Effectiveness of digital resuscitation pad technology innovation on the accuracy of cardiac and lung resuscitation compression

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ABSTRACT

Background: *Cardiac arrest is a crucial problem because it has a short rescue time and requires optimal assistance competence. The global incidence of cardiac arrest is 50-60 per 100,000 per year, while in Indonesia it is 10,000 per year or 30 incidents every day. This is an important problem that must be addressed immediately, apart from improving skills, by using innovative supporting tools. This tool is still very limited and does not even exist in Indonesia.*

Objectives: *To determine the effectiveness of digital resuscitation pads (petitions) on the accuracy of compression of cardiac and pulmonary resuscitation.*

Methods: *The number of samples in this study was 46 respondents as the case group and as the control group. In the case group, we provided the innovative Digital Resuscitation Pad tool and the rhythm of tapping to perform compressions, while in the control group they were only guided by the rhythm of tapping. The inclusion criteria include respondents who have practiced CPR for lay people appropriately. The instrument uses a questionnaire with a validity test of r table 0.621 and reliability r table 0.539. The analysis uses the Wilcoxon test using total sampling.*

Results: *Based on the researchers' findings in this research, in the control group, 56.52% of respondents performed inappropriate compression, meaning that 26 respondents, more than half of the respondents provided compression that was not of good quality. After being given the Digital Resuscitation Pad, compression quality increased to 86.95% or 29 respondents provided quality compression.*

Conclusions: *There is an influence of the Digital Resuscitation Pad on the accuracy of Cardiac and Pulmonary Resuscitation compressions. Researchers concluded that the Pad Digital Resuscitation device could improve the quality of student compressions over a measurable distance even though BMI indirectly plays an important role in nurses' performance in providing optimal cardiopulmonary resuscitation.*

INTRODUCTION

The cessation of heartbeat is a sudden loss of the heart's pumping function, this is caused by electrical damage in the heart, which results in an irregular heartbeat (arrhythmia) which then causes interference with the heart's pumping process, so that the heart cannot pump blood flow to the brain. lungs, and other organs (1).

Out-Of-Hospital Cardiac Arrest (OHCA) is a cardiac arrest that occurs outside the hospital. Due to its high incidence, OHCA has become one of the hotspots for global health problems. The global incidence of OHCA is 50-60 per 100,000 per year (2). In the United States, the incidence of OHCA is 300,000 and 420,000 in Europe (3). It is estimated that the incidence of OHCA in Indonesia is 10,000 per year or 30 OHCA incidents occur every day. Following the high incidence of OHCA, the survival rate for OHCA patients is very low, only 12%(4). The main reason for the low survival rate of OHCA victims is delays in reporting and management of cardiopulmonary resuscitation (CPR).(5).

Efforts that can be made to increase the number of amateur CPR practitioners include providing training to the public on how to carry out appropriate CPR interventions (5). The results show how important emergency training is for the general public. However, the reality, knowledge or skills that exist in the community regarding cardiac arrest and its treatment are not yet adequate. This is based on the results of a survey) in Yogyakarta. In Yogyakarta, the majority of executives have never received emergency training in the community (56.3%) and underestimate their level of personal preparedness to deal with emergencies (55.3%) (6).

The general public who provides initial treatment to emergency victims needs to learn three basic methods for handling emergency victims, including: asking for help, mastering basic life support techniques (Cardiopulmonary Resuscitation) and mastering how to stop bleeding (7). Meanwhile, even though there has been a lot of training on cardiopulmonary resuscitation measures, there are still many location or location errors when performing chest compressions.

Considering the importance of skills in performing CPR in handling cardiac arrest and not knowing where chest compressions are to be performed, it is necessary to have an understanding of the location and have the skills to carry out cardiopulmonary resuscitation measures. The incidence of cardiac and pulmonary arrest outside of health facilities can increase the mortality rate

due to cardiac arrest. Other factors related to the competence of lay people in performing compression are still very lacking, such as the inaccuracy of location when performing cardiac compression. This is an important problem that must be addressed immediately, apart from improving skills, by using innovative supporting tools. This tool is still very limited and does not even exist in Indonesia. The aim is to determine the effectiveness of digital resuscitation pads (petitions) on the accuracy of compression of cardiac and pulmonary resuscitation.

MATERIALS AND METHODS

This research is a quantitative study using analytical observational methods with a cross sectional approach. This study aims to determine the effectiveness of the Digital Resuscitation Pad on the accuracy of cardiac and pulmonary resuscitation compressions. All respondents will perform CPR according to procedures using Phantom CPR (Cardiac and Lung Resuscitation) media which is equipped with an indicator light which is useful for determining the depth when performing phantom chest compressions. The indicator light has 2 colors which will light up according to the depth during compression. If it is green, it indicates that the depth is exactly 5-6 cm, if it is red, then the depth is more than 6 cm.

