Original Article

Pre-recorded instructional audio vs. dispatchers' conversational assistance in telephone cardiopulmonary resuscitation: A randomized controlled simulation study

Alexei Birkun, Maksim Glotov, Herman Franklin Ndjamen, Esther Alaiye, Temidara Adeleke, Sergey Samarin

Department of Anaesthesiology, Resuscitation and Emergency Medicine, Medical Academy named after S. I. Georgievsky of V. I. Vernadsky Crimean Federal University; 295051, Lenin Blvd, 5/7, Simferopol, Russian Federation

***Corresponding Author:** Alexei Birkun, Email: birkunalexei@gmail.com*

BACKGROUND: To assess the effectiveness of the telephone chest-compression-only cardiopulmonary resuscitation (CPR) guided by a pre-recorded instructional audio when compared with dispatcher-assisted resuscitation.

METHODS: It was a prospective, blind, randomised controlled study involving 109 medical students without previous CPR training. In a standardized mannequin scenario, after the step of dispatcher-assisted cardiac arrest recognition, the participants performed compression-only resuscitation guided over the telephone by either: (1) the pre-recorded instructional audio (n=57); or (2) verbal dispatcher assistance (n=52). The simulation video records were reviewed to assess the CPR performance using a 13-item checklist. The interval from call reception to the first compression, total number and rate of compressions, total number and duration of pauses after the first compression were also recorded.

RESULTS: There were no significant differences between the recording-assisted and dispatcher-assisted groups based on the overall performance score (5.6±2.2 vs. 5.1±1.9, P>0.05) or individual criteria of the CPR performance checklist. The recording-assisted group demonstrated significantly shorter time interval from call receipt to the first compression (86.0±14.3 vs. 91.2±14.2 s, P<0.05), higher compression rate (94.9±26.4 vs. 89.1±32.8 min^{-1}) and number of compressions provided (170.2±48.0 vs. 156.2±60.7).

CONCLUSION: When provided by untrained persons in the simulated settings, the compression-only resuscitation guided by the pre-recorded instructional audio is no less efficient than dispatcher-assisted CPR. Future studies are warranted to further assess feasibility of using instructional audio aid as a potential alternative to dispatcher assistance.

KEY WORDS: Cardiopulmonary resuscitation; Cardiac arrest; Dispatcher; Telephone CPR; Audio instructions; Instructional aid

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INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) remains one of the foremost killers worldwide, with an overall survival rate usually not exceeding 10%.[1,2] Whereas the immediate initiation of cardiopulmonary resuscitation (CPR) can substantially improve survival from OHCA, real bystander CPR rates remain low in many communities.[3–5]

Dispatcher-assisted CPR (DA-CPR) was shown to improve bystander CPR rates and survival following cardiac arrest.[6–8] Currently, it is strongly recommended that dispatchers instruct untrained bystanders to provide chest-compression-only CPR before the arrival of professional help in all cases of suspected cardiac arrest.[9,10]

Despite the proven benefits of the successful DA-CPR programs, many countries across the globe have little to no experience of telephone-CPR implementation.[11–13] This critical gap stipulates the need for developing and introducing simple cost-effective alternatives in order to improve and support bystander CPR rates, before the local emergency medical dispatch services could be optimised to achieve the best practice.

When real-time dispatcher support is limited or not available, the electronic instructional aids (audio, video, animation, etc.) can provide callers with step-by-step instructions on how to perform CPR.[14–16] Whereas some preclinical studies showed an improvement in CPR performance when using media aids, the optimal method of the electronic instructional support over the telephone has yet to be determined.[14,15]

This simulation study was aimed to assess the effectiveness of the telephone chest-compression-only CPR guided by the pre-recorded instructional audio compared with real-time dispatcher-assisted resuscitation.

METHODS

Study design and participants

This was a prospective, blind, randomised controlled simulation study conducted in the Medical academy named after S. I. Georgievsky (Simferopol, Russian Federation) from January to May 2017.

