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Training and education

Can hospital adult code-teams and individual members perform high-quality CPR? A multicenter simulation-based study incorporating an educational intervention with CPR feedback

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Abstract

Aims: A multicenter simulation-based research study to assess the ability of interprofessional code-teams and individual members to perform high-quality CPR (HQ-CPR) at baseline and following an educational intervention with a CPR feedback device.

Methods: Five centers recruited ten interprofessional teams of AHA-certified adult code-team members with a goal of 200 participants. Baseline testing of chest compression (CC) quality was measured for all individuals. Teams participated in a baseline simulated cardiac arrest (SCA) where CC quality, chest compression fraction (CCF), and peri-shock pauses were recorded. Teams participated in a standardized HQ-CPR and abbreviated TeamSTEPPS® didactic, then engaged in deliberate practice with a CPR feedback device. Individuals were assessed to determine if they could achieve $\geq$80% combined rate and depth within 2020 AHA guidelines. Teams completed a second SCA and CPR metrics were recorded. Feedback was disabled for assessments except at one site where real-time CPR feedback was the institutional standard. Linear regression models were used to test for site effect and paired *t*-tests to evaluate significant score changes. Logistic univariate regression models were used to explore characteristics associated with the individual achieving competency.

Results: Data from 184 individuals and 45 teams were analyzed. Baseline HQ-CPR mean score across all sites was 18.5% for individuals and 13.8% for teams. Post-intervention HQ-CPR mean score was 59.8% for individuals and 37.0% for teams. There was a statistically significant improvement in HQ-CPR mean scores of 41.3% (36.1, 46.5) for individuals and 23.2% (17.1, 29.3) for teams ($p<0.0001$). CCF increased at 3 out of 5 sites and there was a mean 5-s reduction in peri-shock pauses ($p<0.0001$). Characteristics with a statistically significant association were height ($p=0.01$) and number of times performed CPR ($p=0.01$).

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Conclusion: Code-teams and individuals struggle to perform HQ-CPR but show improvement after deliberate practice with feedback as part of an educational intervention. Only one site that incorporated real-time CPR feedback devices routinely achieved ≥80% HQ-CPR.
Keywords: High-quality CPR, Basic life support, CPR feedback device, Simulation, In-hospital cardiac arrest, Deliberate practice, Inter-professional team training

Introduction

There are an estimated 290,000 in-hospital cardiac arrests (IHCA) that occur each year within the United States[1] and the survival rate is only 1 out of 4.[1,2] Studies demonstrate that resuscitation errors lead to a reduction of return of spontaneous circulation (ROSC) and thereby lower overall survival.[3] The correlation between survival and high-quality CPR (HQ-CPR) has been well documented.[4–7] CPR performance varies among hospital healthcare providers and observational data indicates that it continues to be suboptimal.[4,8]

The American Heart Association (AHA) guidelines emphasize the importance of 5 HQ-CPR recommendations in both 2015[9] and most recently in 2020[10]: (1) chest compression (CC) rate of 100–120 bpm; (2) CC depth of 5–6 cm; (3) chest compression fraction >60% (CCF, percentage of time performing CCs during the resuscitation); (4) allow for full chest recoil; and (5) Avoid over ventilation. Also recommended is frequent compressor changes to avoid physical fatigue of providers, which has been shown to impact HQ-CPR performance.[6,11]

CCF is a critical and modifiable metric of HQ-CPR and research has shown an increase in odds ratio of ROSC with increasing CCF.[12] Research has also found CCF to be an independent predictor of better survival to hospital discharge.[5] Prolonged and disorganized pauses in CCs for pulse-checks, endotracheal intubation attempts, vascular access, and defibrillation can worsen CCF and survival.

