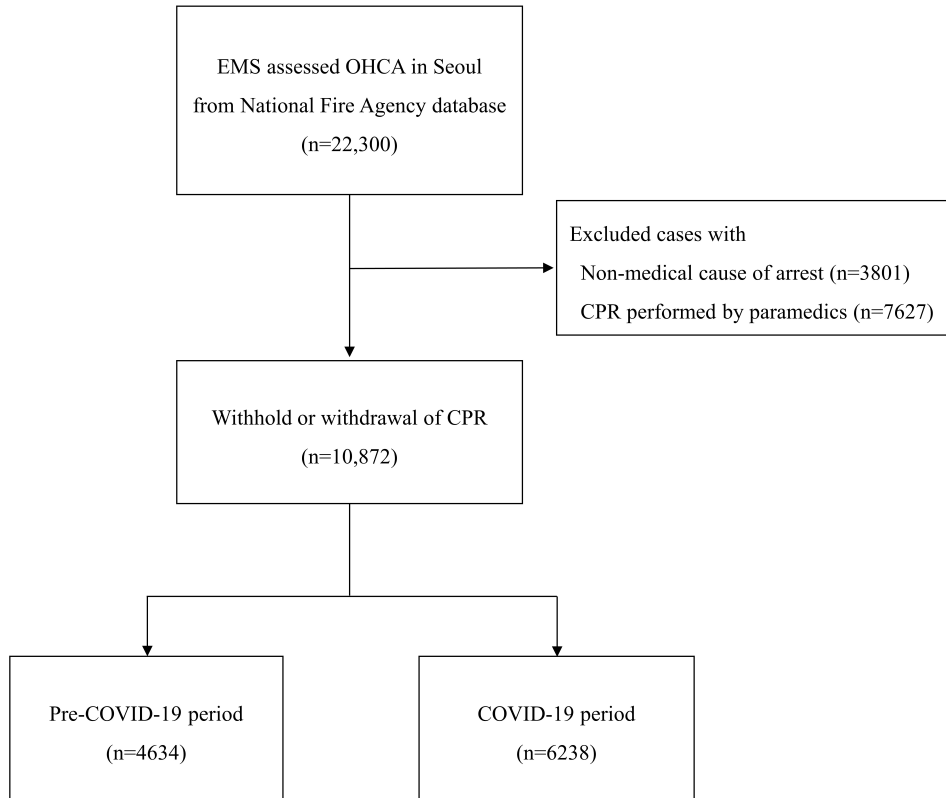


FIGURE 1. Flowsheet of the study. EMS, emergency medical services; OHCA, out-of-hospital cardiac arrest; CPR, cardiopulmonary resuscitation; COVID, Coronavirus disease.

