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EFFECTIVENESS OF FEEDBACK WITH MOBILE DEVICES FOR QUALITY MEASURE OF CPR TRAINING: A SYSTEMATIC REVIEW

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ABSTRACT

Cardiopulmonary resuscitation (CPR) is a life-saving skill that can significantly increase survival rates in an emergency. Medical professionals, health students, and trained lay people must all perform high-quality CPR. As an outcome, effective CPR training using instruments that support the achievement of high-quality CPR is essential. Objective: This systematic review aimed to evaluate the effectiveness of feedback provided via mobile devices in measuring the quality of CPR training. Method: Design used systematic review with reference to the PRISMA Statement Guidelines 2020. Search results through database of ScienceDirect (778 articles), Wiley Online Library (765 articles), PubMed (55 articles), and ResearchGate (73 articles). The research designs of articles analyzed was randomized controlled trial which published from 2013 to 2023 with the keywords cardiopulmonary resuscitation, CPR training, mobile devices. The sample in this study was taken from five articles that match the inclusion criteria. JBI's critical assessment tool for assessing bias risk in randomly controlled 2023 checklist tests is used to critically evaluate the instruments used for the selected article. Results: The primary results that five publications were based on CPR quality metrics such as chest compression depth and speed, as well as the proportion of acceptable chest compression depth. Conclusions: This review discovered evidence that mobile devices have an effect on the effectiveness of real-time feedback on CPR quality in CPR training. CPR trainees received effective instant guidance from a variety of mobile devices, including smartphones and smart watches equipped with sensors.

Keywords: cardiopulmonary resuscitation; cpr training; mobile devices

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INTRODUCTION

In 2020, the death rate from any type of sudden cardiac arrest in the United States was 436,852, and based only on OHCA data in adults, the survival rate to hospital discharge was 9.1% for all Non-traumatic OHCA cardiac arrests are treated with EMS (Tsao et al., 2022). But in Indonesia shows an increasing trend of 0.5% in 2013 heart disease to 1.5% in 2018 (Laporan hasil Riset Kesehatan Dasar (Riskesdas) Tahun 2018, 2018). These data explain the importance of finding solutions to improve survival by providing immediate and adequate cardiopulmonary resuscitation. Cardiopulmonary resuscitation (CPR) is part of the life-saving skills in the chain of survival of individuals with cardiac arrest. Certainly, during an emergency, the quality of CPR provided has a significant impact on the chances of successful resuscitation and patient outcomes. Therefore, to optimize survival rates, high-quality CPR should be performed, characterized by adequate depth and speed of compression and recoil, and minimal interruptions.

The reality is that even trained individuals can have difficulty performing high-quality CPR due to fear and anxiety (Abella BS, 2016). To overcome this non-ideal situation, technological advancements introduced smart devices in the form of innovative educational tools that offer real-time feedback during CPR training. Feedback serves to prevent low-quality CPR from occurring because one of the factors of CPR practitioners is fatigue (Cheng et al., 2015; Yeung et al., 2009). These devices, which may include smart phone apps, wearable sensors, or manikins equipped with sensors, have the potential to improve the quality of CPR training by providing instant guidance and performance metrics to trainees. This feedback can help both healthcare professionals and laypeople to gain and maintain the skills necessary to perform effective CPR.

CPR training continues to evolve, there is a need to evaluate the effectiveness of smart devices as they impact on improving training quality and patient outcomes. In support of this strategy, a systematic review of the literature was conducted to consolidate the evidence and provide a comprehensive overview of the impact of smart device feedback on the quality of CPR training. This systematic review critically examines and synthesizes relevant studies and research findings on the use of smart devices for CPR training, describing their efficacy, strengths, limitations, and potential areas for improvement. By assessing the current state of the literature, this review will contribute to our understanding of the role of smart devices in improving the quality of CPR training, with the ultimate goal of improving survival rates and patient care in cases of cardiac arrest.

METHOD

The main objective of this systematic review is to comprehensively examine and evaluate the impact of feedback provided through smart devices on the quality of cardiopulmonary resuscitation (CPR) training. This review aims to assess the effectiveness of mobile device-based feedback systems in enhancing the knowledge, skills, and performance of individuals undergoing CPR training. By analyzing the existing body of literature, we seek to establish a clear understanding of how these technological advancements have influenced the quality and effectiveness of CPR training programs. Furthermore, this review aims to identify best practices, limitations, and potential areas for improvement in utilizing smart devices for CPR training, with the ultimate goal of contributing evidence-based recommendations for optimizing CPR education and practice.

