Association of COVID-19 Infection With Survival After In-Hospital Cardiac Arrest Among US Adults

Saket Girotra, MD, SM; Maya L. Chan; Monique Anderson Starks, MD, MHS; Matthew Churpek, MD, PhD; Paul S. Chan, MD, MSc; for the American Heart Association Get With the Guidelines–Resuscitation Investigators

**Introduction**

Early on in the COVID-19 pandemic, investigators reported poor survival rates (<3%) after in-hospital cardiac arrest (IHCA) among patients with COVID-19 infection in the US and China.\(^1\,^3\) These findings have prompted discussions regarding universal do-not-resuscitate orders for patients with COVID-19.\(^4\) However, these results were from single-center studies that comprised only 295 patients with COVID-19 in hospitals that were overwhelmed early during the pandemic. Whether the poor IHCA survival rate reported in earlier studies is broadly representative of patients with COVID-19 in US hospitals remains unknown. This study examined the association of COVID-19 infection with survival outcomes of US adults after IHCA.

**Methods**

This cohort study was approved by the Saint Luke's Hospital Institutional Review Board. The board waived the requirement for informed consent because only deidentified data were used. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

The study used data from the American Heart Association Get With the Guidelines–Resuscitation (GWTG-R) registry, which contains detailed information on patients who experience cardiac arrest at participating hospitals in the United States. Within the GWTG-R registry, we identified all adults (aged ≥18 years) who developed IHCA during March to December 2020. Race and ethnicity were self-reported by the study patients, and these data were collected in the GWTG-R registry to examine disparities in care and outcomes of IHCA patients. We constructed multivariable hierarchical regression models to compare survival to discharge and return of spontaneous circulation (ROSC) for 20 minutes or more among patients with and without a suspected or confirmed COVID-19 infection. These models included hospital site as a random intercept and patient variables and calendar month as fixed effects. We used a Poisson link to directly estimate rate ratios. Data are presented as relative risks (RRs) with 95% CIs. Details on the GWTG-R registry, study cohort, study variables, and statistical analyses are included in the eMethods in the Supplement. All statistical analysis was performed in SAS version 9.4 (SAS Institute).

**Results**

This study included 24,915 patients with IHCA from 286 hospitals who had a mean (SD) age of 64.7 (15.2) years. There were 9,848 women (39.5%) and 15,066 men (60.5%), with sex missing for 1 patient. In terms of race and ethnicity, 6,170 patients (24.8%) were Black, 15,223 (61.1%) were White, 949 (3.8%) were of other race or ethnicity (American Indian or Alaska Native, Asian or Pacific Islander, and other races and ethnicities), and 2,573 (10.3%) were of unknown race or ethnicity. A suspected or confirmed COVID-19 infection was present in 5,916 patients (23.7%). Patients with COVID-19 were younger, more frequently men and of Black race, and more likely to have an initial

Open Access. This is an open access article distributed under the terms of the CC-BY License.
Table 1. Baseline Characteristics of Patients With In-Hospital Cardiac Arrest, Overall and Stratified by the Presence or Absence of a Suspected or Confirmed COVID-19 Infection

