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Clinical Paper

Chest compression depth after change in CPR guidelines—Improved but not sufficient☆

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ABSTRACT

Aims: Cardiopulmonary resuscitation is one of the most vital therapeutic options for patients with cardiac arrest. Sufficient chest compression depth turned out to be of utmost importance to increase the likelihood of a return of spontaneous circulation. Furthermore, the use of real-time feedback-systems for resuscitation is associated with improvement of compression quality. The European Resuscitation Council changed their recommendation about minimal compression depth from 2005 (40 mm) to 2010 (50 mm). The aim of the present study was to determine whether this recommendation of the new guidelines was implemented successfully in an emergency medical service using a real-time feedback-system and to what extend a guideline-based CPR training leads to a "change in behaviour" of rescuers, respectively.
Methods and results: The electronic resuscitation data of 294 patients were analyzed retrospectively within two observational periods regarding fulfilment of the corresponding chest compression guideline requirements: ERC 2005 (40 mm) 01.07.2009–30.06.2010 ($n = 145$) and ERC 2010 (50 mm) 01.07.2011–30.06.2012 ($n = 149$). The mean compression depth during the first period was 47.1 mm (SD 11.1) versus 49.6 mm (SD 12.0) within the second period ($p < 0.001$). With respect to the corresponding ERC Guidelines 2005 and 2010, the proportion of chest compressions reaching the minimal depth decreased (73.9% vs. 49.1%) ($p < 0.001$). There was no correlation between compression depth and patient age, sex or duration of resuscitation.
Conclusions: The present study was able to show a significant increase in chest compression depth after implementation of the new ERC guidelines. Even by using a real-time feedback system we failed to sustain chest compression quality at the new level as set by ERC Guidelines 2010. In consequence, the usefulness of a fixed chest compression depth should be content of further investigations.

1. Introduction

Sudden cardiac arrest is the most common cause of death worldwide.[1] Cardiopulmonary resuscitation (CPR) is one of the most vital therapeutic options for patients with cardiac arrest. Therefore, improvement of the algorithms both for basic life support and advanced life support has been content of discussion and research for years.[2–5]

Several changes have been made regarding the importance of interventions during the latest guidelines. Especially the importance of "high quality" chest compressions has been changed throughout the last years with a focus on minimizing the time without chest compression and release of compression depth.[6–9] According to an investigation of Wik et al. in 2002, only 28% of the performed chest compressions during cardiopulmonary resuscitation were within the requested depth[10] Stiell et al. described the resuscitation data of 1.029 patients. In this study, the portion of compliant chest compressions according to the European Resuscitation Council (ERC) Guidelines 2005 and 2010 were 47.2% and 8.4%, respectively.[11] While the ERC Guidelines 2005 advised a compression depth of at least 40 mm, the actual ERC Guidelines 2010 recommend a minimal compression depth of 50 mm instead.[12] Furthermore, the guidelines recommend the use of chest compression feedback-systems to monitor and improve chest compression

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quality.[13] The rationale for this focus on chest compression is the prioritization on a sufficient circulation and so increase the likelihood of a return of spontaneous circulation (ROSC).

The aim of the present study was to determine whether the new recommendations concerning chest compression were implemented successfully in an Emergency medical service serving a city of 300,000 inhabitants. Therefore, we analyzed the sufficiency of chest compressions during cardiopulmonary resuscitation with a real-time feedback-system adapted to the ERC Guidelines 2005 (feedback-system set to a minimum of 40 mm) vs. 2010 (feedback-system set to a minimum of 50 mm) in the city of Muenster between July 2009 and July 2012.

2. Methods

2.1. Ethic approval

Our study complies with the Declaration of Helsinki. This analysis was approved by the ethics committee of the regional medical board of registration (Ärztekammer Westfalen Lippe) and the University of Muenster (Westfälische Wilhelms-Universität Muenster) on 10th September 2012. The present study was compliant with German ethical law and no further permissions were required.

2.2. Observational periods

In this retrospective analysis we compared the resuscitation data of 294 patients with sudden cardiac arrest within two observational periods:

ERC 2005 (performed in accordance with ERC Guidelines 2005): 01.07.2009–30.06.2010 ($n = 145$).

ERC 2010 (performed in accordance with ERC Guidelines 2010): 01.07.2011–30.06.2012 ($n = 149$).