We included English speaking international medical students who responded to the flyer or social media study advertisements and confirmed their willingness to attend the skills assessment in a simulation scenario. Students having any previous CPR training were excluded. After the simulation session, all volunteers passed free peer-led basic life support training and received the certificates of participation.

All volunteers provided written consent for the participation and video-recording of the resuscitation simulation. The study design and procedures were approved by the institutional ethical committee before the study commencement.

Participants were randomised with a 1:1 allocation to perform telephone CPR guided with either: (1) the pre-recorded instructional audio (recording-assisted group, *n*=57); or (2) verbal dispatcher assistance (dispatcher-assisted group, *n*=52). Simple randomisation was done using the random number generating function of Microsoft Excel 2016 (Microsoft Corporation, USA).

Telephone CPR simulation

The scenario was simulating a sudden OHCA in adult victim using Prestan Professional Adult mannequin (Prestan, USA). The lone untrained lay rescuer was expected to provide immediate help following the instructions given over the cellular telephone (Nokia 6303i, Nokia Corporation, Finland). Before the simulation, all participants passed a briefing, describing the procedure and demonstrating how to make a call and activate the loud speaker function.

Both groups followed the same simplified telephone CPR protocol instructing the single untrained lay rescuer to provide chest compression-only CPR (Table 1). Following the initial phase of dispatcher-assisted cardiac arrest recognition, CPR instructions were provided by the dispatcher verbally (dispatcher-assisted group) or by activating the pre-recorded DA-CPR instructional audio (recording-assisted group). When guiding participants, the dispatcher (pre-trained 6th-year medical student from CPR and first aid interest group without real-life experience in providing DA-CPR instructions) adhered to the same verbal pattern (i.e., speech rate, intensity, tone, pauses) as in the audio record. The audio record file is available in Supplementary materials. The overall duration of the CPR effort was 90 seconds (counted from the 1st compression). All simulations were video recorded.

Assessments

The simulation video records were reviewed by two experts using a 13-item CPR performance checklist

Table 1. Telephone CPR script

Telephone CPR Protocol	
1. Emergency medical service, what are you reporting?	
2. Is the environment safe?	
3. Ok. Shake the shoulders of the victim and shout loudly. Any response?	
4. Is the victim breathing normally?	
5. Dispatcher-assisted group: Ok. Emergency help is on the way. In the meantime, listen carefully, I will tell you what to do.	5. Recording-assisted group: Ok. Emergency help is on the way. In the meantime, carefully follow an automatic instructional record.
CPR instructions phase	
1. Put the victim on his back on the floor.	
2. Kneel by the side of the victim.	
3. Put the heel of your hand at the center of the victim's chest.	
4. Put your other hand on top of that hand with your fingers interlocked with each other.	
5. Push down with the heel of your hand as hard as you can.	
6. Keep your arms straight and don't allow your elbows to be bent.	
7. Push as hard as you can, following the rhythm of the timer and counting loudly in pairs of ten.	
Metronome starts	
Encouragements (alternating every 15 seconds): a) Push, push, push hard… You are doing great. b) Come on, come on… Keep it up, help is almost there.	

(Table 2 for the checklist criteria). Each skill on the checklist was scored as either 0 (not done) or 1 (done). Any disagreements between the assessors were resolved through discussion. Alongside the overall performance score (max. 13 points), the interval from call reception to first compression, total number of chest compressions and mean compression rate, the total number and overall duration of pauses after the first compression were recorded. Pauses (hands-off time) were defined as any interruption in chest compressions for >3 seconds.

Before the simulation, all participants answered a questionnaire assessing demographic characteristics, previous experience of facing cardiac arrest situations and extent of fear to perform CPR in real-life settings. An additional questionnaire was filled immediately after the simulation to assess the participants' opinion on the helpfulness of telephone assistance, clarity of the instructions, participants' own perception of the CPR quality and level of emotional stress during the simulation. The questions were answered using an 11-point Likert scale.

Blinding

The participants, the dispatcher and the assessors were all blinded to the study hypothesis and design.