RESULTS

In this systematic review, a meticulously structured research design will be applied to comprehensively investigate the effectiveness of smart device-mediated feedback in enhancing the quality of Cardiopulmonary Resuscitation (CPR) training. Therefore, was conducted to the statement guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement guidelines.This study drew its information from scholarly articles published in both worldwide. The purpose of using these particular references is to provide a full coverage of studies dealing with Effectiveness of Feedback with Mobile Devices for High Quality of CPR Training. ScienceDirect, Wiley Online Library, PubMed, and ResearchGate are among databases the team used to search for articles published in journals. This all-encompassing strategy aids in collecting data from a wide variety of credible studies.

Identify eligible studies was used the PICOS framework (participants, intervention, comparison, outcomes, and study design). The included studies with participants (P) were nurses, healthcare professionals, students, and/or laypeople. The intervention (I) was CPR training using mobile devices. The comparisons (C) were defined as the CPR training using various mobile devices. The outcomes (O) were CPR quality measures by the guidelines from American Heart Association (AHA) and European Resuscitation Council (ERC) (Berg et al., 2010; Monsieurs et al., 2015). The study designs (S) were interventional studies including randomised controlled trial (RCT). The articles were restricted to those written in English. This systematic review only included open access articles and all literature searches were electronic databases between 2013 until 2023 included: ScienceDirect, Wiley Online Library, PubMed, and ResearchGate. Search keywords used according Medical Subject Headings (MeSH) included: ‘CPR’, ‘Cardiopulmonary resuscitation’, ‘Chest compression’, ‘High quality CPR’, ‘CPR training’, ‘Basic life support’, ‘Mobile device’.

Study Screening and Selection

Article searches were conducted electronically using several databases, including ScienceDirect, Wiley Online Library, PubMed, and ResearchGate. with details:

1. Cardiopulmonary Resuscitation AND Mobile Device AND CPR Training: ScienceDirect 778 articles
2. Cardiopulmonary Resuscitation AND Mobile Device AND CPR Training: Wiley Online Library 765 articles
3. Cardiopulmonary Resuscitation AND Mobile Device AND CPR Training: PubMed 55 articles
4. Cardiopulmonary Resuscitation AND Mobile Device AND CPR Training: ResearchGate 73 articles

The search results from several databases were then reviewed and analysed. The author recorded that there were articles that were not eligible based on automation tools (n = 1,549), there were duplicate articles (n = 1), articles that were not relevant to the title / abstract (n = 112) so that the articles were assessed for eligibility (n = 9). However, there were articles that did not meet the inclusion and exclusion criteria so that the articles were excluded (n = 4) so that the articles suitable for analysis were (n = 5). The flow of article search can be seen in the diagram of figure I.

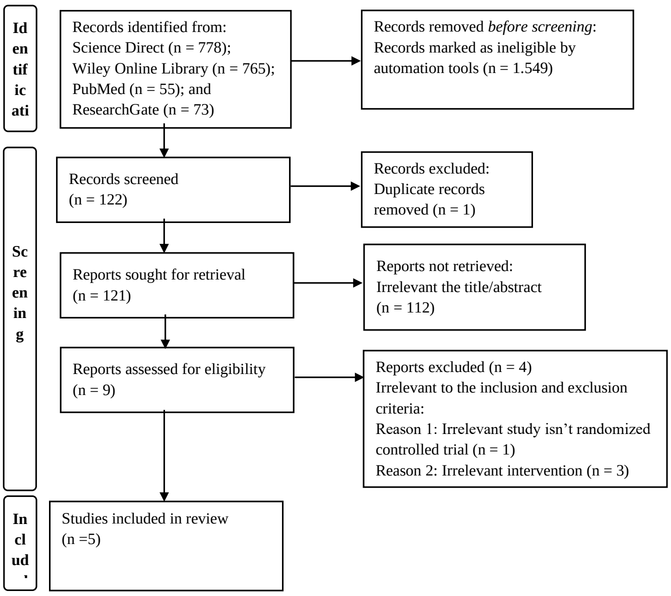

Fig. I - PRISMA 2020 *flow diagram for new systematic reviews which included searches of databases and registers only*

Article Quality Assessment

The selected articles were critically appraised using the JBI critical appraisal tool for assessment of risk of bias for randomized controlled trials 2023. The assessment focused on

13 items to assess the likelihood of bias related to selection, intervention delivery, detection and outcome measurement. Each question must be answered with yes/no/unclear and not applicable. "Yes" answers will score 1 and other answers will score 0, then the result is divided by the total number of questions and multiplied by 100%. Good quality if the score is 100-80%, fair quality 79-50%, and poor quality <50%.