Inclusion criteria of the present study were the performance of chest compressions, the availability of the electronic resuscitation data and an entry in the German resuscitation registry (GRR©). No further exclusion criteria like age, sex or ethical origin were defined.

In 2007 all ambulances of the fire department Muenster were equipped with the real-time feedback-systems for resuscitation. Emergency physicians and ambulance personnel were trained prior to the observational periods in 90 min lectures according to the actual ERC guidelines followed by a practical training. Focus was on CPR quality and use of the real-time feedback-system. CPR training was repeated annually. Ambulance personnel as well as emergency physicians used an integrated real-time feedback-system in order to maintain surveillance regarding the compression quality, frequency and time without compression. The feedback system used in this study was a defibrillator with an accelerometer integrated into the defibrillation pads (Zoll E-Series and AED-pro both using CPR-D Padz, ZOLL Medical Corporation, Chelmsford, MA, USA). The accelerometer sensor is placed in the middle of the sternum at the compression point. Patients had to be positioned on a hard surface (floor or stretcher) to ensure correct measurements. This method has been described in previous studies.[9,10,14,15] The feedback system provides audial and visual prompts guiding chest compressions during CPR. Chest compression quality data is recorded. Feedback is provided by a visual bar graph, indicating chest compression depth. Additionally, verbal prompts are given and an acoustic metronome is beeping at 100/min. whenever compression frequency is below 100/min. Both devices are equipped with Real CPR Help® software (ZOLL Medical Corporation, Chelmsford, MA, USA). A software-update regarding the minimal compression depth was performed prior to the second study-period (ERC 2010).

2.3. Data acquisition

Loss of data occurred in 29 cases. 17 cases were performed with a non-local ambulance without feedback-system. Furthermore, technical defects of the feedback-system were registered in 19 cases (see Fig. 1). The corresponding cases were consequently eliminated from the analysis.

The resuscitation data were extracted from the defibrillator via USB and analyzed with the RescueNet Code Review© 4.10 Software (Zoll DATA Systems, Bloomfield, CO, USA). Inadvertend movements of the accelerometer were excluded by filtering all data: In case of artefacts (due to dislocation of electrodes, disconnection of cables and transport) the affected data were consequently removed from the analysis by using the RescueNet Code Review© 4.10 Software (Zoll DATA Systems, Bloomfield, CO, USA).

Sufficiency of chest compression was defined in accordance with the respective guidelines (compression depth at least 40 mm or 50 mm, respectively).

Primary endpoint of the present study was the proportion of chest compressions reaching the minimal depth according to the corresponding guidelines within the observational period.

2.4. Statistical approach

Statistical analysis was performed with SPSS 21.0© software (SPSS Inc., Chicago, IL, USA). If not explicitly specified, data are presented as mean (±SD). In order to test differences in baseline characteristics and resuscitation data between the groups, chi-squared tests and t-tests were considered as appropriate. Correlations were described with Pearson's correlation coefficient. Generalized estimating equations (GEE) including Wald statistics were used to control for the clustering of chest compressions from within events and to analyze a possible relationship between chest compression depth, gender and age.

3. Results

3.1. Demographic data

The mean patient age during the first period (ERC 2005) was 69.2 years versus 69.8 years within the second period (ERC 2010) without statistical significance. 199 of the 294 patients (67.7%) were male. This relation of gender was also observed within the two cohorts without significant differences (see Table 1).

3.2. Chest compressions

307,956 chest compressions in 145 cases were registered during the first period (ERC 2005) versus 320,870 recorded chest compressions during the second period (ERC 2010) with 149 cases. The mean compression depth of all recorded chest compressions was 48.3 mm (SD 11.7). During the first period (ERC 2005), the mean compression depth was 47.1 mm (SD 11.1) versus 49.6 mm (SD 12.0) within the second period (ERC 2010) (see Fig. 3 and Table 3). Analysing each resuscitation-event, the compression depth in mean is 47.0 mm in the first period and 50.3 mm in the second observational period ($p = 0.004$) (see Fig. 2 and Table 2). Transferring the data to the corresponding ERC recommendation of 2005 and 2010, respectively, 73.9% of the chest compressions during the first period (ERC 2005) were considered as "compliant" versus 49.1% of the chest compressions throughout the second period (ERC 2010). Further resuscitation data are listed in Tables 2 and 3.