Sample size

The sample size was limited by the availability of the medical students with no previous CPR training who expressed their willingness to participate. Due to the limitations of our settings and absence of any preliminary data, no formal sample size calculation was performed.

Statistical methods

The data was tabulated and analysed using Microsoft Excel 2016. The significant differences were assessed using the nonparametric two-sided Wilcoxon test for continuous data and χ^2-test for the proportions calculated for categorical data. *P* values <0.05 were considered statistically significant. Distributions of continuous variables in groups were expressed as means±standard deviation. The outlying cases were identified and removed based on scatter plot analyses per group.

RESULTS

Of the 131 eligible students who provided their consent to participate, 22 did not come for the scheduled appointment (Figure 1). Eighty three percent (*n*=109) completed the study, of which 51% were male. Figure 2 shows the distribution of the students by their home

Table 2. Comparison for participants' performance of CPR, *n* (%)

Parameters	Recording-assisted group (*n*=57)	Dispatcher-assisted group (*n*=52)	*P* value
CPR performance criterion			
1. Shakes victim's shoulders	25 (43.9)	22 (42.3)	>0.05
2. Shouts to the victim	34 (59.6)	29 (55.8)	>0.05
3. Kneels by the side of the victim	41 (71.9)	40 (76.9)	>0.05
4. Places first hand on the lower half of the sternum along the midline	18 (31.6)	11 (21.2)	>0.05
5. Places other hand on top of the first with fingers interlocked	26 (45.6)	20 (38.5)	>0.05
6. Positions himself vertically above the victim's chest	16 (28.1)	7 (13.5)	>0.05
7. Compresses to a depth of 5–6 cm	23 (40.4)	17 (32.7)	>0.05
8. Compresses with a rate of 100–120 per minute	26 (45.6)	16 (30.8)	>0.05
9. Applies pressure with a heel only	12 (21.1)	10 (19.2)	>0.05
10. Keeps arms straight with no flexion in elbows	19 (33.3)	13 (25.0)	>0.05
11. Allows for complete chest recoil after every compression	24 (42.1)	26 (50.0)	>0.05
12. Keeps hands in contact with the chest between compressions	54 (94.7)	48 (92.3)	>0.05
13. Counts compressions aloud	3 (5.3)	5 (9.6)	>0.05
Overall performance score (0–13) (mean±SD)	5.6±2.2	5.1±1.9	>0.05
Time interval from call receipt to the 1st compression (seconds) (mean±SD)	86.0±14.3	91.2±14.2	<0.05
Total number of compressions (mean±SD)	170.2±48.0	156.2±60.7	<0.05
Total number of compressions (mean±SD) – corrected for outliers	176.9±39.3 (*n*=54)	151.1±42.9 (*n*=49)	<0.05
Mean compression rate (min^{-1}) (mean±SD)	94.9±26.4	89.1±32.8	<0.05
Mean compression rate (min^{-1}) (mean±SD) – corrected for outliers	98.6±21.4 (*n*=54)	86.4±22.8 (*n*=49)	<0.05
Total number of pauses after the 1st compression (mean±SD)	1.3±3.0	1.8±2.4	<0.05
Total number of pauses after the 1st compression (mean±SD) – corrected for outliers	0.9±1.1 (*n*=56)	1.6±1.5 (*n*=51)	<0.05
Total duration of pauses after the 1st compression (seconds) (mean±SD)	8.5±14.4	11.3±16.1	>0.05
Total duration of pauses after the 1st compression (seconds) (mean±SD) – corrected for outliers	6.8±7.6 (*n*=56)	9.3±8.1 (*n*=51)	>0.05

country. Fifty seven were randomised to the recording-assisted group, 52 – to the dispatcher-assisted group. There were no significant differences regarding age (mean±SD; 21.3±1.8 vs. 21.2±2.4, respectively) and sex (male 56% vs. 44%, respectively) between the groups (*P*>0.05).