The number of samples in this study was the KSR PMI team, 46 respondents as the case group and as the control group. In the case group, we provided the innovative Digital Resuscitation Pad tool and the rhythm of the beats for compression, while the control group's pad was only guided by the rhythm of the beats. In this study, the sampling used was total sampling. The instrument used in this research is a observation format developed by researchers. This structured format contains an assessment format for patient characteristics and an observation format containing height, weight, BMI and depth at the time of compression. The compression depth is obtained from the color of the indicator on the Phantom RJP. The analysis test in this study used the Wilcoxon Test. This study has been carried out an ethical research at Universitas Muhammadiyah Purwokerto with number KEPK/UMP/109/V/2023.

Data collection is carried out once and at that time. Before the respondent performs CPR, the respondent will first be given education on how to carry out Cardiac and Pulmonary Resuscitation. After obtaining valid data, the researcher will calculate the respondent's BMI

percentage. After that, the respondent was instructed to perform CPR and researchers observed the depth of pressure during chest compressions via the indicator light on the Phantom CPR using the Digital Resuscitation Pad device.

Validity and reliability tests were not carried out because the instrument in this study used SPO taken from the Indonesian National Nurses Association SPO Book and an observation sheet to observe the lights displayed on the CPR phantom according to the compression depth. This research began with a presentation of CPR material and a CPR demonstration. Furthermore,46 research samples performed CPR without using PETISI and assessed the quality of compression using the indicator light on the phantom. Next, 46 samples were given PETISI during compression, and the compression quality was assessed using the indicator light on the phantom.

RESULTS AND DISSCUSSION
RESULTS

Based on **Table 1**, it was found that the frequency distribution of respondents based on gender was 14 respondents (30.4%) male, while 32 respondents (69.6%) were female. Frequency distribution based on age, 20 years old were 18 respondents (39.1%), 21 years old were 21 respondents (45.7%), 22 years old were 7 respondents (15.2%). Frequency Distribution based on BMI, <14.9 as many as 8 respondents (17.4%), BMI 15-18.4 as many as 17 respondents (37%), 18.5-22.9 as many as 17 (37%), and BMI > 23 as many as 4 (8.7%). The color frequency distribution of pre-administered Digital Resuscitation Pad indicators was 26 (56.5%) red and 20 (43.5%) green. The color of the indicator post was given by the Digital Resuscitation Pad with 17 (37%) red and 29 (63%) green.

Table 1. Frequency distribution based on gender, age, BMI and compression quality

Variable	Frequency	Presentage (%)
Gender		
Male	14	30.4
Female	32	69.6
Age		
20	18	39.1
21	21	45.7
22	7	15.2
IMT		
<14.9	8	17.4
15-18.4	17	37
18.5-22.9	17	37
>23	4	8.7

Variable	Frequency	Presentage (%)
Compression Colour		
Control Group		
Red	26	56.5
Green	20	43.5
Intervention Group		
Compression Colour		
Red	17	37
Green	29	63

Based on **Table 2**, the results of the pre-test and post-test bivariate analysis of CPR using the Digital Resuscitation Pad used the Wilcoxon p-value test of 0.039, p-value < 0.05, so there is an influence of the Digital Resuscitation Pad on the accuracy of Cardiac and Lung Resuscitation compressions (Ha accepted).

Researchers found in this research that before using the Digital Resuscitation Pad, 56.52% of respondents performed inappropriate compression, meaning that 27 respondents, more than half of the respondents provided compression that was not of good quality. After being given the Digital Resuscitation Pad, the quality of compression increased to 63% or 29 respondents provided quality compression.

Apart from that, researchers also found that after entering the 3rd cycle, the depth of compression also changed and was inconsistent for 65.21% or 30 respondents. which is dominated by women even though the distance from the sternum to the compression point is correct.

Table 2. Bivariate test Wilcoxon effect of digital resuscitation pad on respondents' compression quality

	Mean	SD	*p-value*
Pad Digital Resuscitation (Intervention Group)	1.63	0.488	0.039
Control Group with bytstander	1.43	0.501	

DISSCUSSION

The Pad Digital Resuscitation tool in this study was used as a medium to assist the CPR simulation learning method in the intervention group. This tool is designed to determine the distance or location for chest compressions by measuring the distance from the mandible to the mid sternum.

The researchers' findings in this research were that in the control group, 56.52% of respondents performed compressions that were inaccurate, meaning that 26 respondents, more than half of the respondents provided compressions that were not of good quality. After being given the Digital Resuscitation Pad, the compression quality increased to 86.95%

or 29 respondents provided quality compression, apart from that the researchers also found that after entering the 3rd cycle, the compression depth also changed and was inconsistent at 65.21% or 30 respondents were predominantly female even though the distance from the sternum to the compression point was correct.

The results of this study are in line with research conducted by Gonzaleza, stating that the CPR algorithm using assistive devices was proven to be reliable and accurate when tested retrospectively with out-of-hospital cardiac arrest events. CPR aids can help in the field of resuscitation. The tool used in this research is almost similar to the tool made by researchers, namely that they both use sensors for compression accuracy, the difference is that in Fanshan's research the sensor is used to detect tilt, in our research the sensor is used to detect the accuracy of the distance of the point on the sternum to be carried out. compression (8).

