78310_Auto_Edited - check.docx

Video-assisted Bystander Cardiopulmonary Resuscitation Improves the Quality of Chest Compressions during Simulated Cardiac Arrests: A Systemic Review and Meta-Analysis

The quality in video-assisted CPR

Pan Dong-Feng, Li Zheng-Jun, Ji Xin-Zhong, Yang Li-Ting, Pei-Feng Liang

Abstract

BACKGROUND

It remains unclear whether video aids can improve the quality of bystander CPR.

AIM

To summarizesimulation-based studies aiming at improving bystander CPR associated with the quality of chest compression and time-related quality parameters.

METHODS

The systematic review was conducted according to the PRISMA guidelines. All relevant studies were searched through PubMed, EMbase, Medline and Cochrane Library databases. The risk of bias was evaluated using the Cochrane collaboration tool.

RESULTS

A total of 259 studies were eligible for inclusion, and 6 RCT studies were ultimately included. The results of meta-analysis indicated that V-CPR was significantly associated with the improved mean chest compression rate [OR = 0.66 (0.49–0.82), P < 0.001], and the proportion of chest compression with correct hand positioning [OR = 1.63 (0.71–2.55), P < 0.001]. However, the difference in mean chest compression depth was not statistically significant [OR = 0.18 (-0.07–0.42), P = 0.15], and V-CPR was not associated with the time to first chest compression compared to T-CPR [OR = -0.12 (-0.88–0.63), P = 0.75].

CONCLUSION

Video real-time guidance by the dispatcher can improve the quality of bystander CPR to a certain extent. However, the quality is still not ideal, and there is a lack of guidance caused by poor video signal or inadequate interaction.

Core Tip: This study conducted a Systemic Review and Meta-Analysis to summarized the outcomes of training programs aimed at improving bystander CPR associated with the quality of chest compressions and time-related quality parameters.

INTRODUCTION

Although the likelihood of survival with cardiac arrest (CA) is increasing, CA has emerged as the leading cause of death worldwide [1, 2]. A meta-analysis showed that the aggregate survival rate of hospital discharge of adult patients with cardiac arrest(OHCA) was only 7.6%, which remained stable over the past 30 years [3]. Immediate cardiopulmonary resuscitation (CPR) is the most effective measure to improve the prognosis of patients with CA [4]. Studies have shown that the first witness's CPR can double the survival rate of patients with OHCA [5]. Generally, the patient's family members are most likely to witness the occurrence of CA, and they are more willing to perform CPR on the spot. However, most CA witnesses are lacking life support knowledge and have not received any CPR training. Thus, they are not able to perform on-site CPR for patients with CA. An effective way to fill such shortcomings is that the dispatcher who receives emergency calls should guide the witnesses to perform CPR on the spot by telephone, that is, the dispatcher uses telephone or video facilities to improve dispatcher-assisted CPR (DA-CPR).

DA-CPR has been widely carried out in European and American countries [6]. It has been proven that DA-CPR can increase the quality of CPR performed by the first

witnesses [7] and improve the survival rate of victims with CA [8, 9]. In 2015, the American Heart Association (AHA) included DA-CPR in the guidelines for cardiopulmonary resuscitation for the first time [10]. Many emergency medical service systems have established verbal CPR instructions to help callers cope with CPR. However, the quality of DA-CPR is still not ideal [11, 12]. Although many efforts have been made to improve the quality of DA-CPR by modifying the command protocol, its actual effect is still not satisfactory [13-16].

The communication method of DA-CPR guidance is usually based on voice and telephone guidance. As a result, the quality of CPR performed by bystanders cannot be intuitively controlled, and a low-quality CPR is more likely to occur. Low-quality CPR may not improve the prognosis of patients with CA. Therefore, improving the quality of bystander CPR has become a focus of attention in recent years. With the advancement of wireless telecommunications, the introduction of video phones enables simultaneous voice and video commands. Video guidance *via* mobile phones can be a powerful tool for CPR guidance in emergency situations. For example, bystanders call CPR guidance and receive real-time voice instructions and video demonstrations *via* mobile phones, such as video self-learning programs. At the same time, the CPR performance of bystanders can be monitored and fed back to the dispatcher. Some preliminary studies have evaluated the possibility of applying video link instructions to improve the quality of bystander CPR [17], and the effect of video-assisted CPR (V-CPR) training has been extensively studied. Video self-learning procedures or video-based instructions have been documented to have more or at least as effective CPR training than conventional training methods [18-24]. However, the outcomes associated with V-CPR during simulated CAs remain unclear and await further study.

To address this issue, we conducted a systematic review and meta-analysis of quantitative studies to assess the effectiveness of video-assisted and telephone-assisted CPR in increasing chest compression rates during simulated CAs. The outcomes of training programs aimed at improving bystander CPR, including the quality of chest compression and time-related quality parameters, were analyzed in this study.