The duration of the peri-shock pause surrounding defibrillation (i.e. total time before and after defibrillation without compressions) inversely correlates with ROSC[13] and survival.[14–16] One strategy to minimize this pause is to begin charging the defibrillator during CCs, ensuring immediate delivery of a shock if indicated, and resuming CCs directly following the shock for a peri-shock pause goal of <10 s.[17] One study demonstrates this technique is safe without increased incidence of inadvertent shocks.[18] Research shows that a 5-s increase in pre-shock pauses correlates with a 14% decrease in survival to hospital discharge.[15]

Studies have demonstrated that use of an audiovisual CPR feedback device during training is an effective method to reinforce skills.[19–21] Furthermore, the concept of deliberate practice, described by Ericsson,[22] yields significant improvements. Deliberate practice with a CPR feedback device may increase CPR proficiency. On a broader level, simulation-based medical education (SBME) with deliberate practice has better learning outcomes than traditional education.[23]

To address this complex issue of technical proficiency, resuscitation team-dynamics, communication and leadership skills for IHCA, we developed an educational intervention designed to supplement routine CPR training for hospital adult code-teams at 5 member institutions of the New England Simulation, Education, and Research Consortium (NESERC). The educational intervention focused on the importance of HQ-CPR with simulation debriefing, didactics, and deliberate practice. Furthermore, the intervention includes abbreviated TeamSTEPPS®[24] training, which is an evidence-based team training course aimed at improving communication.

This study includes an initial assessment phase, an educational intervention and then a final assessment phase. We assessed HQ-CPR separately in both individuals and interprofessional teams of 4 during simulated cardiac arrests (SCAs).

We hypothesized that CPR quality would be low at baseline for both individuals and teams, even with experienced AHA certified providers. We further hypothesized that we could demonstrate improvement in all metrics with the intervention.

Methods

We obtained IRB approval at each site and written informed consent from all participants. This study received funding from an investigator-initiated research grant from ZOLL Medical Corp. including use of the ZOLL R-Series monitor/defibrillators.

Study participants

Each of the 5 study sites sought to recruit ten interprofessional teams of four individuals, with at least one physician, who would typically act as code leader within the hospital. Participants were required to be either BLS or ACLS certified and members of hospital code-teams or expected to provide CPR in their immediate work area.

Interventions

Participants completed a survey on demographic characteristics. Individuals then performed a 2-min round of CPR on a standardized adult manikin and the quality of CCs was recorded. Site-5 had already incorporated audiovisual CPR feedback devices into their clinical environment before starting the study and was the only site that had real-time feedback throughout all testing, including for pre- and post-intervention, as it was their institutional standard. The feedback device used accelerometer technology built into the defibrillator pads with visual feedback shown on the monitor/defibrillator in real-time (calculated rate, depth, chest recoil), as well as auditory feedback with a metronome and verbal prompts (ZOLL Medical Corp., Chelmsford, MA, USA) (see supplemental material, Appendix A).

After gathering the initial individual baseline CC data, teams of 4 participated in a 12-min simulated cardiac arrest (SCA) using a high-fidelity manikin in a standardized simulated clinical environment, during which quality of CCs, CCF, and peri-shock pauses were recorded. We created two scenarios of identical length: each began in a non-shockable state, followed by either V-Tach or V-Fib. We randomized to which order they were presented. Teams responded to a SCA of an intubated patient in the ICU, attached to a monitor and defibrillator, with a nurse actor present to provide scripted patient background. We chose this format to limit influence of other variables such as delays for intubation (see supplemental material, Appendix B). Teams then went through a structured debrief, including