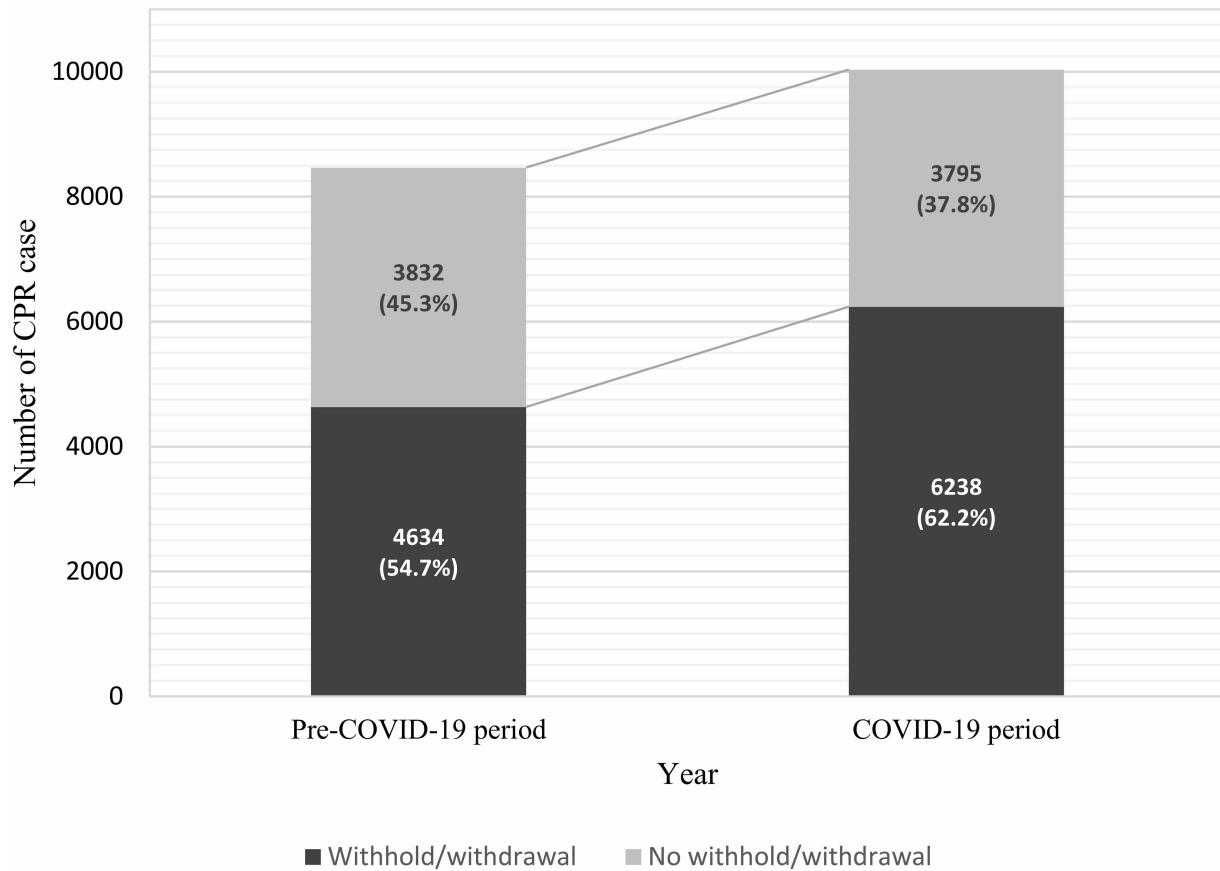


FIGURE 2. Trend of withhold/withdrawal of CPR case. Dark gray bar, withhold/withdrawal of CPR case; light gray bar, CPR performed case. CPR, cardiopulmonary resuscitation; COVID, Coronavirus disease.

TABLE 1. Baseline characteristics of study participants.

Variables	Total (n = 10,872)	Pre-COVID-19 period (n = 4634)	COVID-19 period (n = 6238)	<i>p</i> ^(a)
Gender, female ^(b)	4604 (43.9)	2328 (53.1)	2276 (37.3)	<0.001
Age, year ^(b)	76.0 (60.0–85.0)	75.0 (60.0–84.0)	77.0 (62.0–85.0)	<0.001
Comorbidities ^(c)				
Hypertension	2130 (19.6)	797 (17.2)	1333 (21.4)	<0.001
Diabetes mellitus	1632 (15.0)	636 (13.7)	996 (16.0)	0.001
Cancer	1465 (13.5)	573 (12.4)	892 (14.3)	0.003
Lung disease	500 (4.6)	202 (4.4)	298 (4.8)	0.303
Liver disease	227 (2.1)	95 (2.1)	132 (2.1)	0.812
Renal disease	245 (2.3)	94 (2.0)	151 (2.4)	0.173
Heart disease	988 (9.1)	404 (8.7)	584 (9.4)	0.248
Neurovascular disease	782 (7.2)	276 (6.0)	506 (8.1)	<0.001
Others	2265 (20.8)	926 (20.0)	1339 (21.5)	0.060
Unknown	3159 (29.1)	1457 (31.4)	1702 (27.3)	<0.001
First monitored ECG rhythm				
Asystole	9232 (84.9)	3889 (83.9)	5343 (85.7)	
