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Clinical paper

Early changes in hospital resuscitation practices during the COVID-19 pandemic



Kayla M. Secrest^a, Theresa M. Anderson^a, Brad Trumpower^a, Molly Harrod^b, Sarah L. Krein^{a,b}, Timothy C. Guetterman^c, Paul S. Chan^d, Brahmajee K. Nallamothu^{a,b}

Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic resulted in many disruptions in care for patients experiencing in-hospital cardiac arrest (IHCA). We sought to identify changes made in hospital resuscitation practices during progression of the COVID-19 pandemic.

Methods: We conducted a descriptive qualitative study using in-depth interviews of clinical staff leadership involved with resuscitation care at a select group of U.S. acute care hospitals in the national American Heart Association Get With The Guidelines-Resuscitation registry for IHCA. We focused interviews on resuscitation practice changes for IHCA since the initiation of the COVID-19 pandemic. We used rapid analysis techniques for qualitative data summarization and analysis.

Results: A total of 6 hospitals were included with interviews conducted with both physicians and nurses between November 2020 and April 2021. Three topical themes related to shifts in resuscitation practice through the COVID-19 pandemic were identified: 1) ensuring patient and provider safety and wellness (e.g., use of personal protective equipment); 2) changing protocols and training for routine educational practices (e.g., alterations in mock codes and team member roles); and 3) goals of care and end of life discussions (e.g., challenges with visitor and family policies). We found advances in leveraging technology use as an important topic that helped institutions address challenges across all 3 themes.

Conclusions: Early on, the COVID-19 pandemic resulted in many changes to resuscitation practices at hospitals placing an emphasis on enhanced safety, training, and end of life planning. These lessons have implications for understanding how systems may be better designed for resuscitation efforts.

Keywords: In-hospital cardiac arrest, Resuscitation, COVID-19

Introduction

Mortality following an in-hospital cardiac arrest (IHCA) may be as high as 80%.^{1–4} The current coronavirus disease 2019 (COVID-19) pandemic has only magnified mortality from IHCA, with both higher incidence and lower case-survival rates.^{5,6} As such, health-care systems have grappled with questions about how to treat IHCA given concerns of a highly transmissible and fatal disease. Core challenges included ensuring patient and provider safety during resuscitation practices, managing scarcity of resources and information, and leveraging potentially new technology to address these concerns.⁷ In response, the American Heart Association (AHA) has revised their guidelines on care of IHCA patients and resuscitation practices, with adaptations also made by the European Resuscitation Council regarding COVID-19 guidelines.^{8–11} Despite this attention, studies on how the COVID-19 pandemic has altered local

resuscitation response systems have been lacking. Accordingly, we set out to understand changes made to resuscitation practices during the early COVID-19 pandemic surges at U.S. hospitals.

Methods

We conducted a descriptive qualitative study, which included in-depth interviews of clinical staff at geographically and academically diverse hospitals that were included in the original Hospital Enhancement of Resuscitation Outcomes for In-Hospital Cardiac Arrest (HEROIC) study.¹² HEROIC compared resuscitation practices at top-, middle-, and bottom-performing hospitals, based on their risk standardized rates of survival to discharge for IHCA in the Get with the Guidelines-Resuscitation registry. The original study sample included hospitals with at least 20 IHCA patients from January 1, 2012 to December 31, 2014, a time period notably before the

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COVID-19 pandemic began. The HEROIC mixed methods study included quantitative surveys of hospital on their resuscitation practices as well as qualitative interviews at 9 hospital sites. In this study, our interviews focused on changes made to resuscitation practices with the emergence of the COVID-19 pandemic during 2020.

