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# Bystander cardiopulmonary resuscitation in public locations before and after the coronavirus disease 2019 pandemic in the Republic of Korea

The coronavirus disease 2019 (COVID-19) pandemic is a global disaster. Globally, the cumulative number of confirmed patients with COVID-19 was 82,401,958, while the number of deaths reached 1,801,312 by 31 December 2020 [1]. These figures might increase the fear of infection and decrease the willingness to perform bystander cardiopulmonary resuscitation (CPR), that is a crucial component of the chain of survival that improves outcomes in patients with out-of-hospital cardiac arrest (OHCA) [2-4]. However, results of previous reports of bystander CPR rates during the COVID-19 pandemic period were inconsistent [5-8]. We evaluated the association between the COVID-19 pandemic and bystander CPR provision and clinical outcomes of patients with OHCA in public places.

This retrospective observational study used data from a multicentre emergency medical service-treated OHCA database in the Republic of Korea (ROK); the Korean Cardiac Arrest Resuscitation Consortium (KoCARC) [9].

The Korean EMS system is a partially multi-tiered and government-based system that covers 51,826,287 people across an area of 100,210 $km^2$. The first case of COVID-19 was reported on 20 January 2020, in the ROK [10]. The cumulative number of patients confirmed with COVID-19 was 12,850 (24.8 per 100,000 persons), and the cumulative number of deaths caused by COVID-19 was 282 (0.5/100,000 persons) until 30 June 2020 [11]. The case fatality rate was reported to be 2.2% in the ROK [11]. There was no general lockdown of businesses in the ROK, although high-risk areas such as churches, bars, and gyms were closed soon after the large cluster of cases associated with specific religious groups in late February 2020 [12].

We included patients with OHCA who collapsed in public locations from January 26 to June 30, 2020 (COVID-19 pandemic period) and the same period in 2016, 2017, 2018, and 2019 (non-pandemic period). The exposure variable was the COVID-19 pandemic. The pandemic period spanned from 26 January to 30 June 2020, because the Korean Centers for Disease Control and Prevention upgraded the level of caution for infectious diseases to 'Warning' with the emergence of the COVID-19 pandemic in communities [13]. The primary outcome variable was bystander CPR provision. The secondary outcomes were survival to discharge and neurological recovery. We conducted multivariable logistic regression analyses to assess the associations between the exposure variable and the outcome variables with adjustment for potential confounders, including patient age, patient sex, urbanization level of the OHCA location, season of event, day of event, time of event, witnessed status, patient–bystander relationship, and provision of telephone assisted CPR (TA-CPR) instruction to the bystander.

In total, 788 patients included: 628 (79.7%) in the non-pandemic group and 160 (20.3%) in the pandemic group (Fig. 1). Bystander CPR rates did not differ significantly between the pandemic and non-pandemic groups (63.9% vs 63.1%; $p = 0.86$). There were no significant differences in survival to discharge (21.0% vs. 26.9%; $p = 0.11$) and neurological recovery (16.7% vs 21.3%; $p = 0.18$) between the pandemic and non-pandemic groups (Table 1). In multivariable logistic regression analysis, the adjusted odds ratio (AOR) for bystander CPR was 0.88 (95% confidence interval [CI] 0.57–1.35). Clinical outcomes were maintained in the pandemic (AOR: 1.11; 95% CI: 0.67–1.85 for survival to discharge, and AOR: 0.97; 95% CI: 0.55–1.73 for neurologic recovery) (Table 2).

Bystander CPR rates and clinical outcomes of patients with OHCA collapsed in public locations did not change significantly during the COVID-19 pandemic period compared with those in the non-pandemic period. Overall survival to discharge and neurological recovery of patients with OHCA could be maintained during the pre-pandemic and pandemic periods in the ROK.