PEA/Bradycardia/AED nonshockable	423 (3.9)	167 (3.6)	256 (4.1)	
VF/pVT/AED shockable	22 (0.2)	11 (0.2)	11 (0.2)	<0.001
Others, unknown, etc.	138 (1.3)	17 (0.4)	121 (1.9)	
Not recorded	1057 (9.7)	550 (11.9)	507 (8.1)	
Witnessed arrest				
Not witnessed	8792 (80.9)	3781 (81.6)	5011 (80.3)	
Witnessed	1718 (15.8)	671 (14.5)	1047 (16.8)	<0.001
Unknown	362 (3.3)	182 (3.9)	180 (2.9)	
Transported to ED				
Transported	54 (0.5)	25 (0.5)	29 (0.5)	
Not transported	10,818 (99.5)	4609 (99.5)	6209 (99.5)	0.584
Arrest location				
Home/residence	10,160 (93.5)	4323 (93.3)	5837 (93.6)	
Medical/assisted living/nursing home	237 (2.2)	104 (2.2)	133 (2.1)	
Sport/recreation event	244 (2.2)	105 (2.3)	139 (2.2)	
Industrial/workplace/public building	27 (0.2)	13 (0.3)	14 (0.2)	0.776
Street/highway	43 (0.4)	22 (0.5)	21 (0.3)	
Others/unknown/not recorded	130 (1.2)	57 (1.2)	73 (1.2)	
In Ambulance	31 (0.3)	10 (0.2)	21 (0.3)	
Bystander				
Family	7595 (69.9)	3152 (68.0)	4443 (71.2)	
Passerby	313 (2.9)	137 (3.0)	176 (2.8)	
Colleague	415 (3.8)	192 (4.1)	223 (3.6)	
Healthcare workers, paramedics	636 (5.8)	276 (6.0)	360 (5.8)	0.002
First responder	177 (1.6)	94 (2.0)	83 (1.3)	
Others	1736 (16.0)	783 (16.9)	953 (15.3)	