We approached the 9 hospitals included in the original qualitative dimension of the HEROIC study for virtual visits and 6 hospitals agreed to participate. Two hospitals declined and one never responded after repeated attempts to be contacted. Semi-structured interviews with key informants at each site were conducted using an interview guide (see Appendix) developed by a diverse group of investigators with expertise and experience in qualitative research, clinical medicine, and nursing. Key informants for the interviews included individuals engaged in resuscitation systems at local institutions with roles including but not limited to Code Blue Committee Directors, Critical Care and Emergency Physicians, and Cardiopulmonary Resuscitation (CPR) Quality Coordinators, in total 10 informants were involved in the interviews across 6 sites. **Table 1** lists characteristics of the interviewees. Specifically, we recruited informants who had been in their current positions prior to the onset of the COVID-19 pandemic and were able to compare IHCA resuscitations efforts prior to and during the COVID-19 pandemic at their respected institutions. For interviews, key informants met for one hour virtually with two study team members. To balance methodological and clinical expertise the interview team consisted of one clinician and one qualitative researcher. Interviews were audio and video recorded and reviewed by multiple team members (KMS, BT, PSC, BKN).

We conducted a rapid analysis of the qualitative data collected from interviews to understand changes made during the COVID-19 pandemic in relationship to resuscitation practices. The first analytic step involved developing a templated summary table for each site that included key domains developed from the interview guide. Interviews were then reviewed and data corresponding to each domain was transferred into the table for further analysis. Findings from the completed summary table for each site were then compared across sites to identify convergent and divergent themes and patterns. This table, based on the interview guide, included key points from the interviews and exemplary quotes. Two team members (KMS and BKN) discussed emerging themes and reviewed data gleaned from the interviews over a series of three meetings. One meeting with all eight team members was then held to review data collected from the interviews, discuss patterns, and modify or expand upon emerging themes. Additional refinement through written correspondence with additional meetings was used for clarification. This study was approved by the institutional review board of the University of Michigan (HUM00095267).

Results

In total, 6 interviews with 10 key informants were conducted between November 2020 and April 2021, notably occurring over the course of two prominent COVID-19 surges. **Table 2** lists characteristics of the hospitals. Hospital staff interviewed included physicians and nurses involved in care of IHCA patients, and yielded 5 hours and 44 minutes of interview time. Our analysis resulted in three main themes: 1) patient and provider safety and wellness; 2) protocols and training; 3) goals of care and end of life discussions. Technology related advancements and adaptations served as an underlying concept

Table 1 – Type of Staff Interviewed at Study Hospitals.

Type of Staff	No. of Interviews
Physician	5
Nurse practitioner	1
Nurse manager	2
Nurse code team member/critical care nurse	2

across the three main themes. These themes are described in detail below, along with exemplar quotes. Within each of the three main themes, we highlight issues related to technology advancements and adaptations. To preserve both site and staff anonymity, descriptors within quotes such as physical location, position, and names of staff were removed, while maintaining the integrity of the statement.

Patient and provider safety and wellness

Interviewees identified many changes made regarding safety and wellness among patients and health care workers (HCW) that were driven by the initial scarcity of information and resources during early surges. One prominent change involved the use of personal protective equipment (PPE). Initially, the primary focus of PPE was ensuring broad protection prior to entering resuscitation rooms, which included gowns, gloves, N95 masks, and eye protection. In response to COVID-19, many institutions began to locate more PPE carts in intensive care units as well as creating resuscitation bags for responding personnel to carry, which included broad coverage PPE. "Putting your PPE on first is what's most important." (Director of Adult Critical Care and Nursing; Hospital E)

"We are no help to our patients if we don't take a few seconds to take care of ourselves first." (Critical Care APN; Hospital F)

In addition to physical safety, mental health among HCWs during the initial surges was a concern amongst many and was disclosed by interviewees, unprompted by interviewers. Provider wellness and safety as addressed with a two-prong method described by several interviewees, which included bringing attention to not only physical, but mental wellness for HCWs. In response, behavioral health services were offered to HCWs in varying degrees and capacities, with many interviewees stating that lack of accessible and timely offering of these resources was a regret of theirs during the early stages of the pandemic.

"Taking a mental toll on everybody...hard to describe...you come to work with the goal to save somebody and every effort you are making...and they die alone...overwhelming" (Nurse Coordinator; Hospital C).