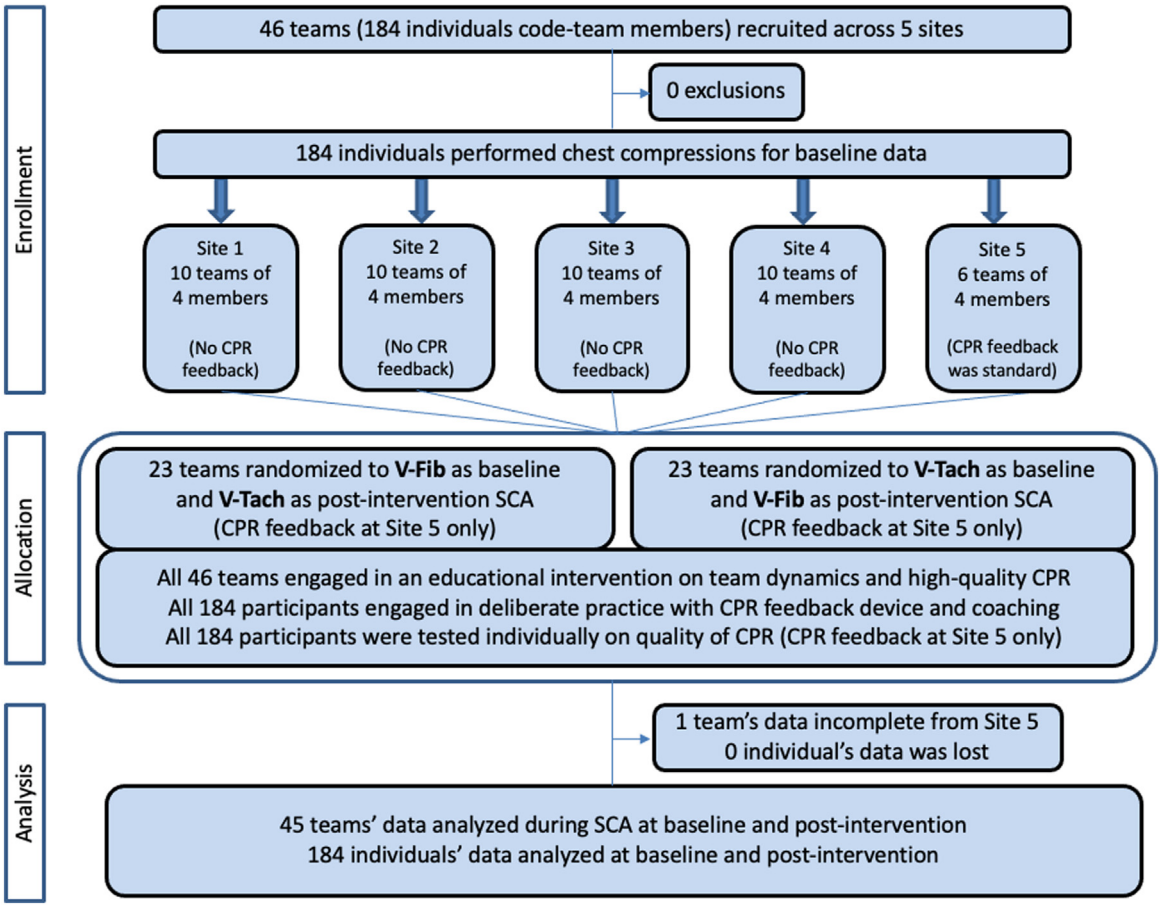

Fig. 1 – Participant enrollment and study flow.

reviewing the teams CPR performance. Following the debrief, there was a standardized didactic emphasizing the rationale and importance of HQ-CPR and an abbreviated TeamSTEPPS® introduction with strategies to improve leadership and communication during IHCA.

After the didactics, individuals engaged in deliberate practice with audiovisual CPR feedback devices and coaching. Each individual was allowed to practice for as long as they desired but needed to achieve 30-s of continuous HQ-CPR. Following deliberate practice, participants took a 2-min timed assessment on a manikin to determine if they could achieve a score of ≥80% combined rate and depth within AHA target ranges. Our study allowed each individual up to three attempts to achieve ≥80% HQ-CPR, with the highest score recorded. Individuals reviewed a visual graph of their 2-min effort between unsuccessful attempts to see how they could improve. They were encouraged to return to the feedback device and continue deliberate practice with coaching. Once again, CPR feedback was only provided if this was their institutional standard (site-5).

We set ≥80% combined CC rate and depth within AHA guideline targets as a goal, based on previous simulation-based resuscitation research[25] and consensus opinion amongst the research team as clinically meaningful. After individual testing, we reassessed teams with a second 12-min SCA. Teams then participated in a structured debrief, reviewed their team HQ-CPR data pre- and post-training and completed a course evaluation (see study flow in supplemental materials, Appendix A).

