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Best Practices for Education and Training of Resuscitation Teams for In-Hospital Cardiac Arrest

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Abstract

Background: Survival outcomes following in-hospital cardiac arrest (IHCA) vary significantly across hospitals. Research suggests clinician education and training may play a role. We sought to identify best practices related to the education and training of resuscitation teams.

Methods: We conducted a descriptive qualitative analysis of semi-structured interview data obtained from in-depth site visits conducted from 2016–2017 at 9 diverse hospitals within the American Heart Association "Get With The Guidelines" registry, selected based on IHCA survival performance (5 top-, 1 middle-, 3 low-performing). We assessed coded data related to education and training including systems learning, informal feedback and debrief, and formal learning through ACLS and mock codes. Thematic analysis was used to identify best practices.

Results: In total, 129 interviews were conducted with a variety of hospital staff including nurses, chaplains, security guards, respiratory therapists, physicians, pharmacists, and administrators, yielding 78 hours and 29 minutes of interview time. Four themes related to training and education were identified: engagement, clear communication, consistency, and responsive leadership. Top-performing hospitals encouraged employee engagement with creative marketing of new programs and prioritizing hands-on learning over passive didactics. Clear communication was accomplished with debriefing, structured institutional review, and continual, frequent education for departments. Consistency was a cornerstone to culture change and was achieved with uniform policies for

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simulation practice as well as reinforced, routine practice (weekly, monthly, quarterly). Finally, top-performing hospitals had responsive leadership teams across multiple disciplines (nursing, respiratory therapy, pharmacy and medicine), who listened and adapted programs to fit the needs of their staff.

Conclusions: Among top-performing hospitals excelling in IHCA survival, we identified core elements for education and training of resuscitation teams. Developing tools to expand these areas for hospitals may improve IHCA outcomes.

Keywords

In-Hospital Cardiac Arrest; Resuscitation; Mock Codes; Qualitative Research

INTRODUCTION

Each year in the United States, approximately 292,000 adult patients[1] suffer an in-hospital cardiac arrest (IHCA) with significant variation in their rate of survival.[2–5] Research has noted improved survival outcomes with early initiation of defibrillation[6] and cardiopulmonary resuscitation (CPR),[7] leading the development of national guidelines. Given this, hospitals invest substantially in training hospital staff in basic life support (BLS) and advanced cardiopulmonary life support (ACLS) to improve IHCA resuscitation efforts. Yet, despite this knowledge of effective practices as well as considerable investment by hospitals in training, clinical outcomes for IHCA continue to vary widely across facilities and remain poor overall.

IHCA is a dynamic event, requiring timely intervention amongst highly skilled individuals, utilizing effective teamwork and communication. As such, moving beyond a traditional view of IHCA key practices may provide a better understanding of how to improve IHCA outcomes. In particular, focusing on the overarching programmatic strategies hospitals use to achieve these objectives and the overall environment of a facility may yield new insights. Based on recent research, for example, one core strategy used by top-performing hospitals to achieve higher survival rates emphasizes the education and training of clinical care providers.[8,9] However, this study did not specifically analyze actions taken by these hospitals or attempt to identify best practices for effective training and education of resuscitation teams. This is important because while the availability of BLS and ACLS training is universal at hospitals, it is unlikely to be sufficient for success in resuscitation efforts. Additional aspects of the hospital culture and the learning environment may contribute to how clinicians are optimally educated and trained in resuscitation efforts.

To address this gap in knowledge, we performed an in-depth qualitative analysis with data obtained from the Hospital Enhancement of Resuscitation Outcomes for In-Hospital Cardiac Arrest (HEROIC) study, a mixed-methods study evaluating IHCA outcomes and resuscitation practices on a national platform. Through this secondary analysis of the HEROIC data, we sought to identify best practices related to training and education of resuscitation teams that distinguished top-performing hospitals from others.

