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ORIGINAL RESEARCH

Impact of COVID-19 pandemic on bystander CPR in patient with OHCA: a registry-based before and after study in Daegu, Korea

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Abstract

Bystander cardiopulmonary resuscitation (BCPR) is a significant factor in the chain of survival; however, various potential barriers are observed. We aimed to identify the impact of the coronavirus disease 2019 (COVID-19) pandemic on BCPR. This retrospective observational study used Daegu out-of-hospital cardiac arrest (OHCA) registry data of patients aged over 18 years with cardiac etiology in Daegu, Korea from 18 February 2019 to 17 February 2021. We divided BCPR into self-led (SBCPR) and dispatcher-assisted BCPR (DACPR). To determine changes in the effect of BCPR on OHCA outcomes from the COVID-19 pandemic, we performed multivariable logistic regression analyses by BCPR type. Furthermore, we performed the Wald test to identify differences in logistic regression analysis results between the two periods. A total of 1680 OHCAs were included (before-pandemic, 804; during pandemic, 876). The BCPR rate was not different between the two periods (DACPR, 43.9% *vs.* 42.0%; SBCPR, 18.7% *vs.* 18.4; p = 0.643). SBCPR showed effectiveness for OHCA outcomes before the pandemic (adjusted odds ratio (aOR), 2.59; 95% confidence interval (CI), 1.09–6.18 for survival to hospital discharge; aOR, 2.58; 95% CI, 1.03–6.46 for favorable neurological outcomes); however, it disappeared after the pandemic (aOR, 1.88; 95% CI, 0.88–4.00 for survival to hospital discharge; aOR, 1.67; 95% CI, 0.69–4.05 for favorable neurological outcomes). However, no statistical difference was observed in the Wald test (survival to hospital discharge, p = 0.586; favorable neurologic outcomes, p = 0.504). A decreasing trend in the effect of SBCPR on OHCA outcomes was observed during the COVID-19 pandemic; however, no statistically significant difference was observed compared with that before the pandemic.

Keywords

Bystander cardiopulmonary resuscitation; COVID-19; Outcomes; Out-of-hospital cardiac arrest; Pandemic

1. Introduction

The global coronavirus disease 2019 (COVID-19) pandemic is continuing after the first report of the pandemic from Wuhan, China, in December 2019 [1]. Unlike severe acute respiratory syndrome coronavirus-2 and Middle East respiratory syndrome, the global COVID-19 pandemic has changed the method of medical use and medical resource requirements [2]. These changes also occurred in the field of emergency medicine, particularly regarding out-of-hospital cardiac arrest (OHCA).

Worldwide, higher mortality and poor neurological outcomes of OHCA have been reported during the pandemic compared with that before the pandemic [3, 4]. Poor OHCA outcomes may be a result of some interventions and impacts following COVID-19 pandemic on patients with OHCA. Ahn *et al.* [3] reported that the emergency medical service (EMS) response time was prolonged owing to wearing personal protective equipment, and OHCA mortality worsened in Korea. Nishiyama *et al.* [5] reported not only a decrease in bystander cardiopulmonary resuscitation (BCPR) rate but also worsened neurologic outcomes in OHCA during the COVID-19 pandemic in Japan. Therefore, analyzing changes at each stage of the chain of survival to identify the factors that have become vulnerable during the COVID-19 pandemic is significant for preparing countermeasures to an ongoing or upcoming pandemic.

BCPR is a significant factor in the chain of survival and has been reported to have a positive effect on OHCA outcomes by reducing no-flow time [6]. However, there are various potential barriers to BCPR, including emotional barriers, physical factors, knowledge and procedural, are observed

[7]. Moreover, responding to OHCA within the regional emergency medical system is highly significant owing to its extremely short golden time; however, it is possible that the social distancing policy and psychological impact due to the regional outbreak affected BCPR willingness and quality in specific regional citizens [8, 9]. Although a previous study was conducted on the impact of the COVID-19 pandemic on BCPR in OHCAs occurring in public places, no study was conducted identifying the influence of the COVID-19 pandemic on BCPR based on specific regions [10]. We aimed to investigate the effect of BCPR on OHCA outcomes under the assumption that the rate and effect of BCPR were affected by the COVID-19 pandemic, in Daegu, Korea.

2. Materials and methods

2.1 COVID-19 pandemic and EMS system in Daegu

Daegu is the fourth largest city in Korea with an area of 883.7 km^2 and a population of 2.4 million individuals [11]. On 20 January 2020, the first COVID-19 case in Korea was reported; on 18 February 2020, the first COVID-19 case in Daegu was reported [3]. Soon after the first reported case, a regional occurred in Daegu. However, total social lockdown was not implemented, and various levels of social distancing policies, including restrictions on the number of gatherings or business hours, were implemented depending on regional circumstances. These policies were maintained during the study period; however, there were intermittent changes [10].

For the prehospital EMS system of Daegu, public-based EMS is provided by one central dispatch center and eight local EMS agencies. Once the OHCA is recognized by the central dispatcher center, the EMS dispatcher attempts initiate BCPR by on-line instruction based on the American Heart Association guideline [12]. The prehospital EMS team consists of three emergency medical technicians (EMTs), and as level 1 EMTs are top-notch crews (similar to EMT-intermediate in the United States); however, EMS crews were not able to provide all advanced cardiovascular life support to patients with OHCA before the COVID-19 pandemic. In Korea, the operation of the special EMS team for critically ill patients was began in November 2019 in Korea, and epinephrine use for OHCA under medical direction in the prehospital phase was frequently applied during the COVID-19 pandemic.