Table 1.
The JBI Critical Appraisal Tool for RCTs

Internal Validity		Article Quality Assessment				
		1 (Sakai et al., 2015a)	2 (Ahn et al., 2017)	3 (Eaton et al., 2018)	4 (Lee et al., 2019)	5 (Lu et al., 2019)
Bias related to selection and allocation						
1	Was true randomization used for assignment of participants to treatment groups?	Y	Y	Y	Y	Y
2	Was allocation to treatment groups concealed?	Y	Y	Y	Y	Y
3	Were treatment groups similar at the baseline?	Y	Y	Y	Y	Y
4	Were participants blind to treatment assignment?	N	Y	Y	N	Y
5	Were those delivering treatment blind to treatment assignment?	N	U	U	N	U
6	Were treatment groups treated identically other than the intervention of interest?	Y	Y	Y	Y	Y
Bias related to assessment, detection and measurement of the outcome						
7	Were outcome assessors blind to treatment assignment?	Y	Y	Y	Y	Y
8	Were outcomes measured in the same way for treatment groups?	Y	Y	Y	Y	Y
9	Were outcomes measured in a reliable way?	Y	Y	Y	Y	Y
Bias related to participant retention						
10	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Y	Y	Y	Y	Y
Statistical Conclusion Validity						
11	Were participants analysed in the groups to which they were randomized?	Y	Y	Y	Y	Y
12	Was appropriate statistical analysis used?	Y	Y	Y	Y	Y
13	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Y	Y	Y	Y	Y
Percentage		84,6 %	92,3 %	84,6 %	92,3 %	92,3 %
Overall appraisal		*Include*	*Include*	*Include*	*Include*	*Include*

**Yes* (Y), *No* (N), *Unclear* (U), *Not Applicable* (NA)
* 1 (Article 1), 2 (Article 2), 3 (Article 3), 4 (Article 4), 5 (Article 5)

Table 2.
Tribution of Study Characteristic

Author, Country	Aim	Design	Sample	Instrument	Data Analyze	Finding
(Sakai et al., 2015) Japan	Comparing the quality of CPR using a newly developed CPR support application on smartphones and without a CPR support application	An Open, Prospective, Individual Randomized Controlled Trial	The sample consisted of 87 laypersons then randomly assigned to the intervention group (44) and control group (43); 1 participant from the intervention group and 2 from the control group did not attend the trial, leaving 43 in the intervention group and 41 in the control group.	The application was based on the 2010 CPR guidelines. Each participant's CPR skills were evaluated using case-based scenarios at Kyoto University using the Leardal Resusci Anne PC Skillreporting Manikin System.	Unpaired t-test for numerical variables and Chi-Square test for categorical variables. Data are presented as mean ± standard deviation	CPR support applications in the form of smart phones contribute to improving the implementation and total number of chest compressions
(Ahn et al., 2017) Korea	Analyse the effectiveness of a smart watch-based feedback system in improving the quality of chest compressions during cardiopulmonary resuscitation (CPR).	RCT	40 medical students	A CPR training dummy (SkillReporter™; Laerdal, Stavanger, Norway) and a recording programme of the dummy through a laptop for simulation. As a feedback device, a smart watch (Galaxy Gear Live; Samsung Electronics, Seoul, Republic of Korea) was used to implement the application.	Student's t-test and Mann-Whitney test were used for comparison of continuous variables, and Chi-square test or Fisher's exact test, for categorical variables. Analysis of covariance (ANCOVA) was conducted to adjust for factors affecting	The use of a smart watch-based feedback system increased the proportion of accurate chest compression depth during cardiopulmonary resuscitation (CPR). The proportion of accurate chest compression depth (mean ± SD) for the intervention and control groups was 64.6 ± 7.8% and 43.1 ± 28.3%, respectively (p = 0.02).