| Characteristic                        | Patients, No. (%) | Overall (N = 24,915) | With COVID-19 (n = 5,916) | Without COVID-19 (n = 18,999) | P value |
|---------------------------------------|-------------------|----------------------|---------------------------|-------------------------------|---------|
| **Demographic**                       |                   |                      |                           |                               |         |
| Age, y                                |                   |                      |                           |                               |         |
| 18-54                                 | 5,576 (22.4)      | 1217 (20.6)          | 4,359 (22.9)              |                               | <.001   |
| 55-64                                 | 5,539 (22.2)      | 1,341 (22.7)         | 4,198 (22.1)              |                               |         |
| 65-74                                 | 6,882 (27.6)      | 1,765 (29.8)         | 5,117 (26.9)              |                               |         |
| 75-84                                 | 4,971 (20.0)      | 1,210 (20.5)         | 3,761 (19.8)              |                               |         |
| ≥85                                   | 1,947 (7.8)       | 383 (6.5)            | 1,564 (8.2)               |                               |         |
| **Sex**                               |                   |                      |                           |                               |         |
| Men                                   | 15,066 (60.5)     | 3,778 (63.9)         | 11,288 (59.4)             |                               | <.001   |
| Women                                 | 9,848 (39.5)      | 2,137 (36.1)         | 7,711 (40.6)              |                               |         |
| Missing                               | 1                 | 1                    | 0                         |                               |         |
| **Race and ethnicity**                |                   |                      |                           |                               |         |
| Black                                 | 6,170 (24.8)      | 1,731 (29.3)         | 4,439 (23.4)              |                               | <.001   |
| White                                 | 15,223 (61.1)     | 3,021 (51.1)         | 12,202 (64.2)             |                               |         |
| Othera                                | 949 (3.8)         | 256 (4.3)            | 693 (3.7)                 |                               |         |
| Unknown                               | 2,573 (10.3)      | 908 (15.4)           | 1,665 (8.8)               |                               |         |
| **Cardiac arrest factor**             |                   |                      |                           |                               |         |
| Illness category                      |                   |                      |                           |                               |         |
| Medical noncardiac                    | 13,106 (52.6)     | 4,400 (74.4)         | 8,706 (45.8)              |                               | <.001   |
| Medical cardiac                       | 8,100 (32.5)      | 1,299 (22.0)         | 6,801 (35.8)              |                               |         |
| Surgical noncardiac                   | 1,794 (7.2)       | 114 (1.9)            | 1,680 (8.8)               |                               |         |
| Surgical cardiac                      | 1,034 (4.2)       | 46 (0.8)             | 988 (5.2)                 |                               |         |
| Other                                 | 875 (3.5)         | 56 (1.0)             | 819 (4.3)                 |                               |         |
| Location of cardiac arrest            |                   |                      |                           |                               |         |
| ICU                                   | 11,746 (47.2)     | 3,608 (61.0)         | 8,138 (42.8)              |                               |         |
| Telemetry unit                        | 3,456 (13.9)      | 787 (13.3)           | 2,669 (14.1)              |                               | <.001   |
| Nonmonitored hospital unit            | 3,981 (16.0)      | 802 (13.6)           | 3,179 (16.7)              |                               |         |
| ED                                    | 3,672 (14.7)      | 537 (9.1)            | 3,135 (16.5)              |                               |         |
| Procedural area                       | 1,627 (6.5)       | 125 (2.1)            | 1,502 (7.9)               |                               |         |
| Other                                 | 431 (1.7)         | 57 (1.0)             | 374 (2.0)                 |                               |         |
| Time of arrest                        |                   |                      |                           |                               |         |
| Night (11 PM to 6:59 AM)              | 7,310 (29.6)      | 1,750 (29.8)         | 5,560 (29.5)              | .67                            |         |
| Weekend                               | 7,767 (31.2)      | 1,884 (31.9)         | 5,883 (31.0)              | .20                            |         |
| Initial cardiac arrest rhythm         |                   |                      |                           |                               |         |
| Pulseless electrical activity         | 14,646 (58.8)     | 3,560 (60.2)         | 11,086 (58.4)             |                               | <.001   |
| Asystole                              | 6,691 (26.9)      | 1,795 (30.3)         | 4,896 (25.6)              |                               |         |
| Ventricular fibrillation              | 1,843 (7.4)       | 252 (4.3)            | 1,591 (8.4)               |                               |         |
| Pulseless ventricular tachycardia      | 1,735 (7.0)       | 309 (5.2)            | 1,426 (7.5)               |                               |         |
| Preexisting condition                 |                   |                      |                           |                               |         |
| Heart failure this admission          | 2,850 (11.4)      | 480 (8.1)            | 2,370 (12.5)              | .001                           |         |
| History of heart failure              | 5,722 (23.0)      | 1,074 (18.2)         | 4,648 (24.5)              | .001                           |         |
| Myocardial infarction this admission  | 3,073 (12.3)      | 460 (7.8)            | 2,613 (13.8)              | .001                           |         |
| History of myocardial infarction      | 3,455 (13.9)      | 599 (10.1)           | 2,856 (15.0)              | .001                           |         |
| Hypotension                           | 8,024 (32.2)      | 1,936 (32.7)         | 6,088 (32.0)              | .33                            |         |
| Respiratory insufficiency             | 13,420 (53.9)     | 4,020 (68.0)         | 9,400 (49.5)              | .001                           |         |
| Renal insufficiency                   | 9,308 (37.4)      | 2,439 (41.2)         | 6,869 (36.2)              | .001                           |         |
| Hepatic insufficiency                 | 2,606 (10.5)      | 539 (9.1)            | 2,067 (10.9)              | .001                           |         |
| Metabolic or electrolyte abnormality  | 7,684 (30.8)      | 1,961 (33.2)         | 5,723 (30.1)              | .001                           |         |
| Diabetes                              | 9,377 (37.6)      | 2,616 (44.2)         | 6,761 (35.6)              | .001                           |         |