No previous experience of real-life cardiac arrest situation was reported by 90% participants; 2% participated in providing CPR, and 8% were bystanders not participating in the CPR attempt.

The baseline level of fear of doing CPR in real-life settings was comparable for the recording-assisted and dispatcher-assisted group (4.2±2.6 vs. 3.5±2.8, respectively, *P*>0.05). The majority of participants (84%) were primarily afraid of making a mistake when doing CPR, consequently harming the victim. Other factors, including fear of being infected or to be a major focus of attention for surrounding people, were much less commonly reported as a main fear for CPR effort (<6% each).

We revealed no significant differences between the dispatcher-assisted and recording-assisted groups based on the overall performance score or individual criterions of the CPR performance checklist (Table 2).

Compared with the participants who received live verbal dispatcher assistance, the recording-assisted rescuers demonstrated a significantly shorter time interval from call reception to the first compression, lower number of pauses, higher compression rate and the number of compressions provided. Whereas the outlying cases were identified for the aforementioned measures, their removal did not result in any change of the statistical significance (Table 2).

Post-simulation, the recording-assisted and dispatcher-assisted groups reported comparable level of helpfulness of the telephone assistance (8.8±1.9 vs. 8.6±2.0, respectively, *P*>0.05) and perspicuity of the instructions (8.2±2.1 vs. 8.3±2.1, respectively, *P*>0.05).

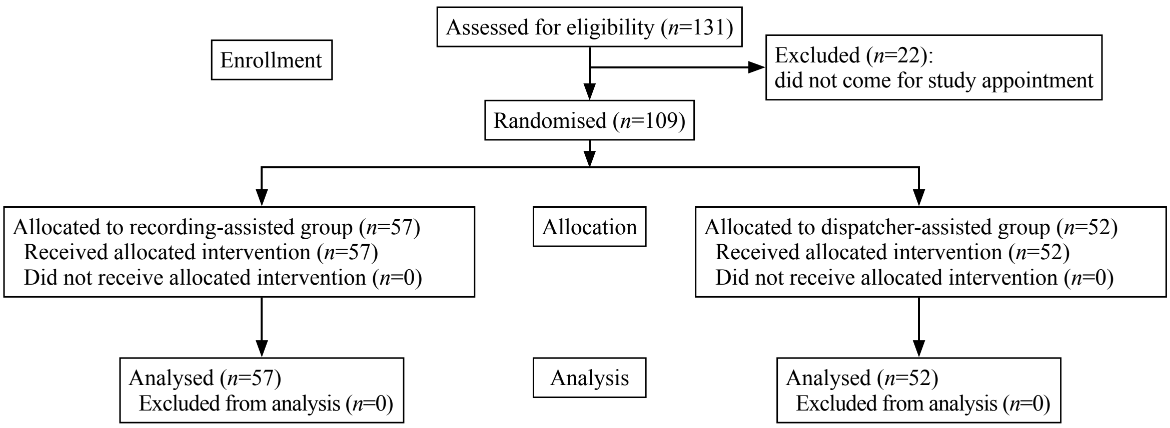

Figure 1. CONSORT flow chart.

