



Clinical paper

Infant chest compression quality: A video-based comparison of two-thumb versus one-hand technique in the emergency department[☆]



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ABSTRACT

Aim: To use video review to compare CC quality between 2-thumb encircling (2T) and one-hand anterior (1H) hand position in infants receiving CPR.

Methods: Events where an infant received >2 min of CC using a CPR monitor device while videorecorded were included. CC were measured in segments provided by a single compressor; segment duration, identity of the compressor, and hand position (2T vs 1H) was determined from video review. CC rate and depth were measured by the monitor device.

Results: Seven infants received 111 min of CCs from a total of 28 providers. 12/28 providers were assessed using both 2T and 1H; 6 providers used 2T and 1H in the same patient. 80 CC segments were analyzed; the median duration of CC segments was 74 s (IQR 50–95 s). Median CC rate across all segments was 127/min (IQR 115–142/min); median CC depth was 3.0 cm (IQR 2.4–3.4 cm). 2T position was used in 33/80 (41%) of segments. There was no significant difference in CC depth between 2T and 1H position (3.0 ± 0.8 vs 3.0 ± 0.6 cm, $p = 0.81$). 1H position was significantly associated with faster CC rate than 2T position (134 ± 18 vs 118 ± 15 CC/min, $p < 0.001$).

Conclusions: During CC in infants, 1H position was associated with a greater prevalence of inappropriately fast CC rate compared to 2T. There was no significant difference in depth between 2T and 1H. Future studies should evaluate the effect of hand position on clinical outcomes.

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Introduction

Cardiopulmonary resuscitation (CPR) guidelines for infants recommend different hand positions based on the number of rescuers present. The two-thumb encircling technique is the recommended position for teams of two or more rescuers. Single rescuers are still recommended to use one hand on the sternum. Current guidelines also recommend compression depth of four centimeters and a rate

of 100–120/min for infants [1]. Studies demonstrating improved CPR quality in infants based on specific hand position are lacking in current literature.

The recommendation for the use of the two-thumb technique whenever possible is based on evidence from animal and mannequin studies. Studies comparing two-thumb (2T) technique to compressions using two fingers on the sternum in mannequins have shown that this hand position yields better compression depth and less provider fatigue [2–5]. Studies in animal models have shown that 2T technique yields higher systolic blood pressure and coronary perfusion pressure [6,7].

Members of our group, as well as others, have previously reported on the use of monitoring and feedback devices to measure chest compression quality in children [8]; additionally, we have reported on the use of video recording during cardiac arrest to quantify CPR parameters and time intervals for providers during

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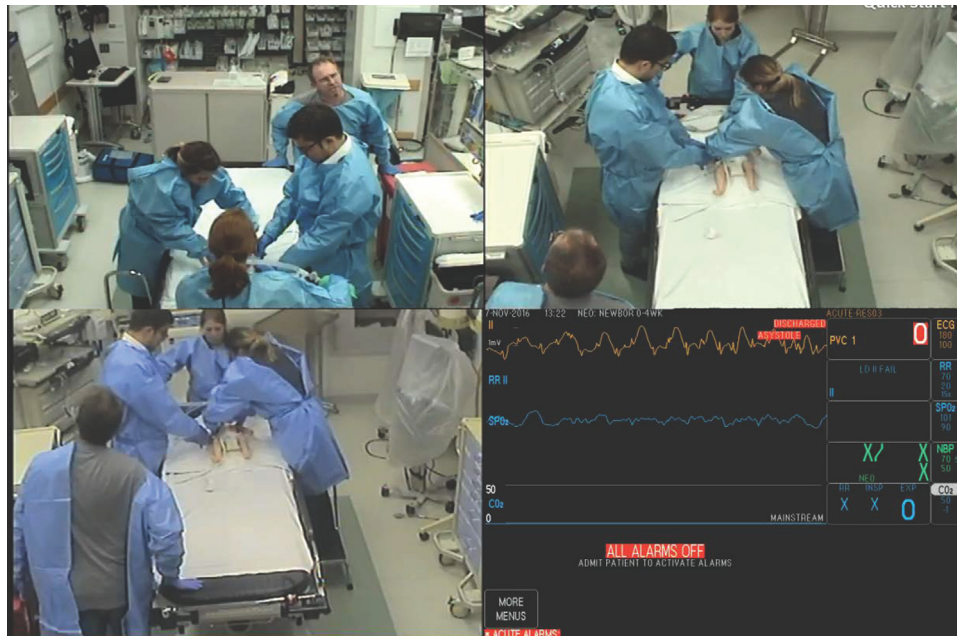