"You are coming to work every day and you are just seeing people die" (Nurse Coordinator; Hospital C)

Technology advancements and adaptations related to patient and provider safety and wellness

At all hospitals, the interviewees described how advancements in technology were being used to minimize HCW exposure risk or prompted the need for additional changes in work processes. This included the implementation of automated compression devices, changes to ventilation strategies, and alterations in resuscitation

Table 2 – Hospital Characteristics.

Hospital	Region	Staffed Beds	Mean RSSR, Percentile, 2012–2014	Mean No. of IHCA per year, 2012–2014	Teaching Status
A	Midwest	>800	95.5	288.0	Major
B	South	>400 to 800	97.3	93.3	Non-Teaching
C	West	200 to 400	56.1	68.7	Minor
D	Midwest	200 to 400	81.7	73.3	Minor
E	Northeast	>800	88.7	140.7	Major
F	Northeast	>400 to 800	5.4	129.3	Minor

RSSR = Risk-Standardized Survival Rate; IHCA = In-Hospital Cardiac Arrest

As previously reported.¹²

team structure. Many interviewees reported introducing automated compression devices to their institutions for the first time, while others commented on the number of these devices increasing exponentially. Ventilation strategies varied widely with reports of compressions being held until an airway was obtained at certain institutions. Several different devices were crafted to place over a patient's mouth during compressions to limit exposure; these ranged from masks to clear acrylic boxes to makeshift tents.

All interviewed sites reported the creation of 'inside vs outside' resuscitation teams. Inside teams were created with the intent to minimize the number of individuals at bedside to essential individuals only. Outside teams were made up of additional support staff such as social workers, representatives from radiology and pharmacy, with additional physicians and nurses, all of whom remained outside of the resuscitation rooms.

Communication during codes involving isolation rooms became imperative with new configurations of code teams. Different modes of communication included walkie-talkies, baby monitors, and converting patient rooms to more glass-centered to enable writing with markers was reported.

"When I'm in a code room the noise from the negative airflow, plus the PAPRs [powered air purifying respirators], plus people screaming over their equipment to talk to one another, is very loud." (Member of Medical-Surgical Emergency Team; Hospital B)

Protocols and training

Training processes and initiatives were not immune to the pandemic and saw significant change. Mock code frequencies decreased at some institutions given concerns about social distancing, but also due to increases in patient care load and staff limitations. There was the introduction of COVID-19 based mock codes, which placed a heavy emphasis on the appropriate donning and doffing of PPE, rapid ventilation strategies, and implementing and troubleshooting automated compression devices. Advanced cardiac life support (ACLS) training also saw pronounced changes. Most interviewees reported a hybrid model approach to ACLS training with a new virtual or on-line component, which resulted in less hands-on clinical opportunities. Training class sizes were also limited to accommodate social distancing, which resulted in decreased opportunities for staff to remain compliant with training. In response "grace" periods were introduced to allow staff to remain compliant with ACLS training, while balancing increases in patient care with limited ACLS training opportunities.

"Units are so busy the last thing they want to do is be told how to run a code blue when they are running five a day" (Nurse Coordinator; Hospital C)

"Suspended from reality" [regarding simulations with social distancing implemented]. (Director of Adult Critical Care and Nursing; Hospital E).

Roles during IHCA were also assigned at the beginning of shifts at some institutions given increasing IHCA numbers. This resulted in less confusion at the beginning of IHCA and had the potential to limit the number of individuals entering a room unnecessarily.

Additionally, interviewees stated that there was the creation of several new healthcare teams regarding resuscitation practices and the treatment of COVID-19 patients to standardize care for this patient population. These included Anesthesia COVID-19 Airway teams, chill teams, and proning teams. Anesthesia COVID-19 Airway teams were created given the increased need for rapid sequence intubations within this population and provide this intervention in a timely manner. Chill teams brought together neurology, cardiology, and pulmonary critical care colleagues to establish cooling protocols given the increased incidence of IHCA amongst COVID-19 positive patients.

Technology advancements and adaptations related to protocols and training

Given increased mortality seen in this population as well as increases in patient volume, technology related developments involving protocols and training included the creation of early warning systems, similar to the National Early Warning Score (NEWS), within electronic medical records (EMR). These systems utilized vital signs and lab value trends as indicators to rapid response-based rounding teams for further assessment and evaluation.