It is unclear why the bystander CPR rate was not affected by the COVID-19 pandemic. One possible explanation is the well-established infrastructure of bystander CPR in the ROK, mandatory CPR education for first responders and students, modified good Samaritans' law, TA-CPR, etc. [14] Additionally, the Korean Association of Emergency Physicians released the recommendation of bystander CPR for laypersons in the early phase of the epidemic. They recommended that the bystander should wear personal protective equipment (PPE), such as masks, gloves, and goggles and should wash hands after performing CPR [15]. Another explanation is that wearing a face mask could mitigate the fear of infection of laypersons. A previous study reported that less than 20% of Koreans admitted being at high risk of contracting COVID-19 in their daily lives [16]. This perception of Korean is based on the belief that face masks play a crucial role in preventing the spread of the infection [17]. An international survey reported that the ROK ranked the highest rate of wearing face masks (94%) among 28 countries, and 63.2% of the Korean respondents reported always wearing a face mask when outside [18]. However, our viewpoint of the maintenance of the bystander CPR rate during the COVID-19 pandemic is not only positive. The bystander CPR rate has constantly been increasing in the ROK [14]. According to our data, the bystander CPR rate in public places improved from 56.2% in 2016 to 70.8% in 2019. Despite this soaring trend of bystander CPR rates in recent years, bystander CPR rates in 2020 reached only 63.1%, breaking away from the uptrend. To overcome this stagnation of the bystander CPR rate, the Korean dispatch centre should consider revising TA-CPR instruction protocols to protect bystanders from the risk of infection and to help reduce bystander fear of the risk of infection.

This study has several limitations. First, all hospitals voluntarily participated in the KoCARC program and were academic teaching hospitals. These hospitals tended to be larger and more specialised than non-participating hospitals. Second, this study was an observational study; therefore, there could be unmeasurable confounders, bystander

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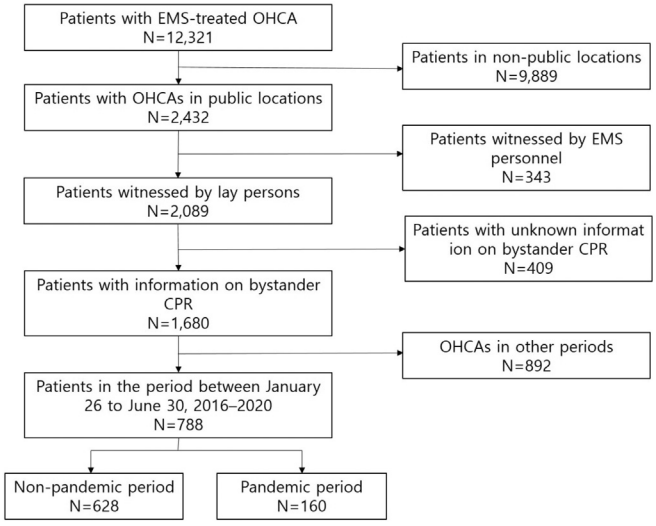


**Fig. 1.** Patients selection flow.

**Table 1**
Baseline characteristics and clinical outcomes of study population

| | Total | Non-pandemic period ($n = 628$) | | Pandemic period ($n = 160$) | | $p$-Value |
|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | |
| Age(years) | | | | | | 0.52 |
| <18 | 10 | 9 | (1.4) | 1 | (0.6) | |
| 18–64 | 443 | 348 | (55.4) | 95 | (59.4) | |
| ≥65 | 335 | 271 | (43.2) | 64 | (40.0) | |
| Sex | | | | | | 0.08 |
| Male | 625 | 490 | (78.0) | 135 | (84.4) | |
| Female | 163 | 138 | (22.0) | 25 | (15.6) | |
| Urbanization level | | | | | | 0.00 |
| Metropolitan | 356 | 304 | (48.4) | 52 | (32.5) | |
| Non-metropolitan | 432 | 324 | (51.6) | 108 | (67.5) | |
| Witnessed by bystander | | | | | | 0.86 |
| No | 310 | 248 | (39.5) | 62 | (38.8) | |
| Yes | 478 | 380 | (60.5) | 98 | (61.3) | |
| Bystander CPR | | | | | | 0.86 |
| No | 286 | 227 | (36.1) | 59 | (36.9) | |
| Yes | 502 | 401 | (63.9) | 101 | (63.1) | |
| Relationship | | | | | | 0.55 |
| Non-family | 662 | 525 | (83.6) | 137 | (85.6) | |
| Family | 114 | 92 | (14.6) | 22 | (13.8) | |
| Unknown | 12 | 11 | (1.8) | 1 | (0.6) | |
| Telephone-assisted CPR | | | | | | 0.36 |
| No | 473 | 382 | (60.8) | 91 | (56.9) | |
| Yes | 315 | 246 | (39.2) | 69 | (43.1) | |
| Season | | | | | | 0.30 |
| Spring | 487 | 395 | (62.9) | 92 | (57.5) | |
| Summer | 163 | 123 | (19.6) | 40 | (25.0) | |
| Winter | 138 | 110 | (17.5) | 28 | (17.5) | |
| Day of the week | | | | | | 0.26 |
| Weekday | 568 | 447 | (71.2) | 121 | (75.6) | |
| Weekend | 220 | 181 | (28.8) | 39 | (24.4) | |
| Time of day | | | | | | 0.06 |
| Day | 206 | 155 | (24.7) | 51 | (31.9) | |
| Night | 582 | 473 | (75.3) | 109 | (68.1) | |
| Initial ECG rhythm | | | | | | 0.42 |
| Non-shockable | 480 | 387 | (61.6) | 93 | (58.1) | |
| Shockable | 308 | 241 | (38.4) | 67 | (41.9) | |
| EMS response time (minute) | | | | | | |
| Unknown | 71 | 67 | (10.7) | 4 | (2.5) | |
| ≤10 | 567 | 449 | (71.5) | 118 | (73.8) | |
| 11–20 | 139 | 103 | (16.4) | 36 | (22.5) | |
| 20–30 | 8 | 8 | (1.3) | 0 | (0.0) | |
| >30 | 3 | 1 | (0.2) | 2 | (1.3) | |
| Survival to discharge | | | | | | 0.11 |
| No | 613 | 496 | (79.0) | 117 | (73.1) | |
| Yes | 175 | 132 | (21.0) | 43 | (26.9) | |
| Neurological recovery | | | | | | 0.18 |
| No | 649 | 523 | (83.3) | 126 | (78.8) | |
| Yes | 139 | 105 | (16.7) | 34 | (21.3) | |

