Journal of the American Heart Association

EDITORIAL

Death by COVID-19: An Open Investigation

Thomas Rea, MD, MPH; Peter J. Kudenchuk, MD

COVID-19 has challenged public health, claiming over half a million lives in the United States alone in <1 year.[1] The conventional understanding of COVID-19–related mortality is a progressive respiratory decline often occurring over days or even weeks. Yet, we now appreciate that COVID-19 has a heterogeneous pathophysiology involving various pathways and multiple organs with the potential to present as different clinical syndromes, which can confound its recognition, particularly during prehospital evaluation.[2]

See Article by Rollman et al.

One set of important public health questions is if and how the pandemic has affected the incidence, presentation, care, and outcome of time-sensitive cardiovascular medical conditions. In stroke, ST-segment–elevation myocardial infarction (STEMI), and most especially out-of-hospital cardiac arrest (OHCA), time is a powerful prognostic player, such that delays in action can have profound morbid and mortal effects. Often in these conditions, layperson behaviors influence opportunities for care; prompt layperson action enables timely access to the healthcare system, where early intervention achieves the best chance of a favorable outcome.

In this issue of the *Journal of the American Heart Association* (*JAHA*), Rollman and colleagues present the findings of an observational investigation from Los Angeles County Emergency Medical Services (EMS) that helps inform this set of interrelated questions.[3] The study evaluated the incidence of OHCA and STEMI between corresponding prepandemic and pandemic periods using EMS-derived information. The investigators observed an ≈25% increase of EMS-treated OHCA, a 25% increase in people deemed dead on arrival without EMS-attempted OHCA resuscitation, and an ≈10% decrease in STEMI during the pandemic relative to the control period. In terms of absolute numbers, the estimated number of excess OHCA (including patients dead on arrival) associated with the pandemic was ≈75 extra events per week, in contrast to an estimated decrease in STEMI by about 7 fewer events per week.

There are important qualifiers for the investigation. The study used administrative data that were not validated or linked to other clinical information, such as hospital or medical examiner records. Nor was information provided on the COVID-19 status of patients. Nonetheless, the findings advance our understanding of the health consequences of the pandemic and spur us forward to understand mechanisms with a goal to better protect and treat patients.

The study results are consistent with other reports that indicate an increase in OHCA incidence (treated and/or dead on arrival) during the pandemic.[4,5] The extent of the increase may be related to the prevalence of COVID-19 in the community, but begs the question of mechanism.[5] Are these sudden death events caused primarily by COVID-19–specific pathophysiology or by other dynamic circumstances related to human behaviors and access to health care during the pandemic

Key Words: Editorials ■ cardiac arrest ■ COVID-19 ■ emergency medical services ■ myocardial infarction

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

Correspondence to: Thomas Rea, MD, MPH, University of Washington, 401 Fifth Ave, Suite 1200, Seattle, WA 98104. E-mail: rea123@uw.edu

For Disclosures, see page 3.

JAHA is available at: www.ahajournals.org/journal/jaha

period? COVID-19 could directly precipitate OHCA via mechanisms of hypoxia, thrombosis, and/or cardiac inflammation through a direct mechanistic pathway.[6]

Alternatively, the increase in OHCA incidence may be the consequence of less-direct but just-as-deadly COVID-19 effects involving altered health behaviors and health access. One hypothesis is that the pandemic adversely changed health-seeking behaviors. Individuals with cardiopulmonary warning symptoms of OHCA delayed or deferred pursuit of emergency health care because of their concern that hospital care would increase their risk of COVID-19 exposure, a conjecture supported by the overall decline in EMS and emergency department use in some regions at least during the first few months of the pandemic.[7]

From this standpoint, the authors astutely evaluated the corollary condition of STEMI during the pandemic. Although EMS activations for OHCA increased, EMS calls for STEMI decreased during the pandemic. The question is why? This dynamic might occur were STEMI to progress to OHCA if patients with STEMI delayed or declined emergency assistance, thereby offsetting the count of one condition with the other. Such an explanation would account for only a modest fraction of the observed increase in OHCA. However, STEMI accounts for a relatively modest proportion of OHCA.[8] OHCA has a heterogeneous cause and can be provoked by acute coronary syndromes other than STEMI, heart failure, primary arrhythmia, or a host of other cardiac and noncardiac causes. These other conditions are often more difficult to identify and classify in the prehospital setting compared with STEMI, for which the ECG serves as a consistent diagnostic tool. As with STEMI, a decrease or delay in EMS activation in response to any of these presentations could also culminate in overt circulatory collapse, and contribute to the magnitude of the OHCA increase observed in the current study. The impact of such behavioral change deserves additional investigation.