Goals of care and end of life discussions

At the beginning of the pandemic there was uncertainty surrounding the clinical trajectory of patients related to not only the disease process of this new virus, but also resuscitation outcomes in this patient population. This uncertainty led to modifications in approaches to goals of care conversations as well as post resuscitation care. Some institutions reported readdressing 'Resuscitation versus Do Not Resuscitate' conversations sooner with COVID-19 patients compared to the non-COVID-19 cohort. Many interviewees expressed concern regarding the ability to obtain appropriate resuscitation status during the pandemic. Their concerns stemmed from visitor policies and the lack of family members at bedside.

“COVID has changed our ability to get appropriate code status” (Nurse Coordinator; Hospital C)

With high patient census numbers, many hospitals implemented visitor policies to limit HCW exposure, with impactful downstream effects observed by hospital staff.

“Normally you know they [family members] come in and see the tubes and see the lines and they may not understand what that means. But the visual picture of what their loved one’s status is plays a big impact on decision making on whether they should be full code or whether they should die in peace, and that piece is now missing. It is broken.” (Nurse Coordinator; Hospital C)

“Some people are holding on to a full code status longer. . .if families could just come in they would say ‘Let’s stop all this’” (Director of Adult Critical Care and Nursing; Hospital E)

Technology advancements and adaptations related to goals of care and end of life discussions

Communication between families, patients, and patient care teams required rethinking during early stages of the pandemic. To address evolving visitor policy changes institutions began to deploy different communication tactics for family members at home to engage with their loved ones in the hospital, as well as with patient care teams. A variety of streaming devices were used including tablets, cell phones, and video streaming applications. However, there were still concerns that the lack of in-person presence of family members was affecting patient care. Support staff, including case managers and social workers, were called upon more frequently in attempts to assist with the communication barriers that resulted from the pandemic between family members and patient care teams.

“Not allowing family to come in has created this barrier. . .they don’t understand the gravity of it. Having someone explain it to you over an iPad I don’t believe is providing the same impact as if they were at bedside” (Nurse Coordinator; Hospital C)

Discussion

A retrospective study demonstrated an 11 % increase in IHCA during the COVID-19 pandemic, with mortality ranging from 88 to 100 % within COVID-19 positive patients experiencing an IHCA.⁵ Given these findings we sought to identify core themes related to changes in resuscitation practices during the COVID-19 pandemic, specifically early on during its first initial surges. Our investigation identified three themes related to how U.S. hospitals shifted in their resuscitation practices: patient and provider safety, protocols and training, and goals of care and end of life discussions. Underlying all themes were advancements and adaptations in technology that helped institutions address challenges related to these themes.

Patient and provider safety came under significant scrutiny with changing AHA guidelines regarding PPE use. The American healthcare community has seen three guideline changes published from AHA over the course of the pandemic thus far, which have stemmed from new variants, level of transmissibility, and IHCA outcomes amongst COVID-19 patients.^{8–10} In January of 2022 with increased

transmissibility of new variants the AHA published their latest guidelines recommending that HCWs should don appropriate PPE prior to engaging in components of cardiac arrest, including chest compressions.⁹ Changes to resuscitation efforts were also seen on an international level with the European Resuscitation Council (ERC) publishing guidelines in June of 2020 addressing advanced life support for adults with suspected or confirmed COVID-19 infections. These changes were similar to those published by the AHA and included donning PPE prior to performing aerosol-generating procedures such as chest compressions, restricting the number of staff at bedside during resuscitation efforts, and use of mechanical chest compressions devices for prolonged CPR.¹¹ The International Liaison Committee of Resuscitation (ILCOR) also published guidelines early during the COVID-19 pandemic that detailed using PPE for aerosol generating procedures during resuscitation, in addition to considering defibrillation before donning PPE in situations where the provider assesses the benefits may exceed the risks.¹³

