ZOLL®

SUMMER 2015

CODECOMMUNICATIONS

IMPROVING PEDIATRIC CPR WITH REAL-TIME FEEDBACK

Introduction

Approximately 16,000 pediatric patients experience sudden cardiac arrest each year in the United States, with nearly triple that number worldwide.[1] Currently, the survival-to-discharge rate in the U.S. for children who suffer cardiac arrest in the hospital is about 40%.[2] Clearly, there is room for improvement. Several hospitals have conducted studies in the past few years to look at how we can improve outcomes from pediatric sudden cardiac arrest.

What Makes Pediatrics Unique?

To better understand the art of resuscitation for the pediatric population, it's important to look at the differences between children and adults. Children present with a shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia) only 15% of the time, compared with 23% in adults. This leaves us with patients in pulseless electrical activity or asystole the remaining 85% of the time, rhythms associated with less favorable outcomes.[3] With a shockable rhythm, we have a sense of security in thinking that the defibrillator is doing the work for us. In reality, as these numbers demonstrate, we need to become more accustomed to the idea of high-quality cardiopulmonary resuscitation (CPR) being the backbone of our resuscitation efforts.

Furthermore, where most hospitalized children arrest is also different from adults. With the increased utilization of rapid response teams, we are seeing that greater than 94% of pediatric cardiac arrests are occurring in pediatric intensive care units.[4] The intensive care unit staff can become resuscitation champions for the rest of the hospital if the correct educational programs are utilized.

Finally, when looking at the pediatric population, the American Heart Association (AHA) guidelines are slightly different for children. The AHA states that clinicians should aim to compress to a depth at least one-third the anterior-posterior dimension of the chest in infants and children. This translates to approximately 1.5 inches for infants and 2 inches for children. Other key AHA recommendations are the same for both children and adults: a rate of 100 to120 compressions per minute, full chest recoil, avoiding excessive ventilations, and minimizing interruptions in chest compressions.

Evidence-Based Practice to Improve Resuscitation Quality

Several studies have looked at ways to improve outcomes for pediatric cardiac arrest. The ideal recommendation would be to utilize the combination of three key components in a resuscitation program: real-time CPR feedback during resuscitation, increased staff training using quantitative feedback, and post-event quantitative debriefing.[5]

Perception of CPR Quality

One multicenter study that included 10 children's hospitals analyzed how clinicians were actually performing chest compressions compared to their perceptions of performance using simulated cardiac arrest scenarios. The suggestion prior to the study was that the clinicians who relied on direct visualization and team member feedback were not providing high-quality CPR on pediatric patients.[6]

The study consisted of four different arms involving two interventions, real-time visual CPR feedback and Just-in-Time (JIT) CPR training. Participants were placed in one of four arms: (1) no intervention, (2) JIT training only, (3) real-time visual CPR feedback only, or (4) a combination of both interventions. Real-time visual CPR feedback was provided by a device placed on the manikin's chest for the compressor to see during CPR. The JIT training was a brief, five-minute CPR video followed by two minutes of practice prior to the simulated cardiac arrest.

The quality of CPR was recorded; clinicians were then asked what proportion of time they believed they had performed chest compressions at the correct rate and depth, as defined by the AHA. They were also asked to estimate the chest compression fraction, the percentage of time that compressions are performed during an arrest. **Figure 1** shows how frequently the clinicians' perceptions were accurate.

As demonstrated in this study, although clinicians consider their CPR to be within the AHA guidelines during pediatric sudden cardiac arrest, that perception is off the mark. In every arm of the study, clinicians were not able to accurately perceive their ability to provide high-quality CPR. Not surprisingly, the group most likely to overestimate the quality of CPR depth and rate was the group that had no JIT training or CPR feedback. Since this is the situation in most pediatric hospitals today, it's likely that many pediatric patients are not receiving high-quality CPR.

Study participants who received JIT training and real-time CPR feedback had the highest percentage of accuracy in their perception of both rate and depth. The authors suggest that this could have been vastly improved had the CPR feedback device been visible to more than just the person performing compressions. The use of the CPR feedback device needs to be implemented as part of a team approach and monitored by the CPR provider as well as other clinicians in the room.