2.2 Study participants

On 01 January 2014, the Daegu Emergency Medical Cooperation Bureau began a citywide prospective population-based clinical registry to collect data on patients with OHCA from onset to hospital discharge (Daegu Emergency Medical Services Registry (DEMSRe)) [13]. The DEMSRe research department identifies variables based on basis of the Utstein style using this registry data. This before-and-after study used DEMSRe data from 18 February 2019 to 17 February 2021. The date of the first COVID-19 case identified in Daegu (18 February 2020) was used to mark the before versus during pandemic periods. Of a total of 2580 patients with OHCA, we excluded individuals aged <18 years, those for whom EMS resuscitation was not attempted (patients who did not receive EMS resuscitation under direct medical direction owing to obvious evidence of death), and those with noncardiac OHCAs (trauma, submersion, drug overdose, asphyxia and exsanguination) [14]. Additionally, OHCAs that occurred in medical facilities or were witnessed by EMS crews were excluded. Lastly, patients who were dead on arrival at the hospital (patients declared dead by a physician immediately after hospital arrival without hospital resuscitation effort) or were identified as having a "do-not-attempt-resuscitate" order upon hospital arrival (OHCAs for whom the resuscitation process was discontinued owing to a known prior request following EMS resuscitation initiation) were excluded. Finally, 1680 OHCAs were included in this study (Fig. 1).

2.3 Variables

Location of cardiac arrest (home, public place, and others), witnessed or non-witnessed, BCPR status (chest compression only by laypersons), first recorded electrocardiography (ECG) rhythm, and BCPR type (no-BCPR, OHCAs without BCPR; dispatcher-assisted BCPR (DACPR), BCPR was provided after EMS dispatcher's order; self-led BCPR (SBCPR), BCPR was provided before dispatcher's order by bystander's willingness). Furthermore, we identified prehospital time-related variables including emergency call time, scene site arrival time, departure time, hospital arrival time, response time (time from emergency call to EMS arrival at the scene site), on-scene time (time from EMS scene arrival to departure to the hospital), and transport time (time from EMS scene departure to arrival at the hospital). Additionally, we identified hospital components including past medical history, prehospital return of spontaneous circulation (ROSC), targeted temperature management application, coronary angiography implementation, extracorporeal membrane oxygenation use, survival to hospital discharge, and cerebral performance category score on hospital discharge, using electronic medical record reviews.

2.4 Outcome measures

The primary outcome was survival to hospital discharge, whereas the secondary outcome was favorable neurological outcomes. Cerebral performance category scores of 1 (full recovery or mild disability) or 2 (moderate disability but independent in activities of daily living) were classified as "favorable".

2.5 Statistical analysis

The patients' baseline characteristics, prehospital elements, and in-hospital processes were evaluated by BCPR type. For continuous variables, following the Shapiro-Wilk test was used to identify normality, medians and interquartile ranges were calculated, and the Mann-Whitney U test or Student's t-test was performed. For categorical variables, percentages were calculated, and the Pearson's χ^2 test was performed. Multivariable logistic regression analysis by BCPR type on survival to hospital discharge and favorable neurologic outcomes was performed. To determine the influence of BCPR type on OHCA outcomes, the multivariable logistic regression model

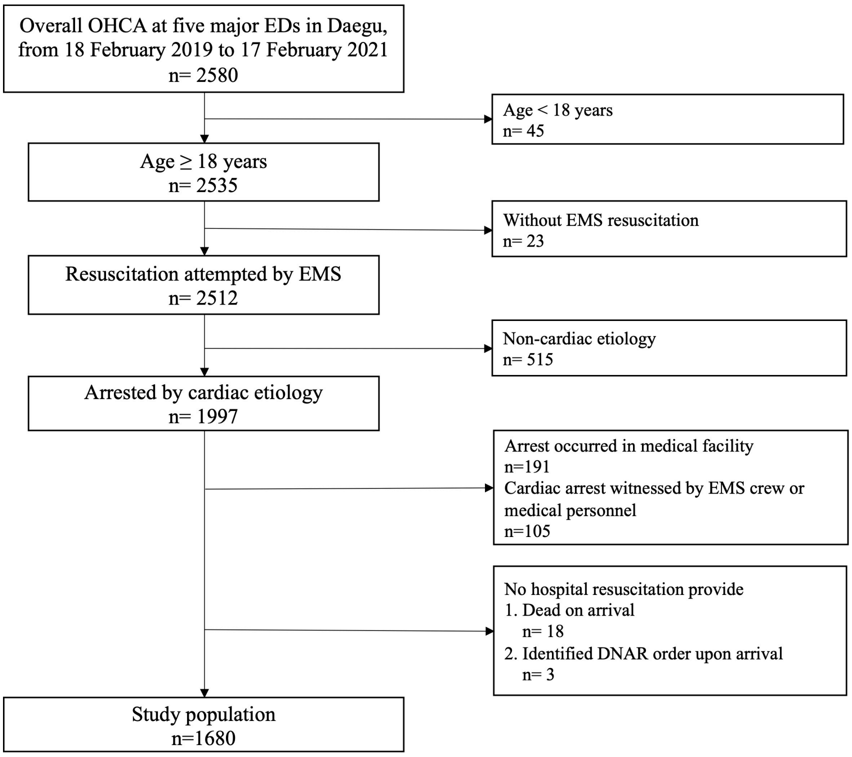

FIGURE 1. Flowchart of the study participants. OHCA, out-of-hospital cardiac arrest; EMS, emergency medical service; EDs, emergency departments; DNAR, do-not-attempt-resuscitation.