Limiting potential exposures to HCWs including aerosolizing procedures was a topic that saw dynamic change, not only across institutions, but over the course of the pandemic. The make-up of resuscitation teams and their roles were modified to address the above concerns. Other methods of limiting HCW exposures included the wider use of automated compression devices and adaptations to ventilation strategies. While HCW safety was a priority early on, a recurring concern amongst interviewees was the emotional burden of the COVID-19 pandemic on HCWs. There have been several studies that have analyzed the impact of the COVID-19 pandemic on healthcare professionals’ mental health, which have also revealed an increased prevalence of anxiety and depressive symptoms.^{14,15}

When approaching resuscitation protocols and training initiatives during the COVID-19 pandemic institutions adapted a variety of strategies. ACLS training began to incorporate a virtual learning component given the need for social distancing. Some training programs began utilizing video conferencing capabilities with computerized manikins for optimized social distancing experiences, while others focused on sanitization and facility preparation to minimize potential exposures.^{16,17} To accommodate social distancing and increased patient care demands many institutions extended accreditation timelines, as noted by many interviewees. The AHA adapted to the evolving training environment for ACLS and expanded card renewal dates by 120 days in July of 2020.¹⁸ Mock resuscitation training was also adjusted to include COVID-19 specific problems, as well as techniques to support social distancing.

With the increasing number of IHCA amongst COVID-19 patients, new warning systems within EMRs, similar to NEWS, were developed to identify unstable or decompensating patients prior to a code. Prior studies have shown systems of this nature can reduce the number of IHCA with a subsequent decrease in in-hospital mortality, but outcomes surrounding these systems have yet to be assessed during the COVID-19 era.¹⁹

Specific teams were created to address resuscitation practices as well as post resuscitation care during the COVID-19 pandemic, these included dedicated anesthesia teams, cooling teams, and proning teams. Proning teams were developed, not for resuscitation specifically, but to assist in proning and unproning patients given increasing incidence of COVID-19 induced acute respiratory distress syndrome (ARDS) cases and proven benefit in this positioning strategy.²⁰

Post cardiac arrest protocols were also addressed during early stages in the pandemic to deliver high levels of care for specific and high resource treatments. For example, hospitals discussed

how extracorporeal membrane oxygen (ECMO) was offered with varying degrees to COVID-19 patients following IHCA and successful return of spontaneous circulation. The Extracorporeal Life Support Organization published new guidelines in May 2021 with data to suggest similar survival rates in COVID-19 ARDS patients compared to non-COVID-19 ARDS patients meeting indications for V-V ECMO with the awareness that COVID-19 patients may require longer durations on this method of support.^{21–26}

There are several limitations of this qualitative study that should be considered in its interpretation. First, interviews occurred during different periods of surges and thus may not reflect comprehensive changes and adaptations made to resuscitation practices following new discoveries and developments related to the COVID-19 virus. Second, our team did not review specific protocols regarding resuscitation practices at institutions which would be a valuable tool for triangulating results with our interview results. Third, we did not perform a quantitative survey to complement our qualitative study. This may be valuable in future studies to understand how changes in protocols shifted nationally. Fourth, additional work may also focus on longitudinal studies that should help ascertain the long-lasting effects of the COVID-19 pandemic on resuscitation practice changes as well as determine if changes made during periods of hospital strain will remain in place. Finally, we were limited to key informants from only 6 institutions. Although we attempted to find diverse institutions, our findings will not be representative for all health care institutions. This work remains hypothesis generating and should be used to complement additional quantitative studies that reflect changes in resuscitation practices.

In summary, we found U.S. hospitals responded to the COVID-19 pandemic with important changes in their resuscitation practices for IHCA that focused on patient and provider safety changes, protocol and training changes, and goals of care and end of life decisions. As

changes and information surrounding the COVID-19 pandemic continue to develop, resuscitation practices for IHCA patients will remain dynamic.

