Resuscitation 89 (2015) 137–141

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Simulation and education

The capability of professional- and lay-rescuers to estimate the chest compression-depth target: A short, randomized experiment☆

Raphael van Tulder[c,a], Roberta Laggner[a], Calvin Kienbacher[a], Bernhard Schmid[b], Andreas Zajicek[c], Jochen Haidvogel[c], Dieter Sebald[c], Anton N. Laggner[a], Harald Herkner[a,*], Fritz Sterz[a], Philip Eisenburger[a,d]

[a] Department of Emergency Medicine, Medical University of Vienna, Austria
[b] University Hospital Tulln, Hospital Association Lower Austria, Austria
[c] Municipal Ambulance Service Vienna, MA 70, Berufsrettung der Stadt Wien, Austria
[d] Department of Emergency Medicine, Wilheminenspital, Vienna Hospital Association, Vienna, Austria

ARTICLE INFO

Article history:
Received 19 August 2014
Received in revised form 13 January 2015
Accepted 23 January 2015

Keywords:
Cardiopulmonary resuscitation
Cardiac arrest
Chest compression
Manikin

ABSTRACT

Background: In CPR, sufficient compression depth is essential. The American Heart Association ("at least 5 cm", AHA-R) and the European Resuscitation Council ("at least 5 cm, but not to exceed 6 cm", ERC-R) recommendations differ, and both are hardly achieved. This study aims to investigate the effects of differing target depth instructions on compression depth performances of professional and lay-rescuers.
Methods: 110 professional-rescuers and 110 lay-rescuers were randomized (1:1, 4 groups) to estimate the AHA-R or ERC-R on a paper sheet (given horizontal axis) using a pencil and to perform chest compressions according to AHA-R or ERC-R on a manikin. Distance estimation and compression depth were the outcome variables.
Results: Professional-rescuers estimated the distance according to AHA-R in 19/55 (34.5%) and to ERC-R in 20/55 (36.4%) cases ($p = 0.84$). Professional-rescuers achieved correct compression depth according to AHA-R in 39/55 (70.9%) and to ERC-R in 36/55 (65.4%) cases ($p = 0.97$).

Lay-rescuers estimated the distance correctly according to AHA-R in 18/55 (32.7%) and to ERC-R in 20/55 (36.4%) cases ($p = 0.59$). Lay-rescuers yielded correct compression depth according to AHA-R in 39/55 (70.9%) and to ERC-R in 26/55 (47.3%) cases ($p = 0.02$).
Conclusion: Professional and lay-rescuers have severe difficulties in correctly estimating distance on a sheet of paper. Professional-rescuers are able to yield AHA-R and ERC-R targets likewise. In lay-rescuers AHA-R was associated with significantly higher success rates. The inability to estimate distance could explain the failure to appropriately perform chest compressions. For teaching lay-rescuers, the AHA-R with no upper limit of compression depth might be preferable.

1. Introduction

Every year, millions of lay-rescuers and health care professionals undergo numerous courses and lectures on cardiopulmonary resuscitation (CPR). High quality chest compressions are hereby one of the major topics to be taught. Adequate rate, short hands-off times and chest release are important issues but adequate compression depth is a crucial aspect of high quality CPR for survival and favorable neurological outcome.[1]

Compression depth is known to correlate with outcome.[1–3] Edelson et al. reported that an increase of 5 mm in compression depth was associated with a 99% increase in the odds of shock success.[2] Adequate compressions increase tolerance against delay of defibrillation, keep rhythms shock-able and increase first shock success and thus improve survival in out-of-hospital cardiac arrest.[2,4,5] In this regard no CPR is equal to poorly performed CPR.[1,6–8]

Following the updated guidelines and the target values advocated regarding compression depth,[1,2] rates[9] and limiting interruptions[2,10,11] resulted in improved outcome.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2015.01.031.

* Corresponding author at: Department of Emergency Medicine, Medical University of Vienna, Waehringerguertel 18-20/6D, A-1090 Vienna, Austria.
E-mail address: harald.herkner@meduniwien.ac.at (H. Herkner).

http://dx.doi.org/10.1016/j.resuscitation.2015.01.031
0300-9572/

Table 1
Demographic data.

	Lay-rescuers $N = 110$	Professional rescuers $N = 110$
Female sex—n (%)	65 (59)	20 (18)
Age (years)—mean ± SD	39 ± 15	32 ± 9
Height (cm)—mean ± SD	173 ± 8	178 ± 8
Weight (kg)—mean ± SD	76 ± 16	78 ± 15
Body mass index—mean ± SD	25 ± 4	25 ± 4
Smoking history—n (%)	19 (17)	45 (41)
Right handed—n (%)	102 (93)	96 (87)

Nevertheless adequate compression depth is seldom achieved, which is not only a problem of lay-rescuers. Even the compression depth of professional rescuers often remains below their expectations.[7,12–15] Therefore CPR courses and lectures need to teach compression depth precisely.

