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Simulation and education

Impact of an untrained CPR Coach in simulated pediatric cardiopulmonary arrest: A pilot study

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Abstract

Aim: To determine if an untrained cardiopulmonary resuscitation (CPR) Coach, with no access to real-time CPR feedback technology, improves CPR quality.

Methods: This was a prospective randomized pilot study at a tertiary care children's hospital that aimed to integrate an untrained CPR Coach into resuscitation teams during simulated pediatric cardiac arrest. Simulation events were randomized to two arms: control (no CPR Coach) or intervention (CPR Coach). Simulations were run by pediatric intensive care unit (PICU) providers and video recorded. Scenarios focused on full cardiopulmonary arrest; neither team had access to real-time CPR feedback technology. The primary outcome was CPR quality. Secondary outcomes included workload assessments of the team leader and CPR Coach using the NASA Task Load Index and perceptions of CPR quality.

Results: Thirteen simulations were performed; 5 were randomized to include a CPR Coach. There was a significantly shorter duration to backboard placement in the intervention group (median 20 s [IQR 0–27 s] vs. 52 s [IQR 38–65 s], $p=0.02$). There was no self-reported change in the team leader's workload between scenarios using a CPR Coach compared to those without a CPR Coach. There were no significant changes in subjective CPR quality measures.

Conclusions: In this pilot study, inclusion of an untrained CPR Coach during simulated CPR shortened time to backboard placement but did not improve most metrics of CPR quality or significantly affect team leader workload. More research is needed to better assess the value of a CPR Coach and its potential impact in real-world resuscitation.

Keywords: Resuscitation, Simulation, CPR Coach, Workload, Pediatric

Introduction

In-hospital cardiac arrest occurs in approximately 6000 infants and children annually and results in significant morbidity and mortality.[1,2] Adherence to high-quality cardiopulmonary resuscitation (CPR) standards may improve patient survival and neurologic outcomes.[3] However, the consistent implementation of high-quality CPR remains a challenge.[4] In an effort to improve high-quality CPR delivery, the field of resuscitative science has explored various innovative strategies during resuscitation events, including the use of a debriefing program, CPR Coaching, and CPR feedback technology.[5,6] Hunt et al. demonstrated improved compliance to American Heart Association (AHA) CPR guidelines with the use of a debriefing program and a trained CPR Coach as part of a resuscitation quality bundle.[5] Similarly, Cheng et al. conducted a multicenter, prospective,

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randomized control trial, demonstrating improved CPR quality metrics with the simultaneous use of trained CPR Coaches and CPR feedback technology.[6]

By reassigning the responsibility of ensuring high-quality CPR to a CPR Coach, it is plausible that the code team leader may have increased mental capacity to focus on the rest of the resuscitation. Recent data has shown that a CPR Coach may decrease mental workload of CPR providers but does not impact the mental workload of the code team leader.[7] There continues to be a paucity of data regarding the impact of a CPR Coach alone on CPR quality and workload for the code team leader, particularly in the absence of CPR feedback technology and CPR Coach training. Our institution, like many across the world, does not have access to CPR feedback technology during simulation events.

In this simulation-based study, resuscitation teams were randomized to include an untrained CPR Coach. The CPR Coach assumed the responsibility of providing real-time feedback to maintain quality CPR in compliance with Pediatric Advanced Life Support (PALS) and American Heart Association (AHA) guidelines. This study aimed to evaluate the impact of a CPR Coach alone, without real-time CPR feedback technology, in simulated cardiopulmonary arrest scenarios.

Methods

This was a prospective, randomized pilot study at a tertiary-care academic medical center. The study took place from 2014 to 2018 and was approved by our institutional review board.