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CRedit authorship contribution statement

Kayla M. Secrest: Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Theresa M. Anderson:** Writing – review & editing. **Brad Trumpower:** Investigation, Formal analysis, Data curation, Writing – review & editing. **Molly Harrod:** Writing – review & editing. **Sarah L. Krein:** Writing – review & editing. **Timothy C. Guetterman:** Writing – review & editing. **Paul S. Chan:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – review & editing. **Brahmajee K. Nallamothu:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – review & editing, Supervision.

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Appendix

INTERVIEWEE NAME: _____

POSITION / TITLE: _____

PRIMARY INTERVIEWER: _____

SECONDARY INTERVIEWER: _____

INTERVIEW LOCATION & TIME: _____

RECORDER #, FILE: _____

I / We want to thank you again for participating in a HEROIC site visit in the past. The time and information you gave us were invaluable in providing us a look inside how your hospital handles IHCA. The purpose of the original site visits was to see behind the scenes. We wanted to discover the strategies used to improve resuscitation care and how they are put into place. I am talking with you again today to learn about how your hospital has adapted it's IHCA practices in response to the COVID-19 Pandemic. As before, I'd like to hear stories that illustrate what your hospital has been innovating for resuscitation care. We are trying to identify best practices and share those with hospitals across the United States. But first, we would like to receive your permission to record our conversation in order to facilitate transcription. [Go over accompanying informed consent document.] Names and other features identifying you, other hospital personnel and the hospital will be manually redacted from the transcripts prior to analysis. [If refused, offer to send interviewee the transcript to reiterate the steps taken to maintain confidentiality. If still refused, ask if you may take notes]. TURN ON RECORDER.

1. Let's start by having you describe what you do here.

- What is your formal title?
- To whom do you report (get title and level)?
- How long have you worked here? How long have you worked in this job?
- What are your formal responsibilities?

- Can you walk us through an average workday since the pandemic began?
Now we would like to know more about how your hospital has been handling IHCA care during the pandemic specifically.

2. Please describe your hospital's policies and practices related to preventing in-hospital spread of COVID-19 during IHCA.

- What is your hospital's general policy for Do-Not-Resuscitate or "code" status since the COVID-19 pandemic?
- Can you tell us a bit about rapid response teams or medical emergency teams at your hospital? Do you have them? How are they used?
How has this changed in response to the pandemic?
- Are COVID-19 patients kept in a specific unit(s) at your hospital?
- Does the code team for the COVID-19 unit differ from the general code team?
- What other measures does your hospital take to prevent COVID-19 spread during IHCA?

3. Please describe the process by which your hospital responds to an IHCA event in patients suspected or confirmed to have COVID-19 and how it is different with patients not suspected of having COVID-19.

- How many IHCA's typically occur at your hospital during an average month?
- What proportion of these are in a patient who was positive or suspected to have COVID-19?
- What happens to a COVID-19 patient when they experience cardiac arrest at your hospital?
- Can you describe the most recent IHCA event with one of these patients that you were involved in?
- How has the composition or roles and responsibilities in your code team changed in response to COVID-19?
- What changes have there been in the types of technology/equipment that your hospital uses during IHCA resuscitation in response to the pandemic?
- What changes have there been in the conduct of chest compressions and ventilation at your hospital during IHCA resuscitation since the pandemic?
- Does your hospital limit the number of individuals in the room with a patient with suspected or confirmed COVID-19 infection during an IHCA resuscitation?
- Prior to the pandemic, did your hospital routinely run mock codes? How has that changed since the pandemic began?
- Prior to the pandemic, did your hospital routinely run immediate debriefing after codes? How has that changed since the pandemic began?

4. Please describe how your hospital cares for patients following IHCA if they survive.

- What happens to the patient after treating cardiac arrest? Are there special units that they are transferred to for advanced care? Is this different based on COVID-19 status?
- What types of new technology/equipment does your hospital use after IHCA resuscitation? Does your hospital use therapeutic hypothermia? Are patients routinely evaluated in the CATH lab, and if so, for all rhythms, or specific rhythms? Does this differ with patients that are suspected or positive for COVID-19? What post-resuscitation care is unavailable for those patients?
- Are there special teams of providers that round on patients following IHCA? Do they include a neurologist?
- How do you make decisions regarding neurological prognostication? How are decisions made about withdrawal of care in patients who don't seem to be improving? How does this change if the patient is COVID-19 positive or suspected?