METHODS

Study Design and Sampling

Data and study materials will not be made available given the sensitive nature of the interviews and the potential for reidentification of individuals. We conducted a secondary descriptive qualitative analysis using data obtained originally from the HEROIC study, which was intended to evaluate how top performing hospitals implemented resuscitation teams more generally. Five of the original investigators (SK, TG, MH, SK, BN) were involved in the secondary analysis. Our data was obtained from pre-coded transcripts used in the original HEROIC study. As previously described, nine hospitals were purposefully selected, based primarily on risk-standardized survival rates, for in-depth qualitative investigation (Table 1). These hospitals all participated in the Get With The Guidelines registry and had at least 20 patients sustaining IHCA from January 1, 2012 to December 31, 2014. Hospitals were then categorized by quartiles based on performance in risk-standardized rates of survival to discharge that were calculated for each hospital. Top-performing hospitals were defined as those in the highest quartile of IHCA survival for each calendar year (2012–2014), middle-performing as those within the middle two quartiles per year, and low-performing as those in the lowest quartile consistently.

Hospitals were then selected for in-person site visits, based on a maximum variation principle, with hospitals differing on four qualities: geographic region, academic status, number of beds and risk standardized IHCA survival. A larger sample of top-performing hospitals was selected since these hospitals were considered the most informative for identifying best practices related to resuscitation following cardiac arrest in the hospital. Middle and lower performing hospitals were included for comparative purposes, and to provide perspective regarding challenges and barriers that may not be noted in top-performing institutions.

Of the twelve hospitals initially approached for participation, one high-performing hospital declined because their resuscitation leader was unavailable, and two additional hospitals (one high and one low performing) declined due to workload concerns. At the nine participating hospitals (4 top-, 2 middle-, 3 low-performing), the individual overseeing the hospital's participation in the Get With The Guidelines-Resuscitation registry was the first point of contact and asked to assist with identifying key staff to recruit for interviews. This was typically the leader of the hospital's resuscitation committee or quality committee. Key staff (Table 2) were defined based on roles, and included members of the hospital's resuscitation team, rapid response or emergency medical team, and resuscitation committee as well as nurses, respiratory therapists, physician trainees, chaplains, attending physicians and both clinical and general administrative leaders. Interview participation was voluntary and confidential. Site visits and interviews were conducted in 2016–2017 and continued until thematic saturation (i.e., no new concepts emerged) was achieved. See Supplemental Table I for the interview guide topics used in HEROIC. The study was approved by the University of Michigan Medical School institutional review board.

Data collection

Semi-structured interviews were conducted using an interview guide developed by the HEROIC study team, which included a diverse group of investigators with expertise and experience in qualitative research, clinical medicine, and nursing.[8] Within the original study, investigator triangulation was approached in multiple domains. Interviews were conducted with clinician and non-clinicians paired to reduce questioning bias. The same interview guide was used across interviews, and during our analysis we reviewed responses within and across sites including disconfirming evidence. The quotes in our findings represent participants from various roles and hospitals to demonstrate the confirmability of our response.

In the original HEROIC study, the vast majority of instances included one interviewee who met for one hour in person with two study team members, one qualitative researcher and one clinician. The interviewers were paired as one clinician with one qualitative researcher to balance expertise (methodological and clinical). When requested by the interviewee in select circumstances, interviews were conducted in groups with two to five participants. Interviews were audio-recorded and later transcribed verbatim. Participants received a $20 gift card as remuneration for their participation.

Data analysis

We conducted a secondary analysis of the data collected to understand education and training of the resuscitation team. We queried the data focusing on previously coded data related to systems learning, informal feedback and debrief, and formal learning through ACLS and mock codes. The categories included in the query were selected as they focused on educational and training initiatives surrounding ACLS and resuscitation teams. Nine team members were involved in discussions. Seven team members initially reviewed two sites to establish consistency across interpretations of the coded data, and two members subsequently reviewed coded data from the additional nine sites. The two middle-performing sites were included in the lower-performing categories given our intention (and the original intention of HEROIC) to focus on top-performing centers for identifying themes potentially linked to improved IHCA outcomes. Three team meetings were held to review a pre-set amount of data and discuss patterns among all team members to identify emerging themes. Themes were then consolidated by two team members and then shared across team members for final discussion.

RESULTS

In total, 158 interviews were conducted at nine hospitals. A variety of hospital staff participated in interviews including nurses, respiratory therapists, physicians, pharmacists and administrators yielding 78 hours and 29 minutes of interview time. Our analysis focusing on the environment around education and team training resulted in four main themes: engagement, clear communication, consistency, and responsive leadership. These themes are summarized in Table 3, and described in detail below, along with exemplar quotes. 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.