was adjusted for possible confounding factors (age, sex, witness status, arrest location, past medical history, response time, arrest time and season) as a covariate in each group to determine the influence of BCPR type on OHCA outcomes [15]. To compare the effect of BCPR, a *p*-value of the Wald test was calculated. All statistical analyses were performed using R version 4. 0. 5 (R Project for Statistical Computing; https://www.r-project.org/). Statistical significance was set at $p < 0.05$.

3. Results

3.1 General characteristics of the study population

Fig. 1 and Table 1 show the general characteristics of the study participants. Of 1680 OHCAs, 804 and 876 were enrolled in the before and during groups, respectively. The home was the most common location of OHCA occurrence (before, 75.6%; during, 75.9%). Age, BCPR type, and location did not significantly differ between the two periods (p = 0.821, 0.643 and 0.885, respectively). Regarding prehospital airway management, an endotracheal tube (ETT) was the most frequently used before the COVID-19 pandemic, whereas a supraglottic airway (SGA) was the most frequently used during the COVID-19 pandemic (50.7% *vs.* 73.6%; $p < 0.001$). The use of prehospital epinephrine increased during the COVID-19 pandemic (before, 58.2%; during, 63.6%; $p = 0.024$). Overall prehospital EMS management times, including response, on-scene, and transport times were increased (response, 7.0–9.0, $p < 0.001$; on-scene, 17.0–18.0, $p = 0.002$; transport, 6.0–7.0, $p < 0.001$). The prehospital return of spontaneous circulation (ROSC) was not different between before and during the COVID-19 pandemic. (before, 14.4% *vs.* during, 11.9%, p = 0.121) Survival to hospital discharge was 7.6% before versus 7.9% during the pandemic, however the difference was not statistically significant ($p = 0.819$). Furthermore, the favorable neurological outcomes rates were 7.1% and 5.7% before and during the pandemic, respectively, and no statistically significant difference was identified ($p = 0.247$).

3.2 Comparison of the characteristics of patients with OHCA by BCPR type

To compare the characteristics of patients with OHCA by BCPR type during each period, patients were divided into the no-BCPR, DACPR or SBCPR groups (Table 2). In the before period, the BCPR group showed a lower age than the no-BCPR group (76.0, 73.0 and 69.5 years for the no-BCPR, DACPR and SBCPR groups, respectively; $p = 0.030$), however no statistical difference was noted in the during period (74.0, 73.0 and 73.0 for the no-BCPR, DACPR, and SBCPR groups, respectively; p = 0.342). In both periods, DACPR was the most common BCPR type. Further, the SBCPR group showed a higher rate of initial shockable rhythm than the other types. During the pandemic, survival to hospital discharge was increased in the no-BCPR and DACPR groups but decreased in the SBCPR group, compared with before the pandemic (before, 4.3%, 7.1% and 15.3% for no-BCPR, DACPR and SBCPR, respectively). The prehospital ROSC was not different by BCPR type. Favorable neurological outcomes were decreased in the all BCPR groups during the pandemic (before, 4.0%, 6.5% and 14.7% for no-BCPR, DACPR and SBCPR, respectively; during, 3.7%, 5.4% and 10.6% for no-BCPR, DACPR and SBCPR respectively).

TABLE 1. General characteristics of patients with out-of-hospital cardiac arrest before and during the COVID-19 pandemic.

Variables	Before the pandemic N = 804	During the pandemic N = 876	*p*-value
Age	74.0 (60.5, 81.0)	73.5 (61.0, 81.0)	0.821
Sex			
Male	506 (62.9)	562 (64.2)	0.604
Female	298 (37.1)	314 (35.8)	
BCPR type			
No-BCPR	301 (37.4)	347 (39.6)	0.643
DACPR	353 (43.9)	368 (42.0)	
SBCPR	150 (18.7)	161 (18.4)	
Witnessed	424 (52.7)	454 (51.8)	0.709
Arrest time			
Daytime (06:00–18:00)	510 (63.4)	549 (62.7)	0.747
Nighttime (18:00–06:00)	294 (36.6)	327 (37.3)	
Season			
Spring	214 (26.6)	230 (26.3)	0.810
Summer	173 (21.5)	189 (21.6)	
Autumn	197 (24.5)	201 (22.9)	
Winter	220 (27.4)	256 (29.2)	
Location of arrest			
home	608 (75.6)	665 (75.9)	0.885
public place	148 (18.4)	155 (17.7)	
others	48 (6.0)	56 (6.4)	
Past medical history			
Heart disease	180 (22.4)	174 (19.9)	0.205
Stroke	74 (9.2)	119 (13.6)	0.005
HTN	325 (40.4)	351 (40.1)	0.882
DM	230 (28.6)	260 (29.7)	0.629
COPD	72 (9.0)	72 (8.2)	0.590
CKD	60 (7.5)	71 (8.1)	0.624
LC	17 (2.1)	19 (2.2)	0.939
Cancer	107 (13.3)	120 (13.7)	0.815
Initial shockable rhythm	134 (16.7)	130 (14.8)	0.304
Bystander AED use	8 (1.0)	14 (1.6)	0.277
Epinephrine use	468 (58.2)	557 (63.6)	0.024
Airway			
BVM	58 (7.2)	54 (6.2)	<0.001
ETT	408 (50.7)	177 (20.2)	
SGA	338 (42.0)	645 (73.6)	
Response time (min)	7.0 (6.0, 9.0)	9.0 (7.0,11.0)	<0.001
On-scene time (min)	17.0 (14.0, 20.0)	18.0 (15.0, 21.0)	0.002
Transport time (min)	6.0 (4.0, 9.0)	7.0 (5.0, 10.0)	<0.001
Prehospital ROSC	116 (14.4)	104 (11.9)	0.121
TTM	31 (3.9)	20 (2.3)	0.061
Coronary angiography	63 (7.8)	64 (7.3)	0.681
ECMO	8 (1.0)	14 (1.6)	0.277
Survival to hospital discharge	61 (7.6)	69 (7.9)	0.819
Favorable neurological outcomes	57 (7.1)	50 (5.7)	0.247