(continued)
nonshockable rhythm, pneumonia, respiratory insufficiency, or sepsis and be receiving mechanical ventilation and vasopressors at the time of IHCA (Table 1). Patients with COVID-19 and IHCA had lower rates of survival to discharge (11.9% vs 23.5%; adjusted RR, 0.65 [95% CI, 0.60-0.71]; P < .001) and ROSC (53.7% vs 63.6%; adjusted RR, 0.86 [95% CI, 0.83-0.90]; P < .001). They were also more likely to have received delayed defibrillation (27.7% vs 36.6%; RR, 1.30 [95% CI, 1.09-1.55]; P = .003) but not delayed epinephrine treatment. The association between COVID-19 infection and worse survival outcomes was consistent for patients with nonsurgical diagnoses, patients in the intensive care unit (ICU), and patients who had received timely defibrillation or epinephrine treatment (Table 2).

### Table 1. Baseline Characteristics of Patients With In-Hospital Cardiac Arrest, Overall and Stratified by the Presence or Absence of a Suspected or Confirmed COVID-19 Infection (continued)

| Characteristic                                      | Overall (n = 24 915) | With COVID-19 (n = 5 916) | Without COVID-19 (n = 18 999) | P value |
|-----------------------------------------------------|----------------------|---------------------------|-------------------------------|---------|
| Baseline depression in CNS function                 | 1913 (7.7)           | 464 (7.8)                 | 1449 (7.6)                    | .59     |
| Acute stroke                                        | 939 (3.8)            | 159 (2.7)                 | 780 (4.1)                     | <.001   |
| Acute CNS nonstroke event                           | 3867 (15.5)          | 825 (14.0)                | 3042 (16.0)                   | <.001   |
| Pneumonia                                           | 5909 (23.7)          | 3044 (51.5)               | 2865 (15.1)                   | <.001   |
| Major trauma                                        | 1197 (4.8)           | 174 (2.9)                 | 1023 (5.4)                    | <.001   |
| Sepsis                                              | 6020 (24.2)          | 1925 (32.5)               | 4095 (21.6)                   | <.001   |
| Metastatic or hematologic malignant neoplasm        | 2715 (10.9)          | 378 (6.4)                 | 2337 (12.3)                   | <.001   |
| Intervention in place at time of cardiac arrest     |                      |                           |                               |         |
| Continuous intravenous vasopressor                  | 7937 (31.9)          | 2319 (39.2)               | 5618 (29.6)                   | <.001   |
| Mechanical ventilation                              | 10 677 (42.9)        | 3412 (57.7)               | 7265 (38.2)                   | <.001   |
| Hemodialysis                                        | 980 (3.9)            | 280 (4.7)                 | 700 (3.7)                     | <.001   |
| Survival outcome                                    |                      |                           |                               |         |
| ROSC                                                | 15 252 (61.2)        | 3176 (51.7)               | 12 076 (63.6)                 | <.001   |
| Survival to discharge                               | 5161 (20.7)          | 706 (11.9)                | 4455 (23.5)                   | <.001   |

**Abbreviations:** CNS, central nervous system; ED, emergency department; ICU, intensive care unit; ROSC, return of spontaneous circulation.

