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Comparison of two techniques of cardiopulmonary resuscitation performed by nurses. Randomized, cross-over, simulation study

Porównanie dwóch technik resuscytacji krążeniowo-oddechowej przez pielęgniarki. Badanie randomizowane, krzyżowe, symulacyjne

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Abstract

Background. Sudden cardiac arrest is the leading world-wide cause of death. Chances for survival are mainly dependent on high quality cardiorespiratory resuscitation, including the rate and depth of chest compressions, the degree of chest recoil, and the correctness of the position of the hands on the chest during compression. The purpose of the study was to compare two cardiopulmonary resuscitation techniques depending on the position of the rescuer with respect to the cardiac arrest victim. Cardiopulmonary resuscitation was conducted in one rescuer settings. ***Material and methods.*** The study was designed as a prospective, randomized, crossover simulation study. The study involved 36 nurses who had to perform a 2-minute chest compression while being localized on the victim's side (control technique - classic) or behind the victim's head (experimental technique). Both participants and resuscitation methods were random. ***Results.*** In the manikin study the results with chest compression behind the victim's head were significantly better than chest compressions on the side of the patient ($P < .05$) for the analyzed variables (chest compression rate, full chest recoil and correct hand position). In order to chest compression depth the results were similar for distinct methods (55 [IQR; 52-62] *vs.* 55 [IQR; 52-54]mm). ***Conclusions.*** A manikin study indicates that nurses perform higher quality chest compression when resuscitation is performed behind the victim's head than the standard position when the rescuer is located on the side of the victim. *Anestezjologia i Ratownictwo 2017; 11: 368-373.*

Keywords: cardiopulmonary resuscitation, chest compressions, quality, nurse

Streszczenie

Wstęp. Nagłe zatrzymania krążenia stanowi główną przyczynę zgonów na świecie. Szanse na przeżycie w głównej mierze zależą od wysokiej jakości resuscytacji krążeniowo – oddechowej, na którą składają się m.in. częstość i głębokość ucisków klatki piersiowej, stopień relaksacji klatki piersiowej czy też poprawność ułożenia rąk na klatce piersiowej podczas jej uciskania. Celem badania było porównanie dwóch technik resuscytacji krążeniowo-oddechowej w zależności od pozycji ratownika względem osoby z zatrzymaniem krążenia. Resuscytacja krążeniowo-oddechowa była prowadzona w jedną osobę. ***Materiał i metody.*** Badanie było zaprojektowane jako badanie prospektywne, randomizowane, krzyżowe badanie symulacyjne. W badaniu udział wzięło 36 pielęgniarek, które musiały wykonywać 2-minutowy cykl uciskania klatki piersiowej będąc z boku poszkodowanego (technika kontrolna - klasyczna), bądź znajdując się za głową poszkodowanego (technika eksperymentalna). Zarówno kolejność uczestników, jak i metod resuscytacji były losowe. ***Wyniki.*** In the manikin the results with chest compression behind the patient head were significantly better than chest compressions on the side of the patient ($P < .05$) for the analyzed variables (chest compression rate, full chest recoil and correct hand position). In order to chest compression depth the results were similar for distinct methods (55 [IQR; 52-62] *vs.* 55 [IQR; 52-54]mm). ***Wnioski.*** Przeprowadzone badanie manekinowe wskazuje, iż pielęgniarki wykonują wyższej jakości uciski klatki piersiowej w przypadku prowadzenia resuscytacji zza głowy pacjenta aniżeli w przypadku standardowej pozycji, gdy osoba wykonująca resuscytację znajduje się u boku poszkodowanego. *Anestezjologia i Ratownictwo 2017; 11: 368-373.*

Słowa kluczowe: resuscytacja krążeniowo-oddechowa, uciskanie klatki piersiowej, jakość, pielęgniarka

Introduction

Out-of-hospital cardiac arrest (OOHCA) remains a major cause of death in the world [1]. The global average incidence of OOHCA with a presumed cardiac cause was 54.6 per 100 000 person-years [1]. Cardiac arrest is the sudden cessation of the development of ventricular fibrillation/sustained ventricular tachycardia, or cardiac mechanical activity, due to asystole, pulseless electrical activity (PEA). Regardless of the rhythm initiating cardiac arrest, the implementation of chest compressions is the most important element of resuscitation. According to ILCOR 2015 recommendations [2], the chances of survival during an out-of-hospital cardiac arrest as well as during in-hospital cardiac arrest, strongly depend on early and high quality cardiopulmonary resuscitation (CPR), meaning CPR with chest compressions performed with correct depth (between 5 and 6 cm), correct rate (between 100 and 120 compressions per minute), correct hand position and complete chest recoil [3,4]. Both the depth of chest compressions and the degree of its recoil directly affect the induction of organ perfusion, which affects cardiac output and therefore survival from cardiac arrest. [5].