Presented as medians (interquartile ranges) or numbers (%).
BCPR, bystander cardiopulmonary resuscitation; DACPR, dispatcher-assisted BCPR; SBCPR, self-led BCPR; HTN, hypertension; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; LC, liver cirrhosis; AED, automated external defibrillator; BVM, bag-valve mask; ETT, endotracheal tube; SGA, supraglottic airway; ROSC, return of spontaneous circulation; TTM, target temperature management; ECMO, extracorporeal membrane oxygenation.

TABLE 2. Characteristics of the study population before and during the COVID-19 pandemic by bystander cardiopulmonary resuscitation type.

Variables	No bystander CPR			Dispatcher assisted bystander CPR			Self-led bystander CPR		
	Before the pandemic N = 301	During the pandemic N = 347	*p*-value	Before the pandemic N = 353	During the pandemic N = 368	*p*-value	Before the pandemic N = 150	During the pandemic N = 161	*p*-value
Age	76.0 (62.0–81.0)	74.0 (64.5–81.0)	0.846	73.0 (60.0–83.0)	73.0 (59.0–81.0)	0.239	69.5 (58.0–79.0)	73.0 (59.0–81.0)	0.188
Sex, male	202 (67.1)	227 (65.4)	0.650	210 (59.5)	229 (62.2)	0.451	94 (62.7)	106 (65.8)	0.560
Witnessed	126 (41.9)	145 (41.8)	0.985	1 56 (44.2)	175 (47.6)	0.365	98 (65.3)	102 (63.4)	0.716
Location of arrest									
Public place	239 (79.4)	272 (78.4)		49 (13.9)	42 (11.4)		48 (32.0)	47 (29.2)	
Home	51 (16.9)	66 (19.0)	0.608	283 (80.2)	306 (83.2)	0.563	86 (57.3)	87 (54.0)	0.295
Others	11 (3.7)	9 (2.6)		21 (5.9)	20 (5.4)		16 (10.7)	27 (16.8)	
Past medical history									
HTN	127 (42.2)	137 (39.5)	0.484	139 (39.4)	152 (41.3)	0.598	59 (39.3)	62 (38.5)	0.882
DM	90 (29.9)	99 (28.5)	0.702	95 (26.9)	120 (32.6)	0.095	45 (30.0)	41 (25.5)	0.372
Heart disease	77 (25.6)	66 (19.0)	0.045	69 (19.5)	84 (22.8)	0.282	34 (22.7)	24 (14.9)	0.079
Stroke	30 (10.0)	50 (14.4)	0.086	33 (9.3)	48 (13.0)	0.116	11 (7.3)	21 (13.0)	0.098
COPD	30 (10.0)	31 (8.9)	0.653	29 (8.2)	30 (8.2)	0.975	13 (8.7)	11 (6.8)	0.545
CKD	18 (6.0)	26 (7.5)	0.445	35 (9.9)	35 (9.5)	0.855	7 (4.7)	10 (6.2)	0.549
LC	1 (0.3)	10 (2.9)	0.012	12 (3.4)	8 (2.2)	0.317	4 (2.7)	1 (0.6)	0.152
Cancer	39 (13.0)	47 (13.5)	0.826	55 (15.6)	48 (13.0)	0.33	13 (8.7)	25 (15.5)	0.065

TABLE 2. Continued.

