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Are Chest Compressions Using the Truecprtm Feedback Device More Effective Than Manual Compressions During Pediatric Resuscitation? a Randomized Controlled Trial.

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ABSTRACT

Study objective: To determine the effectiveness of chest compressions with the TrueCPRTM feedback device (Physio-Control, Redmond, WA, USA) compared with manual compressions in pediatric cardiopulmonary resuscitation.
Methods:Following training, 173 EMS-paramedics performed either standard BLS or used a TrueCPRTM for 8 min in a random computer-generated sequence. The primary outcome measure was effective compressions, being defined as having the correct depth (40-50mm), complete decompression and correct hand position.
Results. The use of the TrueCPR resulted in a significantly higher number of effective compressions compared with standard BLS (72.5±17.8% vs. 36.7±21.6%; p<0.001). Compared with standard BLS the TrueCPRTM more often performed correctly in terms of depth (42.5mm vs. 35.6mm; p<0.001) and compression rate (103.4min-1vs. 129.4min-1; p<0.001) and had fewer incorrect decompressions (3.1 vs. 9.5%; p<0.001). Hands-off time was shorter with the TrueCPR than standard BLS (48.5s. vs. 127.5s.; p<0.001).
Conclusion:. We conclude that the TrueCPRTM can improve the effectiveness of pediatric chest compression. Further clinical studies are needed to test the TrueCPRTMdevice's safety and efficacy in patients.

KEYWORDS	feedback device; resuscitation;pediatric; chest compression; TrueCPR.

INTRODUCION

Resuscitation in emergency medical conditions and out-of-hospital cardiac arrest (OHCA) are global health concerns [1]. Out-of-hospital cardiac arrest (OHCA) is uncommon in children and is usually the result of respiratory failure or trauma. Although a relatively rare occurrence, survival rates from out-of-hospital cardiac arrest (OHCA) in children are generally low, ranging between 0% and 27% depending on the setting and inclusion criteria [2].Among children who achieve sustained return of spontaneous circulation, a favorable neurological outcome is observed in about 5% with an out-of-hospital cardiac arrest and 15-45% with an in-hospital cardiac arrest [1,3].Cardiopulmonary resuscitation (CPR) quality has been highlighted as an important determinant of survival outcome after cardiac arrest. Specific quality targets such as achieving adequate chest compression depths and rates and limiting CPR interruptions have been associated with improved survival outcomes after adult cardiac arrest. However, these same quality targets in infants and children have largely been developed by expert clinical consensus, using data extrapolated from animal, manikin, and adult studies, with little data collected from actual children [4]. This paucity of child-specific data highlights an important gap in the pediatric resuscitation knowledge base. The use of specialized devices is important toimprove the effectiveness of CPR.

We hypothesized that the use of the TrueCPRdevice during pediatric CPR would increase the efficiency of chest compressions (CC) compared to manual BLS. In the current study, we compared the effectiveness of the TrueCPR and Standard BLS in pediatric resuscitation.

METHODS

Study design

This study has been approved by Institutional Review Board of International Institute of Rescue Research and Education (Approval 10.2014.11.51, October 3th, 2014). Before the study commenced it was registered at the ClinicalTrials register (www.clinicaltrials.gov, identifier NCT02281903). This was a randomized non-blind crossover simulation trialEnrollment occurred from October 2014 to November 2014 and there wereone hundred and seventy-three EMS-paramedics participating,none of whom had prior experience with CPR feedback devices.

We used a PediaSIM CPR training mannequin (FCAE HealthCare, Sarasota, FL, USA), which is designed to be an accurate representation of a 6 year-old child. As a CPR feedback device we used the TrueCPR™ (Physio-Control, Redmond, WA, USA). After voluntary written informed consent, participants took a 45-minute course of pediatric CPR. At the end of the training, each participant performed 8 minutes of single-rescuer CPR with standard BLS using the TrueCPR in a computer-generated randomized sequence (www.researchrandomizer.com; Figure

1). Resuscitation was performed according the guidelines of the European Resuscitation Council (2010)[5]. This period was chosen deliberately because in Poland the median travel time of an EMS in urban areas is 8 minutes. There participants were not allowed to watch each other to avoid learning through observation.

Figure 1. Flow chart of design and recruitment of participants according to CONSORT statement.

The primary outcome measurement of the study was to determine the effectiveness of compressions (defined as compression with correct depth [40-50mm], decompression and hand position) when carrying out CPR using the TrueCPR and standard BLS. Apart from these data, socio-demographic data such as gender (male, female), age (in years), level of education (master, bachelor), work experience (in years) were documented.

Statistical analysis

The results were analyzed using the R statistical package for Windows (version 3.0.0). Results are reported as percentages or mean and standard deviation (±SD). A Mann-Whitney-U test (for skewed data) and t test were used for continuous variables. McNemar's test was used to analyze endpoints with a binary outcome. $p<0.05$ was considered as statistically significant.

RESULTS

173 EMS-paramedics (59 female; 34.1%) participated in this study, none of whom had previously performed CPR with any audio-visual feedback devices. Mean age was 35.4±11.5 years and mean work experience was 9.6±6.4 years.