5. How has COVID-19 affected the ACLS training at your hospital?

- Has the training gone virtual (interactive or pre-recorded)? Smaller groups?

6. Who is responsible for oversight and QI efforts related to IHCA at your hospital? (e.g., CPR committee)

- Are QI efforts still ongoing despite the pandemic? Did they stop at any point since the pandemic began?
- Do you have a CPR or Code Blue committee? Who's on it?
- Did the CPR or Code Blue committee develop protocols for COVID-19 patients? If so, can you share these with us?
- Were those protocols implemented? •Are QI efforts successfully implemented at your hospital, or do they typically fail? Has this changed since the pandemic began?
- Have you had specific QI targets for COVID-19?
- Is data or feedback related to the arrest process and outcomes collected and disseminated back to providers at your hospital? Has this occurred since the pandemic started?
- If so how would you describe the timeliness of your hospital's data on performance? How would you describe the accuracy of your hospital's data on performance? Does your hospital use benchmarks in data feedback? How? What do the providers do with these reports? What has been their reaction? Do you know how past performance compares to performance during the pandemic?

We would like to ask some final general questions about how you think IHCA care processes could be best improved.

7. If you could change one thing about the IHCA care processes since the pandemic started at your hospital, what would it be?

8. If you were helping other hospitals improve IHCA care during the pandemic, how would you recommend they structure a program?

- What barriers would you foresee in implementing those recommendations?

Author details

^aDepartment of Internal Medicine, University of Michigan Medical School, Ann Arbor, MI, USA ^bVeterans Affairs Ann Arbor Center for Clinical Management Research, Ann Arbor, MI, USA ^cDepartment of Family Medicine, University of Michigan Medical School, Ann Arbor, MI, USA ^dDepartment of Internal Medicine, Saint Luke's Health System, Kansas City, MO, USA