Variables	No bystander CPR			Dispatcher assisted bystander CPR			Self-led bystander CPR		
	Before the pandemic N = 301	During the pandemic N = 347	*p*-value	Before the pandemic N = 353	During the pandemic N = 368	*p*-value	Before the pandemic N = 150	During the pandemic N = 161	*p*-value
Initial shockable rhythm	41 (13.6)	37 (10.7)	0.248	55 (15.6)	54 (14.7)	0.722	38 (25.3)	39 (24.2)	0.821
Bystander AED use	0 (0.0)	0 (0.0)		6 (1.7)	10 (2.7)	0.354	2 (1.3)	4 (2.5)	0.461
Prehospital epinephrine use	170 (56.5)	221 (63.7)	0.061	213 (60.3)	244 (66.3)	0.097	85 (56.7)	92 (57.1)	0.932
Prehospital Airway									
BVM	20 (6.6)	16 (4.6)		19 (5.4)	21 (5.7)		19 (12.7)	17 (10.6)	
ETT	157 (52.2)	75 (21.6)	<0.001	181 (51.3)	65 (17.7)	<0.001	70 (46.7)	37 (23.0)	<0.001
SGA	124 (41.2)	256 (73.8)		153 (43.3)	282 (76.6)		61 (40.7)	107 (66.5)	
Response time (min)	7.0 (6.0–9.0)	9.0 (8.0–11.0)	<0.001	7.0 (6.0–9.0)	9.0 (7.0–11.0)	<0.001	7.0 (6.0–10.0)	9.0 (7.0–11.0)	0.001
On scene time (min)	18.0 (14.0–21.0)	18.0 (15.0–22.0)	0.017	17.0 (14.0–20.0)	17.0 (14.5–20.0)	0.469	16.0 (13.0–19.0)	18.0 (14.0–21.0)	0.029
Transport time (min)	6.0 (4.0–9.0)	6.0 (4.0–10.0)	0.223	6.0 (4.0–9.0)	7.0 (5.0–10.0)	0.005	6.0 (4.0, 9.0)	7.0 (5.0–11.0)	0.022
Prehospital ROSC	33 (11.0)	32 (9.2)	0.462	48 (13.6)	40 (10.9)	0.263	35 (23.3)	32 (19.9)	0.459
TTM	17 (5.6)	3 (0.9)	<0.001	7 (2.0)	12 (3.3)	0.284	7 (4.7)	5 (3.1)	0.475
Coronary-angiography	16 (5.3)	18 (5.2)	0.942	25 (7.1)	27 (7.3)	0.895	22 (14.7)	19 (11.8)	0.455
ECMO	2 (0.7)	6 (1.7)	0.221	5 (1.4)	8 (2.2)	0.445	1 (0.7)	0 (0.0)	0.299
Survival to hospital discharge	13 (4.3)	18 (5.2)	0.600	25 (7.1)	27 (7.3)	0.895	23 (15.3)	24 (14.9)	0.916
Favorable neurologic outcomes	12 (4.0)	13 (3.7)	0.874	23 (6.5)	20 (5.4)	0.540	22 (14.7)	17 (10.6)	0.274

Presented as medians (interquartile ranges) or numbers (%).
BCPR, bystander cardiopulmonary resuscitation; DACPR, dispatcher-assisted BCPR; SBCPR, self-led BCPR; HTN, hypertension; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; LC, liver cirrhosis; AED, automated external defibrillator; BVM, bag-valve mask; ETT, endotracheal tube; SGA, supraglottic airway; ROSC, return of spontaneous circulation; TTM, target temperature management; ECMO, extracorporeal membrane oxygenation.

3.3 Number of the COVID-19 confirmed patients and change of the BCPR rate

The monthly number of the COVID-19 confirmed patients in Daegu and the BCPR rate are shown in Fig. 2 [16]. Following the first COVID-19 case on 18 February 2020, the number of patients rapidly increased in the next 2 months. The number of patients started to decrease until the second surge in December 2020. The BCPR rate was the lowest at 47.6% in August 2020 and the highest at 72.7% in February 2021.

3.4 Logistic regression analysis of effect of BCPR on OHCA outcomes

Table 3, Fig. 3 and **Supplementary Table 1** shows the effect of BCPR for OHCA outcomes by BCPR type in before and during the pandemic. DACPR did not have a statistically significant impact on clinical outcomes before the COVID-19 pandemic (adjusted odds ratio (aOR) 1.79, 95% confidence interval (CI) 0.80–4.01 for survival to hospital discharge; aOR 1.69, 95% CI 0.72–3.96 for favorable neurological outcomes), and it continued to have no statistically significant impact during the COVID-19 pandemic (aOR 1.34; 95% CI, 0.68–2.66 for survival to hospital discharge; aOR, 1.30; 95% CI, 0.58–2.90 for favorable neurological outcomes). SBCPR presented a positive effect before the pandemic (aOR, 2.59; CI, 1.09–6.18 for survival to hospital discharge; aOR, 2.58; 95% CI, 1.03–6.46 for favorable neurological outcomes); however, this effect disappeared at the during pandemic (aOR, 1.88; 95% CI, 0.88–4.00 for survival to hospital discharge; aOR, 1.67; 95% CI, 0.69–4.05 for favorable neurological outcomes). However, in the Wald test for comparing the ORs of each period did not show a statistically significant difference (survival to hospital discharge, p = 0.586; favorable neurologic outcomes p = 0.504).

4. Discussion

To the best of our knowledge, this is the first study to investigate the impact of the COVID-19 pandemic on BCPR on OHCA outcomes according to BCPR type, based in a metropolitan city (Daegu, South Korea). In this study, the ratio of BCPR type was not different regardless of the COVID-19 pandemic period. The decreasing trend of the effect of BCPR before and during the COVID-19 pandemic has been observed; however, statistically significant differences have not been demonstrated.