Ultimately, a better understanding of the mechanisms is essential if we are to undertake effective actions to mitigate excess OHCA risk related to COVID-19. If COVID-19 itself directly produces precipitous cardiopulmonary collapse, what is the risk profile and are there measures that can prevent OHCA? Alternatively, if the mechanisms relate to layperson behaviors and delays to access care, then a distinctly different public health strategy may be necessary. Progress will come from a better understanding of COVID-19 prevalence and its OHCA prodrome among those presenting with OHCA. To date, however, few investigations have been able to accurately classify individual COVID-19 status among patients with OHCA.[9] More-recent widespread availability of testing than what was available during the study's time period may assist in such classification. This accurate classification could help us better understand whether COVID-19 infection was present and directly responsible for the OHCA in the individual patient or if the event instead resulted from a more generic pandemic (behavioral) effect.

The adverse effects of COVID-19 extend beyond the excess incidence of OHCA observed during the pandemic. COVID-19 appears capable of delivering a one-two punch given its adverse influence on OHCA resuscitation. Although clinical OHCA outcomes were not specifically reported in the current investigation, there are clear signs that OHCA survival is negatively impacted by an array of circumstances produced by COVID-19. The authors report longer EMS response intervals, less frequent use of defibrillation (a marker for ventricular fibrillation OHCA), and lower rate of return of spontaneous circulation. The findings are corroborated by other investigation, which has highlighted the downturn in survival during the pandemic.[4,10,11]

Indeed, the COVID-19 pandemic seems custom designed to disrupt the links in the chain of survival. During the pandemic, people have less social interface so fewer arrests are witnessed or in public, features that enable earlier recognition, access, and action.[4,10,11] Fewer people also have access to community programs of public access or early defibrillation. Resuscitation guidelines now alert potential lay rescuers to integrate COVID-19 considerations and apply masks to themselves and the patient, producing new impediments for what is already a time-sensitive and challenged task of layperson action.[12] EMS response is slower, presumably caused in part by the requirements of donning personal protective equipment. The quality of EMS care is also challenged given the potential to change established best practices, including the details of high-performance professional cardiopulmonary resuscitation and advanced life support.[12] Finally, hospital care to support high-resource temperature management, access to early revascularization, and general intensive care may also logically be challenged as hospitals balance the strain of COVID-19 care.[13]

These adverse impacts to the chain of survival are not specific to those people with COVID-19 who experience OHCA; they are unfortunately also applied en bloc to all patients with OHCA regardless of their COVID-19 status.[9,10] This reality translates to thousands of additional lives lost from OHCA in the United States alone.[14] The development is discouraging given how it has impeded the growing momentum to improve community-based resuscitation care as systems measure their performance and implement locally adapted programs to target promising system-specific shortcomings. In recent years, "average" survival had exceeded 10% for all-rhythm OHCA and 30% for Utstein cases (layperson-witnessed ventricular fibrillation) in the United States.[14] Top-performing systems have nearly doubled these averages, providing motivation

and a roadmap for more widespread community improvement.[15] COVID-19 appears to have produced a real step backward.

Resuscitation stakeholders appreciate how tenuous the chain of survival can be, and hence the pandemic's substantial ability to undermine these links. The solution will require extra efforts if we are to overcome the sobering developments in resuscitation during the COVID-19 era. Vaccination can help reduce disease and potentially accelerate strategies that deliver proven care sooner. Careful evaluation of these strategies will hopefully highlight both their lifesaving effectiveness for patients and their safety for rescuers.

The adverse health impacts from COVID-19 are substantial, including the care of time-sensitive cardiovascular conditions. This reality is highlighted by OHCA, where the pandemic period has produced a public health increase in incidence *and* undermined effective resuscitation strategies across the chain of survival. Progress will come as we understand OHCA mechanisms related to COVID-19, including its behavioral impact, refine resuscitation strategies by defining the balance of benefit and risk for patient and rescuer, and more generally address the COVID-19 pandemic through vaccination and other public health interventions. Studies like the one by Rollman et al can help us measure the health toll of COVID-19 and in turn prioritize efforts to understand and overcome its consequences.

ARTICLE INFORMATION

Affiliations

Department of Medicine, General Medicine, University of Washington, Seattle, WA (T.R.); The Division of Emergency Medical Services, Public Health Seattle & King County, Seattle, WA (T.R., P.J.K.); and Department of Medicine, Cardiology, University of Washington, Seattle, WA (P.J.K.).

Disclosures

None.