1. Engagement

Top-performing hospitals used engagement through multiple domains including focused marketing, prioritizing hands-on learning experiences and minimizing didactics to enhance the environment around training and education. Through a multifaceted approach, top-performing hospitals were able to engage with employees on various levels involving direct interactions and indirect experiences as described below.

Marketing new initiatives and incorporating slogans to highlight relevant information was a core element to engaging employees and improving recollection of guideline standards.

> "We created 1–2-5 Strive to Revive inhouse. We sort of cribbed the Strive to Revive portion from an existing [American Heart Association] AHA program, but the 1–2-5 concept was based on Get With the Guidelines. [1 minute to CPR, 2 minutes to defibrillation, 5 minutes to epinephrine.]"
>
> (Nursing Educator; Hospital A, Top-Performing)

Hospitals also utilized visual abstracts and posters to articulate concise messages in readily accessible locations. Posters allowed for quick and concise information delivery to employees, which can be used at any time. In addition, top-performing hospitals were able to reduce didactics and optimize simulation time, which was pivotal to employee buy-in of new programs.

> "We created a poster first, and we developed a 4-hour course. They told us, "You can have 2 hours"… and I remember sitting at a conference room table with the poster and going you know what, the whole course should just be the poster, just focus on the poster... and get right on the mannequin, and that's what it became."
>
> (Nursing Educator; Hospital A, Top-Performing)

A central theme for improving engagement involved recognizing the importance of clinical duties and implementing high impact learning with mock codes in a reasonable timeframe.

> "When we first started the mock code program, people were a little bit peeved to be leaving their duties and showing up to a practice, you know— until they found it useful... We [now] have a policy that from the time we call the mock code to the time they are dismissed is no longer than 20 minutes. It generally means 10 minutes of resuscitation time, 10 minutes of debrief… they saw this was not wasting their time, but that this was very considerate of their time."
>
> (Attending Physician - Emergency Medicine; Hospital B, Top-Performing)

All top-performing centers prioritized hands on learning across disciplines – with nurses, pharmacists, respiratory therapists and physicians. Developing *relevant* curriculum with real-world examples also resonated more deeply with employees. This resulted in a more engaging learning experience, highlighting the importance of creating immersive, plausible case simulations.

> "Our policy here in the hospital is when we start our PCAs [patient controlled analgesia], everybody gets an end-tidal CO2 monitor, and…they didn't understand the significance of what that's supposed to tell you. So, we had hypoxemic events. What we did [in training] was we took that scenario of somebody who had a femur fracture, and we hooked them up to a PCA and [the] end-tidal [was] set up to 56. What is that significant of? How do you troubleshoot that? What are we looking for? You go through those different points… key points."
>
> (Chief Nursing Officer; Hospital C, Top-performing)

In contrast, lower-performing hospitals lacked the ability to engage their employees in ways that ensured retention.

> "We get people regurgitating back what they've memorized, and then as soon as they leave the class, and the retention falls off and [they] hit the rooms and that's the outcome that you get out of it."
>
> (Manager; Hospital I, Lower-performing)

Lastly, better engagement with intensive programs like mock codes was able to highlight larger systems-level flaws, which provided opportunities for hospitals to make proactive policy and structural changes to broadly improve patient safety across the health system.

> "We found out a lot of things without somebody's life being at stake when we did a mock code. I did one once in the inpatient dialysis unit, and they realized they didn't have an Ambu bag in there. Why wouldn't they have it? Those patients are sick… but they didn't, so we got one there after that."
>
> (Educator of Life Support; Hospital B, Top-Performing)

2. Consistency

Performing education and training initiatives as a routine practice was a cornerstone to culture change and employee development. For example, top-performing hospitals viewed mock code training as a core job responsibility rather than a supplemental task.

> "[When we] started to do mock codes… We did our first one and we just stopped because it was so disjointed. We did these mock codes [and] kept doing it… Now, it's routine that the floor staff will get everything set up and get the first defibrillation… That's really a highlight… We know they know this stuff. They do it every day in their jobs. We needed to take away the barriers to them doing it."
>
> (Emergency Medicine Physician; Hospital B, Top-performing)

All hospitals had difficulty with training and enhancing the education of employees initially. Maintaining consistency in code sessions with routine practice were core elements to success at top-performing hospitals.

> "We estimate about 300 people in the hospital are potential team members. So how do you coordinate that? Well, one, we generally train together in the ACLS classes and, two, our mock code program is set up where we do two a month, but we do it on a different floor, a different shift, a different day."

