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SELECTED FACTORS DETERMINING THE QUALITY OF CARDIOPULMONARY RESUSCITATION PERFORMED BY HEALTHCARE STUFF WITHOUT MEDICAL DEGREE[6]

Abstract:
*Introduction. A sudden cardiac arrest may occur in both intra-hospital and non-hospital environment. High quality of cardiopulmonary resuscitation (CPR) performed by bystander may be of crucial importance in increasing the survival rate. **Aim:** The aim of this study was to assess the influence of selected sociodemographic factors on the quality of CPR performed by healthcare stuff without medical degree. **Material and methods:** The simulation observational study was conducted among 138 healthcare employees without medical degree. Every subject performed CPR on the adult life-like manikin Little Anne QCPR.*

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*The frequency and depth of compressions, relaxation and ventilation volume were measured and analyzed with the aid of dedicated SkillReporter Software Resusci Anne tablet. The measurable values were related to the guidelines of European Resuscitation Council 2021. The statistical analysis was calculated with SPSS 20 statistical software. **Results:** Based on authors' own research, it was concluded that during CPR activities, females were more efficient in chest compressions with slower ventilation of high average volume, whereas males had higher average compression rate with sufficient depth and they ventilated faster and more shallow. Moreover, the higher number of chest compressions of adequate depth was observed with older age group with no significance in obtained ventilation parameters in both groups. People who completed basic resuscitation training, obtained significantly higher average results of ventilation and better tidal volume from the ones without such training. **Conclusions:** The gender, age and basic training in CPR substantially differentiate the quality of obtained cardiovascular and respiratory parameters. The acceptable quality of cardiovascular parameters with inadequate ventilation parameters were presented.*

Keywords:
cardiopulmonary resuscitation, hospital personnel, non-medical persons

Introduction

According to European Resuscitation Council (ERC) the frequency of occurrence of sudden cardiac arrest (SCA) in Europe ranges between 67 to 170 cases per 100 thousand residents per annum. The incidents most frequently happen in unexpected locations and times, thus creating a serious medical and social problem [1]. In United States alone, the cardiac arrest is registered among 290 thousand hospitalized patients, the main cause being heart (50-60%) and respiratory failure (15-40%) [2]. The priority actions at the scene include a fast emergency assistance, early resuscitation, ventilation and defibrillation. Early and correct proceeding is closely related with better treatment results of hospitalized patients and in out-of-hospital conditions [2,3]. The employment in health care center may increase the risk of contact with the patient in a life-threatening condition. Therefore, they are more often exposed to the situation which requires providing first pre-medical aid. Immediate rescue actions have a decisive influence on the health and life of the victim [4].

The analysis of the national results of the study showed the apparent interest in the respondents' knowledge level. The authors indicate the necessity of confronting the knowledge with the practical skill competence assessment, an essential element of the resuscitation activities [5,6]. The research into the

source of knowledge in the field of the first aid indicated the significant role of television – including the series, social media and also the word of mouth among friends and families. Nevertheless, such knowledge is different from the evidence-based medicine [7,3]. There is a research gap in the study where practical skills of potential rescuers were analyzed.

The main factors that may influence the standard of performed activities at the scene include: awareness, technique and fatigue of the rescuer, individual factors and training. Unfortunately people without medical degree are still unwilling to undertake direct life-saving activities, stating the reasons such as the fear of infection, inappropriate cardiopulmonary resuscitation (CPR) activities and legal consequences of such actions [8]. Additionally, students should be informed of the potential risks during CPR training. [9,10].

Current strategies of improving the quality of cardiopulmonary resuscitation should be based on the research results, including the technology to monitor the quality of cardiopulmonary resuscitation and provision of feedback [3]. The following study allows to determine whether the selected variables such as gender, age and training completion significantly influence the correct and effective execution of cardiopulmonary resuscitation.

Aim

The aim of this work was to assess the influence of sociodemographic factors on the quality of cardiopulmonary resuscitation performed by healthcare employees with no medical degree.

Material And Methods

The study received positive approval issued by the Bioethics Committee of the University of Rzeszów (Nr 2018/03/13e). It was conducted between July and September of 2017. The study took place in the Independent Public Healthcare Centre in Przeworsk.