The purpose of the study was to compare two cardiopulmonary resuscitation techniques depending on the position of the rescuer with respect to cardiac arrest victim.

Material and methods

The study protocol was approved by the Institutional Review Board of the Polish Society of Disaster Medicine (Approval no.: 23.06.2017.IRB). The study is a continuation of the study undertaken by the authors to determine the optimum position during chest compression [6].

34 nurses with no more than 5 years of professional experience participated in the study. The study was conducted during training sessions organized by EasyRescue. Participation in the study was voluntary and all participants in the study expressed their willingness to participate.

Prior to the study, all participants participated in a Basic Life Support course based on the American Heart Association guidelines by accredited AHA instructors. One month after the course, the participants were asked to perform a two minute cardiopulmonary resuscitation in one rescuer scenario, with manual chest compression, and rescue breaths were performed using a PocketMask. The participants were asked to perform chest compressions using two techniques:

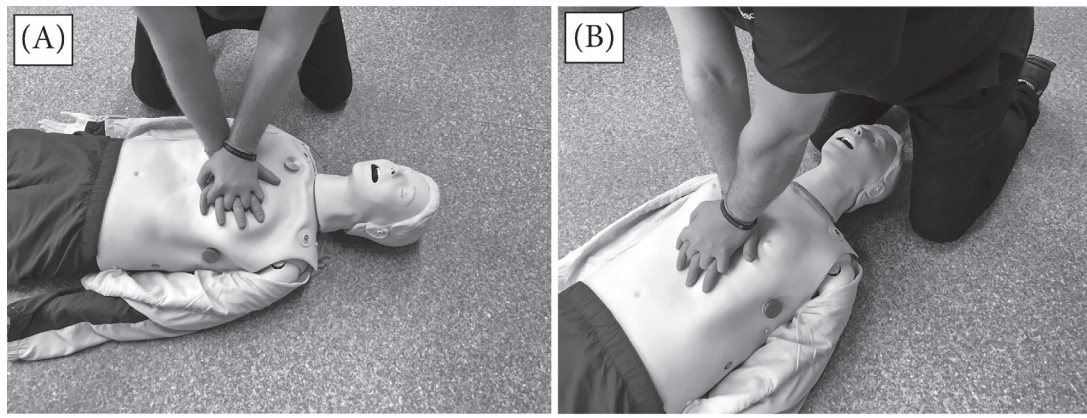
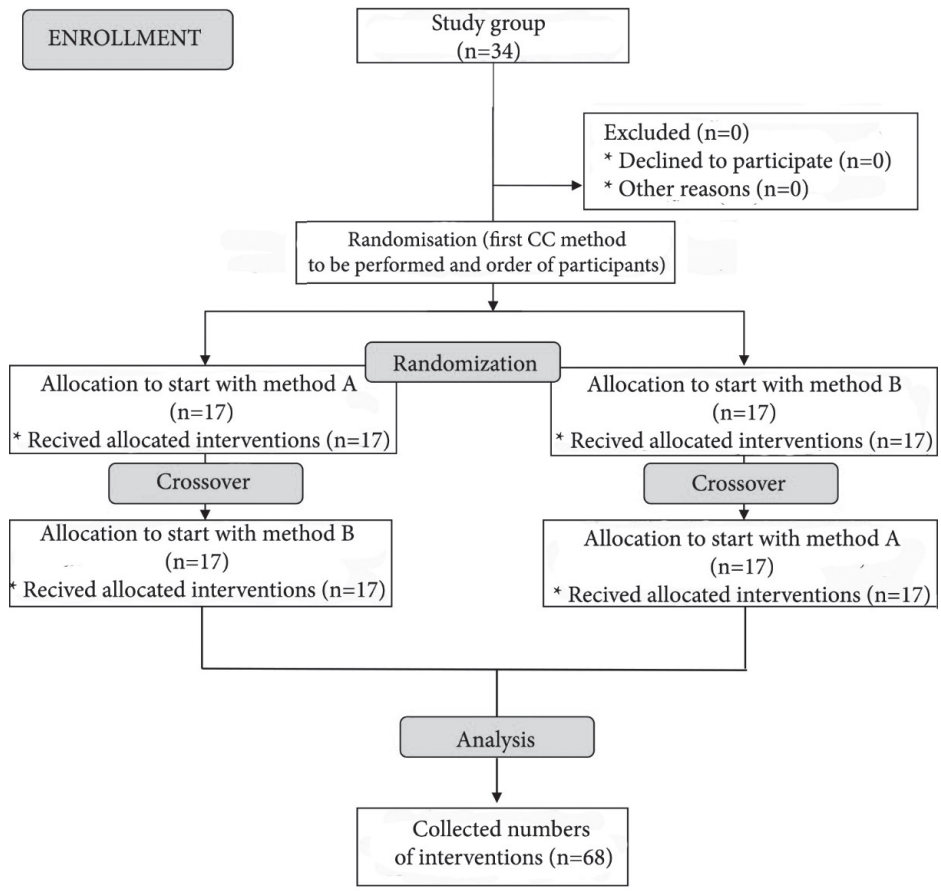