(Emergency Medicine Physician; Hospital-B, Top-performing)

Investing in dedicated facilitator training and having a uniform experience also helped create consistency in the learning experience, which was noted as an advantage among top-performing hospitals.

> "We focused heavily the first year on facilitator training so that those that were conducting the mock codes were doing so consistently. So, if you went through a mock code this week and went next week and had different facilitators…it would still be the same thing."

(ACLS Program Coordinator; Hospital H, Top-performing)

Lower performing hospitals, in contrast, relied heavily on orientation or had inconsistent mock code programs.

> "We opened this whole west tower. They did more mock codes for a little bit but then it literally kind of fizzles and you won't hear a mock code for 6 to 8 months and... I don't know, very inconsistent but it happens occasionally."

(Clinical Risk Manager; Hospital G, Lower-performing)

Given the diversity of institutions both geographically and academically, understanding the structural and resource limitations of each institution was important. For example, some institutions performed mock codes in simulation centers rather than on the floors due to limited bed availability and the need to conserve resources – and this did not appear to differ across hospitals based on their performance in IHCA survival.

3. Clear Communication

Clear communication was demonstrated in multiple ways: with intentional messaging highlighting the value of training initiatives, debriefing after codes, institutional review with code committees, and continual education for departments.

Top-performing hospitals placed emphasis on thoroughly communicating to employees the value and importance of education and training to improve IHCA outcomes. This subsequently fostered mutual understanding between leadership and employees amid new programming or culture change as in the example described below with mock codes.

> "At the time, really working with the entire enterprise and just kept putting out there that this is what we're here to do. Here's why we're here and going to the point. At that time [the former Chair] had a lot of one-on-one meetings with the chairs of departments to say look, here's the pushback we're feeling; however, we're not here trying to step on your territory. We're here to help."

(Administrator in Anesthesia Department; Hospital A, Top-performing)

Debriefing was considered a priority for communication among all top-performing centers. However, debriefing often occurred in silos, divided between disciplines (e.g.,

nursing debriefing was done separately than physician debriefing). Participants agreed that interdisciplinary review would be beneficial, however few centers debriefed in such a way.

> "Then after the code is over the leader of the code has the responsibility with the [rapid response] nurse, then we go and review it. We say what we have learned from that. We implement it… and tell everybody. Then we have sessions with our hospitalists, nurses have them with their own team. Everybody will inform their team."
>
> (Hospitalist; Hospital C, Top-Performing)

Many centers, top- and lower-performing, also described challenges with debriefing after a code due to constraints of clinical responsibilities.

> "With the mock codes, we do the debriefing right as soon as it's done. We do it as quickly as we can… But I think it is hard to debrief after a [real] code especially when the patient survives because there are still so many things to do to keep going."
>
> (Nursing Mock Code Instructor; Hospital B, Top-performing)

Most hospitals did not establish a system where a designated person would lead the debriefs after each code. However, some rapid response nurses would initiate debriefing after a code ad hoc, although, this was not an institutional policy.

> "There isn't a point where we say, hey, let's all get together and kind of go over what happened. If there's a case where there seemed to be a lot of emotion or a lot of chaos or a lot of...things just didn't run as smoothly as they should of, then a lot of times the [rapid response] nurse will say, come on over and let's talk about this a little bit."
>
> (Respiratory Therapist; Hospital C, Top-performing)

Clear communication was also implemented across departments through code committee review or via administrators who reviewed and disseminated code data for their floors. Code committee reviews were often asynchronous, which created a barrier to providing rapid feedback about deficiencies even at top-performing hospitals.

> "If we find something in code committee and then have to bring it back to a pharmacist, typically, they don't remember about it because it was a month or two ago. So—and I wish we would do more immediate debriefing,"
>
> (Pharmacist; Hospital B, Top-performing)

Re-education and emphasis on continued iterative improvement through the use of clear messaging was a useful strategy utilized by some top-performing hospitals.

> "After those events are categorized by color: red, yellow, or green. Red being the most severe, meaning there is something different we need to do in our practice. Yellow is concerning, something we need to get out there to everybody just to be aware of the practice. And then green is kind of an FYI [applied to increase knowledge base or simple areas of concern].