The test group consisted of 138 healthcare employees with no medical degree employed in the facility. The sample selection was purposive. The accepted eligibility criteria included: voluntary participation, physical fitness that allows chest compression and ventilation, no medical degree directly connected with CPR in the workplace and employment in the medical sector. Non-inclusion criteria included: absence of consent to participate in the study, medical contra-indications disallowing chest compression and ventilation of manikin, working as a doctor, nurse, midwife or paramedic.

The sample group was divided into two age categories of 27-51 years of age (younger age group n=67), and older age group (n=71) 52-67 years of age. The division was made based on median age of the test subjects. The

sample group consisted of 60.1% females (N=83) and 39.9% males (N=55). 11.6% of the study group (N=16) including 16.4% males (N=9) and 8.4% females (N=7) underwent CPR training.

Immediately prior to the proper measurement, study participants were presented with simulation scenario for performing a two minute cardiopulmonary resuscitation in accordance with individual knowledge and skills. The activity was performed on the adult life-like manikin Little Anne QCPR (Laerdal Resusci Anne®, 50 kg, Laerdal, Norway). The measured activity parameters were registered through a monitoring panel SimPad SkillReporter Software Resusci Anne (Laerdal Norway 2015) for QCPR Little Anne manikins (Laerdal Resusci Anne®, 50 kg, Laerdal, Norway).

The following evaluation criteria were adopted:
1. chest compressions at a rate of 100-120 per minute with minimum intervals, waiting after each compression to regain its original shape,
2. chest compressions to the depth of below 5 cm, with 5-6 cm of correct value, above 6 cm,
3. ventilation below 500 ml, 500-600 ml of correct value, above 600 ml over-ventilation.

To verify the differences among variables, χ2 independence test, t test for independent samples and U Mann-Whitney test were used. The tests were selected to verify normality distributions of variables (Kolmogorow-Smirnov test with Lillefors modification and Shapiro-Wilka test). Moreover, the equipotency of groups was verified with χ2 test. The significance level was adopted to $p < 0.05$. The calculations were performed with SPSS 20 software.

Results

Based on authors' own research, it was concluded that the average percentage of chest compressions with adequate depth and its mean depth were significantly lower with females with reference to males ($p<0.001$). Notwithstanding, the female test group obtained a significantly higher percentage of fully released compressions (K: 85.93±26.31 vs. M: 68.09±35.03; $p<0.001$). Despite indicated differences, no significant variances in the mean percentage results of compressions for both genders were observed. In terms of ventilation parameters, males achieved a significantly higher mean tidal volume (380.78±523.46ml) than females (157.49±305.52 ml). The were no statistically significant differences observed for the ventilation of adequate tidal volume, considering the gender of the test group ($p=0.647$) (Table 1).

Table 1. The characteristics of selected parameters versus the gender of test subjects

Parameters	Females (N = 83)	Males (N = 71)	P-value
Average number of compressions [%]	59.1±32.1	62.4±30.8	0.546
Compressions fully released [%]	85.9±26.3	68.±35	< 0.001
Compressions with adequate depth [%]	53.9±40	85.5±28.2	<0.001
Mean depth [mm]	50.1±9.8	57.1±6.6	<0.001
Compressions with adequate frequency [%]	25.9±35.5	28.4±33.4	0.401
Average result of ventilation [%]	10.1±25.7	15.4±25.7	0.030
Tidal volume [ml]	380.78±523.46	157.4±305.5	0.014
Ventilation with adequate volume [%]	6.96±18.64	7.1±16.6	0.647
The frequency of all ventilation per session [/min]	0.55±1.34	1±1.5	0.019

Mann-Whitney U Test ; N – number of persons, the significance level was adopted to p<0.05

Source: own study.

Considering the age of the test subjects, the higher average percentage of chest compressions with adequate depth were with people of 52-67 years of age (71.5±37.9%) than with people of 27-51 years of age (61.2±39.5%). Moreover, in the older group, the average depth of compressions was significantly higher than with the younger group of 27-51 years of age (p=0.01). The average number of chest compressions fully released was significantly higher with people of 27-51 years of age (84.3±27.1%) than with people of 52-67 years of age (73.2±33.8%) (Table 2).