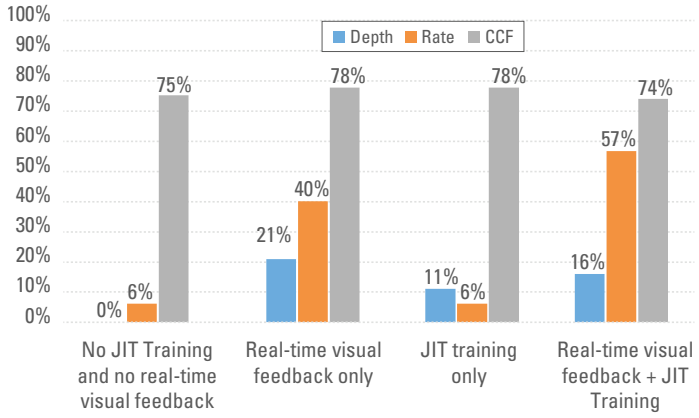
Also, the authors suggested that using this CPR feedback data to provide clinicians with a post-event debriefing session could improve awareness of CPR performance and help resolve misperceptions about CPR quality.

Improving CPR Quality Using Low-Dose, High-Frequency Training Sessions

Another study, this one at the Children's Hospital of Philadelphia, involved Basic Life Support–certified registered nurses and resident physicians from the emergency department and acute-care areas of the hospital. The goal of the study was to gauge whether providing clinicians with brief, high-frequency bedside CPR training sessions would increase their retention level of CPR skills.[7]

There were four study arms consisting of the following groups: (1) instructor-only training, (2) automated defibrillator feedback only, (3) instructor training combined with automated feedback, and (4) a control group (no structured training or feedback). The training sessions were conducted at initiation of the study and at 1, 3, and 6 months. Each session included a pre-training evaluation (1 minute), booster training (2 minutes), and a post-training evaluation (1 minute). Clinicians were rated on their ability to achieve "excellent CPR."

Figure 1 – Participants who accurately estimated CPR quality



JIT: Just-in-Time; CCF: chest compression fraction
Based on Cheng A, et al. *Resuscitation*. 2015;(87)44-50.

Excellent was defined as a depth of one-third the anterior-posterior chest depth, compression rate between 90 and120 compressions per minute, < 20% of chest compressions with incomplete release, and a no-flow fraction < 0.30.

This study found that CPR skills were 2.3 times more likely to be retained after two trainings and 2.9 times after three trainings. **Figure 2** illustrates the percentage of study participants who were able to provide excellent CPR immediately following a 2-minute booster training session. At the end of the study, the 6-month mark, more than 80% of participants performed excellent CPR, but more importantly, as the authors note, more than 65% of participants performed excellent CPR *before* the 6-month pre-booster training. This contrasts with traditional CPR training methods, which have poor 6-month retention success. This study provides evidence that there is a need for frequent skills refreshers using both quantitative feedback and positive reinforcement from an instructor-led training.

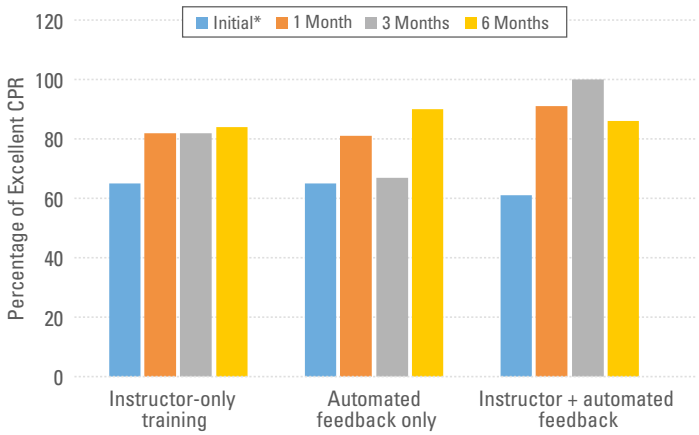
Post-Event Quantitative Debriefing

Another study from the Children's Hospital of Philadelphia evaluated whether a novel post-arrest quantitative debriefing program had an impact on patient outcomes. This study was limited to patients in the ICU and included 119 chest compression events (60 control and 59 interventional). The primary outcome was survival to hospital discharge.[5]

All ICU staff were invited to the debriefing, regardless of whether they participated in the actual code event. Each session was conducted within three weeks of the event and was led by a critical care fellow, under the supervision of an attending physician with expertise in resuscitation. These structured sessions included patient history, pre-arrest studies, quantitative resuscitation data, and a summary of patient outcome.