> An example of a green would be that we had a patient develop torsades after a drug-loading event. We sent out articles to the nursing staff via email stating ‘in review of a recent event, we noticed the patient developed torsade; just so everyone is aware -- these are the medications that can cause those types of events.’”
>
> (Nurse Anesthetist; Hospital A, Top-performing)

4. Responsive Leadership

Cultural resistance to change while implementing mock code programs was ubiquitous across all centers. Top-performing hospitals, however, distinguished themselves in a tangible manner with supportive leadership who directly demonstrated commitment with floor staff, made real-time adjustments to the curriculum in response to feedback, and used these programs to identify flaws in the medical system and change practice.

Personal interaction and visibility by supervisors were both noted as opportunities to build trust with nurses, physicians and other floor staff.

> “Doing the physical rounding. A lot of people kind of might snuff it off, but you know what? I see your face every day. I see your face. You’ve called me for a case or questioned me on something. You build up a rapport and a comfort level [with staff]. You know, it’s a big culture change. I mean that’s probably the biggest thing if you want one take away, is you get everybody on campus or in your hospital on board with it. It’s a good thing.”
>
> (Rapid Response Nurse; Hospital A, Top-performing)

Conversely, employees from lower-performing hospitals perceived their educators to be limited in their visibility and presence for training due to managing multiple demands.

> “Our educators are strapped. They are spread so thin...We don’t get to see them enough... How are you supposed to do anything beyond just new orientation?”
>
> (Charge Nurse; Hospital I, Lower-Performing).

When resistance to participating in the mock code programs occurred, leadership at top-performing hospitals directly addressed the issue and provided perspective to hospital staff on the shared value of continued education and training for staff.

> “Anesthesia didn’t want to have anything to do with mock codes, we felt—and they said ‘why do we need to participate in a mock code because we intubate people all day long. I don’t have to manage an airway at a mock code; I don’t have to show you how good I am at that.’ And we went to them and said it’s not about you, it’s about the rest of the team functioning off you. So, if you are there and you need this or need that, the rest of the team can respond or the committee can help find what you need, make adjustments.”
>
> (Emergency Medicine Director; Hospital B, Top-performing)

Developing and implementing curriculum often involves continual review and adjustment by leadership. Top-performing hospitals were adaptive to the needs of their learners.

> "We sat down, we talked to the folks... Identified what their barriers were, what worked well, what didn't work well and [kept] in mind that it be a sustainable program. And of course, really focusing in on the objectives…what's the overall goal of the program. What are we looking for our learners to walk away with from this experience? If you don't have that…your ship is going to go all over the place."
>
> (ACLS Program Coordinator, Hospital G, Top-Performing)

In contrast, individuals from lower-performing hospitals commented on the difficulties of both identifying areas for improvement and implementing sustainable solutions.

> "I think backtracking to the actual procedure itself is where there's an opportunity to fix, and I don't know if that's been explored. Every time we try to have a conversation on the matter...it evaporates because everybody keeps going back to the protocols because it's their recipe box now. It's really come to that."
>
> (Training Center Manager; Hospital I, Lower-Performing)

Lower-performing hospitals generally lacked integration across disciplines within their mock code programs that might have been influenced by lack of leadership.

> "As far as I know they [physicians] have never participated. I don't know what they do as far as on their end with that, but as far as on the unit, they don't generally participate and as far as I know they never have."
>
> (Nurse Educator; Hospital F, Lower-performing)

In contrast, leadership at top-performing sites fostered multidisciplinary collaboration and emphasized the value of an integrated approach to resuscitation training.

> "It is an interdisciplinary group both for our facilitators but also for our participants. And that, we felt, was extremely important that it be interdisciplinary… Nurses, pharmacy, physicians, advanced practice providers and respiratory."
>
> (ACLS Program Coordinator; Hospital G, Top-performing)

DISCUSSION

Using qualitative data from a national study, we identified core themes related to resuscitation team training and education that distinguished top-performing hospitals which excelled in IHCA survival. Our investigation identified four themes: engagement, consistency, clear communication and responsive leadership. The hospitals include a diverse set of facilities both geographically and academically, and we noted that some experienced different barriers to these themes, whether financial, cultural or resource scarcity. Hospital leaders who understood and addressed these challenges appeared to create environments where IHCA education and training programs were able to better suit the needs of their staff and patient population.