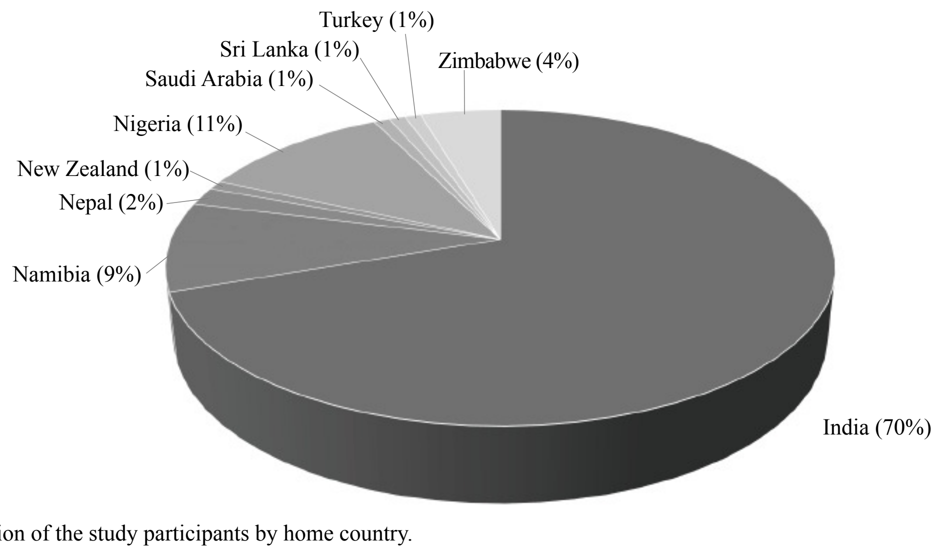

Figure 2. Distribution of the study participants by home country.

The participants assisted with audio record estimated their own performance lower than the dispatcher-assisted students (6.7±2.4 vs. 7.5±2.4, respectively, $P<0.05$), and reported a higher level of stress during the simulation (5.8±2.9 vs. 4.2±3.1, respectively; $P<0.05$).

DISCUSSION

Previous simulation studies reported better performances of CPR guided with animations and videos stored in cellular telephones, when compared with conversational assistance of the dispatcher.[14,16]

Choa et al[14] compared the effectiveness of animation-assisted CPR instruction through a cellular telephone with DA-CPR in previously untrained non-medical hospital employees in a simulated cardiac arrest setting. Audio-visual animated instruction resulted in a significantly higher CPR performance score and shorter time to the completion of the first CPR cycle.[14] Similarly, in a simulation study conducted by Lee et al,[16] adult untrained volunteers aided by watching a video on a cellular telephone demonstrated better performance of chest compression-only CPR (in terms of higher compression rate, better hand positioning, shorter time to first compression and less interruptions in compressions) compared to the subjects directed by a dispatcher.

While showing promising preclinical results, the multimedia electronic aids involving visual support may have some limitations for their widespread practical application. Apart from being associated with increased software-engineering and financial requirements, these systems are sensitive to the technical characteristics of the mobile device, including display size and screen resolution.[16,17] The visual type of instructions urges the rescuer to look at the display, thus introducing interruptions in CPR.[17] Further, in order to be readily available in emergency settings of cardiac arrest, the multimedia aids should be installed to the handheld device in advance.

The pre-recorded instructional audio seems to be free of such limitations: its development is relatively cheap; there are no specific requirements for the mobile device, excepting the loud speaker function; and there is no need for preloading and storing – being activated by the dispatcher and reproduced over the cellular telephone line, the audio is immediately available to assist CPR efforts.

Merchant et al[15] performed a randomised controlled simulation study to assess the quality of CPR performed by trained and untrained participants with or without cell telephone audio instructions. The authors found substantially better CPR performance (better compression rate, depth, hand placement and less hands-off time) in those using cell telephone audio instruction aid, regardless of whether they had previous resuscitation training.[15]

Our simulation study was designed to assess the feasibility of using dispatcher-activated instructional audio record as a potential alternative to live dispatcher CPR instructions when given to untrained bystanders over the telephone.

We found that participants guided by the pre-recorded audio provided no less efficient chest compression-only CPR compared with dispatcher-assisted group in terms of both overall performance score (5.6±2.2 vs. 5.1±1.9, $P>0.05$) and individual criteria of the CPR performance checklist. We also observed an earlier start of CPR (86.0±14.3 vs. 91.2±14.2 seconds, $P<0.05$), higher rate (98.6±21.4 vs. 86.4±22.8 min^{-1}, $P<0.05$) and total number of compressions (176.9±39.3 vs. 151.1±42.9, $P<0.05$) provided by the participants who followed the instructional audio. Despite revealing significant differences for the total number of pauses in compressions (0.9±1.1 vs. 1.6±1.5, $P<0.05$), absolute difference between the groups does not appear to be clinically relevant. This is also supported by the comparable total hands-off time (6.8±7.6 vs. 9.3±8.1 seconds, $P>0.05$).