A higher mean percentage of effective compressions was observed when using the TrueCPRTM (72.5±17.8%) compared with standard BLS (36.7±21.6%; p<0.001; Table 1). Furthermore, there was a statistically significant difference between chest compression with the TrueCPRTM and standard BLS in: compression depth (42.5±9.4mm vs. 35.6±16.5mm; p<0.001), compressions which were too shallow (12.1±10.6% vs. 28.6±15.7%; p<0.001) and compressions which were too deep (3.2±3.1% vs. 12.5±9.8%; p<0.001).

The mean compression rate was significantly different between trials with and without the CPR feedback device (103.4±9.4 min-1 vs. 129.4±25.7 min-1; p<0.001). Compared with the standard BLS, the TrueCPRTM mean absolute hands-off time was shorter (48.5±21.2 vs. 127.5±33.2 seconds; p<0.001) and incorrect decompressions were lower (3.1±3.9% vs. 9.5±6.2%; p<0.001). A total of 85.5% of the participants in our study regard pediatric cardiopulmonary resuscitation to be more effective when using a CPR feedback device.

DISCUSSION

This is the first study investigating the use of the TrueCPR feedback device during pediatric cardiopulmonary resuscitation. The goal of this study was to comprehensively evaluate single rescuer pediatric cardiopulmonary resuscitation with a CPR feedback device compared to standard BLS. Key parameters that the reflect the quality of chest standards showed that the use of the TrueCPR resulted in a significantly higher percentage of effective compressions and a drastically lower hands-off time compared to standard BLS. Decreased hands-off time has been linked to better outcomes [6].

One reason the poor performance of standard BLS regarding absolute hands-off time might have been that the rescuer, who was situated by the side of the manikin's chest during chest compressions, had to move to the side of the manikin's head to provide rescue breaths.

In a study by Fischer et al. [7] medical personnel performed chest compressions which were too shallow in 38% of attempts, while 21% were too deep. Inadequate depth while manual CC are confirmed by both the results of this trial as well as by other authors [8,9] .

Aufderheide et al. [10] described 16% to 95% complete decompression rates during manual chest compressions on manikins. Our results also show a lower percentage of incomplete decompressions when standard BLS was used (9.5%).

Chest compression rates obtained with the TrueCPR were significantly closer to the rate recommended by the 2010 ERC guidelines [5] than in the standard BLS group (103.4±9.4 min^{-1} vs. 129.4±25.7 min^{-1}). Other studies have shown that the target of 100 compressions per minute is often missed due excessively rapid chest compressions [7,8,9]. CPR feedback devices help rescuers attain adequate compression rate and depth and have been shown to significantly improve resuscitation quality.

One limitation ofthe study is that it was performed in laboratory settings and did not replicate all the aspects of a real-life CPR attempt.However, according to the International Liaison Committee on Resuscitation (ILCOR), randomized clinical trials for cases of cardiac arrest are unethical and cannot determine the expected benefits of CPR [11].The strengths of this study include the use of a highly advanced patient simulator for performing pediatric advanced life support and the randomized crossover procedure.

CONCLUSIONS

To our knowledge, this is the only study evaluating the TrueCPR™ for child resuscitation. In this study, the TrueCPR™ was associated with higher efficiency of chest compressions during pediatric resuscitation. More studies are required to confirm these results.

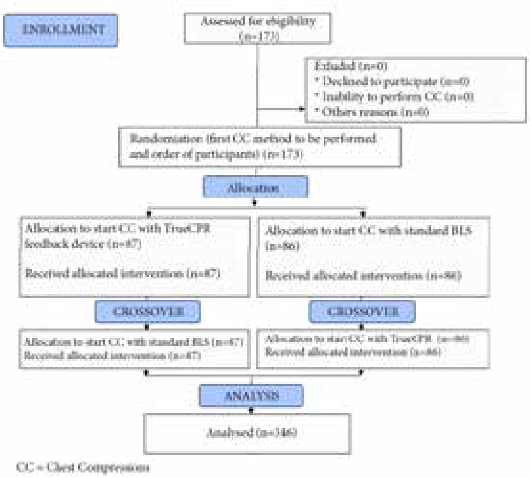

Table 1. Compression parameters (observation period 8 min)

Chest compression parameter	TrueCPR[a]	Standard BLS	p-Value
Effective compressions [%] [b]	72.5±17.8	36.7±21.6	p<0.001
Compression depth [mm]	42.5±9.4	35.6±16.5	p<0.001
Compression too shallow (<40mm) [%]	12.1±10.6	28.6±15.7	p<0.001
Compression too deep (>50mm)[%]	3.2±3.1	12.5±9.8	p<0.001
Compression rate [min^{-1}]	103.4±9.4	129.4±25.7	p<0.001
Incorrect decompressions [%]	3.1±3.9	9.5±6.2	p<0.001
Incorrect pressure point [%]	3.5±3.2	10.2±7.5	p<0.001
Absolute hands-off time [s] [c]	48.5±21.2	127.5±33.2	p<0.001

[a]TrueCPR™ feedback device.

[b] Effective compression was defined as compression with correct depth (50-60mm), compete decompression and correct hand position

[c]Absolute hands-off time was defined as: the sum of all periods during which no hand was placed on the chest minus time used for patient ventilation.

NS = Not statistically significant.

Data are presented as mean ± standard deviation.

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