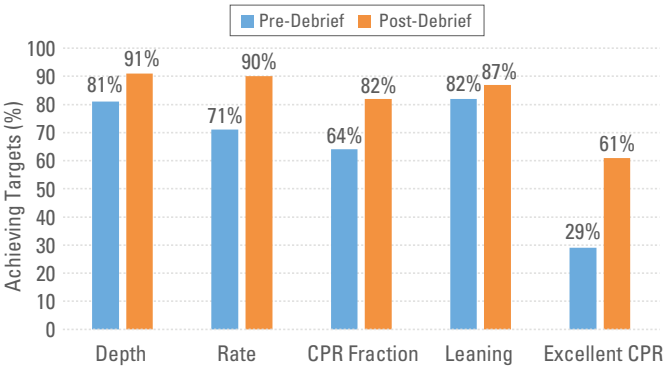
During the study, the quantitative data pulled from the defibrillator for debriefing purposes showed an increase in all targets that were assessed for CPR quality. These included depth, rate, CPR fraction, and leaning. These four components were also combined into a category labeled "excellent CPR," which was rated. The percentage of "excellent CPR" that was performed during the control phase was only 29%. With the use of this debriefing technique, the clinicians were able to more than double this score, to 61% **(Figure 3).**

Figure 2 – Training success: percentage providing excellent CPR after 2-minute booster training



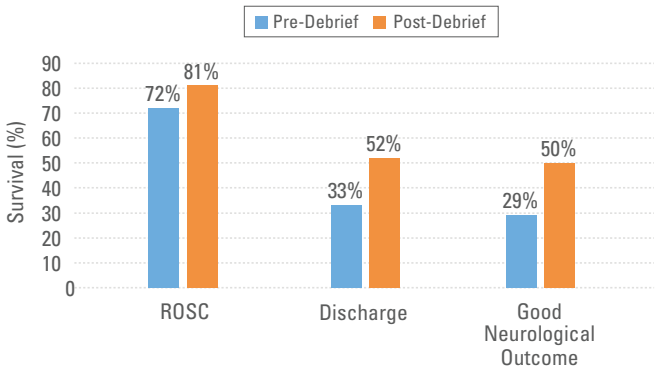
*Initial skill level at outset
Based on Sutton RM, et al. *Pediatrics*. 2011;128(1):145-151.

Figure 3 – CPR quality comparison before and after novel debriefing program



Based on Wolfe H, et al. *Critical Care Medicine*. 2014;42(7):1688-1695.

Figure 4 – Patient outcomes



Based on Wolfe H, et al. *Critical Care Medicine*. 2014;42(7):1688-1695.

The patient outcomes achieved in this study were remarkable. Following implementation of this debriefing program, the number of children who received chest compressions and survived to discharge improved from 33% to 52%. Even more encouraging was the increase in patients who survived to discharge with good neurological outcomes, 29% before initiation of this debriefing protocol versus 50% after its implementation **(Figure 4)**.

Solutions for Pediatric Resuscitation

Several key components must be in place if a resuscitation program is to be successful in increasing survival to discharge from sudden cardiac arrest. According to the 2013 AHA Consensus Statement on CPR Quality, ". . . monitoring of CPR quality is arguably one of the most significant advances in resuscitation practice in the past 20 years and one that should be incorporated into every resuscitation and every professional rescuer program."[8] This statement applies to the resuscitation of children and adults alike. It is the reason clinicians need technology that is not built for adult patients.

The ZOLL® R Series® monitor/defibrillator is the only defibrillator with CPR Dashboard,™ which displays the actual depth and rate of compressions delivered. These measurements are captured with the OneStep™ Pediatric CPR Electrodes, and this detailed event data can be downloaded for in-depth debriefing.

The ability to use such technology on patients of all ages will enable clinicians to utilize quality-improvement techniques. With this quantitative data, clinicians can improve their CPR quality to improve patient outcomes.

In the 2013 AHA consensus statement, the message was very strong regarding CPR: "It has become increasingly clear that delivery of high-quality CPR will be the factor that determines whether a patient survives sudden cardiac arrest with a good neurological outcome."[8] Pediatric caregivers must act as advocates for their patients in situations where they are needed most. Clinicians must insist on using the available technology for pediatrics that will enable them to provide the same, if not a higher, level of care as adults are able to receive.

References

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[7] Sutton RM, et al. *Pediatrics*. 2011;145-151.
[8] Meaney, PA, et al. *Circulation*. 2013;1-19.