

# In-Hospital Cardiac Arrest Outcomes During the Early COVID-19 Pandemic in RI: A Qualitative Analysis

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## ABSTRACT

Throughout the COVID-19 pandemic, there has been growing but limited data describing the poor mortality outcomes in COVID-19 patients who experienced In-Hospital Cardiac Arrest (IHCA). This study evaluated the baseline characteristics and outcomes of COVID-19 patients who underwent cardiopulmonary resuscitation (CPR) during hospitalization in the early phases of the pandemic and compared them to that of several national and international centers. A list of all the IHCA events in the Lifespan hospital network from March 2020 to April 2021 was generated, and data, including de-identified patient characteristics, comorbidities, and details of the IHCA event, were examined. The primary outcome of all-cause mortality was then calculated. Forty-three patients with COVID-19 who experienced an IHCA event and underwent CPR were identified. Return of spontaneous circulation (ROSC) was achieved in 23 (53%) patients, and all-cause in-hospital mortality was 97.67%, with only one patient surviving until discharge. During the early pandemic, experiencing an IHCA event while admitted with COVID-19 carried an extremely poor prognosis, even if ROSC was achieved. This outcome likely reflects the lack of clear management guidelines or established therapeutic agents and the prevalence of the Delta strain during this time period.

**KEYWORDS:** COVID-19; CPR; In-Hospital Cardiac Arrest; ROSC; Mortality

## BACKGROUND

Before the COVID-19 pandemic, the average IHCA survival-to-discharge rate in the United States was approximately 25%, predominantly in patients who experienced shockable rhythms (ventricular fibrillation and pulseless ventricular tachycardia).<sup>1,2</sup> As the pandemic unfolded, investigators analyzing CPR outcomes in patients admitted with the original COVID-19 and Delta variant strains described survival-to-discharge rates much lower than the pre-pandemic average. Several single and multicenter studies reported that 3.6 - 66% of COVID-19 patients achieved ROSC, but IHCA and 30-day mortality remained persistently elevated.<sup>3,4,5,6</sup>

Interestingly, a US-based multicenter cohort found that 57.1% of COVID-19 patients achieved ROSC, and only 12.0% survived until discharge.<sup>7</sup> This is in sharp contrast to the pre-pandemic rates. This study evaluated the baseline characteristics, and IHCA outcomes of all COVID-19 patients admitted to the Lifespan hospital network, a large tertiary referral system serving the tri-state confluence of southern New England (Rhode Island, Massachusetts, and Connecticut), to determine if they possessed a similar increased mortality risk as described in other regions.

## METHODS AND DATA COLLECTION

This study is a retrospective analysis of pertinent baseline characteristics and mortality outcomes of COVID-19 patients who experienced an IHCA event and underwent CPR anytime during their hospital stay. The study was conducted by the Division of Pulmonary, Critical Care, and Sleep Medicine of the Brown University Warren Alpert Medical School and was approved by the local Institutional Review Board (IRB). A list of all documented IHCA events was obtained from the registry for adult patients (age 18 years and older) who were admitted to Rhode Island Hospital, The Miriam Hospital, and Newport Hospital in Rhode Island from March 2020 to April 2021. The list of compiled IHCA events did not include out-of-hospital cardiac arrests that occurred prior to admission.

Three investigators reviewed the electronic medical records (EMRs) of patients who experienced an IHCA event and identified those who also had a diagnosis of active COVID-19 infection. Active COVID-19 infection was defined as a known positive polymerase chain reaction (PCR) test anytime during the hospital admission in which the IHCA event occurred but prior to the event itself. Patients with COVID-19 infection prior to admission but with subsequent negative PCR tests upon the admission in which the IHCA event occurred were excluded from this study. Upon filtering IHCA events based on study exclusion criteria, the EMRs of included patients were reviewed, and de-identified patient data was collected into the study database. Collected data included patient baseline characteristics, e.g., age, sex, ethnicity, history of smoking, and comorbid conditions present upon admission. Comorbid conditions were defined as the documented diagnoses of the following diseases on

admission: cardiac (hypertension, coronary artery disease, chronic arrhythmias, congestive heart failure), pulmonary (chronic obstructive pulmonary disease, asthma, interstitial lung disease, pulmonary hypertension), endocrine (diabetes mellitus), or renal (chronic kidney disease, end-stage renal disease).