Outcome measures

CPR quality data were recorded on a monitor/defibrillator device and data were reviewed using RescueNet Code Review software (ZOLL Medical Corp.). Study data were collected and managed using REDCap (Research Electronic Data Capture) and hosted by Tufts CTSI (grant number UL1TR002544).

Primary outcome measures included the following: per cent change in HQ-CPR for individuals and teams; and change in CCF and peri-shock pauses for teams. For individual post-intervention 2-min CPR tests, participants had up to 3 attempts to achieve ≥80%. If they failed, their highest score was used.

Secondary outcome measures included any association of participant characteristics and success in achieving ≥80% HQ-CPR.

Sample size considerations

We sought to recruit ten teams per site, for a total of 50 teams and 200 participants to allow detection of an effect size of 0.40, using a paired *t*-test for change in CPR quality as the primary outcome. These calculations assume 80% power, $\alpha = 0.05$, and two-tailed testing.

We randomized the order of the simulations pre- and post-intervention separately for each site using PROC PLAN in SAS using varying block sizes of 2 or 4.

Statistical analysis

We utilized linear regression models to test whether there was a site effect for the primary and secondary endpoints. If no site effect was found, then a paired t-test was used to evaluate whether the change scores were significantly different from zero. Otherwise, we ran mixed models, with site as a random effect, baseline value as an independent variable, and post-intervention value as the outcome to assess whether there was a significant change after the intervention. Regression diagnostics, including residuals, were examined.

Logistic univariate regression models were used to explore whether various demographic characteristics, CPR experience and CPR confidence, chosen a priori, were associated with the individual achieving competency. The assumption of linearity for continuous variables was checked. Potential influential points were checked using deviance residuals and DFBetas.

$p<0.05$ was considered statistically significant. We performed all analyses with SAS Enterprise 7.15 (Cary, NC, USA).

Results

All but one site met their recruitment goal of ten teams. Site-5 recruited six teams, and five teams had complete data; however, we recorded data for all 24 individuals. In total, we analyzed for 184 individuals and 45 teams (Fig. 1).

Demographic characteristics of participants are shown in Table 1. Table 2 presents the results for individual performance (2-min uninterrupted CC testing) and team performance (12-min SCA) for mean HQ-CPR, rate and depth at baseline and after the intervention. Team performance also includes CCF and peri-shock pause. Fig. 2 presents these results graphically with data combined across all sites for individuals and teams. Fig. 3 shows results for individuals at each of the 5 sites (see supplemental materials Fig. S1 for team results at each of the 5 sites).

Individual participant baseline HQ-CPR mean scores [95% CI] across all sites was poor at 18.5% (14.3, 22.7). The lowest baseline HQ-CPR mean was 10.3% (3.2, 17.3) at Site-2. The highest mean score of 60.4% (50.2, 75.6) was at Site-5, the only site to use audiovisual feedback during testing. Post-intervention HQ-CPR mean scores across all sites was 59.8% (55.2, 64.4) indicating significant improvement, although it did not reach our study goal of ≥80%. Only Site-5 (with feedback) reached the 80% threshold, with a post-intervention HQ-CPR mean of 86.7% (82.4, 91.0).

Individual HQ-CPR improved across all sites after our intervention, with a statistically significant ($p<0.0001$) mean improvement of 41.3% (36.1, 46.5) with a range from 26.3% (16.4, 36.2) at Site-5 to 52.2% (39.1, 65.1) at Site-4, although we did not find a significant difference between sites (site effect $p=0.054$). Individual CC rate and depth scores at baseline and post-intervention are also included in Table 2, showing statistically significant improvements ($p<0.0001$).

Team scores showed statistically significant (<0.0001) improvement in guideline compliant CC from baseline to post-intervention (see Table 2 and Fig. 2). Teams showed lower baseline HQ-CPR mean scores than individuals at 13.8% (7.6, 19.9). Post-intervention HQ-CPR mean scores improved significantly and ranged from 18.6% (6.9, 30.3) at Site-2 to 74.2% (55.9, 92.5) at Site-5. The overall mean improvement post-intervention was 23.2% (17.1, 29.3) for HQ-CPR, 44.9% (35.9, 53.9) for CC rate, and 14.2% (7.6, 20.8) for CC depth. No significant site effects were found for improvement in HQ-CPR, rate, or depth ($p<0.05$).