Table 2. The characteristics of selected parameters versus the age of test subjects

Parameters	Younger group 27-51 (N=67)	Older group 52-67(N=71)	P-value
Average number of compressions [%]	61.3±34.4	73.2±33.8	0.528
Compressions fully released [%]	84.3±27.1	73.2±33.8	0.002
Compressions with adequate depth [%]	61.2±39.5	71.5±37.9	0.037
Mean depth [mm]	50.9±9.1	54.7±9.3	0.014
Compressions with adequate frequency [%]	34.1±37.6	20.1±30.2	0.042
Average result of ventilation [%]	14.6±28.7	9.7±22.6	0.526

	219.7±377.8	271.7±456.4	0.945
Tidal volume [ml]	219.7±377.8	271.7±456.4	0.945
Ventilation with adequate volume [%]	9.5±21.1	4.6±13.8	0.223
The frequency of all ventilation per session /min	0.8±1.5	0.6±1.3	0.618

Mann-Whitney U Test ; N – number of persons, the significance level was adopted to p<0.05

Source: own study.

Analytical determination of table 3 indicates that people with BLS training had significantly higher average result of ventilation (38.31±36.1%) than test subjects without such training (8.67±22.1%). Moreover the test group with BLS training had a higher average of tidal volume (635±522.6%) than test subjects without such training (195.52±377.79%). There were no statistically significant differences for ventilation with adequate tidal volume considering the BLS training among test subjects. There were no observed differences in quality of chest compressions for test subjects without CPR training (53.38±8.25) and with CPR training (53.38±8.25).

Table 3. The characteristics of selected parameters versus BLS training among test subjects

Parameters	BLS training		P-value
	YES (N=16)	NO (N=122)	
Average number of compressions [%]	66.5±32.8	59.6±31.4	0.420
Compressions fully released [%]	85.8±21.5	77.8±32.2	0.863
Compressions with adequate depth [%]	68.3±38.7	66.3±39.1	0.830
Mean depth [mm]	53.3±8.2	52.8±9.5	0.896
Compressions with adequate frequency [%]	32.7±36.6	26.1±34.4	0.332
Average result of ventilation [%]	38.3±36.1	8.6±22.1	< 0.001
Tidal volume [ml]	635. 0±52.6	195.5±377.7	0.002
Ventilation with adequate volume [%]	12.8±22.5	6.2±17.0	0.087
The frequency of all ventilation per session [/min]	2.3±2.02	0.5±1.2	<0.001

Mann-Whitney U test ; N – number of persons, the significance level was adopted to p<0.05

Source: own study.

The general percentage result while performing a two minute cardiopulmonary resuscitation for males equaled to (46.6±24.3%) and was comparable (p=0.51) to an average general result for females (44.1 ±24.6%). There were no statistically significant differences for the general result, including the age of test subjects (p=0.43). It was proven that people with BLS training decisively reached a higher general result (55.1±25.5%) than test subjects without such training (43.8±24.1%) (Table 4).

Table 4. Overall results by individual groups of subjects

Parameters		Overall result	P-value
Gender	Females	44.11 ±24.64%	0.519
	Males	46.69±24.35%	
Age [years]	27-51	46.57±26.44%	0.438
	52-67	43.79±22.56%	
BLS training	Yes	55.13±25.53%	0.045
	No	43.83±24.13%	

Mann-Whitney U test ; N – number of persons, the significance level was adopted to p<0.05.

Source: own study.

Discussion

The study assessed the influence of sociodemographic factors on the quality and efficacy of CPR activities performed by healthcare employees with no medical degree. The observation of test subjects revealed that resuscitation skills are not satisfactory. This applies to respiratory parameters, where volume of air was lower than accepted criteria for the test groups. The lower frequency of chest compressions versus the expected was also observed. Similar conclusions were described by Sitek et al., where the need was raised to study the quality and efficacy of CPR activities in practical simulations to check and correct mistakes [11]. Moreover, research carried by Szpunar et al. interestingly confirms the fact that non-professional knowledge and frequent passive eyewitness participation in CPR activities are not sufficient to perform correct resuscitation [12]. Król et al. share similar conclusions in analyzing knowledge of CPR amongst young people, stating furthermore that beside theoretical information, practical skills are of crucial importance with necessity of undertaking appropriate periodical basic CPR trainings, customized for the specific social group, underlining the fact of systematic changes in SCA

treatment algorithm [13]. It is also worth noting the observations of Więch et al., where research of medical test group proved a significant influence of body composition of people performing resuscitation on the chest compression and ventilation parameters. Over-mentioned authors describe the results of relation between anthropometrical measurements, nutritional status of participants and quality and efficacy of CPR [14].