BCPR can improve the survival of patients with OHCA [17, 18]. However, during the pandemic, the general public should consider that chest compressions during CPR could increase the risk of transmission owing to the generation of aerosols, and the psychological pressure of these infections may make them hesitate to perform CPR or reduce chest compression quality [19]. However, previous studies on the BCPR rate before and during the COVID-19 pandemic are controversial. Previous reports have indicated a decline in BCPR willingness and a decrease in BCRP rates during the COVID-19 pandemic, with fear of infection was considered as one of the significant causes of the decline in BCPR willingness [8, 20, 21]. However, Lim *et al*. [10] have reported that BCPR rates and OHCA outcomes in public areas did not change during the pandemic. Additionally, there were also previous reports of an increase in BCPR rates during the COVID-19 pandemic [4, 22, 23]. In this study, the overall BCPR rate and the ratio of BCPR type did not differ before and during the pandemic. Various social factors, including socioeconomic status, educational background, well-planned public policies and cultural barriers, could affect BCPR willingness; there is a possibility that the psychological pressure on the public about infection has been offset following the stabilization of the short-term regional outbreak [24]. Determining the extent to which the surge in COVID-19 cases influences COVID-19 infection-related fear and how long this effect lasts remains challenging, and clear evidence on this matter is still lacking. In this study, we set the research period as 1 year before and during the pandemic. 2 months after the regional epidemic in Daegu, the number of patients stabilized. The COVID-19 vaccine was introduced on February 2021, and social distancing had been eased on July 2021 [25]. These changes would potentially have had an impact on the general public by providing BCPR with psychological stability and easing their fears of infection. Moreover, considering the seasonal variation in the BCPR effect, we selected 1 year before and during the pandemic as the study periods [8, 26]. We believe that this could be reasons for no difference in BCPR rates between both periods in this study.

In the previous study, the survival rate of patients with in-hospital cardiac arrest decreased following the COVID-19 pandemic, and delayed activation of the chain of survival was suggested as one possible cause [27]. In this study of patients with OHCA, it was also confirmed that the EMS response time, one of the significant factor in the chain of survival, was delayed following the pandemic. We believed that this may be because of EMS protocols requiring EMS crew members to wear personal protective equipment when in contact with patients, following the regional surge in the number of patients with COVID-19 [3]. However, a previous study presented that BCPR can offset poor outcomes resulting from response time delays [28]. Moreover, even if SBCPR was performed, there was a delay until the first chest compressions were initiated by a bystander, which may have offset the positive effects of SBCPR observed before the pandemic. However, the interval between the cardiac arrest and the BCPR initiation could not be identified in this study. To investigate this aspect, further studies are needed.

The location of OHCA could influence the BCPR rate. Sondergaard *et al*. [29] reported that the BCPR rate in residences was lower than that in public places, and Sato *et al*. [30] reported that the BCPR rate of witnessed family members was lower than that of witnessed non-family members. The rate of individuals staying at home may vary by region or time period owing to the regional outbreak, self-quarantine, or social distancing during the COVID-19 pandemic [26]. These differences may have resulted from variations in the location of OHCA by region or time period. However, in this study, the location of OHCA did not differ between the periods before and during the COVID-19 pandemic. We believe this could also be a reason for the lack of difference in BCPR rates between both periods in our study.

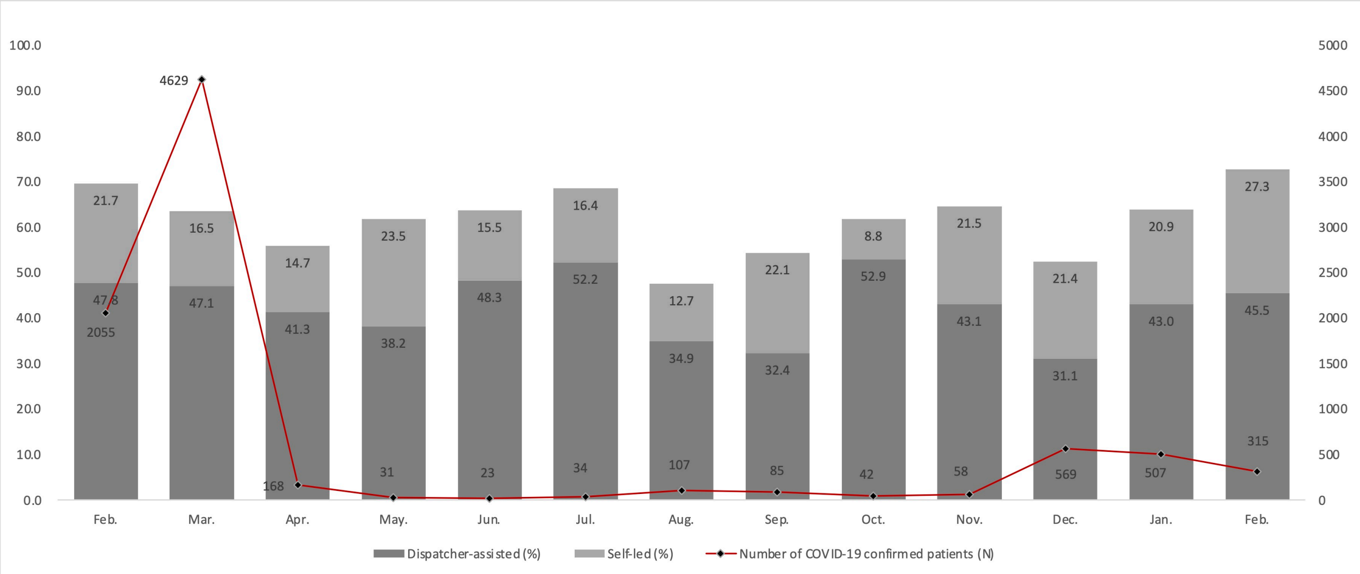

FIGURE 2. The monthly number of COVID-19 confirmed patients and bystander cardiopulmonary resuscitation rate during the pandemic in Daegu, South Korea.