According to Jin Wang, innovative strategies are needed to increase the number of trained CPR providers. There is an opinion that video-based CPR teaching can be used as a simple tool to teach CPR, so that it can reach a larger group of people (9). In a rural Danish island community, mass education regarding basic life support (BLS) and a year-long television campaign led to a significant increase in confidence in providing chest compressions and mouth-to-mouth ventilation (10).

Noventra's research uses Q-CPR technology which relies on additional sensors to detect the rescuer's tilt. However, human chest stiffness varies greatly between patients and with time throughout the resuscitation cycle. The accelerometer senses chest displacement, which in this case corresponds to the amount of chest compression and mattress compression. A possible solution to this problem is to use two accelerometers. Despite these limitations, he thinks this tool is a reasonable tool for comparison in providing quality compression.. Noventra & Lim also supports the results of this research that the resuscitation device made by Noventra, within a period of 1 minute, produced 100 compressions and within a period of 18 seconds, produced 30 compressions. The movement of the stepper motor meets American Heart Association standards, so this tool is also effectively used to improve compression quality (11).

The researchers' findings were that after entering the third cycle, the depth of compression also changed and was inconsistent as much as 65.21% or 30 respondents who were predominantly

female. This has been discussed in previous research that body mass index (BMI) plays a role in this. Endiyono, Adhi, & Setiyabudi, (2022) stated that someone who has a high and low BMI category when performing chest compressions on a patient will experience fatigue, especially with a high BMI, it will be difficult to perform chest compressions when getting into bed (12).

Manual chest compressions without mechanical CPR require a lot of energy. Rescuers who are underweight will have difficulty reaching compression depth when performing CPR. The higher the BMI, the deeper the compression, but you will quickly experience fatigue and experience incomplete chest recoil. The higher the BMI, the greater the person's strength will be and can cause thoracic trauma during compression. A lower BMI will decrease compression strength and affect chest compression depth. Therefore, BMI needs to be considered to create appropriate and high-quality chest compressions (12).

This is similar to research from Bruska, Szankin, Ratajczak, & Fabiszak, (2021) that in his research, improving the quality of CPR with the help of compression devices, the average compression frequency significantly increased the compression quality (5). No differences were found between the medical personnel group and the student group. The main difference between students and medical workers concerns compression frequency, which favors the student group. However, the overall quality of CPR was similar in both groups.

According to Laksita (13), rapidly developing technology makes it possible to use the features of mobile phones to help increase the speed and quality of first aid. Findings from some studies discuss the weaknesses of the application or hardware used so that users experience difficulties in using it which results in delays in providing first aid. There were also obstacles in Patricia's research regarding the placement of devices when administering RJP which was then overcome by transferring functions to wearable devices such as smartwatches. Extension equipment and automatic sensors connected to smartphones need to be developed to make it easier to provide CPR (14). Health technology innovation tools make it possible to help lay people perform quality CPR.

Recent research has also developed measurements of heart rate, electrocardiogram (ECG), and temperature with the latest system, namely the Internet of Things (15) (16). These two applications have the potential to reduce deaths from heart attacks. This relates to treatment that

can be given immediately before a heart attack occurs. However, both of these studies are still limited to application development and system improvements are still needed. To test the accuracy of this application, trials need to be carried out (17). Findings from several studies discuss the weaknesses of the application or hardware used so that users experience difficulty in using it which results in delays in providing first aid (18).

This research is in line with Vilhar, that the use of location detection features has the potential to improve CPR by trained lay volunteers. However, existing research is still rarely conducted, making it difficult to determine its effectiveness. The use of a nearby helper recruitment system is important, especially in areas where it is difficult to reach emergency services quickly (16). Based on a scoping review, BLS training involving a large portion of the population or combined interventions could be considered to increase bystander CPR rates among laypeople in OHCA cases should use additional tools that utilize technology to empower them to provide help (19). It can also provide advice to decision makers and other stakeholders to develop and implement policies and guidelines to involve lay people in resuscitation to improve outcomes of out-of-hospital events (20).

Yeung, Meeks, and Edelson have identified that the use of technology-based CPR, either in addition to or in lieu of instructor-facilitated training, can improve the acquisition and retention of basic CPR skills (as tested without the use of technological innovation) (21). The utility functions of technological innovation appear promising. Care should be taken to ensure that these devices do not unduly interrupt laypeople or delay rescuers from performing CPR.

CONCLUSION AND RECOMMENDATION

Researchers concluded that the Pad Digital Resuscitation device could improve the quality of student compressions over a measurable distance, although in the third cycle there was a decrease in compression quality, which was dominated by women because it was influenced by BMI due to fatigue. Then, regarding the follow-up plans for this research, we will upgrade the innovative Digital Resuscitation Pad tool to become a tool that is easier to use and applied to ordinary people, so that cardiopulmonary resuscitation will be of higher quality and reduce the mortality rate for patients given CPR.

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