The baseline means for CCF were already above guideline recommendation of 60% for Sites 1–4. Site-5 had baseline CCF of 54.4% (38.5, 70.3). There was a significant site effect ($p=0.03$) with three sites demonstrating improvement. Only Site-3 showed a statistically significant improvement for CCF of 8.6% (1.6, 15.6) from a baseline of 84.2% to post-intervention of 92.8% ($p=0.02$).

We found a mean baseline peri-shock pause of 13.1 s (guideline recommendations of less <10 s). There was a statistically significant ($p<0.0001$) reduction in peri-shock pause of 5.0 s (−7.3, −2.8) for a post-intervention mean of 8.1 s. Mean improvement ranged from 3.8 to 7.2 s, and there was no significant site effect ($p=0.63$).

We evaluated the association between individual characteristics and individual success of obtaining a score of ≥80% HQ-CPR post-intervention (see Table 3). The assumption of linearity for continuous variables was met and no potential influential points were identified.

Table 1 – Participant demographics across all sites.

Sex, *n* (%)	
Female	113 (61.4)
Male	71 (38.6)
Age (years) (mean (SD))	33.1 (10.0)
Height (inches) (mean (SD))	66.9 (4.0)
Years on code-team (mean (SD))	4.8 (7.8)
Role on code-team, *n* (%)	
MD	76 (41.3)
RN	50 (27.2)
CCT (tech)	32 (17.4)
RT	9 (4.9)
Other	17 (9.2)
Previous training with feedback device, *n* (%)	
Yes	102 (55.7)
No	81 (44.3)
Does your institution have CPR feedback during codes?	
Yes	28 (15.3)
No	155 (84.7)
Last ACLS/BLS Course taken, *n* (%)	
Less than 3 months	25 (13.6)
3–6 months	36 (19.6)
7–12 months	83 (45.1)
Greater than 12 months	40 (21.7)
Confidence in your ability to do chest compressions, *n* (%)	
Extremely confident	17 (9.2)
Very confident	62 (33.7)
Confident	80 (43.5)
Somewhat unconfident	23 (12.5)
Not confident	2 (1.1)
Number of times performed CPR on patients, *n* (%)	
Never	34 (18.5)
1–5	64 (34.8)
6–10	26 (14.1)
11–15	19 (10.3)
>15	41 (22.3)
Last time CPR performed on a patient, *n* (%)	
Never	34 (18.5)
Less than 1 month	38 (20.7)
1–6 months	52 (28.3)
7–12 months	25 (13.6)
Greater than 12 months	35 (19.0)

Table 2 – Individual and team mean CPR scores combined across all sites.

	n	Baseline Mean (95% CI)	Post training Mean (95% CI)	Change Mean (95% CI)	*p*-value for change
Individuals					
HQ-CPR	184	18.5 (14.3, 22.7)	59.8 (55.2, 64.4)	41.3 (36.1, 46.5)	<0.0001
Rate	184	37.3 (31.5, 43.1)	82.7 (79.1, 86.4)	45.4 (39.1, 51.7)	<0.0001
Depth	184	37.4 (32.9, 42.0)	69.0 (64.7, 73.2)	31.6 (26.7, 36.4)	<0.0001
Teams					
HQ-CPR	45	13.8 (7.6, 19.9)	37.0 (30.1, 43.9)	23.2 (17.1, 29.3)	<0.0001
Rate	45	26.9 (18.0, 35.7)	71.8 (64.3, 79.2)	44.9 (35.9, 53.9)	<0.0001
Depth	45	33.5 (25.7, 41.3)	47.7 (40.6, 54.8)	14.2 (7.6, 20.8)	<0.0001
CCF	45	73.8 (66.6, 81.1)	80.5 (73.9, 87.1)	6.6 (1.7, 11.6)	0.0091
Peri-Shock Pause (s)	45	13.1 (10.1, 16.2)	8.1 (6.2, 10.1)	−5.0 (-7.2, -2.8)	<0.0001