CPR, Cardiopulmonary resuscitation; ECG, electrocardiogram; EMS, Emergency medical services.

**Table 2**
Multivariable logistic regression analysis on the bystander CPR and clinical outcomes

| | Non-pandemic period n/N (%) | Pandemic period n/N (%) | Crude OR | (95% CI) | Adjusted OR | (95% CI) |
|---|---|---|---|---|---|---|
| Bystander CPR | 401/628 (63.9) | 101/160 (63.1) | 0.97 | (0.68–1.39) | 0.88 | (0.57–1.35) |
| Survival to discharge | 132/628 (21.0) | 43/160 (26.9) | 1.38 | (0.93–2.06) | 1.11 | (0.67–1.85) |
| Neurologic recovery | 105/628 (16.7) | 34/160 (21.3) | 1.34 | (0.87–2.07) | 0.97 | (0.55–1.73) |

Adjusted variables of Bystander CPR: age, sex, urbanization level, season, day of event, time of event, witnessed status, relationship between patient and bystander, providing the TA-CPR instruction to bystander.
Adjusted variables of Survival and neurologic recovery: age, sex, urbanization level, witnessed status, provision of bystander CPR, first documented ECG rhythm, EMS response time interval.

characteristics, patients' clinical information (pre-arrest symptoms such as fever, respiratory symptoms, etc.), PPE usability of bystanders, etc. Finally, the results of this study are short-term outcomes of the COVID-19 pandemic. We included data from only five months after the COVID-19 pandemic in our analysis. The long-term effects of the COVID-19 pandemic on bystander CPR rate should be investigated because the number of education and training sessions for laypersons reduced, and many sessions were virtually converted after the COVID-19 pandemic.

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(1) Conception and design of the study, or analysis and interpretation of data: Dr. Lim, and Dr. Ahn
(2) Drafting the article or revising it critically for important intellectual content: Dr. Lim and Dr. Ahn,
(3) Acquisition of data and Obtained funding: Dr. Park, Dr. Lim, and Dr. Lee
(4) Final approval of the version to be submitted: All authors.

**Declaration of Competing Interest**

All authors report no conflicts of interest.

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Kyu Tae Lim, MD
*Department of Emergency Medicine, Myongji Hospital, Goyang, Republic of Korea*

Ki Ok Ahn, MD, PhD
*Department of Emergency Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea*
*Corresponding author at: 679-24 Hwajung-Dong, Deokyang-Gu, Goyang-Si, Gyeonggi-Do 412-270, Korea.
*E-mail address:* arendt75@hanyang.ac.kr

Jeong Ho Park, MD
*Department of Emergency Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea*
*Laboratory of Emergency Medical Services, Seoul National University Hospital Biomedical Research Institute, Seoul, Republic of Korea*

Chi Ho Park, MD
*Department of Emergency Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea*

Jangsun Lim
*Department of Emergency Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea*

Kyeongjae Lee
*Department of Emergency Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea*


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