Figure 1. Chest compression methods
(A) - chest compression while being localized on the victim's side (control technique - classic)
(B) - chest compression while being localized behind the victim's head



CC= Chest compressions
Method A = Chest compression while being localized on the victim's side (control technique - classic)
Method B = Chest compression while being localized behind the victim's head

Figure 2. Randomization flow chart

1) Chest compression while being localized on the victim's side (control technique - classic)
2) Chest compression while being localized behind the victim's head (figure 1).

Both participants order and methods of chest compression were random. For this purpose, ResearchRandomizer (www.randomizer.org) was used (figure 2). The Advanced Skill Trainer training manikin (Laerdal, Stavanger, Norway) to simulate a patient with cardiac arrest positioned on the floor in a brightly lit room was used.

The quality of chest compressions, such as the rate of chest compressions, the depth of compression, the degree of complete chest relaxation, and the interruption in chest compression for rescue breathing were assessed during the study. The analyzed parameters were evaluated on the basis of data provided by the SIMPad monitoring device connected to the manikin (Laerdal, Stavanger, Norway).

The results are shown as numbers (percentages), or medians and interquartile ranges (IQR). Data were analyzed using Statistica 13.2 EN (StatSoft, Tulusa, OK, USA). The occurrence of normal distribution was confirmed by the Kolmogorov-Smirnov test. When the data were not characterized by normal distribution, non-parametric tests were used. All the statistical tests were two-sided. The p-value of less than .05 was considered significant.

Results

The study involved 34 nurses (all female). Median age of participants was 28.5 years [IQR; 25-32.5], and the median of professional work experience was 4 years [IQR; 3.5-5].

No flow time in chest compression was 8 seconds when chest compressions were performed from the victim's side, and in the case of resuscitation from behind the victim's head, and the interruption in chest compression was 6 seconds ($p < 0.001$). The chest compression rate using the distinct chest compression methods varied and amounted to 121 [IQR; 115-125] for chest compressions performed from the victim's side *vs.* 115 [IQR; 110-116] in the case of resuscitation from behind the victim's head ($p < 0.001$; figure 3).

The degree of full chest relaxation during resuscitation from the victim's side was 67 [IQR; 3-88]% *vs.* 70 [IQR; 38-90]% behind his head ($p = 0.002$). Also, the correctness of the hand position on the chest was higher in the case of chest compression performed from behind the victim's head (100 [IQR; 92-100]%) compared to resuscitation from the victim's side (83 [IQR; 34-91]%; $p < 0.001$). There was no statistically significant difference in the depth of compression between the chest compression techniques ($p = 0.377$; table I).