Author, Country	Aim	Design	Sample	Instrument	Data Analyze	Finding
(Eaton et al., 2018) United Kingdom	Analyse the effectiveness of using the British Heart Foundation Pocket CPR training app in improving chest compression performance against resuscitation guidelines in lay people who have never received CPR training.	A Randomized Crossover Study	The sample consisted of 118 lay people	British Heart Foundation Pocket CPR application on iPod Touch 2009 device. Performance measurements were from a connected Laerdal Resuscitation manikin (Resusci Anne Skills Station, Laerdal Medical Limited, Orpington, UK) and recorded onto a laptop.	Uji Wilcoxon	The British Heart Foundation Pocket CPR training app resulted in a higher percentage of chest compressions at the required depth compared to when the app was not used.
(Lee et al., 2019) Korea	Evaluate the effectiveness of a smart watch-based feedback device in performing high-quality chest compressions in infants with cardiac arrest. Analyse the effectiveness of smart watch in feedback system to achieve ideal chest compression depth according to CPR guidelines.	A Randomized, Controlled Simulation Study	There were 30 medical students randomly allocated in a 1:1 ratio to the interventio n and control groups using a sequence generator. The interventio n group consisted of 15 people who wore the feedback programm e smart watch, while the control group consisted of 15 people who performed chest compressi ons without	An infant mannequin for CPR training (Resusci Baby QCPR; Laerdal, Stavanger, Norway) and a recording programme (Simpad Skillreporter; Laerdal) as research instruments. The mannequin can measure several parameters, including chest compression depth, chest compression rate, and decompression depth, with a sensor when participants perform compressions below the intermammary line. A smart watch (Galaxy Gear Live; Samsung Electronics, Seoul, Republic of Korea) was used as a feedback device	Student's t-test or Mann-Whitney test is used for comparison of continuous variables; χ2-test or Fisher's exact test is used for categorical variables.	The use of a smart watch-based feedback device is effective in performing high-quality chest compressions during infant cardiac arrest. Rescuers receiving feedback from the smart watch were able to maintain the correct depth and avoid superficial or too deep compressions.

Author, Country	Aim	Design	Sample	Instrument	Data Analyze	Finding
			the aid of a feedback device.	to implement the android application.		
(Lu et al., 2019) Taiwan	Testing a smart watch app with real-time audiovisual feedback on the delivery of high-quality CPR by healthcare providers for patients with cardiac arrest in simulated emergencies.	Randomized Controlled Simulation Study	The sample consisted of 80 emergency profession als	A smart watch app that provides real-time feedback on the quality of cardiopulmonary resuscitation (CPR)	T-test, Chi-square test, Mann Whitney test	A smart watch with real-time feedback improved the quality of cardiopulmonary resuscitation (CPR) performed by healthcare professionals. The sample using the smart watch achieved more appropriate compression rate and depth. The percentage of high-quality CPR was significantly higher in the intervention group using the smart watch.

DISCUSSION

Mobile devices are experiencing rapid development and are becoming commonly used devices in the health care environment so that health workers have the convenience of conducting clinical practice (Ventola, 2014). In this case, mobile devices are applied as CPR training instruments in the scope of emergency nursing and the types of mobile devices include smartphones and smart watches (Ahn et al., 2017; Eaton et al., 2018; Lee et al., 2019; Lu et al., 2019; Sakai et al., 2015b). Smartphones with built-in feedback systems and accelerometers have been developed and these devices provide information through audio-visual speakers and screens to rescuers (Song et al., 2015). Smart watch as a smart mobile has an internal accelerometer and can also be used as a CPR feedback device. It is in line with the research that the compression depth estimation algorithm using smart watch and smart watch application has developed, namely the ability to provide visual information about the depth and speed of chest compression in real-time (Song et al., 2016).

CPR feedback devices, whose use can improve compression skills, are being applied by healthcare professionals and the general public (Sakai et al., 2015b). In addition, feedback devices with built-in accelerometers and pressure sensors can provide data on the depth, speed and intensity of chest compressions (Buléon et al., 2013; Kirkbright et al., 2014). Rescuers have improved performance quality in performing chest compressions with audio-visual CPR feedback devices (Buléon et al., 2013; Kirkbright et al., 2014). Mobile devices for CPR training based on smartphones can create difficulties in implementation because smartphones must be held by one hand when implementing CPR, while smart watches are used on the wrist and do not interfere with activities during CPR (Lu et al., 2019). In addition, the smart watch used in chest compressions in infants provides benefits because it is not directly in contact with the baby's body (Eaton et al., 2018).

CONCLUSION

The conclusion of the systematic review on the effectiveness of mobile device feedback in measuring the quality of CPR training showed that the use of such technology has an effect on improving CPR skills. This includes real-time feedback on increasing compression depth and speed, and reducing distractions that can affect training quality. A variety of mobile devices consisting of smartphones and smart watches equipped with sensors provide effective instant guidance to CPR trainees.This systematic review enriched the understanding of the potential positive role of mobile devices in improving the quality of CPR training to support more effective emergency response and improve client survival.

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