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Simulation and education

Performance of chest compressions with the use of a new audio–visual feedback device: A randomized manikin study in health care professionals☆

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ABSTRACT

Aim: Optimal depth (50–60 mm) and rate (100–120 min^{-1}) of chest compressions (CC) is the prerequisite of effective cardiopulmonary resuscitation (CPR). However, insufficient CC during CPR are common even among health care professionals. We sought to evaluate if CC are more effective with the use of a novel feedback device compared to standard CC. Primary endpoints were absolute percentage of correct CC of all CC (correct rate and correct depth, classified as "optimal" CC), and the percentage of CC in target rate and percentage of CC in target depth.
Methods: 63 healthcare professionals performed CC on a manikin with the use of a novel feedback device. The device provides audio–visual information about compression depth and rate. Each participant performed two minutes of CC with and without feedback. Participants were randomized into two groups that performed either CC with feedback first, followed by a trial without feedback, or vice versa. All participants answered a short questionnaire on self-estimation of CC performance.
Results: The absolute percentage of optimal compressions of all compressions has increased from 27.9 ± 28.8% to 47.6 ± 33.5% ($p < 0.001$) with use of the device. Furthermore, a significant increase of the percentage of CC in target depth (35.9 ± 30.6% without vs. 54.8 ± 33.5% with the device, $p = 0.003$) and in target rate (70.5 ± 37.7% without vs. 82.7 ± 27.8 with the device, $p = 0.039$) were observed.
Conclusion: This novel feedback device significantly improved the quality of CC in health care professionals.

1. Introduction

Cardiac arrest (CA) is one of the world major health issues, with a global incidence of 95.9 cases per 100,000 person-years.[1] Despite increasing knowledge on pathophysiology of CA and optimization of cardiopulmonary resuscitation (CPR) strategies, survival rates of out of hospital CA show remain considerably low, although a great variability is reported.[1] It is well established that optimal depth and rate of external chest compressions (CC) are prerequisites for effective cardiopulmonary resuscitation (CPR).[2] Insufficient rate and depth of CC are associated with worse outcomes.[3] It has been shown recently that performance of chest compressions is poor even among health care professionals and that CC can be improved with the use of different feedback systems.[3,4,15,16]

Most available feedback devices today use accelerometer-based feedback technology.[4,5] However, accuracy of accelerometer feedback is limited, especially when performed on a soft surface or during transport.[5,6,20] Recently, a new feedback device has become commercially available with a different technical approach. The TrueCPR™ uses triaxial field induction (TFI) technology. The basic principle is that a chest sensor continuously measures the distance to a second sensor under the patient via a three dimensional magnetic field. A recent publication showed that the device measured compression depth more accurate than accelerometer based feedback systems.[20] The aim of our study was to evaluate the new feedback device in healthcare professionals in a simulated

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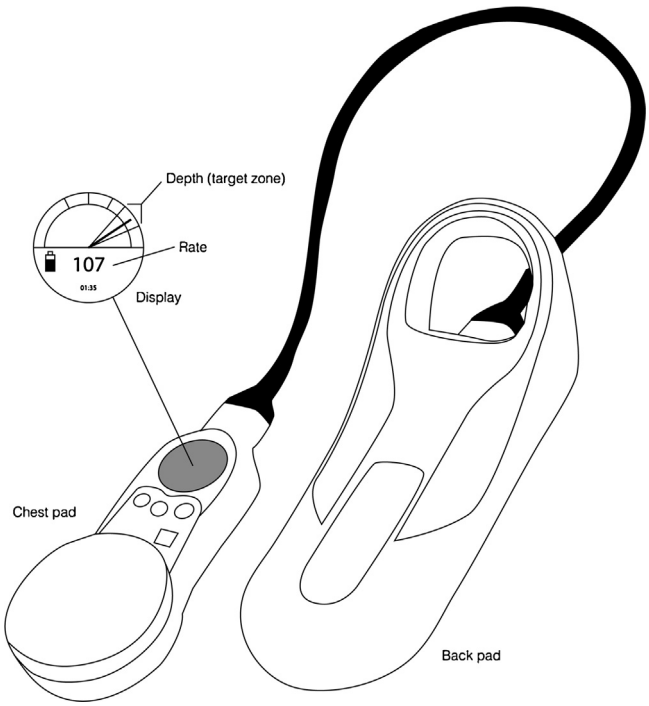

Fig. 1. True CPR™ feedback device.

model of cardiac arrest. Improvement of CC with the use of the device and self-estimation of CPR performance by CPR providers were assessed. A prospective randomized protocol was used. Our hypothesis was, the CC quality is significantly improved with the use of the device compared to CC without the device. Primary endpoints were absolute percentage of CC with correct rate and depth of all CC, as well as percentage of CC in target rate and percentage of CC in target depth.