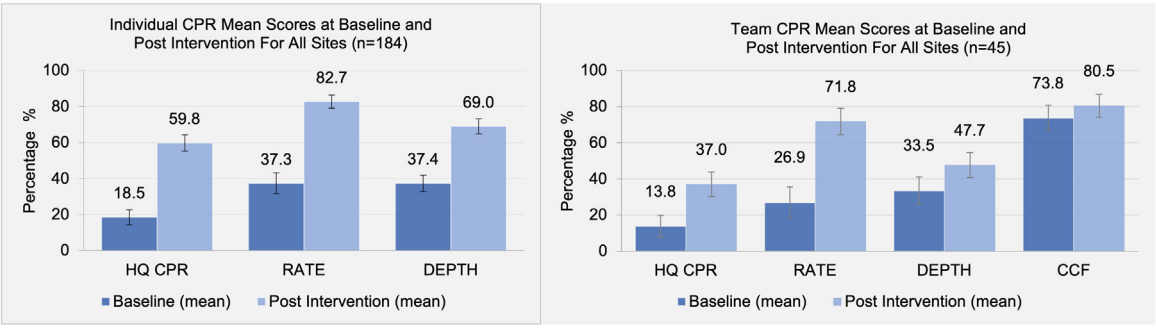

Fig. 2 – Individual and team mean CPR scores combined across all sites.

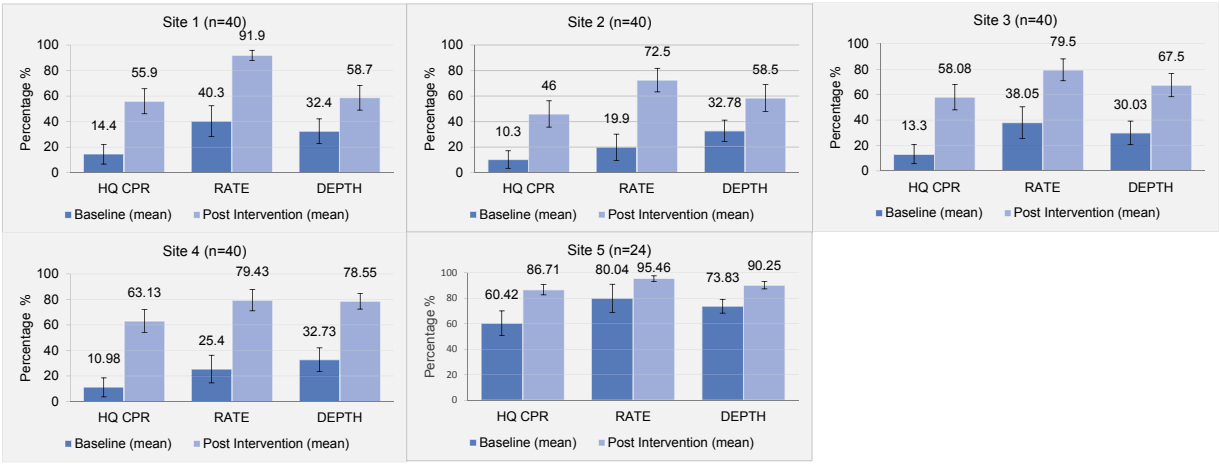

Fig. 3 – Individual mean CPR scores by site.

Variables that showed a statistically significant association were height ($p=0.01$) and number of times performed CPR ($p=0.01$). There was no statistically significant association with sex, age, role on team, confidence level, prior use of feedback device, or last BLS/ACLS certification.