In-hospital cardiac arrest is a dynamic event integrating multiple stages of care that is ideally suited for education and training programs. First, responders need to be able to rapidly and correctly identify, diagnose, resuscitate and re-assess the patient. Every minute delayed in delivering treatment is associated with a 10% decrease in survival.[10] Given this, adequate training of medical providers can make a difference in a life saved. Traditional approaches to education have included BLS and ACLS; however, research has shown continued variation in survival outcomes after IHCA.[2,3] Furthermore, education can be integrated in many platforms including mock code programs, information dissemination and feedback from code committee review. Understanding how higher performing hospitals integrate such approaches to enhance learning environments may provide novel perspective on how to improve IHCA survival. In this context, our findings provide useful insight for identifying how top-performing hospitals utilize and optimize their educational initiatives. These core themes, see Table 3, can be used as guidance for clinicians and hospital leadership when developing programs for training of any medical providers involved in IHCA resuscitation.

A striking characteristic noted among top-performing hospitals was their ability to engage employees through internal marketing and enhancing efficiency with mock code programs. For example, top-performing hospitals developed slogans such as “1–2-5 Strive to Revive,” reflecting one minute to compressions, two minutes to defibrillation and five minutes to epinephrine. Additionally, top-performing hospitals strategically placed posters to gain the attention of employees. Posters not only promoted educational programs, but were convenient in centralizing pertinent information to minimize didactics and enhance simulation time. Current guidelines recommend shorter, more frequent training for improved retention in areas related to technical skill such as CPR,[7] however we noted top-performing hospitals expanded this concept to deliver high-impact learning within their mock code sessions. One site limited their mock code session to twenty minutes and received feedback that employees felt their time was respected with the brief sessions. Efficiency with training is advantageous for both learners and hospitals, as it reduces the amount of time away from clinical duties while maintaining the appropriate balance of time needed for education.

Mock codes have continued to be a cornerstone of resuscitation training, however we found that not all training is equal. Studies have shown skill decay in providers within 3 to 6 months after the American Heart Association training classes.[11–13] We found top-performing sites increased the frequency of training, with one center performing simulations twice a month. Leadership from these hospitals viewed training as a continuation of clinical responsibilities, which was in stark contrast to lower-performing hospitals who scarcely incorporated training as a routine task. Top-performing centers also developed interdisciplinary and relevant curriculum, often reflecting real-world events, whereas lower-performing hospitals focused on rote memorization. Training on medical floors highlighted systemic flaws such as missing bag valve masks in patient care areas, which resulted in safer environments for patients as these structural gaps were promptly addressed. Given the diversity of hospitals included for study, some had logistical constraints limiting their access to vacant rooms. These hospitals adapted and utilized their simulation center or other non-patient care areas instead to maintain effectiveness.

Our findings noted that all facilities experienced a baseline level of resistance or hesitancy from staff with implementing mock code programs. Emphasis on clear communication and supportive leadership mitigated these tensions. Leaders at top-performing hospitals frequently rounded on floors and discussed with employees the value of training. Additionally, leaders made real-time adjustments to the training in response to feedback, which fostered an inclusive environment where staff felt supported. In lower-performing centers, employees felt their educators were overworked and unable to support them adequately, which led to dissatisfaction among staff. One distinct difference among top-performing centers was the celebration of clinical diversity with nursing, pharmacy, medicine and other clinicians in their leadership team.

Top-performing sites performed robust debriefing after codes, however, across most sites (top- and lower-performing) these events occurred asynchronously and were separated by discipline, limiting their effectiveness in addressing team dynamics. Barriers to performance of rapid debriefing included the need to return to clinical duties, post-arrest intensive care unit follow-up, and a lack of a standard process or designated facilitators to gather individuals to debrief. Regardless, interviewees frequently commented on a desire to have an integrated approach to debriefing.