MATERIALS AND METHODS

Inclusion and exclusion criteria

To answer the PICOS question, the inclusion criteria for our systematic review were as follows:

P: Subjects were adult volunteers or high school students, without any previous CPR training.

I: Intervention is a dispatcher initiated standardized video-guided CPR.

C: Control group dispatcher initiated standardized telephone-guided CPR.

O: Outcome indicators were: (i) The quality of chest compression, including the mean compression rate, the number of subjects who performed an adequate compression rate, the mean compression depth (between 5 and 6 cm), the number of subjects who performed an adequate compression depth, and adequate positioning of hands (on the lower half of the sternum). (ii) Time-related quality parameters, including time to initiate continuous compression, and total hands-off time (the pause between compressions longer than 1.5 s).

S: Research design is randomized simulation-based studies. We did not consider articles published in non-English journals, repetitive publications, no relevant outcome indicators, and unavailable or incomplete original data.

Literature search strategy

We searched PubMed, EMbase, Medline, and Cochrane Library databases for studies published between the establishment time of the database to May 2021. The following search terms were used: "heart arrest", "cardiopulmonary resuscitation", "cardiac arrest" and "video-assisted", "telephone-assisted", "dispatcher-assisted", *etc.* Take PubMed as a working example, Box 1 Lists the specific search strategy. In addition, we manually checked the reference list of each article for further appropriate studies.

Data extraction

Two researchers independently screened the articles, extracted data, and cross-checked them. If there is a disagreement, it will be resolved through discussion or negotiation with a third party. After excluding the irrelevant documents, the abstract and full text of each article were thoroughly read to determine its eligibility. If necessary, the authors of an original research article will be contacted *via* email or telephone to obtain the missing information. The following data were extracted: (1) Basic information of the included studies, including research titles, first authors, published journals, *etc.* (2) Baseline characteristics and intervention measures of the research object. (3) Key elements of the risk of bias evaluation. (4) Outcome measures and performance indicators.

Risk of bias assessment

Two investigators independently evaluated the risk of bias for the included studies and cross-checked the results. The Cochrane handbook version 5.1.0 was used for assessing the risk of bias.

Statistical analysis

Meta-analysis was conducted with version 13.0 Stata software. The count data were analyzed by calculating the odds ratio (OR) and its 95% confidence interval (CI). The measurement data involved different research types and measurement methods. Thus, the standardized mean difference (SMD) was used as an effect indicator, and each effect size was given a point. The heterogeneity among the included studies was analyzed by the χ^2 test ($\alpha=0.1$), and the I^2 statistic was used to quantitatively judge the size of the heterogeneity. If there was no statistical heterogeneity, the fixed-effects model was used for interpreting the meta-analysis results; otherwise, the random-effects model was chosen and the source of the heterogeneity was further analyzed. Meanwhile, obvious clinical heterogeneity was analyzed descriptively.

RESULTS
Study selection and risk of bias

A total of 259 relevant articles were retrieved by searching the online databases. Six studies [25], involving 537 volunteers, were included after layer-by-layer screening. The flow diagram of the study selection is illustrated in Figure 1. The basic characteristics of the included studies are demonstrated in Table 1. The results of the risk of bias assessment are shown in Figure 2.

The quality of chest compression

The mean chest compression rate was reported in all six studies involving 537 volunteers [25]. The results of the fixed-effects inverse-variance model indicated that video-guided CPR was significantly associated with the improved mean chest compression rate [OR = 0.66, 95%CI: 0.49–0.82, P < 0.001] (Figure 3A). The weighted mean chest compression rate increased from 92.01 min^{-1} in T-CPR group to 105.62 min^{-1} in V- CPR group.

The mean chest compression depth was reported in all six studies (25-30) involving 537 volunteers. The results of random-effects REML model showed that the difference in the mean chest compression depth between the two groups was not statistically significant [OR = 0.18, 95%CI: -0.07–0.42, P = 0.15] (Figure 3B). The proportion of chest compression with correct hand positioning was reported in all six studies. However, four studies set this indicator as a continuous variable and the other two studies set as the dichotomous variables [26, 27]. The first four studies included 382 volunteers, and the results of random-effects REML model indicated that no significant difference was found between the T-CPR and V-CPR groups [OR = 0.24, 95%CI: -0.33–0.82, P = 0.41] (Figure 3C 1). The last two studies included 155 volunteers, and the results of random-effects REML model indicated that V-CPR was significantly associated with the improved proportion of chest compression with correct hand positioning [OR = 1.63, 95%CI: 0.71–2.55, P < 0.001] (Figure 3C 2)

There was obvious statistical heterogeneity in the number of subjects who performed adequate chest compression and the proportion of chest compression with appropriate depth. Thus, a qualitative description was provided. Three out of the four

studies [26-28] demonstrated that the number of subjects who performed adequate chest compression was significantly higher in V-CPR group than in T-CPR group. One out of the five studies [28] indicated that the proportion of chest compression with appropriate depth in V-CPR was significantly greater than that in T-CPR group.