Lin et al. In studies show that high-quality CPR improves survival outcomes. The author indicates the measurement of CPR process parameters as a standard in studies assessing the quality of resuscitation. It also describes the significant impact of real-time training feedback on the improvement of CPR quality in accordance with the guidelines [15, 16]. Souchtchenko SS mentions the correct positioning of the hands on the chest, the depth, the frequency of compressions, the degree of chest relaxation and properly conducted ventilation as factors significantly affecting the effectiveness of resuscitation [17]. Sari et al. Observed in the study that the use of the chart during CPR improves the quality of resuscitation [18].

Based on authors' own research, the number of chest compressions with adequate depth was significantly higher with older people of 52-67 years of age and amounted to 72% in relation to younger people of 27-51 years of age. Presented results were similar to the ones obtained by Fernando et al., where number of chest compressions with adequate depth were at 66% and 55%, with the average age of participants set at 62.3 years of age [19]. Skorning et al. obtained the results of chest compressions with adequate depth in the test group of 21-61 at the level of 45 % [20]. In turn, other research of chest compressions with adequate depth showed 70% in the test group of average age of 23 years (IQR 21-32) [21].

Non-medical healthcare employees achieved the depths of chest compressions on the level of (61.2±39.5). However, the study of Bucki et al. showed lower results for non-professionals of 36.03±1.22 mm. [22]. Analysis of gender influence indicated the fact that males had better results in depth of chest compressions (57.18±6.69) than females (50.10±9.88). The research of Lopez-Gonzalez et al. showed the data concerning the gender influence on the quality of chest compressions. The authors suggested that gender did not determine the efficacy of compressions, but the physical fatigue and BMI of the test subjects did, which would explain lack of unambiguous dominance of gender in the results obtained [23]. On the other hand, other studies also indicated that gender had a statistical significance on the number of male chest compressions [24].

Within the test group, the average result of ventilation among people with BLS training was 38%, whereas people without such training had merely 8.6%. Ventilation with adequate volume in the test group was 6.9% for males and 7.1% for females, thus indicating lack of differences for the results

considering the gender and age of test subjects. It is well worth noticing the study results of Iskrzycki et al., where efficient ventilation was on a high level (approx. 91%), with ventilation of adequate volume reaching around 33% [21]. Analysis of the study results obtained in the test group showed the highest differences in the variable of BLS training. People with completed training indicated higher level of general efficacy of resuscitation. The general result while performing a two minute cardiopulmonary resuscitation within the test subject group was 25.5-55.1%, thus indicating a low level of execution of the resuscitation. The results were similar to those achieved by Kurowski et al. (approx. 40%), and much higher to those of Iskrzycki et al. (approx. 61%) [21,25].

The conducted study showed a low level of performance of ventilation and chest compressions among the group of healthcare employees with no medical degree. The need of additional trainings and skill improving activities for the respondents, resulting in better quality of cardiopulmonary resuscitation in the out-of-hospital environment, is evident.

The limitations of the study

The study registered some limitations. We have assessed the practical skills of respondents and their influence on correct CPR activities. The male test group was decisively less numerous, but with a higher percentage of people who underwent CPR training in comparison to females. Moreover, people with CPR training represented a proportionally less numerous group. Additional limitation was the use of manikin in the CPR activities, which only provided similar conditions to real scenarios, suggesting a lower engagement of test subjects.

Conclusions:

The gender, age and basic training in CPR substantially differentiate the quality of obtained cardiovascular and respiratory parameters. The acceptable quality of cardiovascular parameters with inadequate ventilation parameters were presented.

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