Fig. 1. Screenshot of video capture system in use in a simulated infant resuscitation.

CPR [9,10]. For the current study, we sought to examine chest compression quality in infants receiving CPR using a combination of a pressure sensor/accelerometer device and data from video review. Our data collection methodology was designed to quantify chest compression quality at the level of individual providers to permit analysis of the influence of hand position. We hypothesized that the two-thumb encircling technique would be associated with better compliance with recommended depth and rate of compressions.

Methods

Study design

This was an observational study done in the emergency department of a single tertiary pediatric center between September 2015 and September 2016. Resuscitative care in the ED is video recorded as a part of an intradivisional continuous quality assurance program. In the creation of the program, appropriate input and oversight from our center's legal, risk management, and patient safety divisions was provided. Patient/parent consent is obtained at the time of consent for treatment.

Videorecording is done with specific software (LiveCapture®, BLine Medical, Washington, DC). The relevant technology of this video recording and ethical issues around this video review for study have been described in detail previously in studies by our team [9,10].

CPR data collection and analysis is approved by the Institutional Review Board of the Children's Hospital of Philadelphia; data from video review is collected as part of an existing quality assurance program and is exempted from Institutional Review Board oversight.

Inclusion and exclusion criteria

Patients aged less than one year receiving chest compressions in the ED as a continuation of ongoing care for out-of-hospital cardiac arrest or for cardiac arrest and/or critical bradycardia while being cared for in the ED were eligible for enrollment. All events where chest compressions were performed for >2 min were considered for inclusion. Events were included in the analysis if the CPR monitor

device was used and the event was captured by video recording. Events that were not captured by video recording or when the CPR monitor device was not utilized were excluded.

Data collected on patients included age, initial rhythm, out-of-hospital versus in-hospital arrest, event duration, and outcomes according to Utstein definitions. Event duration was defined as the time from when CPR was initiated (or CPR was taken over by hospital personnel from prehospital personnel in the case of out-of-hospital arrests) to when return of spontaneous circulation was achieved or the resuscitation was terminated.

Data collection: video review

Fig. 1 shows the configuration of the video system used in the study, consisting of multiple synchronized camera views along with vital sign monitor waveforms. Segment duration, identity of the compressor, and compression technique (2T versus 1H) were determined from video review by study team members (HYJ, TCH, MKF, AD). A list of all providers (physicians, nurses, and technicians) was created and each individual was assigned a unique identification number.

Chest compressions were analyzed by compressor segment; this was defined as the period of time where a single provider performed chest compressions (with or without interruptions) until that provider was replaced by another provider to take over compressions. Start and stop times for each compression segment were measured to the nearest second. Hand position (2T or 1H) was determined by video review. Hand position during a given compression segment was designated as 'one hand' if the provider was using either two fingers or the heel of one palm on the sternum.

Data collection: monitor device

Chest compression rate and depth were measured by the defibrillator monitor device (R-series®, ZOLL Medical, Chelmsford, MA, USA) with dual sensor electrode pads in anterior-posterior position. The small pads for this device are approved for use for patients less than 25 kg on body weight. Chest compression depth is measured by a combination of accelerometry and impedance, which permits accurate measurement of depth with either 2T or 1H technique.

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