Time-related quality parameters

Time to first chest compression was reported in five studies [25] involving 480 volunteers. The results of random-effects REML model showed that V-CPR was not associated with the time to first chest compression compared to T-CPR [OR = -0.12, 95%CI: -0.88–0.63, P = 0.75] (Figure 4).

"Hands-off" time was reported in four studies [26-29]. However, the statistical heterogeneity was apparent; thus, the qualitative description was used. Two studies [27, 29] indicated that volunteers guided by telephone interrupted their chest compression more frequently; and two other studies [26, 28] showed a longer hands-off time in V-CPR group due to the poor quality of the signal, and chest compression was delayed or broken off.

DISCUSSION

In addition to the instructor and guidance factors, the modes of communication, including telephone voice guidance and remote video online guidance, are important factors affecting the quality of DA-CPR. Video instructions through a telephone can be a potentially powerful tool for CPR instruction in emergencies. Previous studies showed that DA-CPR with video instructions improved rescuers' self-reported confidence, which could positively affect the number of bystanders willing to start CPR [30]. Besides, video-calls influenced the information basis and understanding of the dispatchers, thereby improving the rescuer compliance [17].

There is no unified quality evaluation standard for DA-CPR at home and abroad, but in the comprehensive literature [31, 32], the overall quality evaluation index recommends the time of dispatcher accepting emergency calls to judge suspected OHCA, time of starting guidance CPR, time of starting chest compression, location of chest compression, frequency and depth, *etc.* The AHA 2015 guidelines recommended high-quality CPR requiring adequate chest compression depth (50–60 mm), adequate chest compression rate (100–120/min), full chest wall recoil, minimal pause in chest compression, correct hand position during compression, and avoidance of hyperventilation [10].

Our systematic review included 6 randomized controlled trials reporting on the quality of DA-CPR under different communication methods. The meta-analysis results showed that video communication could improve the average chest compression rate of bystanders during simulated CAs. The compression speed increased from an average of 92 min^{-1} in the telephone group to more than 100 min^{-1}, reaching the standard compression rate for CPR. Abella *et al* [22] found that a high chest compression rate was significantly related to the initial return of spontaneous circulation. It is expected that the compression speed improved by video communication can be transformed into a better chance of survival in reality. If the chest compressions are guided by a moving video, it will be easier to maintain a proper chest compression rate. However, by judging from the number of subjects who performed an adequate compression rate, there was still a 10~70% proportion of subjects who did not achieve an adequate compression rate. This reminds us that when guiding bystanders to perform cardiopulmonary resuscitation, we must emphasize that the compression frequency of bystanders reaches 100-120 times/min as recommended by the AHA guidelines.

The depth of chest compression is another key factor in high-quality CPR. Our meta-analysis revealed that video communication did not improve the average chest compression depth of bystanders during simulated CAs. At the same time, most of the compression depths did not meet the 2015 AHA guidelines for high-quality CPR to a depth of at least 5-6 cm in adults. Regardless of T-CPR or V-CPR, it is realized through

interactive real-time feedback between dispatchers and subjects. In this study, most CPR performances did not meet the recommended compression depth. Therefore, it is necessary to emphasize the depth of chest compression during interactive counseling, either through video presentations or phone calls.

According to the AHA and European Resuscitation Council guidelines as the correct hand position on the lower half of the sternum [33]. In the included 6 randomized controlled trials, different description methods resulted in divergent results regarding the correct hand position during chest compression. When as a continuous variable, four studies indicated there was no significant difference between the V-CPR and T-CPR groups, but as dichotomous variable, the other two studies showed V-CPR was significantly associated with the included proportion of chest compression with correct hand positioning. In the included studies, the correct hand position of the participants in T-CPR group was only 43.6%, and that of the participants in V-CPR group was only 45%. The possible reason is that the subjects in T-CPR group may call the dispatcher to ask questions, thus, the position of their hands is changed during chest compression. Video-guided CPR should be able to guide the correct hand position more intuitively to improve the correct hand position. However, some volunteers did not correct their hand position according to the instructions provided in the CPR video, which might be attributed to the small screen or location of the mobile phone. Different positions of the video phone may help to monitor and feedback the quality of CPR performed, such as the horizontal positioning, thereby achieving the adequate compression depth; on the other hand, the bird's eye view can optimize the judgment of hand positioning. Nevertheless, further research is needed to determine the best location of the video phone and the information obtained during DA-CPR.