Discussion

Results showed individuals had a very low baseline mean HQ-CPR score of 18.5% in a 2-min best effort performance despite being experienced adult code-team members, self-rating as confident to extremely confident in HQ-CPR abilities (86.4%) and having received recent AHA certification. Other studies have shown similar poor HQ-CPR scores,[4,8,19] even with experienced providers such as CPR instructors.[25] We found individuals were equally challenged in obtaining the narrow target window of both CC rate (37.4%) and depth (37.3%). Other studies show that participants have had more challenges obtaining optimal CC depth than rate.[19,26]

Baseline team scores were similarly low. Teams, like individuals, were challenged in achieving targets for both rate and depth. Baseline individual and team HQ-CPR data for Site-5 exceeded all other sites but had the advantage of real-time CPR feedback throughout.

Training with deliberate practice on a feedback device with coaching and didactics lead to statistically significant improvements in scores for HQ-CPR, rate and depth, across all 5 sites for both

Table 3 – Univariate regression analysis for participant characteristics in predicting HQ-CPR ≥80%.

Variable	Category	# of people	% achieved HQ CPR	Odds ratio (95% confidence interval)	*p*-value
Age (years)		184	38.6	0.99 (0.96, 1.02)	0.36
Height (in.)		184	38.6	1.11 (1.02, 1.19)	0.01
Sex					0.08
	Male	71	46.5	1.71 (0.93, 3.15)	
	Female	113	33.6	Reference	
Role on team					0.70
	MD/DO	76	35.5	Reference	
	RN	50	36.0	1.02 (0.48, 2.15)	
	RT/other	26	46.2	1.56 (0.63, 3.84)	
	Tech	32	43.8	1.41 (0.61, 3.28)	
Confidence					0.85
	Extremely confident	17	41.2	1.49 (0.41, 5.35)	
	Very confident	62	37.1	1.25 (0.47, 3.36)	
	Confident	80	41.3	1.49 (0.58, 3.86)	
	Some unconfident/no confidence	25	32.0	Reference	
Times performed CPR					0.01
	≤5	98	33.7	Reference	
	6–10	26	65.4	3.72 (1.50, 9.24)	0.005
	>10	60	35.0	1.06 (0.54, 2.09)	0.86
Ever used feedback device					0.22
	No	81	33.3	Reference	
	Yes	102	42.2	1.46 (0.80, 2.67)	
Last certification					0.17
	<3 months	25	36.0	1.48 (0.51, 4.33)	
	3–6 months	36	52.8	2.95 (1.13, 7.65)	
	6–12 months	83	38.6	1.65 (0.73, 3.77)	
	>12 month	40	27.5	Reference	

individuals and teams. We found that Site-5 (which uses feedback devices routinely) demonstrated both the highest individual scores, with almost 87% HQ-CPR (rate of 95% and depth of 90%) and team scores with 74% HQ-CPR (rate of 92% and depth of 79%). Although we did not design this study to compare the use of feedback versus no-feedback, these findings support previous studies showing that feedback improves the quality of CPR.[19,20,27] Sites 1–4, without feedback, made greater improvements for individuals and teams than Site-5 (Fig. 3 and supplemental material Fig. S1).

We selected an HQ-CPR of ≥80% for individuals to achieve during post-intervention testing. Other studies have used the 80% target,[25] but its clinical significance is unclear and future research would be useful. Despite deliberate practice with a feedback device, most participants could not reach this threshold without real-time feedback. Only 38.6% of participants across all sites achieved HQ-CPR ≥80%. Site-5 was the only site to reach this goal, scoring 86.7%, suggesting hospitals driven to ensure HQ-CPR is optimized should consider real-time audiovisual feedback for IHCA. Its role in patient outcomes is mixed but a recent study by Goharani et al.[28] which was a randomized controlled trial of 900 patients, showed a 25.6% improvement to hospital discharge with an analogue "clicker" feedback device. In the recent 2020 AHA guidelines, the use of a feedback device was recommended for IHCA, as long as it is part of a comprehensive quality assurance and training program.[10]

This study did not measure participant fatigue performing chest compression, which has been previously investigated.[11,29,30] We suspect fatigue became a factor as many participants could not complete all three attempts to score ≥80% after deliberate practice. Because of our concern for fatigue as a confounder, we ultimately accepted the best of two attempts based on participants' preference.