COVID, Coronavirus disease; ECG, electrocardiography; PEA, pulseless electrical activity; AED, automated external defibrillator; VF, ventricular fibrillation; pVT, pulseless ventricular tachycardia; ED, emergency department; ^(a)Comparison between pre-COVID and COVID period; ^(b)The variables includes the missing value; ^(c)These variables were counted to duplicate; Categorical variables were expressed by number (%), continuous variables by median (interquartile range).

TABLE 2. Reasons for withhold/withdrawal of CPR

Causes	Pre-COVID-19 period (n = 4634)	COVID-19 period (n = 6238)	<i>p</i>
Clear evidence of death	2872 (62.0)	3030 (48.6)	<0.001
Refusal of family member	1388 (30.0)	2289 (36.7)	
Decision by medical director	316 (6.8)	811 (13.0)	
DNR in advance directives	58 (1.3)	108 (1.7)	

CPR, cardiopulmonary resuscitation; COVID, Coronavirus disease; DNR, do-not resuscitate.

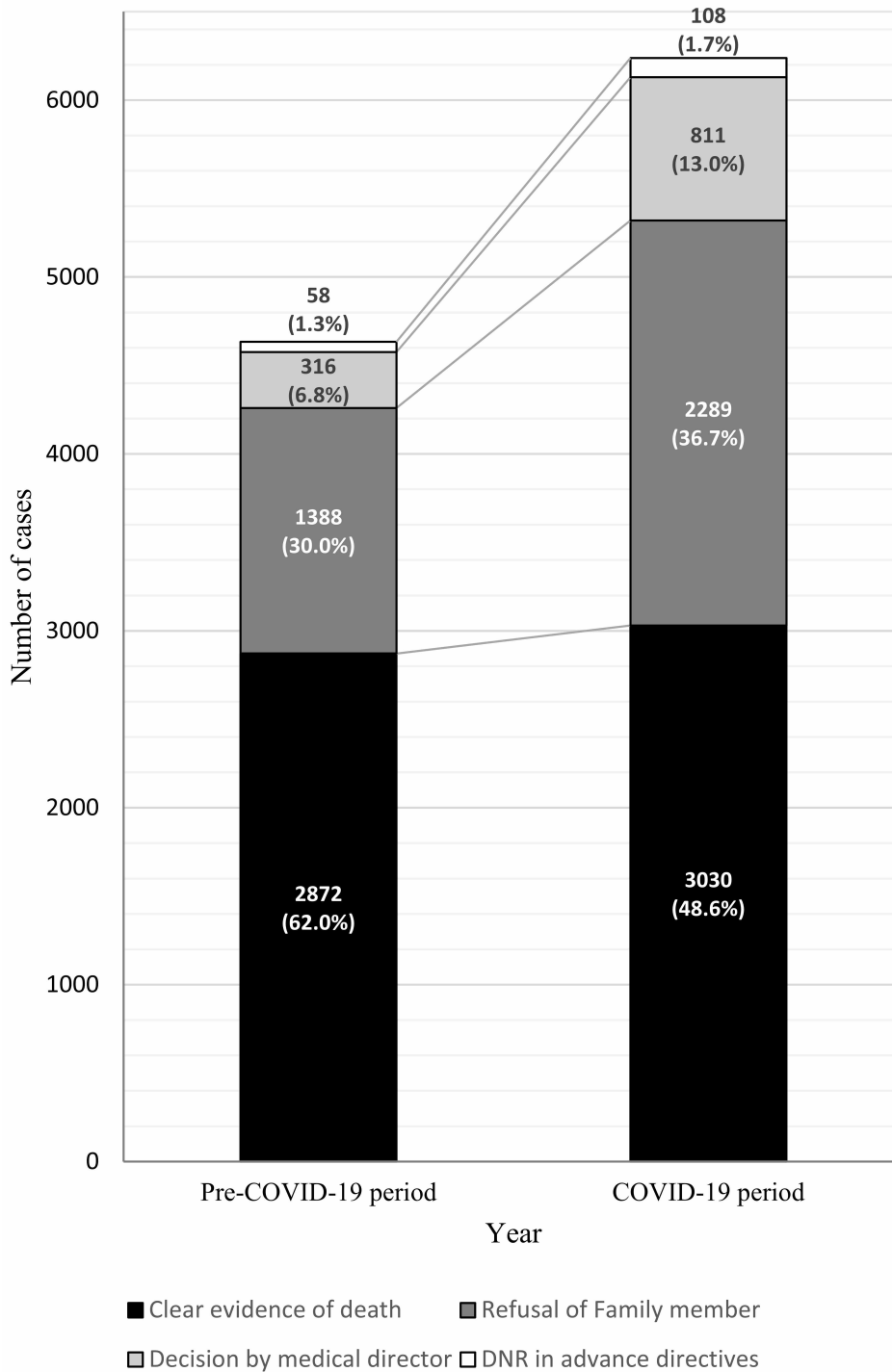


FIGURE 3. Number of withhold/withdrawal of CPR by causes. Starting from the bottom of the bar chart, black bar, clear evidence of death; dark gray bar, refusal of family member; light gray bar, decision by medical director; whitish gray bar, DNR in advance directives. CPR, cardiopulmonary resuscitation; COVID, Coronavirus disease; DNR, do-not resuscitate.

evidence of death decreased. Among these patients, only 166 (1.5%) had completed the DNR form in advance directives (Table 2). Clear evidence of death accounted for 2872 cases in 2019, which increased to 3030 cases in 2020; however, the proportion significantly decreased from 62.0% in 2019 to 48.6% in 2020. Refusal of CPR by family members accounted for 30.0% of all reasons for TOR in 2019, and this proportion significantly increased to 36.7% in 2020 during the COVID-19 period. Decisions by medical directors accounted for 6.8% of the reasons for TOR in 2019 but significantly increased to 13.0% in 2020 (Fig. 3).

There was no significant difference in the reasons for TOR between before and after the COVID-19 pandemic among patients who did not have comorbidities and were aged <65 years. Patients with comorbidities had increased refusal of CPR by family members in all age groups compared to the pre-COVID-19 period. Among patients without comorbidities, those aged 65–74 years had increased refusal of CPR by family members, but those aged ≥ 75 years showed no significant difference (48.4% during the pre-COVID-19 period vs. 48.2% during the COVID-19 period; Table 3).

4. Discussion

In this study conducted on patients with OHCA in Seoul, the number of TOR cases confirmed by EMS paramedics increased during the COVID-19 pandemic, and those due to decisions by medical directors and refusal of CPR by family members significantly increased. These results are consistent with those of previous studies reporting a rise in OHCA occurring at home and an increase in TOR at the scene due to strengthened social distancing and a decrease in patients' use of medical institutions during the COVID-19 pandemic [15–17]. In an observational study using an OHCA registry in the United States, Chan *et al.* [18] found that, in regions with high COVID-19 mortality rates, the number of on-site resuscitation termination cases was more likely to be increased; however, even in areas with relatively low COVID-19 mortality rates, the number of on-site resuscitation termination cases significantly increased.