2. Materials and methods

2.1. Device

The TrueCPR™ (Physio-Control, Redmond, Washington, USA) is a novel non-invasive, easy to apply device to guide compression rate and compression depth during CPR in patients of 8 years or older. It consists of a chest pad (35 mm × 225.6 mm × 83 mm) and a back pad (74 mm × 266 mm × 100 mm) that are positioned on the chest and under the back of the patient (Fig. 1). An image on both pads shows the correct position. A display on the chest pads provides information about compression depth and rate. The target range of compression depth (50–60 mm) is marked green and an arrow indicates compressions that are too shallow or too deep. An acoustic signal (metronome at 104.4 beats per minute) provides orientation for target rate. The display shows the actual rate applied (Fig. 1).

The distance between the two pads is measured during CPR with the use of three-dimensional magnetic fields, a technique called triaxial field induction (TFI). With the use of a three-dimensional field instead of accelerator technology, the inaccuracy in alignment of the two pads should be compensated as well as possible disturbances caused by soft surfaces or movement of patient and device during transport.

The device is declared compatible with implanted devices such as implantable cardioverter-defibrillators (ICDs) and pacemakers and can be kept on the patient while defibrillating.

2.2. Participants

Nurses and physicians from the department of internal medicine at a large university hospital were eligible for participation. Participants were recruited via public announcement on the same day the study took place. The participants received no compensation. All participants were instructed to perform two minutes of CPR (with secured airway) on manikin with and without the information of the device. The participants were randomized into two groups: group 1 performed two minutes of CPR with the feedback information first and then performed two minutes without information on compression rate and depth (with the display of the device covered and the metronome muted). Group 2 performed the test vice versa.

The participants completed an 8-item questionnaire after the test. (1) My profession is—physician/nurse. (2) I have performed chest compressions on a human before—yes/no. (3) Number of cardiopulmonary resuscitations (CPR) in professional experience—absolute number. (4) My last CPR was—more than 6 months ago/less than 6 months ago. (5) My last CPR training was—more than 6 months ago/less than 6 months ago. (6) My chest compression trial without the feedback device was sufficient—yes/no. (7) My chest compression trial with the feedback device was sufficient—yes/no. (8) I felt more secure performing chest compressions with the device—yes/no). Participants who had already performed CC on humans in clinical practice were categorized as “having CPR experience”.

All participants gave informed consent for participation. The study was approved by the local ethics committee of the Charité—Universitätsmedizin Berlin (registration no. EA2/128/13) and was conducted in accordance with the declaration of Helsinki.

2.3. Study protocol

Participants were instructed to perform CC without interruption (in a scenario with secured airway) with the device on a manikin (Adult Brad™, Simulaids, Saugerties, U.S.). The back pad was already placed in the right position, while a short instruction (<1 min) on the function and the position of the chest pad including the information displayed on the chest pad was given. Immediately after the instruction, group 1 performed the first two minutes CC with the metronome turned on and the display visible. Participants were instructed to adjust the compression rate and depth to the audiovisual information. The second two minutes of CC were performed by group 1 after a pause of 20 min with a covered display and the metronome muted. Group 2 performed the task vice versa. Participants performed the trials on the floor under direct supervision of a researcher

Sample size calculation was performed based on pilot data with the percentage of optimal CC of all CC as primary endpoint. The calculated sample size was 37 subjects for 80% power and a significance level of 5%.

Participants were randomized with a randomization list created with Research Randomizer (Urbaniak, G. C., & Plous, S. Research Randomizer Version 4.0; www.randomizer.org) using permuted blocks of 4. Study flow chart is displayed in Fig. 2.

2.4. Data analysis

Primary endpoints were absolute percentage of optimal compressions of all compressions (rate between 100–120 min^{-1} and depth of 50–60 mm), compressions with adequate rate (100–120 min^{-1}) and compressions in target depth (50–60 mm).

Secondary endpoints were the mean rate and depth of CC, the longest interval without CC in target depth and rate, and the percentage of trials that were classified as “effective” of all