We suppose, the concept of using instructional audio record to guide untrained bystander CPR may offer several benefits with a potential to improve patient outcomes following OHCA.

The analysis of DA-CPR cases by Vaillancourt et al[7] showed, that when a victim is described as unconscious, the caller is put on hold while paramedics are dispatched to the location, and CPR instructions take place after the conversation resumes with the caller. This may introduce a significant time interval, which could have an adverse effect on patient outcome from OHCA. The pre-recorded CPR instructions, may have a potential to fill this gap, allowing for earlier initiation of compressions by a bystander.

We also hypothesized that elimination of the possibility of unnecessary verbal communication with the dispatcher (e.g., redundant questions from bystanders), offered by the audio record, can further decrease the extent of delay in provision of CPR. The assumption is partly confirmed by the significantly shorter time interval from call reception to the first compression by those participants who followed the pre-recorded instructions.

Another presumable benefit of the pre-recorded instructional audio may be related with the language barrier problem, which is well known to restrict bystander CPR provision.[12,18] Lack of proficiency in English was shown to be one of the key obstacles to calling 911.[19] It may cause substantial delays to telcommunicators in recognizing the need for CPR and starting CPR instructions, and result in delays until 1st chest compression, thus potentially influencing the outcome of OHCA patient.[20] Theoretically, the audio instructions, if recorded in multiple languages may help to improve communication with limited English proficient callers, thus increasing the rate of bystander CPR provision.

There is no clear explanation for lower self-estimated CPR performance and higher levels of simulation-related emotional stress in those participants assisted with instructional audio revealed in our study. We remain cautious about drawing respective conclusions and to presume that these findings need to be further clarified.

Whereas telephone-CPR programs have been proven to increase the rate of bystander CPR and survival from cardiac arrest,[6,7] many communities have not implemented DA-CPR yet.[11,13] Being as efficient as live dispatcher assistance, the pre-recorded instructional audio seems to be a reasonable alternative to the DA-CPR, supporting bystander CPR efforts in the settings where real-time dispatcher assistance is limited or unavailable. Nevertheless, this tool should not be considered as a full substitute to the dispatcher. In particular, early recognition of cardiac arrest still entirely depends on active caller-to-dispatcher communication.

Limitations

Considering the fact that the initial phase of cardiac arrest recognition needs active conversation between the emergency dispatcher and the caller, it is obvious that the audio record cannot totally replace the dispatcher assistance.

The CPR performance assessed in a simulated cardiac arrest scenario may differ from real-life actions, when a complex of additional factors may impede the implementation of telephone CPR, including dispatcher failing to recognize cardiac arrest, emotional distress or physical limitation of caller.

The study evaluated only first 1.5 minutes of resuscitation, while longer CPR effort may influence the performance of chest compressions as a consequence of progressive rescuer fatigue.

Medical students may have higher intent to learn CPR and additional knowledge that may potentially influence their performance.

Limited sample size warrants cautious interpretation of the observed statistically significant findings. We suggest that it is reasonable to conduct further studies with a larger sample size in order to achieve solid statistical power for interpreting the significance and relevance of our results. Our study can be considered as an exploratory study providing preliminary data to establish the sample size for a larger study.

CONCLUSIONS

When provided by untrained lay rescuers in a simulation cardiac arrest scenario, the chest-compression-only CPR guided by the pre-recorded instructional audio is no less efficient than dispatcher-assisted CPR.

Instructional audio record seems to be a reasonable potential alternative to the verbal dispatcher assistance in settings of limited functional capabilities of the dispatcher service.

Future studies are warranted to confirm the results and further investigate the concept of using pre-recorded audio instructions to assist telephone CPR.

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Contributors: AB determined the concept of the study and was a major contributor to the study design, data collection, data analysis and manuscript production. MG, HFN, EA, TA and SS assisted in data collection and analysis, in writing the manuscript and revising the article. All authors read and approved the final manuscript.

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