Study participants

Eligible participants in the resuscitation team included critical care, pediatric, cardiac, or emergency medicine physicians, critical care nurse practitioners, critical care nurses, pharmacists, respiratory therapists, and medical students who were working in the PICU at the time of the simulation. All participants were certified in Basic Life Support (BLS) and/or PALS. Prior to simulations being performed, all eligible participants were approached and consented to be video recorded during simulated cardiopulmonary arrest scenarios. All participants were oriented to the study by the study investigators at the time of consent. Eligible team leaders included critical care, emergency medicine, or pediatric subspecialty fellows, all trained in PALS and Advanced Cardiac Life Support (ACLS). Individuals who performed the role of the CPR Coach were the critical care charge nurse or a critical care nurse with >5 years of experience, and all were certified in PALS.

Resuscitation team size was not standardized, as it was dependent on the availability of PICU providers at the time of the simulation. This allowed for more generalizability to real-life CPR events. Resuscitation team members included only those who were available to participate in the simulation event once the code alarm rang, similar to a real-life code event. All simulation events took place in situ in the PICU.

Interventions

Study procedures

Simulated cardiopulmonary arrest scenarios were randomized into one of two study arms: control (no CPR Coach) or intervention (CPR Coach). Six scenarios were developed, which included hypovolemia, hyperkalemia, and hypoglycemia, either beginning with PEA/asystole and progressing to ventricular tachycardia/fibrillation, or beginning with ventricular tachycardia/fibrillation and progressing to PEA/asystole. Rhythms flipped halfway through each scenario such that each scenario required defibrillation (Appendix A1). Study investigators served as confederates. Simulation duration was approximately 10−15 min.

Participants were not notified of simulations in advance, such that participation and performance could be more generalizable to real-life resuscitation events. Control simulations were run as usual practice by the code team leader. In the intervention group, the code team leader was prompted by a study investigator to assign the role of CPR Coach to a PICU charge nurse or experienced nurse. The CPR Coach then observed CPR and provided real-time feedback to those performing CPR, while the code team leader guided the remainder of the resuscitative efforts. As blinding was not possible, in an effort to minimize bias, the assignment to control or intervention group was not announced until the start of the simulation.

Scenarios were video recorded from the head and foot of the manikin's bed. CPR was performed on the Laerdal SimJunior© manikin. The manikin did not have the capability to integrate CPR feedback technology.

CPR Coach identification and "CPR Coach card"

The primary objective of the CPR Coach was to monitor chest compressions and provide real-time feedback to ensure compliance with AHA guidelines regarding rate, depth, recoil, and interruptions. CPR Coaches did not receive any formal training. In lieu of training, the CPR Coach was given the opportunity to review a checklist with AHA cardiac arrest guidelines prior to the beginning of each simulation (Appendix A2). The CPR Coach had access to this checklist, in the form of a handheld card, for the duration of the simulation.

Outcome measures

The primary outcome measure was compliance with CPR quality metrics. CPR quality was assessed via video review (performed by CB and ZLH). This included compression rate, frequency of rotating compressors, time to backboard placement, time to epinephrine, time to shock, and pre-, post-, and peri-shock pause duration. Time zero for each resuscitation event was defined as the time when the code leader entered the room. Given that not all scenarios began with a shockable rhythm, the "time to shock" was measured from the time that the rhythm became shockable to the time the shock was delivered. "No flow time" was defined as any period without chest compressions from time zero until return of spontaneous circulation was achieved. Peri-shock "no flow time" was defined as the time without compressions around each shock. The time from identification of a pulseless event to the time the code leader arrived was also measured.

Secondary outcomes included assessment of workload and perceptions of CPR quality. Workload was assessed via the NASA Task Load Index (NASA-TLX) (Appendix A3). This multidimensional survey measures subjective mental workload, deriving an overall workload score based on a weighted average of ratings on six subscales. It has been used clinically to assess workload during procedural tasks.[8,9] The code team leader and CPR Coach completed this tool following the simulation.

A secondary outcome measure assessed perception of CPR quality. All resuscitation participants completed a survey regarding their perceptions of communication surrounding CPR quality (Appendix A4).