Additionally, data was collected on hospitalization complications present prior to IHCA and included the requirement of vasopressor support, invasive mechanical ventilation, or renal replacement therapy. Further, quantitative analysis to determine trends was performed of the cardiac rhythm at the time of IHCA, length of CPR (defined as the time from initiation of "Code Blue" until ROSC was achieved), CPR survival, post-IHCA vasopressor requirement, the total length of hospital stay, discharge disposition, 30-day mortality, and in-hospital mortality.

## RESULTS

This study identified 43 patients with COVID-19 who experienced an IHCA event and underwent CPR within the defined time period. General patient characteristics are described in **Table 1**. The mean age was 66 years, with a range of 29–93 years. Among comorbid conditions, cardiac disease was the most common, with 33 patients possessing at least one cardiac diagnosis, followed by 15 patients with diabetes and 12 patients with a pulmonary condition. Of the 43 patients, 4 patients had known thromboembolic disease, and 3 patients were on renal replacement therapy.

At the time of IHCA, 90.6% of patients did not require vasopressor support, and 41.8% of patients required invasive mechanical ventilation. The predominant cardiac rhythms at the time of IHCA were pulseless electrical activity (PEA), identified in 32 (74.4%) patients, and asystole in 4 (9.3%) patients. The remaining cardiac rhythms are outlined in

**Table 1.** Characteristics of COVID-19 patients who underwent CPR.

General Characteristics		
<b>Age</b>	<b>Years</b>	
Mean Age	66	
Range Age	29–93	
Median Age	66	
<b>Gender</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Female	16	37.20%
Male	27	62.70%
<b>Ethnicity</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Hispanic/Latino	17	39.50%
Non-Hispanic/Latino	26	60.40%
<b>History of Smoking</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Yes	25	58.10%
No	17	39.53%
Unknown	1	2.33%

**Table 2.** ROSC was achieved in 23 (53.4%) patients. Among the patients that initially achieved ROSC, post-arrest goals-of-care (GOC) discussions were held with each of their families, leading to the transition of 18 (78.2%) patients to comfort-measures-only (CMO) management. One patient survived until discharge from the hospital; the remaining 42 patients (97.67%) died during the hospital stay, as described in **Table 3**.

**Table 2.** Characteristics of IHCA Events of COVID-19 Patients.

Cardiac Arrest Characteristics		
<b>Rhythm Type</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
PEA	32	74.42%
Asystole	4	9.30%
V-Fib	2	4.65%
Pulseless V tach	3	6.98%
Unknown	2	4.65%
<b>Code Duration</b>	<b>Minutes</b>	
Mean Duration	21.3	
Range Duration	2–90	
<b>Vasopressor Requirement Prior to Arrest</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
No	39	90.70%
<b>Vasopressor Requirement After Arrest</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Yes	27	63.79%
<b>Mechanical Ventilation Prior to Arrest</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
No	26	60.47%
<b>Number of Arrests</b>		
Mean Arrests	1.65	
Range Arrests	1–8	
Median Arrests	1	

**Table 3.** Outcomes of IHCA Events of COVID-19 Events.

Cardiac Arrest Outcomes		
<b>Length of Stay (LOS)</b>	<b>Days</b>	
Mean LOS	14	
Range LOS	1–43	
Median LOS	13	
<b>ROSC</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Achieved	23	53%
<b>30-Day Survival</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Yes	1	2.33%
No	42	97.67%
<b>In-Hospital Mortality</b>	<b>Number of Patients</b>	<b>Percent of Total</b>
Yes	42	97.67%
No	1	2.33%

## DISCUSSION

These results indicate that, within the Lifespan hospital network, a patient hospitalized with COVID-19 between March 2020 to April 2021 who experienced an IHCA event had just above a 50% probability of surviving CPR, and overall, a very poor prognosis, as only one patient survived until hospital discharge. The findings of this study reflect similar trends to the previously published COVID-19 IHCA mortality outcomes during that time period. For example, in April 2020, Shao et al published one of the first studies describing IHCA outcomes of COVID-19 patients over the period of January to February 2020 in Wuhan, China. Their study reported ROSC was achieved in 13.2% of patients, and only 2.9% of patients survived for 30 days.<sup>7</sup> In late 2020, Thapa et al described a 53.7% rate of ROSC among COVID-19 patients who experienced an IHCA event and a 100% in-hospital mortality rate.<sup>8</sup> In the United States, Mitchell et al conducted a multicenter retrospective cohort study of COVID-19 patient IHCA outcomes covering March through May 2020 and described a rate of ROSC in only 22.3% of patients, with a 12.3% 30-day survival rate.<sup>4</sup>