In our analysis of the reasons for TOR, the number of cases of resuscitation termination due to refusal of CPR by family members was significantly increased during the COVID-19 pandemic. This trend was true across all age groups, particularly among patients with comorbidities. Because of limited access to health care during the COVID-19 pandemic, the proportion of patients with comorbidities who remain at home during cardiac arrest increased, and it is assumed that family members who witnessed the cardiac arrest also refused to be transported to hospitals (Tables 1,2,3).

In Korea, when paramedics terminate cardiac arrest at the scene, they must receive medical supervision from an on-duty EMS medical director [19]. In this study, compared to before the COVID-19 pandemic, decisions made by the medical director increased the rate of TOR, and this result is presumed to have occurred because paramedics declared the termination through medical direction without being sure about the evidence of death (Fig. 3, Table 2). Furthermore, the COVID-19 pandemic itself may have influenced the determi-

nation of clear evidence of death. The pandemic situation may have caused a delay in evaluating clear evidence of death until quarantine release, and EMS paramedics could also have been reluctant to evaluate the death. However, further research is needed to verify these findings.

In this study, the number of patients who completed a DNR form in advance directives was small among those who experienced TOR (1.5% of all cases). In Korea, the Act on Decisions on Life-sustaining Treatment for Patients in Hospice and Palliative Care or at the End of Life, which allows patients with no possibility of revitalization to not receive life-sustaining treatment by order of themselves or at the consent of their family members, was introduced in 2017. However, official forms are rarely prepared and presented to paramedics at an actual cardiac arrest scene. Considering that the rate of CPR refusal by family members continued to increase in this study, measures for activating DNR in advance directives are necessary for the future (Fig. 3, Table 2).

Hutton *et al.* [20] confirmed in a study conducted in the United States using the North American Resuscitation Outcomes Consortium Epistry that 1622 out of 27,232 prehospital TOR cases involved a DNR in advance directives and 1018 involved verbal directives given by family. Even after accounting for differences in study participants' selection, the proportion of verbal directives given by family was lower than that in this study. In contrast, the proportion of DNR orders in advance directives was significantly higher than in this study. This trend is probably due to cultural differences between the East and West regarding the right to self-determination of death.

This study has a strength compared to previous studies because it relied on a large-scale database with a population of about 10 million people. It was conducted among 18,499 non-traumatic OHCA patients in Seoul during a 2-year study period; among them, 58.8% ($n = 10,872$) of patients experienced TOR. The emergency dispatch protocol in Korea indicates that two ambulances are dispatched promptly when EMS dispatchers recognize a cardiac arrest situation. Determining the need to terminate resuscitation is not implemented during this stage. Therefore, if caregivers or witnesses who call EMS do not proactively express their intention to refuse CPR, paramedics are unaware of this until they arrive at the scene of the cardiac arrest. Consequently, unnecessary ambulance dispatch is likely to occur. As confirmed by the results of this study, more than half of all non-traumatic OHCA patients in Seoul experienced TOR, suggesting the preparation of countermeasures. If a process is added to quickly examine the DNR in advance directives and the intention to refuse CPR at the stage of obtaining EMS calls, the quality of emergency treatment in OHCA situations that require actual resuscitation can be improved by reducing unnecessary ambulance dispatches. This is the clinical implication that our study has. Therefore, further research will be needed for the effective EMS operation of non-traumatic OHCA.

TABLE 3. Trends of withhold/withdrawal of CPR according to age and comorbidities.