REFERENCES

1. Centers for Disease Control. https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days. Accessed April 19, 2021.
2. Yang BY, Barnard LM, Emert JM, Drucker C, Schwarcz L, Counts CR, Murphy DL, Guan S, Kume K, Rodriquez K, et al. Clinical characteristics of patients with coronavirus disease 2019 (COVID-19) receiving emergency medical services in King County, Washington. *JAMA Netw Open*. 2020;3:e2014549. DOI: 10.1001/jamanetworkopen.2020.14549
3. Rollman JE, Kloner RA, Bosson N, Niemann JT, Gausche-Hill M, Williams M, Clare C, Tan W, Wang X, Shavelle DM, et al. Emergency medical services responses to out-of-hospital cardiac arrest and suspected to ST-segment–elevation myocardial infarction during the COVID-19 pandemic in Los Angeles County. *J Am Heart Assoc*. 2021;10:e019635. DOI: 10.1161/JAHA.120.019635
4. Lim ZJ, Ponnapa Reddy M, Afroz A, Billah B, Shekar K, Subramaniam A. Incidence and outcome of out-of-hospital cardiac arrests in the COVID-19 era: a systematic review and meta-analysis. *Resuscitation*. 2020;157:248–258. DOI: 10.1016/j.resuscitation.2020.10.025
5. McVaney KE, Pepe PE, Maloney LM, Brinsky ES, Crowe RP, Augustine JJ, Gilliam SO, Asaeda GH, Eckstein M, Mattu A, et al. The relationship of large city out-of-hospital cardiac arrests and the prevalence of COVID-19. *EClinicalMedicine*. 2021;34:100815. DOI: 10.1016/j.eclinm.2021.100815
6. Greenberg A, Pemmasani G, Yandrapalli S, Frishman WH. Cardiovascular and cerebrovascular complications with COVID-19. *Cardiol Rev*. 2021;29:143–149. DOI: 10.1097/CRD.0000000000000385
7. Goldberg SA, Cash RE, Peters G, Weiner SG, Greenough PG, Seethala R. The impact of COVID-19 on statewide EMS use for cardiac emergencies and stroke in Massachusetts. *J Am Coll Emerg Physicians Open*. 2021;2:e12351. DOI: 10.1002/emp2.12351
8. Behnes M, Mashayekhi K, Weiß C, Nienaber C, Lang S, Reiser L, Bollow A, Taton G, Reichelt T, Ellguth D, et al. Prognostic impact of acute myocardial infarction in patients presenting with ventricular tachyarrhythmias and aborted cardiac arrest. *J Am Heart Assoc*. 2018;7:e010004. DOI: 10.1161/JAHA.118.010004
9. Sayre MR, Barnard LM, Counts CR, Drucker CJ, Kudenchuk PJ, Rea TD, Eisenberg MS. Prevalence of COVID-19 in out-of-hospital cardiac arrest: implications for bystander cardiopulmonary resuscitation. *Circulation*. 2020;142:507–509. DOI: 10.1161/CIRCULATIONAHA.120.048951
10. Ball J, Nehme Z, Bernard S, Stub D, Stephenson M, Smith K. Collateral damage: hidden impact of the COVID-19 pandemic on the out-of-hospital cardiac arrest system-of-care. *Resuscitation*. 2020;156:157–163. DOI: 10.1016/j.resuscitation.2020.09.017
11. Chan PS, Girotra S, Tang Y, Al-Araji R, Nallamothu BK, McNally B. Outcomes for out-of-hospital cardiac arrest in the United States during the coronavirus disease 2019 pandemic. *JAMA Cardiol*. 2021;6:296–303. DOI: 10.1001/jamacardio.2020.6210
12. Edelson DP, Sasson C, Chan PS, Atkins DL, Aziz K, Becker LB, Berg RA, Bradley SM, Brooks SC, Cheng A, et al; American Heart Association ECC Interim COVID Guidance Authors. Interim guidance for basic and advanced life support in adults, children, and neonates with suspected or confirmed COVID-19: from the Emergency Cardiovascular Care Committee and Get With The Guidelines-Resuscitation Adult and Pediatric Task Forces of the American Heart Association. *Circulation*. 2020;141:e933–e943. DOI: 10.1161/CIRCULATIONAHA.120.047463
13. Kiss P, Carcel C, Hockham C, Peters SAE. The impact of the COVID-19 pandemic on the care and management of patients with acute cardiovascular disease: a systematic review. *Eur Heart J Qual Care Clin Outcomes*. 2021;7:18–27. DOI: 10.1093/ehjqcco/qcaa084
14. Cardiac Arrest Registry to Enhance Survival. https://mycares.net/sitepages/data.jsp. Accessed April 19, 2021.
15. van Diepen S, Girotra S, Abella BS, Becker LB, Bobrow BJ, Chan PS, Fahrenbruch C, Granger CB, Jollis JG, McNally B, et al. Multistate 5-year initiative to improve care for out-of-hospital cardiac arrest: primary results from the HeartRescue Project. *J Am Heart Assoc*. 2017;6:e005716. DOI: 10.1161/JAHA.117.005716