Under this aspect it seems interesting, that the current compression depth recommendations of the American Heart Association (AHA) and the European Resuscitation Council (ERC) do differ slightly. The AHA recommends a compression depth of "at least 5 cm" (AHA-R) whereas the ERC recommends a compression depth of "at least 5 cm but not to exceed 6 cm" (ERC-R). This particular recommendation to not exceed 6 cm is based on the fear of harming the patient even though the target depth is rarely exceeded.[12] Our expectation is that a given maximum could imply potential harm if exceeded, thus causing fear in the rescuer's mind. Therefore, our hypothesis was that rescuers would compress deeper if given only a minimum and that a close range with a maximum would keep rescuers from even reaching the minimum in a relevant fraction.

Therefore the current study was designed to investigate the difference of the two given target-depth estimations on compression-depth performance of professional rescuers and untrained lay-rescuers.

Furthermore, it remains unclear whether the failure to achieve targets is explained by target definition or by an inability to estimate compression depth. We therefore also measured the ability of rescuers to visually estimate a linear distance.

2. Methods

2.1. Trial design

This study was a prospective, randomized, controlled trial. The ethics board of the Medical University of Vienna approved the study.

2.2. Participants

We recruited professional rescuers from a large tertiary emergency care center and lay rescuers from a large shopping mall near Vienna, where visitors were invited to participate. Volunteers above the age of 18 providing informed consent were eligible to participate. Exclusion criteria for both groups were pregnancy, restricted physical exercise and any obvious incapability to estimate a distance, i.e. visual impairment.

In the professional rescuers group emergency physicians, nurses and paramedics were included. In the lay-rescuer group health care professionals were excluded.

2.3. Study setting

After a short instruction, agreement and informed consent participants' demographic information were collected by self-reporting questionnaires. Demographic data included sex, age, body mass index, and smoking habits (see Table 1). We also registered duration and time point of the most recent attended CPR course as well as the professional experience of health care professionals (see Tables 2 and 3).

We measured the ability to visually estimate a linear distance on a paper sheet with a given horizontal line from a predefined starting point using a pencil.

Participants were randomized to either estimate and compress the "at least 5 cm" recommendation of the AHA (AHA-R) or to estimate and compress "at least 5 cm, but not to exceed 6 cm" the recommendation of the ERC (ERC-R). Chest compression assessment was performed on a standard Laerdal® Resusci Anne Simulator (Laerdal Medical AS, Norway) manikin. Compression data were extracted via the Laerdal PC skill reporting system. Participants were allowed to make themselves comfortable with the manikin by performing chest compressions (without any feedback on depth or correctness) before entering the study. After familiarization with the situation, participants were requested to provide chest compressions with the target depth to the corresponding group assignment. Measurement of compression depth was averaged from up to six consecutive compressions, once participants were sure to provide the requested target depth. Due to the manikin properties compressions over 6 cm were not exactly measureable and therefore recorded as 6 cm.

2.4. Outcomes

Two different endpoints were measured: Length of the visual estimation (cm) and compression depth as recorded in cm by the manikin.

2.5. Sample size

Based on evidence from prior experiments we expected a standard deviation of 10 mm for the estimation of the expected compression depth. Given a power of 80% and a two-sided alpha-level of 5% we calculated a necessary sample size of 55 participants per group to detect a significant difference of 6 mm. This difference was regarded as relevant based on prior research.

2.6. Randomization

For group assignment we used a web based, online available software provided by the Institute for Medical Informatics, Statistics and Documentation at the Medical University of Graz, Austria. This website provides a self-serve, easy to use randomization. Groups and number of participants need to be defined in advance of using this software. In total, 220 volunteers, 110 professional rescuers and 110 lay-rescuers were randomly assigned to 4 groups in a 1:1 ratio each. The program concealed allocation until online randomization.

2.7. Implementation

Participants were blinded to the purpose and endpoint of this study. Assignment occurred by using the randomizer software by the time a new participant finished the demographic questionnaire.

2.8. Statistical methods

Continuous data are presented as mean and standard deviation (SD) or median and 25–75% interquartile range (IQR), categorical data as count and relative frequency. For the hypothesis testing we used a t-test. We used MS Excel for Mac and Stata 11 (Stata Corp, College Station, TX) for data management and calculations. A two-sided p-value <0.05 was considered statistically significant.