REFERENCES

- Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-Hospital Cardiac Arrest: A Review. *JAMA* 2019;321:1200–10.
- Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. *Intensive Care Med* 2007;33:237–45.
- Saghafinia M, Motamedi MHK, Piryaie M, et al. Survival after in-hospital cardiopulmonary resuscitation in a major referral center. *Saudi J Anaesth* 2010;4:68–71.
- Yonis H, Winkel B, Andersen MP, et al. Duration of resuscitation efforts and long-term prognosis following in-hospital cardiac arrest (IHCA) ehab724.1542. *Eur Heart J* 2021;42.
- Roedi K, Söffker G, Fischer D, et al. Effects of COVID-19 on in-hospital cardiac arrest: incidence, causes, and outcome – a retrospective cohort study. *Scand J Trauma Resusc Emerg Med* 2021;29:30.
- In-Hospital Cardiac Arrest Survival in the United States During and After the Initial Novel Coronavirus Disease 2019 Pandemic Surge | *Circulation: Cardiovascular Quality and Outcomes* [Internet]. [cited 2022 May 5]; Available from: <https://www.ahajournals.org/doi/full/10.1161/CIRCOUTCOMES.121.008420>.
- Chan PS, Berg RA, Nadkarni VM. Code Blue During the COVID-19 Pandemic. *Circ Cardiovasc Qual Outcomes* 2020;13:e006779.
- 2021 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19 | *Circulation: Cardiovascular Quality and Outcomes* [Internet]. [cited 2022 May 5]; Available from: <https://www.ahajournals.org/doi/full/10.1161/CIRCOUTCOMES.121.008396>.
- Atkins DL, Sasson C, Hsu A, et al. 2022 Interim Guidance to Health Care Providers for Basic and Advanced Cardiac 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 in Collaboration With the American Academy of Pediatrics, American Association for Respiratory Care, the Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists. *Circ Cardiovasc Qual Outcomes* 2022;15:e008900.
- Interim Guidance for Basic and Advanced Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19 | *Circulation* [Internet]. [cited 2022 May 5]; Available from: <https://www.ahajournals.org/doi/full/10.1161/CIRCULATIONAHA.120.047463>.
- Nolan JP, Monsieurs KG, Bossaert L, et al. European Resuscitation Council COVID-19 guidelines executive summary. *Resuscitation* 2020;153:45–55.
- How Do Resuscitation Teams at Top-Performing Hospitals for In-Hospital Cardiac Arrest Succeed? | *Circulation* [Internet]. [cited 2022 May 5]; Available from: <https://www.ahajournals.org/doi/full/10.1161/CIRCULATIONAHA.118.033674>.
- Perkins GD, Morley PT, Nolan JP, et al. International Liaison Committee on Resuscitation: COVID-19 consensus on science, treatment recommendations and task force insights. *Resuscitation* 2020;151:145–7.
- Mental Health Conditions of Italian Healthcare Professionals during the COVID-19 Disease Outbreak - Bettinsoli - 2020 - *Applied Psychology: Health and Well-Being* - Wiley Online Library [Internet]. [cited 2022 May 5]; Available from: <https://iaap-journals.onlinelibrary.wiley.com/doi/full/10.1111/aphw.12239>.
- Lu W, Wang H, Lin Y, Li L. Psychological status of medical workforce during the COVID-19 pandemic: A cross-sectional study. *Psychiatry Res* 2020;288 112936.
- Interim CPR Guidelines - National Safety Council [Internet]. [cited 2022 Sep 9]; Available from: <https://www.nsc.org/workplace/safety-topics/coronavirus/interim-cpr-guidelines>.
- Shok R. March 2022 Update: CPR Training and COVID-19 Safety [Internet]. *Code One CPR Train.* 2022 [cited 2022 Sep 9]; Available from: <https://code1web.com/learning-center/2022-update-cpr-training-and-covid-19-safety/>.
- Updated-Interim-Guidance-on-Card-Extensions-72320_FINAL.pdf [Internet]. [cited 2022 Sep 9]; Available from: https://cpr.heart.org/-/media/CPR-Files/Resources/COVID-19-Resources-for-CPR-Training/Updated-Interim-Guidance-on-Card-Extensions-72320_FINAL.pdf.
- Mathukia C, Fan W, Vadyak K, Biege C, Krishnamurthy M. Modified Early Warning System improves patient safety and clinical outcomes in an academic community hospital. *J Community Hosp Intern Med Perspect* 2015;5:26716.
- Ghelichkhani P, Esmaeili M. Prone Position in Management of COVID-19 Patients; a Commentary. *Arch Acad Emerg Med* 2020;8:e48.
- Schmidt M, Hajage D, Lebreton G, et al. Extracorporeal membrane oxygenation for severe acute respiratory distress syndrome associated with COVID-19: a retrospective cohort study. *Lancet Respir Med* 2020;8:1121–31.
- Barbaro RP, MacLaren G, Boonstra PS, et al. Extracorporeal membrane oxygenation support in COVID-19: an international cohort study of the Extracorporeal Life Support Organization registry. *The Lancet* 2020;396:1071–8.
- ECMO for COVID-19 patients in Europe and Israel | SpringerLink [Internet]. [cited 2022 May 5]; Available from: <https://link.springer.com/article/10.1007/s00134-020-06272-3>.
- Jäckel M, Rilinger J, Lang CN, et al. Outcome of acute respiratory distress syndrome requiring extracorporeal membrane oxygenation in Covid-19 or influenza: A single-center registry study. *Artif Organs* 2021;45:593–601.
- Mustafa AK, Alexander PJ, Joshi DJ, et al. Extracorporeal Membrane Oxygenation for Patients With COVID-19 in Severe Respiratory Failure. *JAMA Surg* 2020;155:990–2.
- Extracorporeal Membrane Oxygenation for Patients With COVID-19 in Severe Respiratory Failure | *Critical Care Medicine* | *JAMA Surgery* | *JAMA Network* [Internet]. [cited 2022 May 5]; Available from: <https://jamanetwork.com/journals/jamasurgery/article-abstract/2769429>.