Table 1 – Demographics of study participants.

Demographics	Team leader, *n* (%), *n*=13	First assist, *n* (%), *n*=5	CPR provider, *n* (%), *n*=67
Gender			
Female	5 (38%)	5 (100%)	54 (81%)
Profession			
Attending	0 (0%)	0 (0%)	1 (1%)
Fellow	13 (100%)	0 (0%)	1 (1%)
Resident	0 (0%)	0 (0%)	25 (37%)
Medical student	0 (0%)	0 (0%)	7 (10%)
Nurse	0 (0%)	5 (100%)	31 (46%)
Respiratory therapist	0 (0%)	0 (0%)	2 (3%)
Years of post-graduate training			
0–3	N/A		
4–7	13 (100%)		
PALS certified	13 (100%)	5 (100%)	60 (90%)
ACLS certified	13 (100%)		

Statistical analysis

Demographic data was analyzed using descriptive statistics. Mann Whitney *U* tests were conducted to assess the effect of intervention between the control and intervention groups. A *p* value of <0.05 was considered significant.

Results

Demographics

Thirteen simulations events were randomized, and five simulations were assigned to the intervention group. Simulations lasted for an average of 11 min (range 10–13 min). Demographics of the team leaders, CPR Coach, and CPR providers were recorded for each scenario (Table 1).

Primary outcome

Objective CPR quality metrics are shown in Table 2. There was a statistically significant difference in median time to backboard placement between scenarios that included a CPR Coach compared to those without a CPR Coach (22 s vs. 55 s, $p=0.02$). There were no other significant differences in CPR quality measures between scenarios with a CPR Coach and those without, although there was a trend toward improvement for shorter "no flow" time per CPR epoch and shorter peri-shock pause in scenarios that included a CPR Coach (Table 2).

Secondary outcomes

There were no significant differences in team leader workload for scenarios that included a CPR Coach versus those without a CPR Coach, although there was a trend toward significance for performance failure when a CPR Coach was present (Table 3).

Survey questions assessed the perception of CPR quality using a Likert scale. There were no statistically significant differences in survey responses between those participating in a CPR Coach simulation compared to those participating in a traditional simulation.

Discussion

This study evaluated the impact of a low-resource intervention, an untrained CPR Coach, on simulated pediatric cardiopulmonary resuscitation. We showed that inclusion of an untrained CPR Coach was associated with a shorter time to backboard placement. However, the CPR Coach was not associated with significant improvements in other CPR quality metrics. We did not identify a significant change in team leader workload when a CPR Coach was present. Finally, there was no significant change in perceived CPR quality among resuscitation team members.

Table 2 – Cardiopulmonary resuscitation quality metrics.

CPR quality metrics (median [IQR])	First assist present, *n*=5	First assist absent, *n*=8	*p*-value
Compression rate (compressions/min)	93 (85–100)	89 (85–93)	0.66
No flow time per CPR epoch (s)	4.8 (3.8–5.4)	9.2 (6.2–12.2)	0.06
Time to backboard (s)[a]	22 (0–27)	52 (38–65)	0.02
Time to first Epi (s)	225 (149–235)	231 (179–293)	0.52
Time to first shock (s)[b]	78 (71–107)	164 (88–228)	0.37
Peri-shock pause (s)	8.5 (7.5–9.0)	11.3 (10.5–12.1)	0.07

[a] No backboard was placed in one "First assist absent" scenario (*n*=7).
[b] No shock was delivered in one "First assist present" scenario (*n*=4).