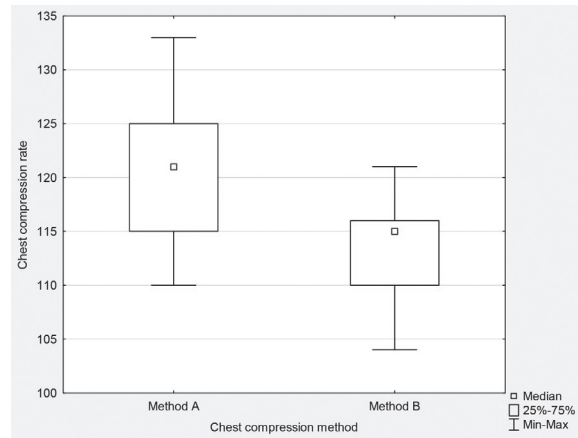


Figure 3. Median chest compression rate
Method A - chest compression while being localized on the victim's side (control technique - classic)
Method B - chest compression while being localized behind the victim's head.

Table I. Chest compression parameters

Resuscitation parameter	Chest compression from behind the victim's side	Chest compression from behind the victim's head	p-value
No flow time (s)	8 [IQR; 7-8]	6 [IQR; 5-6]	< 0.001
Chest compression depth (mm)	55 [IQR; 52-62]	55 [IQR; 52-54]	0.377
Chest compression rate (/min^{-1})	121 [IQR; 115-125]	115 [IQR; 110-116]	< 0.001
Full chest recoil (%)	67 [IQR; 3-88]	70 [IQR; 38-90]	0.002
Correct hand placement (%)	83 [IQR; 34-91]	100 [IQR; 92-100]	< 0.001

Discussion

External chest compressions are the key elements of circulatory support during cardiopulmonary resuscitation. The American Heart Association, as well as the European Resuscitation Council guidelines emphasis that the high quality chest compression include correct chest compression rate and depth as well as correctness of chest recoil, and the correctness of the position of the hands on the chest during compression [7,8].

In our study the depth of chest compression between analyzed resuscitation techniques was statistically insignificant and the median depth in both cases was 55 mm, which according to the resuscitation guidelines is consistent with the recommendations [7]. Tanaka et al. [8], showed that rescuers who compressed the chest with the use of the Little Anne manikin (Laerdal, Stavanger, Norway) performed the chest compression to a depth of about 45mm.

Yuksen et al. [9] suggested in his study that subjects performed chest compressions at a rate of approximately 108 min^{-1}. In our study the rate of chest compression was 115 min^{-1} from behind the head resuscitation and 121 min^{-1} for resuscitation performed from the victim's side.

As indicated by Kuzolev et al. [10] the healthcare providers have low chest compression skills. Odegaard et al. [11], indicated that continuous chest compressions without ventilations gave significantly more chest compressions per minute, but with decreased compression quality. However, in our study, cardiopulmonary resuscitation was performed with a sequence of 30 chest compressions to 2 rescue breaths ratio.

It is worth emphasizing that chest compressions with appropriate depth decreased more rapidly during chest compression-only CPR than conventional CPR [12].

Another important factor influencing the quality of resuscitation is chest wall recoil. Complete chest wall recoil improves hemodynamics during cardiopulmonary resuscitation (CPR) by generating relatively negative intrathoracic pressure, causing the same cardiac preload prior to the next chest compression phase [13]. In study performed by Aufderheide et al., incomplete chest wall decompression was observed at some time during resuscitative efforts in (46%) consecutive adult out-of-hospital cardiac arrests [13]. Moreover, Yannopoulos et al. [14], suggest that incomplete chest wall recoil during the decompression phase of cardiopulmonary resuscitation increases endotracheal pressure, impedes venous return and decreases mean arterial pressure, and coronary and cerebral perfusion pressures.

This study has specific limitations due to medical simulation trial techniques. However, the use of manikin is the only method of measuring the quality of chest compression as well as the method used by all medical universities in Poland for both basic and advanced resuscitation training.

The choice of the nursing team for the study was justified by the fact that nurses, same as paramedics often face with cardiac arrest either in the clinic or in the hospital ward, and it their duty to quickly start the chain of survival, including the rapid implementation of high-quality chest compression. An undoubted advantage of the study is its randomized cross-over character, which allows to fully compare the predispositions of the participants in this particular area.

Conclusions

In this simulation study, nurses performed higher quality chest compressions in case of resuscitation behind the victim's head than in the standard position when the resuscitation was performed from the victim's side.

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Conflict of interest
None

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