* includes American Indian or Alaska Native, Asian or Pacific Islander, and other races and ethnicities, which were combined for descriptive purposes.

### Table 2. Association Between COVID-19 Infection and Survival Outcomes Among Patients With In-Hospital Cardiac Arrest

| Characteristic                                      | No. of patients | Adjusted RR (95% CI) | P value |
|-----------------------------------------------------|-----------------|----------------------|---------|
| Overall cohort                                      | 24 915          | 0.65 (0.60-0.71)     | <.001   |
| Survival to discharge                              |                 | 0.86 (0.83-0.90)     | <.001   |
| Medical patients only                              | 21 206          | 0.65 (0.59-0.71)     | <.001   |
| Survival to discharge                              |                 | 0.86 (0.82-0.90)     | <.001   |
| ICU patients only                                   | 11 746          | 0.66 (0.58-0.75)     | <.001   |
| Survival to discharge                              |                 | 0.87 (0.82-0.92)     | <.001   |
| ICU patients with pneumonia only                    | 3543            | 0.61 (0.50-0.74)     | <.001   |
| Survival to discharge                              |                 | 0.85 (0.77-0.94)     | .001    |
| Patients with prompt treatment*                    | 19 906          | 0.64 (0.51-0.81)     | <.001   |
| Survival to discharge                              |                 | 0.85 (0.73-0.99)     | .03     |

**Abbreviations:** ICU, intensive care unit; ROSC, return of spontaneous circulation.

* Denotes patients who received prompt defibrillation for 2 minutes or less for a shockable arrest or prompt epinephrine for 5 minutes or less for a nonshockable arrest.
Discussion

In this cohort study, approximately 1 in 4 patients with IHCA identified in the GWTG-R registry during 2020 had a suspected or confirmed COVID-19 infection. This observation underscores the sizable effect of the pandemic on in-hospital resuscitation. Even after accounting for substantial differences between patients with and without COVID-19 infection, the disease was associated with a one-third lower rate of overall survival and was accompanied by a 30% increased rate of delayed defibrillation in shockable IHCA. Although delays in resuscitation, especially defibrillation, may have contributed to lower survival, the negative association of COVID-19 with survival in this study was consistent across subgroups, including patients who received timely treatment with defibrillation and epinephrine.

The absolute survival rate we observed for US patients with IHCA and COVID-19 (11.9%) was higher than the survival rates reported initially (0%, 1 2.9%, 2 and 3.0%), which likely represented the isolated experience of health systems overwhelmed early during the pandemic. Our findings are consistent with those of Hayek et al 6 (12.0% survival in 400 patients with COVID-19 in 68 ICUs) and Mitchell et al 6 (11.9% survival in 260 patients with COVID-19 at 11 hospitals) and extend the previous findings by adding a comparison group of patients without COVID and including non-ICU patients from a larger group of hospitals. We believe that these data will be relevant to health care providers and hospital administrators as the COVID-19 pandemic continues. Because IHCA survival among patients with COVID-19 in this study was not as poor as reported previously, we believe that COVID-19 infection alone should not be used as a criterion for withholding resuscitation care from hospitalized patients.

