



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Available online at [ScienceDirect](https://www.sciencedirect.com)

# Resuscitation

journal homepage: [www.elsevier.com/locate/resuscitation](http://www.elsevier.com/locate/resuscitation)

## Editorial

# In-hospital cardiac arrest during the COVID-19 pandemic: Where do we go now?



The management of patients who suffer in-hospital cardiac arrest (IHCA) is complex and requires ongoing attention to quality assurance, education, and clinical expertise. The critical steps of survival from IHCA are often presented as links in the chain of survival: early recognition and activation of emergency response, high-quality cardiopulmonary resuscitation (CPR), defibrillation, advanced resuscitation, excellent post-arrest care, and recovery.<sup>1</sup> However, despite substantial improvements in survival from IHCA over recent years, outcomes continue to vary widely between hospitals.<sup>2–4</sup>

The impact of the COVID-19 pandemic on the management of IHCA has been profound and has affected every link of the inpatient chain of survival, regardless of a patient's COVID-19 infection status. Hospitals have been overwhelmed with massive influxes of critically ill patients during COVID-19 surges, making early identification of decompensation challenging, and straining the ability to provide comprehensive post-arrest care. The management of IHCA in patients infected with COVID-19 is further complicated by the need to delay CPR, endotracheal intubation, and defibrillation to allow for donning of personalized protective equipment (PPE).<sup>5–6</sup> However, the impact of these effects on national survival rates from IHCA had not been well characterized.

In this issue of *Resuscitation*, Gupta and colleagues present an analysis of IHCA outcomes from the Get-With-The-Guidelines®-Resuscitation registry over the course of the first three COVID-19 surges in the United States.<sup>7</sup> The investigators compared risk-adjusted rates of survival to discharge for the 22,899 IHCA that occurred from March to December 2020 with the 79,736 which occurred during the same months in the years 2015–2019, ultimately determining that rates of survival to discharge were significantly lower during each COVID-19 surge period in 2020, as compared with the same periods in 2015–2019. By linking each hospital included in the study to county-level COVID-19 mortality rate, authors were able to demonstrate that survival from IHCA was significantly lower in counties with moderate or high monthly COVID-19 mortality rates. Although these findings will come as no surprise to many, this robust analysis of a large national quality improvement registry quantifies the magnitude of impact the COVID-19 pandemic has had on survival from IHCA during successive pandemic surges and raises important questions and considerations for future studies in the area.

However, the study highlights an important unaddressed question, which is of paramount importance to researchers and clinicians alike: does infection with COVID-19 impact the odds of survival from IHCA?

A number of observational studies have suggested lower survival from IHCA in patients with COVID-19 than historical rates of survival from IHCA, raising the possibility that infection with COVID-19 may itself impart a worse prognosis.<sup>8–10</sup> A recent report from the Swedish Registry of Cardiac Arrest demonstrated that patients with COVID-19 infection were less likely to survive IHCA than those without infection during the COVID-19 pandemic.<sup>11</sup> If COVID-19 infection is indeed associated with worse rates of survival, this is a critical avenue for future investigation. While it is possible that COVID-19 infection itself could mediate these observed outcomes, this finding seems likely to be driven primarily by alterations in the care of patients with COVID-19, which may impact the quality of resuscitation provided during IHCA as well as post-resuscitation care.

Several key changes were made to consensus IHCA guidelines and protocols during the first wave of the COVID-19 pandemic to protect resuscitation providers from infection. These included delaying CPR to don PPE and pausing CPR for endotracheal intubation.<sup>5</sup> It is unclear how these changes affected the quality of resuscitation and whether these changes have had a clinically significant impact on IHCA survival. Another important consideration could be misinterpretation of COVID-19 IHCA reports from early in the pandemic, which suggested that resuscitation in this population was futile.<sup>12–13</sup> Misunderstanding the prognosis of IHCA and subsequent medical nihilism may have direct impacts on the duration of resuscitative efforts, provision of post-arrest care, and the likelihood of premature withdrawal of life-sustaining therapies. This may be particularly marked in hospitals strained during surges of COVID-19. As the authors note, they were unable to determine rates of hospital occupancy, bed availability, and staff shortages. These factors directly impact hospital strain, and potentially affect the care team's ability to provide the resource-intensive care that is required both during and after IHCA.

Finally, as raised by the authors, the impact of public health interventions such as vaccination is another fascinating avenue for future investigation. It has been well demonstrated that communities with higher levels of vaccination have lower rates of hospital admission and that once hospitalized, patients who are vaccinated are less likely to die during their hospitalization.<sup>14–15</sup> It would be interesting to determine whether increasing community rates of vaccination may serve as an intervention that could improve outcomes from COVID-19 IHCA, and yet another compelling reason to bolster vaccination efforts.

The COVID-19 pandemic has profoundly affected all areas of healthcare over the past two years. Gupta and colleagues have highlighted that IHCA is no exception. Ongoing research is crucial to determine which specific factors have mediated the reduced survival in IHCA over the course of the COVID-19 pandemic, so that we may identify areas for intervention.