TABLE 3. Multivariable logistic regression analysis of the effect to OHCA outcomes by bystander cardiopulmonary resuscitation type at before and during the COVID-19 pandemic.

	Before the pandemic			During the pandemic			*p*-value[b]
	Outcomes n/N (%)	Crude OR (95% CI)	aOR[a] (95% CI)	Outcomes n/N (%)	Crude OR (95% CI)	aOR[a] (95% CI)	
Survival to hospital discharge							
No BCPR	13/301 (4.3)	1.00	1.00	18/347 (5.2)	1.00	1.00	
DACPR	25/353 (7.1)	1.69 (0.85–3.36)	1.79 (0.80–4.01)	27/368 (7.3)	1.44 (0.78–2.67)	1.34 (0.68–2.66)	0.592
SBCPR	23/150 (15.3)	4.01 (1.97–8.17)	2.59 (1.09–6.18)	24/161 (14.9)	3.19 (1.68–6.07)	1.88 (0.88–4.00)	0.586
Favorable neurologic outcomes							
No bystander CPR	12/301 (4.0)	1.00	1.00	13/347 (3.7)	1.00	1.00	
DACPR	23/353 (6.5)	1.68 (0.82–3.43)	1.69 (0.72–3.96)	20/368 (5.4)	1.48 (0.72–3.02)	1.30 (0.58–2.90)	0.660
SBCPR	22/150 (14.7)	4.14 (1.99–8.62)	2.58 (1.03–6.46)	17/161 (10.6)	3.03 (1.44–6.41)	1.67 (0.69–4.05)	0.504

[a]*Adjusted for age, sex, witnessed, location of arrest, time of arrest, seasons, past medical history (heart disease, stroke, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, chronic kidney disease, liver cirrhosis, cancer) and response time.*
[b]*p-value by Wald test that calculated to test the significance of adjusted odd ratios between groups.*
BCPR, bystander cardiopulmonary resuscitation; DACPR, dispatcher-assisted bystander cardiopulmonary resuscitation; SBCPR, self-led bystander cardiopulmonary resuscitation; OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio.