Our study has the following limitations. First, despite robust risk adjustment, confounding as a result of unmeasured variables cannot be excluded. Second, GWTG-R is a quality improvement registry, and our findings may not be representative of nonparticipating hospitals. Finally, it is possible that some patients suspected to have a COVID-19 infection were later confirmed to have a negative test result; however, this was expected to occur infrequently, as data were typically abstracted once COVID-19 results were known. As new variants emerge, future studies will be needed to assess the ongoing impact of COVID-19 infection on IHCA survival.
Conflict of Interest Disclosures: Dr Girotra reported receiving grants from the National Heart, Lung, and Blood Institute (NHLBI) outside the submitted work and receiving an honorarium from the American Heart Association for editorial work outside the submitted work. Dr Starks reported receiving grants from the NHLBI outside the submitted work. Dr Churpek reported receiving research support from EarlySense and grants from the NHLBI, the National Institute on Aging, the National Institute on Drug Abuse, the National Institute of Diabetes and Digestive and Kidney Diseases, the National Institute of General Medical Sciences, and the Department of Defense Peer-Reviewed Medical Research Program outside the submitted work and having a patent pending (ARCD.P0535US.P2) for risk stratification algorithms for hospitalized patients. Dr P.S. Chan reported receiving grants from NHLBI outside the submitted work and receiving consultant funding from the American Heart Association and OptumRx. No other disclosures were reported.

The American Heart Association Get With the Guidelines–Resuscitation Investigators: Dana Edelson, MD, MS (University of Chicago); Zachary Goldberger, MD, MS (University of Wisconsin); Anne Grossstreuer, PhD (Beth Israel Deaconess Medical Center and Harvard Medical School); Michael Kurcz, MD (University of Alabama); Ari Moskowitz, MD (Beth Israel Deaconess Medical Center and Harvard Medical School); Joseph Ornato, MD (Virginia Commonwealth University); Mary Ann Peberdy, MD (Virginia Commonwealth University); Sarah Perman, MD, MSCE (University of Colorado).

Additional Information: The Get With the Guidelines (GWTG) programs are provided by the American Heart Association. Hospitals participating in the registry submit clinical information regarding the medical history, hospital care, and outcomes of consecutive patients hospitalized for cardiac arrest using an online, interactive case report form and the IQVIA Patient Management Tool. IQVIA serves as the data collection and coordination center for the American Heart Association/American Stroke Association GWTG programs. The University of Pennsylvania serves as the data analytic center and has an agreement to prepare the data for research purposes.

REFERENCES
1. Thapa SB, Kakar TS, Mayer C, Khanal D. Clinical outcomes of in-hospital cardiac arrest in COVID-19. JAMA Intern Med. 2021;181(2):279-281. doi:10.1001/jamainternmed.2020.4796
2. Shao F, Xu S, Ma X, et al. In-hospital cardiac arrest outcomes among patients with COVID-19 pneumonia in Wuhan, China. Resuscitation. 2020;151:18-23. doi:10.1016/j.resuscitation.2020.04.005
3. Miles JA, Mejia M, Rios S, et al. Characteristics and outcomes of in-hospital cardiac arrest events during the COVID-19 pandemic: a single-center experience from a New York City public hospital. Circ Cardiovasc Qual Outcomes. 2020;13(11):e007303. doi:10.1161/CIRCOUTCOMES.120.007303
4. Cha AE. Hospitals consider universal do-not-resuscitate orders for coronavirus patients. Washington Post. March 25, 2020. Accessed July 27, 2021. http://www.washingtonpost.com/health/2020/03/25/coronavirus-patients-do-not-resuscitate
5. Hayek SS, Brenner SK, Azam TU, et al; STOP-COVID Investigators. In-hospital cardiac arrest in critically ill patients with COVID-19: multicenter cohort study. BMJ. 2020;371:m3513. doi:10.1136/bmj.m3513
6. Mitchell OJL, Yuriditsky E, Johnson NJ, et al; Coronavirus 2019 In-Hospital Cardiac Arrest (COVID IHCA) Study Group. In-hospital cardiac arrest in patients with coronavirus 2019. Resuscitation. 2021;160:72-78. doi:10.1016/j.resuscitation.2021.01.012

SUPPLEMENT.
eMethods.
eReferences