	Age <65 (n = 1730)			65 ≤ Age <74 (n = 1150)			75 ≤ Age (n = 4726)		
	Pre-COVID-19 period	COVID-19 period	<i>p</i> ^(a)	Pre-COVID-19 period	COVID-19 period	<i>p</i> ^(a)	Pre-COVID-19 period	COVID-19 period	<i>p</i> ^(a)
No Comorbidities (n = 1270)									
Clear evidence of death	164 (85.0%)	172 (77.1%)		62 (91.2%)	42 (71.2%)		150 (47.2%)	155 (37.9%)	
Refusal of family member	8 (4.1%)	14 (6.3%)	0.201	2 (2.9%)	10 (16.9%)	0.009	154 (48.4%)	197 (48.2%)	<0.001
Decision by medical director	21 (10.9%)	36 (16.1%)		4 (5.9%)	7 (11.9%)		13 (4.1%)	53 (13.0%)	
DNR in advance directives	0 (0.0%)	1 (0.4%)		0 (0.0%)	0 (0.0%)		1 (0.3%)	4 (1.0%)	
Comorbidities (n = 6336)									
Clear evidence of death	454 (76.3%)	462 (64.3%)		259 (62.4%)	286 (47.0%)		592 (39.1%)	733 (29.5%)	
Refusal of family member	82 (13.8%)	128 (17.8%)	<0.001	116 (28.0%)	228 (37.5%)	<0.001	813 (53.7%)	1452 (58.4%)	<0.001
Decision by medical director	52 (8.7%)	118 (16.4%)		34 (8.2%)	75 (12.3%)		82 (5.4%)	244 (9.8%)	
DNR in advance directives	7 (1.2%)	11 (1.5%)		6 (1.4%)	19 (3.1%)		26 (1.7%)	57 (2.3%)	

CPR, cardiopulmonary resuscitation; COVID-19, Coronavirus disease; DNR, do-not resuscitate. ^(a) Comparison between pre-COVID and COVID period; Age and comorbidities variables had missing values. Categorical variables were expressed by number (%).

This study had several limitations. First, as a retrospective observational study, it was conducted over a relatively short period of time; our participants are not representative of all OHCA patients in Korea, as this study only targeted those who had experienced TOR among OHCA patients in Seoul. Second, although the COVID-19 period began in January 2020, there could be a gap between the appearance of COVID-19 cases in Seoul and the time of implementing social distancing reinforcement policies. However, the first confirmed case in Korea was diagnosed in January, and the first epidemic was declared in February, so the start of the COVID-19 period in this study differs from the date of the World Health Organization's pandemic declaration. Third, data quality could be affected herein because only some of the data were collected based on prehospital EMS care reports provided by the Seoul Metropolitan Fire and Disaster Headquarters. Information such as dispatch time, multi-tiered dispatches, and the number of emergency personnel dispatched was omitted, limiting the study results. Fourth, because prehospital care reports are created with the information collected by paramedics in an emergency situation, there may be recall bias among the collected data, which could affect the statistics. Fifth, there were factors that could not be analyzed. Changes in local epidemic peaks and local shelter-in-house policies could have an impact on TOR. Therefore, additional research at the national level should be conducted in the future.

5. Conclusions

In this study conducted on OHCA patients in Seoul, the number of TOR cases confirmed by EMS paramedics increased with the onset of the COVID-19 pandemic. During the COVID-19 pandemic, the rates of decision-making by a medical director and refusal of CPR by family members increased, while the rates of clear evidence of death as a reason for TOR decreased. There was a significant difference in the reasons for TOR before and after the start of the COVID-19 pandemic.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from Seoul Metropolitan Fire and Disaster Headquarters but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the papers as follows. JH—writing original draft and interpretation of results; YC and GCC—data collection, data analysis, and reviewing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This retrospective observational study was conducted using prehospital EMS care reports in Seoul and was approved by the Kangdong Sacred Heart hospital's institutional review board