Our study has limitations and should be interpreted within this context. First, our study is a qualitative analysis, taken from individual perceptions at a single point in time. Our intent was to understand the perspectives of individuals and it is possible our interviewees experienced social desirability response bias, in which their responses were misrepresenting of their programs to instead give our team desirable answers. However, with our team of nine reviewers, we found considerable agreement with responses and even a willingness to discuss faults or setbacks, specifically with top-performing hospitals. Risk standardized rates of survival were used to provide a global performance measure comparable across hospitals. However, we recognize this as a limitation given there are multiple quality metrics associated with resuscitation care for IHCA, which were not included in our study. Additionally, this is a secondary analysis of a qualitative data set whose original intent was to better understand how hospitals with high survival rates for IHCA design and utilize their resuscitation teams. The original HEROIC study identified training and education as a core aspect which distinguished top-performing from lower-performing hospitals. Our secondary analysis further evaluated the original data to better understand key differences related to training and education. However, given the nature of a secondary analysis, our data may not reflect all themes or ideas related to successful training and education within hospitals to improve IHCA outcomes. Further qualitative and quantitative evaluation related to training and education may offer additional insight or novel themes for how top-performing hospitals utilize training and education. Future work may benefit from evaluating education and training structures more formally and assessing their relationship with IHCA outcomes over time. This work could include quantitative studies as well as additional qualitative research to further define critical education and training components in greater detail.

CONCLUSIONS:

The organization and implementation efforts to educate and train medical providers involved in IHCA resuscitation differs substantially across hospitals with varying rates of IHCA survival outcomes. Among top-performing hospitals excelling in survival outcomes for in-hospital cardiac arrest, we identified four core themes related to resuscitation team training and education: engagement, consistency, clear communication, and responsive leadership. Focusing on interventions that are able to enhance these areas may improve IHCA outcomes by leading to better education and training in resuscitation care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Non-standard Abbreviations and Acronyms

IHCA	In-Hospital Cardiac Arrest
CPR	Cardiopulmonary Resuscitation
BLS	Basic Life Support
ACLS	Advanced Cardiopulmonary Life Support
HEROIC	Hospital Enhancement of Resuscitation Outcomes for In-Hospital Cardiac Arrest
AHA	American Heart Association

References

1. Holmberg Mathias J., Ross Catherine E., Fitzmaurice Garrett M., Chan Paul S., Duval-Arnould Jordan, Grossestreuer Anne V., Yankama Tuyen, Donnino Michael W., Andersen Lars W., The American Heart Association's Get With The Guidelines- Resuscitation Investigators, et al. Annual Incidence of Adult and Pediatric In-Hospital Cardiac Arrest in the United States. Circ Cardiovasc Qual Outcomes. 2019;12:e005580. [PubMed: 31545574]
2. Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-Hospital Cardiac Arrest: A Review. JAMA. 2019;321:1200–1210. [PubMed: 30912843]
3. Merchant RM, Berg RA, Yang L, Becker LB, Groeneveld PW, Chan PS, The American Heart Association's Get With the Guidelines-Resuscitation Investigators. Hospital Variation in Survival After In-hospital Cardiac Arrest. J Am Heart Assoc. 2014;3:e000400. [PubMed: 24487717]
4. Mitchell OJL, Yuriditsky E, Johnson NJ, Doran O, Buckler DG, Neefe S, Seethala RR, Motov S, Moskowitz A, Lee J, et al. In-hospital cardiac arrest in patients with coronavirus 2019. Resuscitation. 2021;160:72–78. [PubMed: 33515638]
5. Qvick A, Radif M, Brever C, Myrvik JO, Schenk Gustafsson K, Djärv T. Survival of in-hospital cardiac arrest in men and women in a large Swedish cohort. Scand J Trauma Resusc Emerg Med. 2018;26:108. [PubMed: 30567581]

6. Chan PS, Krumholz HM, Graham N, Nallamothu BK. Delayed Time to Defibrillation after In-Hospital Cardiac Arrest. N Engl J Med. 2008;358:9–17. [PubMed: 18172170]

7. Merchant RM, Topjian AA, Panchal AR, Cheng A, Aziz K, Berg KM, Lavonas EJ, Magid DJ, On behalf of the Adult Basic and Advanced Life Support, Pediatric Basic and Advanced Life Support, Neonatal Life Support, Resuscitation Education Science, and Systems of Care Writing Groups. Part 1: Executive Summary: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142:S337–S357. [PubMed: 33081530]

8. Nallamothu BK, Guetterman TC, Harrod M, Kellenberg JE, Lehrich JL, Kronick SL, Krein SL, Iwashyna TJ, Saint S, Chan PS. How Do Resuscitation Teams at Top-Performing Hospitals for In-Hospital Cardiac Arrest Succeed?: A Qualitative Study. Circulation. 2018;138:154–163. [PubMed: 29986959]

9. Guetterman TC, Kellenberg JE, Krein SL, Harrod M, Lehrich JL, Iwashyna TJ, Kronick SL, Girotra S, Chan PS, Nallamothu BK. Nursing roles for in-hospital cardiac arrest response: higher versus lower performing hospitals. BMJ Qual Saf. 2019;28:916–924.