The authors suspect COVID-19 infection to be a catalyst for IHCA and the worsened mortality outcomes. This was supported by the lack of vasopressor requirement in the majority of patients at the time of IHCA, nearly half of all patients requiring mechanical ventilation at the time of arrest, and that PEA arrest was the most frequently observed rhythm upon cardiac arrest. These trends seem to suggest that IHCA in COVID-19 patients was likely driven by hypoxia from a respiratory infection and was likely compounded by the predominance of the highly virulent Delta strain as well as the lack of vaccination in the majority of patients during this time period. The first COVID-19 vaccines were not available until December 2020, and even then were relegated to high-risk patient populations.<sup>9,10</sup> In addition, the healthcare workforce was primarily unvaccinated during most of the studied time period, and some questioned the safety of caregivers providing CPR to COVID-19 patients given the risk of viral transmission in the context of almost universally poor outcomes at the time. In some instances, this led to the ethically supported universal “do not resuscitate” orders for COVID-19 patients.<sup>11</sup> At the time, it would have been very appropriate to consider all this information while caring for COVID-19 patients and making decisions about the aggressiveness of end-of-life care.

## LIMITATIONS

The implications and applications of this study are limited by several factors. First, this study reviews the beginning of the COVID-19 pandemic through April 2021, during which time the Delta strain was the most prevalent variant of the COVID-19 virus. Additionally, during that time period,

there was an absence of clear guidelines on the management of COVID-19 infection, with only the last two months of this study overlapping with the formal recommendation of corticosteroids for COVID-19-induced hypoxia. As the pandemic progressed, additional COVID-19 treatments, including monoclonal antibodies, antiviral agents, and anti-coagulation guidelines would be developed. These therapies greatly increased the clinical tools available for the treatment of COVID-19 infection, thereby lowering morbidity and mortality.<sup>12,13</sup> Furthermore, the COVID-19 virus itself would continue to evolve, with the Omicron variant overtaking Delta as the dominant viral strain.<sup>14</sup> For all these reasons, CPR outcomes observed in this study cannot be extrapolated to our current COVID-19 population.

Another limitation of this study is the absence of a comparison group for CPR survival in non-COVID-19 patients. In addition, only 11.63% of patients in this study experienced a shockable rhythm, nearly half of the pre-pandemic prevalence of IHCA shockable rhythms. As shockable rhythms are associated with improved outcomes, the comparison of this study's results to that of the pre-pandemic survival rates is limited by the underrepresentation of these IHCA rhythms. This study is further limited by the small sample size. From the available population, the authors were only able to identify 43 patients with COVID-19 infection who experienced an IHCA event, which diminishes the generalizability of these results. Finally, this study is limited by the level of care which was reviewed. The IHCA data set reviewed by the authors is suspected to have omitted CPR performed on patients in the intensive care unit (ICU) and the emergency department (ED), as in both settings, an official “Code Blue” is not activated. Ippolito et al reported improved survival rates in a systematic review of COVID-19 IHCA events, observing an estimated mortality rate of 85.8% for IHCA occurring in the ICU, compared to a 95.5% mortality rate in non-ICU settings.<sup>15</sup>

## CONCLUSION

During the early pandemic, patients hospitalized with COVID-19 infection who experienced an IHCA event carried an abysmal prognosis. The results of this study are consistent with prior national and international studies during the early Delta phase of the pandemic, suggesting an overall worsened multifactorial trend in COVID-19 patients. Larger studies are warranted to investigate factors contributing to these poorer outcomes and to compare these early IHCA mortality rates to a more recent time period which would include different variants, additional therapeutics, and a population with a higher vaccination rate. This information would be important for clinicians to consider as they discuss goals of care with patients admitted with COVID-19.

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## Disclosures

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