(No. 2022-10-021). The need for informed consent has been waived owing to its retrospective nature.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- [1] Roh SY, Choi JI, Park SH, Kim YG, Shim J, Kim JS, *et al.* The 10-year trend of out-of-hospital cardiac arrests: a Korean nationwide population-based study. *Korean Circulation Journal*. 2021; 51: 866–874.
- [2] Hasselqvist-Ax I, Riva G, Herlitz J, Rosenqvist M, Hollenberg J, Nordberg P, *et al.* Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. *The New England Journal of Medicine*. 2015; 372: 2307–2315.
- [3] Kim TH, Shin SD, Ahn KO, Lee T, Jun C, Cha WC, *et al.* Linear planning and simulation for allocation of ambulances in a two-tiered emergency medical service system. *Journal of The Korean Society of Emergency Medicine*. 2011; 22: 1–8.
- [4] Park JH, Song KJ, Shin SD, Hong KJ. Does second EMS unit response time affect outcomes of OHCA in multi-tiered system? A nationwide observational study. *The American Journal of Emergency Medicine*. 2021; 42: 161–167.
- [5] Holmén J, Herlitz J, Ricksten S, Strömsöe A, Hagberg E, Axelsson C, *et al.* Shortening ambulance response time increases survival in out-of-hospital cardiac arrest. *Journal of the American Heart Association*. 2020; 9: e017048
- [6] Bürger A, Wnent J, Bohn A, Jantzen T, Brenner S, Lefering R, *et al.* The effect of ambulance response time on survival following out-of-hospital cardiac arrest. *Deutsches Arzteblatt International*. 2018; 115: 541–548.
- [7] Tataris KL, Richards CT, Stein-Spencer L, Ryan S, Lazzara P, Weber JM. EMS provider perceptions on termination of resuscitation in a large, urban EMS system. *Prehospital Emergency Care*. 2017; 21: 610–615.
- [8] Bailey ED, Wydro GC, Cone DC. Termination of resuscitation in the prehospital setting for adult patients suffering nontraumatic cardiac arrest. *National Association of EMS Physicians Standards and Clinical Practice Committee*. *Prehospital Emergency Care*. 2000; 4: 190–195.
- [9] Stockinger ZT, McSwain NE Jr. Additional evidence in support of withholding or terminating cardiopulmonary resuscitation for trauma patients in the field. *Journal of the American College of Surgeons*. 2004; 198: 227–231.
- [10] World Health Organization. Third round of the global pulse survey on continuity of essential health services during the COVID-19 pandemic. 2022. Available at: https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2022.1 (Accessed: 31 October 2022).
- [11] Al Amiry A, Maguire BJ. Emergency medical services (EMS) calls during COVID-19: early lessons learned for systems planning (a narrative review). *Open Access Emergency Medicine*. 2021; 13: 407–414.
- [12] 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.
- [13] Jung H, Lee MJ, Cho JW, Lee SH, Lee SH, Mun YH, *et al.* External validation of multimodal termination of resuscitation rules for out-of-hospital cardiac arrest patients in the COVID-19 era. *Scandinavian*

- Journal of Trauma, Resuscitation and Emergency Medicine. 2021; 29: 19.
- ^[14] Chavez S, Huebinger R, Chan HK, Gill J, White L, Mendez D, *et al.* The impact of COVID-19 on incidence and outcomes from out-of-hospital cardiac arrest (OHCA) in Texas. *The American Journal of Emergency Medicine.* 2022; 57: 1–5.
- ^[15] Teoh SE, Masuda Y, Tan DJH, Liu N, Morrison LJ, Ong MEH, *et al.* Impact of the COVID-19 pandemic on the epidemiology of out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Annals of Intensive Care.* 2021; 11: 169.
- ^[16] Mathew S, Harrison N, Chalek AD, Gorelick D, Brennan E, Wise S, *et al.* Effects of the COVID-19 pandemic on out-of-hospital cardiac arrest care in Detroit. *The American Journal of Emergency Medicine.* 2021; 46: 90–96.
- ^[17] Baldi E, Sechi GM, Mare C, Canevari F, Brancaglione A, Primi R, *et al.* Treatment of out-of-hospital cardiac arrest in the COVID-19 era: a 100 days experience from the Lombardy region. *PLoS One.* 2020; 15: e0241028.
- ^[18] Chan PS, Girotra S, Tang Y, Al-Araji R, Nallamothu BK, McNally B. Outcomes for out-of-hospital cardiac arrest in the United States during the coronavirus disease 2019 pandemic. *JAMA Cardiology.* 2021; 6: 296–303.
- ^[19] Lee MJ, Shin TY, Lee CH, Moon JD, Roh SG, Kim CW, *et al.* 2020 Korean guidelines for cardiopulmonary resuscitation. Part 9. Education and system implementation for enhanced chain of survival. *Clinical and Experimental Emergency Medicine.* 2021; 8: S116–S124.
- ^[20] Hutton G, Kawano T, Scheuermeyer FX, Panchal AR, Asamoah-Boaheng M, Christenson J, *et al.* Out-of-hospital cardiac arrests terminated without full resuscitation attempts: Characteristics and regional variability. *Resuscitation.* 2022; 172: 47–53.

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