10. Ali B, Zafari AM. Narrative review: cardiopulmonary resuscitation and emergency cardiovascular care: review of the current guidelines. Ann Intern Med. 2007;147:171–179. [PubMed: 17679705]

11. Hamilton R Nurses' knowledge and skill retention following cardiopulmonary resuscitation training: a review of the literature. J Adv Nurs. 2005;51:288–297. [PubMed: 16033596]

12. Mancini ME, Kaye W. The effect of time since training on house officers' retention of cardiopulmonary resuscitation skills. Am J Emerg Med. 1985;3:31–32.

13. Smith KK, Gilcreast D, Pierce K. Evaluation of staff's retention of ACLS and BLS skills. Resuscitation. 2008;78:59–65. [PubMed: 18406037]

Clinical Perspective

What Is Known?

- In-hospital cardiac arrest (IHCA) is common and outcomes are variable across U.S. hospitals, despite universal training with ACLS and BLS for hospitals.
- Prior research has noted training and education to be a priority for top performing hospitals with higher survival outcomes.

What The Study Adds?

- Our findings identified core themes related to training and education of resuscitation teams identified in top-performing hospitals with higher survival rates.
- While future work is needed to evaluate education and training in defining optimal education for medical providers, our results focus on interventions that are tangible and actionable for hospitals to pursue, which may lead to improved IHCA outcomes.

Table 1.

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	West	200 to 400	12.9	25.3	Non-Teaching
C	South	>400 to 800	97.3	93.3	Non-Teaching
D	Midwest	200 to 400	87.7	57.0	Major
E	West	200 to 400	56.1	68.7	Minor
F	South	>800	2.9	130.7	Minor
G	Midwest	200 to 400	81.7	73.3	Minor
H	Northeast	>800	88.7	140.7	Major
I	Northeast	>400 to 800	5.4	129.3	Minor

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

As previously reported.[8]

Table 2.

Type of Staff Interviewed at Study Hospitals

Type of Staff	**Interviews, *n***
Critical Care and Emergency Medicine Physician	9
Anesthesiologist	3
Hospitalist and other	9
Resident Physician	6
Nurse Manager	11
Nurse Practitioner/Clinical Nurse Specialist/CRNA	4
Nurse Educator	12
Nurse Code Team Member or ED/Critical Care Nurse	35
Emergency Department/Intensive Care Unit/Coronary Care Unit Director/Supervisor	10
Pharmacy	8
RT Code Team Member	9
Other (Lab Team Member, EKG, Biomedical Services, Chaplain, Security)	10
Senior Leadership (President, Vice-President, Chief Medical and Nursing Officers	9
Director of Service Lines (e.g., Critical Care, Emergency Medicine, Anesthesia, Cardiac Catheterization Laboratory, Pharmacy)	9
Quality and Data Management Team	9
Other (Department Administrator, ACLS Trainer)	5
Total	158

CRNA: Certified Registered Nurse Anesthetists, ED: Emergency Department, ACLS – Advanced Cardiopulmonary Life Support

As previously reported.[8]

Table 3.

Core Themes Identified in Top-Performing Hospitals.

Theme	Characteristics
Engagement	Top-performing hospitals marketed their programs to increase awareness, used posters for visibility, prioritized efficiency while creating relevant immersive curriculum.
Consistency	Top-performing hospitals maintained frequent mock code sessions on regular intervals and standardize training of both instructors and learners.
Clear Communication	Top-performing hospitals emphasized the value and importance of resuscitation training as a continuation of job responsibilities, which improved culture change. Top-performing hospitals held prompt code committee review or leadership review, with quick turnaround in providing feedback to employees involved in real codes.
Responsive Leadership	Leaders physically rounded with employees to elicit feedback which was then promptly addressed. Small interactions such as these built substantial trust with nurses, physicians and other healthcare workers. Top-performing hospitals celebrated clinical diversity and integrated nurses, physicians, respiratory therapists and pharmacists on leadership teams.

IHCA = In-Hospital Cardiac Arrest