### Conflicts of Interest Statement

OJLM is supported by an NIH T32 grant, 5T32HL007891-24. AR has declared no conflicts of interest. BSA holds equity and research funding from VOC Health, a company developing novel COVID testing. He also holds research funding and has received speaking honoraria from Zoll and Becton Dickinson.

### REFERENCES

- Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, et al. Part 3: adult basic and advanced life support: 2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2020;142:S366–468.
- Merchant RM, Berg RA, Yang L, Becker LB, Groeneveld PW, Chan PS, et al. Hospital variation in survival after in-hospital cardiac arrest. *J Am Heart Assoc* n.d.;3:e000400.
- Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS, et al. Trends in survival after in-hospital cardiac arrest. *N Engl J Med* 2012;367:1912–20.
- Girotra S, Nallamothu BK, Tang Y, Chan PS for the American Heart Association Get With The Guidelines–Resuscitation Investigators. Association of hospital-level acute resuscitation and postresuscitation survival with overall risk-standardized survival to discharge for in-hospital cardiac arrest. *JAMA Network Open* 2020;3:10.
- Edelson DP, Comilla S, Chan PS, Atkins DL, Khalid A, Becker LB, et al. Interim guidance for basic and advanced life support in adults, children, and neonates with suspected or confirmed COVID-19. *Circulation* 2020;141:e933–43.
- Jansen G, Ebeling N, Latka E, Krüger S, Scholz SS, Trapp S, et al. Impact of COVID-19 adapted guidelines on resuscitation quality in out-of-hospital-cardiac-arrest: a manikin study. *Minerva Anestesiol* 2021.
- Gupta K, Girotra S, Nallamothu BK, Kennedy K, Starks MA, Chan PS. Impact of the three COVID-19 surges in 2020 on in-hospital cardiac arrest survival in the United States. *Resuscitation* 2022;170:134–40.
- Mitchell OJL, Yuriditsky E, Johnson NJ, Doran O, Buckler DG, Neeffe S, et al. In-hospital cardiac arrest in patients with coronavirus 2019. *Resuscitation* 2021.
- Ippolito M, Catalisano G, Marino C, Fucà R, Giarratano A, Baldi E, et al. Mortality after in-hospital cardiac arrest in patients with COVID-19: A systematic review and meta-analysis. *Resuscitation* 2021;164:122–9.
- Yuriditsky E, Mitchell OJL, Brosnahan SB, Smilowitz NR, Drus KW, Gonzales AM, et al. Clinical characteristics and outcomes of in-hospital cardiac arrest among patients with and without COVID-19. *Resusc Plus* 2020;4 100054.
- Holm A, Jerkeman M, Sultanian P, Lundgren P, Ravn-Fischer A, Israelsson J, et al. Cohort study of the characteristics and outcomes in patients with COVID-19 and in-hospital cardiac arrest. *BMJ Open* 2021;11 e054943.
- Shao F, Xu S, Ma X, Xu Z, Lyu J, Ng M, et al. In-hospital cardiac arrest outcomes among patients with COVID-19 pneumonia in Wuhan, China. *Resuscitation* 2020;151:18–23.
- Shah P, Smith H, Olarewaju A, Jani Y, Cobb A, Owens J, et al. Is cardiopulmonary resuscitation futile in coronavirus disease 2019 patients experiencing in-hospital cardiac arrest?\*. *Critical Care Med* 2021;49:201–8.
- Tenforde MW, Self WH, Adams K, Gaglani M, Ginde AA, McNeal T, et al. Association between mRNA vaccination and COVID-19 hospitalization and disease severity. *JAMA* 2021;326:2043–54.
- Dagan N, Barda N, Kepten E, Miron O, Perchik S, Katz MA, et al. BNT162b2 mRNA covid-19 vaccine in a nationwide mass vaccination setting. *N Engl J Med* 2021;384:1412–23.

Amina Ramadan

*Department of Emergency Medicine, University of Illinois at Chicago, United States*

*Department of Internal Medicine, University of Illinois at Chicago, United States*

Benjamin S. Abella

*Department of Emergency Medicine, University of Pennsylvania, United States  
Center for Resuscitation Science, University of Pennsylvania, United States*

Oscar J.L. Mitchell\*

*Division of Pulmonary, Allergy, and Critical Care, University of Pennsylvania, United States  
Center for Resuscitation Science, University of Pennsylvania, United States  
Leonard Davis Institute of Health Economics, University of Pennsylvania, United States*

\* Corresponding author at: Division of Pulmonary, Allergy and Critical Care, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104, United States.  
E-mail address: [Oscar.mitchell@penmedicine.upenn.edu](mailto:Oscar.mitchell@penmedicine.upenn.edu),

Received 6 December 2021  
Accepted 7 December 2021

<https://doi.org/10.1016/j.resuscitation.2021.12.007>

© 2021 Elsevier B.V. All rights reserved.