We found mixed CCF results across all sites, with three sites showing an improvement and two sites actually showing a slight decrease. The overall CCFs were quite high with an average baseline of 73.8% and post-intervention of 80.5%. We feel the design of the scenarios played a role in these high numbers. Scenarios began with the patient intubated and the facilitator announcing that the patient was unresponsive and pulseless. This appears to have promoted a high CCF but would not have impacted rate or depth.

The mean peri-shock pause time for all sites combined at baseline was 13.1 s. Post-intervention, the mean peri-shock pause was 8.1 s. This was likely related to teaching participants to consistently charge the defibrillator during compressions to avoid delays during the pause. We found a mean decrease across all sites of 5.0 s ($p<0.0001$), which has been shown in previous research to correlate with a 14% increase in survival to hospital discharge.[15]

We analyzed characteristics associated with individuals' ability to achieve ≥80% HQ-CPR during post-intervention testing. Only height and times performed CPR was statistically significant, reflecting both depth and rate. Cheng et al., found among taller pediatric providers an improvement in depth but no statistical difference in rate.[32] Prior studies show the use of a step stool for compressors improves compression depth.[31,32] In our study a step stool was used nearly universally. There was a trend towards sex ($p=0.08$), but this did not reach statistical significance, and height could be a confounder. Leary et al. (2017)[33] found both age and sex to be associated with shallower depth in layperson CPR, although others have found that sex differences disappear when BMI and fitness are controlled for.[30]

Our multisite prospective study attempted to enroll 40 individuals making 10 teams at each of the five sites. We were only successful in recruiting 24 participants (6 teams) at one site. This demonstrates the challenges of recruiting working interprofessional healthcare providers. Another limitation was the lack of a control group, which was outside the scope of our resources. Our study did not address the retention of knowledge and skills, and multiple studies demonstrate their degradation over time.[34–36]

We allowed participants a period of deliberate practice before testing. We did not consistently record how long each person practised, although we instructed coaches to assist participants to achieve "30 s of perfect CPR" during deliberate practice. It would be useful to know if limited deliberate practice is associated with poor performance or if extended practice results in fatigue and decreased performance. We also did not standardize rest periods between testing and that could also have an impact on fatigue.

Finally, this was a simulation-based study and improved CPR on a manikin may not necessarily translate into improved patient outcomes. Other studies have used a bundle approach with simulation to show an improvement in CPR quality in the clinical environment.[37]

Conclusion

This study demonstrated that adult code-team members across five hospitals had a low baseline HQ-CPR success rate. It also showed a significant improvement in individual and team HQ-CPR in a simulated environment after deliberate practice with a CPR feedback device and an educational intervention including teamwork training. Achieving HQ-CPR scores $\geq$80% for even 2 min was difficult and occurred in less than 40% of the participants post-intervention. One could consider this a negative study if the objective was to achieve $\geq$80% HQ-CPR in a code situation. Only participants who were allowed to use a feedback device in real-time achieved scores $\geq$80%, suggesting broader usage during actual IHCA may be the only reliable way to achieve such performance. Additional research is also needed regarding retention of knowledge and skills in addition to considering that there may be a cohort of adult code-team members not capable of performing HQ-CPR and hospitals may need to consider delegating the role of chest compressions to providers who have proven high-performance abilities.

Authors' contribution

Jesse Rideout: conceptualization, funding acquisition, methodology, investigation, supervision, writing-original draft preparation, writing-reviewing and editing. Frank Overly: conceptualization, funding acquisition, methodology, investigation, writing-original draft preparation, writing-reviewing and editing. Edwin Ozawa, Darlene Bourgeois and Micheline Chipman: investigation, writing-reviewing and editing.

Conflict of interest

Funding for this study was supported by ZOLL Medical Corp. through an investigator-initiated and sponsored research grant and temporary use of monitor/defibrillators with feedback. They were not involved in the study design, data collection, analysis or interpretation of study data.

Ethical statement

The principal investigator (J.M. Rideout) had full access to all of the data in this study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resplu.2021.100126.

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