Time to first chest compression is an important time-related quality parameter. In this meta-analysis, the V-CPR group had no significant improvement in time to first chest compression compared to the T-CPR group. In fact, only one study showed that the time to first chest compression was 72 s; while the remaining 5 studies were all greater than 100 s, and the longest record reached 211 s. Such delay can exhibit an

impact on the survival rate of patients with CA. These were limited by the low quality of the video connection and poor training of the dispatcher in using video calls. Although the dispatcher gave accurate instructions, the bystanders in T-CPR group lacked a clear understanding and repeatedly asked questions, thus resulting in a time extension.[A1]

There were some inevitable limitations to this systematic review and meta-analysis. Firstly, this study incorporated simulation trials with mannequins, while might not represent real-life CAs. In fact, some bystanders can get plagued with fear; thus, more real-life studies with standardized protocols are needed in the future. Secondly, although the 2015 AHA guidelines recommended that dispatchers should provide CPR instructions with only chest compression for adults with suspected OHCA, the emergency medical services are different and there are no unified standardized scheduling tools, hence, the instructions provided by the dispatcher may be varied. Thirdly, the research subjects included both adult volunteers and high school students, which could lead to differences in CPR quality due to their ability to learn from mobile videos. Although adult volunteers (average age = 50 years) reported that they had no difficulty watching and understanding mobile videos, further research should target on older volunteers who are more likely to encounter patients with CA. Fourthly, most included studies did not report the adjusted ORs of primary outcomes, and the ORs calculated by cross-tabs did not consider confounding factors. Therefore, the results of this meta-analysis should be interpreted with caution.

CONCLUSION

This study reveals that the average rate of chest compression during simulated CAs can be improved by video-guided bystander CPR. However, the mean chest compression depth and time-related quality parameters, such as the first chest compression and "hand-off" time, demonstrate no significant improvement in V-CPR group. Video real-time guidance by the dispatcher can improve the quality of the bystander CPR to a

certain extent, but the quality is still not ideal, and there is a lack of guidance caused by poor video signal or inadequate interaction.

78310_Auto_Edited - check.docx

PRIMARY SOURCES

1 Bolle, S. R., E. Johnsen, and M. Gilbert. "Video calls for dispatcher-assisted cardiopulmonary resuscitation can improve the confidence of lay rescuers - surveys after simulated cardiac arrest", Journal of Telemedicine and Telecare, 2011.
Crossref

20 words — 1%

2 Hannes Ecker, Falko Lindacher, Niels Adams, Stefanie Hamacher et al. "Video-assisted cardiopulmonary resuscitation via smartphone improves quality of resuscitation", European Journal of Anaesthesiology, 2020
Crossref

20 words — 1%

3 Dr. Pritam Biswas, Dr. Sukumar TK. "The Efficacy of Adjuvant N Acetyl Cysteine for the Eradication of H pylori infections: A Systematic Review and Meta-analysis of Randomized Clinical Trials.", Clinics and Research in Hepatology and Gastroenterology, 2021
Crossref

18 words — 1%

4 Caihong Qiu, Cui Ma, Nana Fan, Xiaoyu Zhang, Guofeng Zheng. "Comparative efficacy of pulmonary surfactant in respiratory distress syndrome in preterm infants: a Bayesian network meta-analysis", Archives of Medical Science, 2020
Crossref

16 words — < 1%

5   Chih-Wei Yang, Hui-Chih Wang, Wen-Chu Chiang, Wei-Tien Chang et al. "Impact of adding video communication to dispatch instructions on the quality of rescue breathing in simulated cardiac arrests—A randomized controlled study", Resuscitation, 2008
Crossref

16 words — < 1%

6   Dongsheng He, Jun Hu, Ying Li, Xiaofei Zeng. "Preventive use of beta-blockers for anthracycline-induced cardiotoxicity: A network meta-analysis", Frontiers in Cardiovascular Medicine, 2022
Crossref

16 words — < 1%

7   Miao Yu, Deng-Chao Wang, Sheng Li, Li-Yan Huang, Jian Wei. "Does a long interval between neoadjuvant chemoradiotherapy and surgery benefit the clinical outcomes of locally advanced rectal cancer? A systematic review and meta analyses", International Journal of Colorectal Disease, 2022
Crossref

15 words — < 1%

8   kclpure.kcl.ac.uk
Internet

14 words — < 1%

9   core.ac.uk
Internet

13 words — < 1%

10   Ji Sook Lee, Woo Chan Jeon, Jung Hwan Ahn, Yoon Joo Cho, Yoon Seok Jung, Gi Woon Kim. "The effect of a cellular-phone video demonstration to improve the quality of dispatcher-assisted chest compression-only cardiopulmonary resuscitation as compared with audio coaching", Resuscitation, 2011
Crossref

12 words — < 1%