Table 3 – Cognitive load of team leader and first assist based on NASA-TLX.[a]

NASA-TLX domain (median [IQR])	First assist present (n=5)	First assist absent (n=8)	p-value
Team leader			
Mental demand	14 (13–17)	14.5 (12–16)	0.55
Physical demand	2 (1–4)	4 (2.5–6.5)	0.34
Temporal demand	11 (10–12)	13 (10–15)	0.41
Performance	14 (11–15)	7.5 (6–9.5)	0.09
Effort	14 (10–14)	15.5 (13.8–16.3)	0.16
Frustration	10 (10–11)	11 (6.5–12.3)	0.94
First assist			
Mental demand	10 (5–12)		
Physical demand	0 (0–1)		
Temporal demand	10 (9–10)		
Performance	10 (9–14)		
Effort	10 (9–10)		
Frustration	10 (3–10)		

[a] 21 gradations on each scale, higher score associated with higher cognitive load.

Prior research has shown that trained CPR Coaches improve the quality of simulated CPR when they receive structured training and when they are incorporated in conjunction with an automated feedback device.[6,10] However, many institutions, including those in low-resource settings, may find it difficult to provide CPR Coach training, and do not have access to CPR feedback technology.[11] This study was unique in that it assessed the impact of a CPR Coach with no formal training, without the use of CPR feedback technology. In lieu of CPR Coach training, we provided our CPR coaches with a checklist to serve as a cognitive aid during the resuscitation (Appendix A2). Unlike prior research,[6] our CPR Coaches did not receive in-depth training, such as simulation-based repetitive practice to ensure skill acquisition. Our intent was to test a CPR Coach intervention that could be generalizable to the vast majority of institutions (including those with limited resources), but this may have ultimately impacted the effectiveness of the intervention.

Recent research suggests that visual assessment of CPR quality is variable and subjective. Jones et al. evaluated the accuracy of visual assessment, finding limitations in the assessment of rate, depth and recoil. They also reported that accuracy of visual assessment was dependent on the position of the CPR Coach in relation to the manikin.[12] We did not provide specific instruction to our CPR Coaches regarding where to stand, although most stood at the foot of the bed next to the team leader. While reliance on visual assessment may add to the generalizability of our study to many institutions, the lack of real-time CPR feedback likely contributed to the lack of significant improvement in CPR quality.

There remains a knowledge gap related to other beneficial aspects of CPR Coaches: not only could some aspects of CPR quality improve, but the rest of the resuscitation may improve due to lower team leader workload. However, our study did not show a difference in the workload of the team leader, consistent with recent literature.[7] In fact, our team leaders were more likely to report a performance failure when a CPR Coach was present (Table 3). While the reasons for this observation are unclear, it may be that the team leader had more opportunity to reflect on team management and overall performance when the number of tasks to complete was reduced. Given our small sample size, we were unable to adjust for differences in team leader characteristics that could impact workload, including fellowship experience, acuity in the PICU at the time of the resuscitation, and time of day. A larger study may provide insight into the ability of a CPR Coach to reduce subjective workload on the team leader and allow further exploration of the team leader's performance assessment with and without a CPR Coach.

Other limitations include the possibility that survey tools were answered quickly without much thought, given factors such as acuity in the PICU and urgency to return to patient care. A more controlled setting with dedicated time away from the unit might yield different perspectives on CPR quality and workload. Another limitation was the Laerdal SimJunior© manikin had technical limitations such as the inability to assess CPR depth and chest recoil. Participants were not oriented to the simulator or environment in advance; however, simulations are frequently performed in our PICU such that most participants had prior experience with the simulator and environment. As with the above limitations, foregoing in-depth orientation does offer more generalizability to real-world CPR. Lastly, due to our small sample size, we were likely underpowered to detect many clinically significant changes. It is unclear if our lack of significant outcomes in other CPR quality metrics was related to our small sample size or a true lack of impact of the CPR Coach.

Conclusions

Inclusion of an untrained CPR Coach to a pediatric resuscitation team, without access to CPR feedback technology, does not result in improved CPR quality metrics or reduced team leader workload during simulated pediatric cardiac arrest. Further research is needed to determine the optimal type of CPR Coach training required to enhance provider performance and patient outcomes.

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None.

Conflict of interest

None declared.

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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.2020.100035.

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