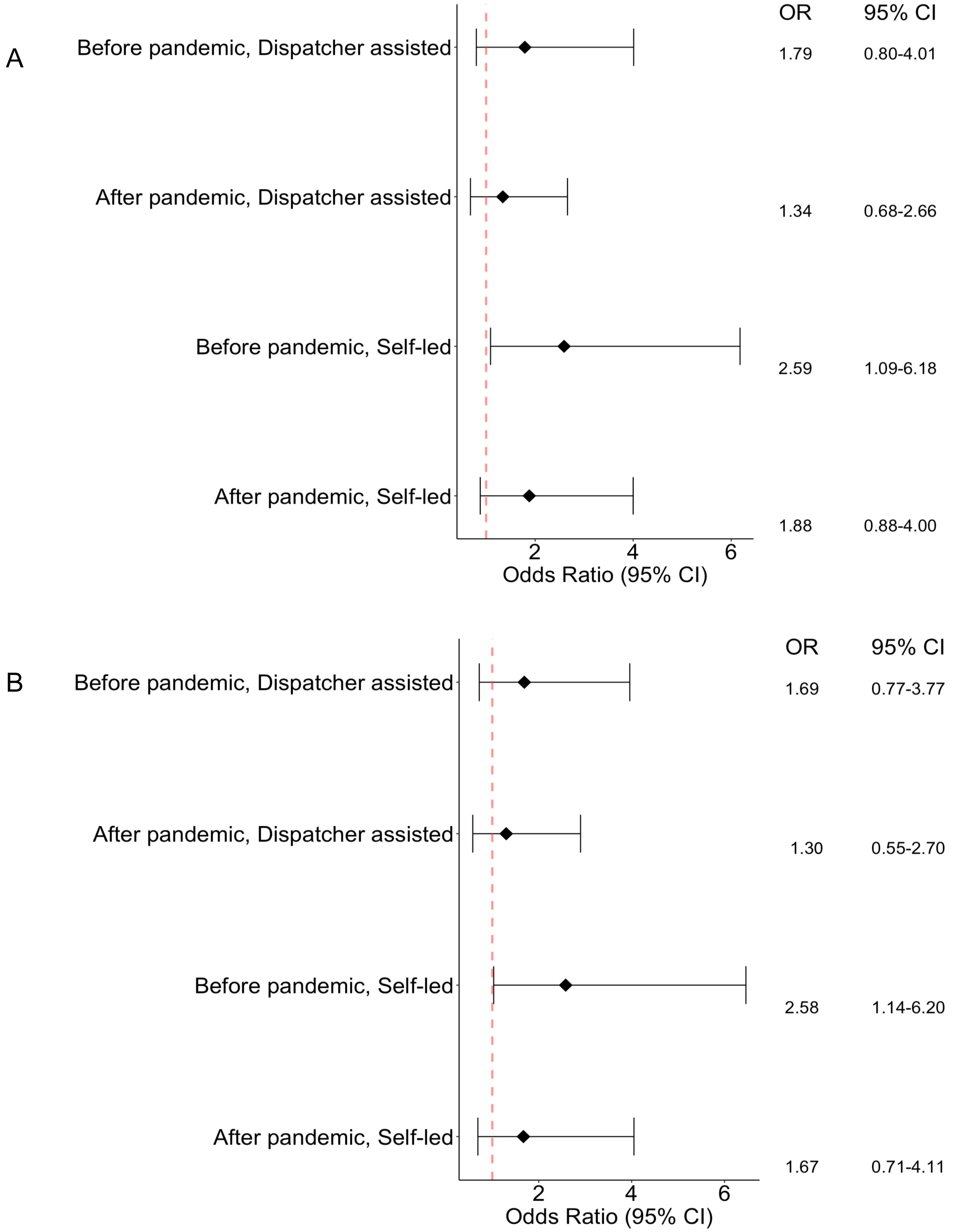

FIGURE 3. OR plots for (A) survival to hospital discharge and (B) favorable neurologic outcomes. OR, odds ratio; CI, confidence interval.

Even when CPR is initiated, better OHCA outcomes will be ensured by maintaining high-quality CPR. A previous study reported that BCPR quality can increase by trained laypersons who are more active in providing SBCPR, and SBCPR provides better CPR quality than DACPR. SBCPR could reduce no-flow time by initiating chest compressions faster [31–33]. However, the BCPR quality may deteriorate owing to decreased aggressiveness of bystanders due to psychological fear of infection. In this aspect, we presumed that BCPR quality, particularly in the SBCPR, could be changed by the COVID-19 pandemic, and that it could affected the OHCA outcomes during the pandemic. Consequently, there was a tendency for BCPR effectiveness to decrease during the COVID-19 pandemic compared with that before the pandemic; however, statistical differences were not observed in this study. We believed that there were two potential reasons for this result. First, we considered aggressive publication and deliver of changed BCPR guidelines could have affected. The International Liaison Committee on Resuscitation recommended implementing modified BCPR guidelines, including hands-only CPR during blocking a patient's mouth and nose with a towel or cloth, in special situations including the COVID-19 pandemic [34]. To avoid the fear of infection and actual infection, continuous education is required to ensure the public awareness of the changed optimal guidelines for these special situations. Furthermore, EMS dispatchers' enthusiastic tele-guidance or CPR motivation would be helpful if there is insufficient public education, and training EMS dispatchers on more effective tele-approach methods and improvement of communication proficiency to the bystander would be helpful for this [35, 36]. In Korea, during the early stages of the COVID-19 pandemic, the recommendation of modified BCPR guidelines has been aggressively publicized to the general public, EMS crews, and dispatchers. We believe that this could be a reason for the absence of a statistical difference in BCPR effects between both periods in this study. We believe this could be reasons of no statistical difference in BCPR effects between both periods in this study. However, in this study, BCPR effectiveness tended to decrease during the COVID-19 pandemic. Therefore, considering more effective tele-approach methods and communication proficiencies of EMS dispatchers would be helpful to prepare the next unknown pandemic. Second, the small sample size, the variance of the sample resulting from the limited study to a single metropolitan city, and the unpredictable intermittent spikes of infected patients could have influenced this. We believe that further studies, including nationwide or international studies are needed.

This study had several limitations. First, the study of a specific region can be influenced by regional characteristics or cultural differences. The culture of each region or country can affect psychological responses to infectious diseases; therefore, carefully generalizing such findings is necessary. Second, Daegu is the place where the first large-scale regional outbreak outside China occurred at the beginning of the global COVID-19 pandemic [3]. If the prevalence in each region or country is different, the impact on the public may also be different, and this aspect should be considered when interpreting the results of this study. Third, the analysis was not subdivided according to the COVID-19 incidence rate, even though the prevalence was not constant during the during period. Therefore, differences according to COVID-19 prevalence were not investigated, which may have affected the results. However, it is estimated that the effect of the COVID-19 prevalence rate in the post-pandemic period on the BCPR quality was not significant. Fourth, we attempted our best to consider every confounder in this retrospective study; however, there could be unidentifiable confounders, including whether laypersons received any CPR training, which may have affected the BCPR quality [33]. Lastly, unlike other studies, DACPR did not affect clinical outcomes in this study. This study should be carefully interpreted considering these characteristics. Additional studies that take these aspects into account are needed.

5. Conclusions

The carry-out rate of BCPR did not show a significant difference before and during the COVID-19 pandemic. A decreasing trend in the effect of BCPR before and during the COVID-19 pandemic was observed. However, there was no significant statistical difference in the effect of BCPR was observed between the two periods.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

HWR and JHK—Conceptualization; Supervision. JYK, WKL and SHL—Data curation. HJ, JYK and WKL—Formal analysis. JHK—Funding acquisition. HWR, JHK, JYK, JYA, SM and WKL—Methodology. HJ and JHK—Visualization. HJ—Writing-original draft. HJ, HWR, JHK, JYA, SM and SHL—Writing-review & editing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board (IRB) of Kyungpook National University Hospital (IRB No. 2016-03-027), which waived the requirement for written informed consent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.signavitae.com/mre-signavitae/article/1724622933528068096/attachment/Supplementary%20material.docx.

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