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Education

Comparison of Tele-Education and Conventional Cardiopulmonary Resuscitation Training During COVID-19 Pandemic

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☐ Abstract—Background: Cardiopulmonary resuscitation (CPR) performed by lay rescuers can increase a person's chance of survival. The COVID-19 pandemic enforced prevention policies that encouraged social distancing, which disrupted conventional modes of health care education. Tele-education may benefit CPR training during the pandemic. Objective: Our aim was to compare CPR knowledge and skills using tele-education vs. conventional classroom teaching methods. Methods: A noninferiority trial was conducted as a Basic Life Support workshop. Participants were randomly assigned to a tele-education or conventional group. Primary outcomes assessed were CPR knowledge and skills and secondary outcomes assessed were individual skills, ventilation, and chest compression characteristics. Results: Pretraining knowledge scores (mean ± standard deviation [SD] 3.50 ± 2.18 vs. 4.35 ± 1.70; $p = 0.151$) and post-training knowledge scores (7.91 ± 2.14 vs. 8.52 ± 0.90; $p = 0.502$) of the tele-education and conventional groups, respectively, had no statistically significant difference. Both groups' training resulted in a significant and comparable gain in knowledge scores ($p < 0.001$). The tele-education and conventional groups skill scores (mean ± SD 78.30 ± 6.77 vs. 79.65 ± 9.93; $p = 0.579$) had no statistical difference. Skillset scores did not differ statistically except for the compression rate and ventilation ratio; the conventional group performed better ($p = 0.042$ vs. $p = 0.017$). The tele-education and conventional groups' number of participants passed the skill test (95.5% and 91.3%, respectively; $p = 1.000$). Conclusions: Tele-education offers a pragmatic and reasonably effective alternative to conventional CPR training during the COVID-19 pandemic. © 2022 Published by Elsevier Inc.

☐ Keywords—Tele-education; Lay rescuers; Out-of-hospital cardiac arrest; Basic Life Support 2020

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death worldwide (1,2). Approximately 90% of people with an OHCA die. Nearly 45% of patients with an OHCA survived with bystander cardiopulmonary resuscitation (CPR) (3). CPR, especially if administered immediately by a lay rescuer after cardiac arrest, can increase a person's chance of survival (4–6). In Western countries, survival to hospital discharge is more likely among patients with an OHCA who received CPR performed by a bystander or emergency medical services (EMS). Non-Western countries have much lower incidence rates of return of spontaneous circulation (ROSC), survival to admission, and survival to discharge. Asia has the lowest incidence of ROSC (7). Basic Life Support (BLS) training for lay rescuers has a substantial impact on survival after OHCA (8).

However, the ongoing COVID-19 pandemic has rapidly disrupted conventional modes of health care education, including CPR training. Prevention policies have discouraged direct contact and encouraged social distancing (9). These measures have placed us in a position where conventional in-person training sessions are limited. Furthermore, in-person resuscitation training has some no-

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table limitations, especially in developing countries. CPR learning centers are scarce, difficult to access, and expensive. Also, there are few trained instructors available. Therefore, tele-education has an increasing role for resuscitation training under these measurements.

Satellite-based telemedicine has long been used for patient consultations. Previous studies in the field of telemedicine in emergency medicine have focused mainly on patient care in the emergency department (10). Ellis et al. reported benefits of telemedicine in terms of effective consultations in the emergency department and reductions in the need for patient transportation (11).

During the pandemic, many hospitals implemented the use of telemedicine in patient triage, diagnosis, monitoring, and treatment via online application (12–14). EMS uses telemedicine via real-time video call (15,16). The same technology when used for medical education (tele-education) offers an alternate, potentially time-saving, cost-utility, and cost-effective interface between students and instructors (17).

Telemedicine technology has been used less commonly for resuscitation training of health care workers. Previous studies compared conventional BLS training with self-instruction training videos (18). No studies exist that examine the efficacy for live tele-BLS training. Live training has a considerable advantage due to real-time interaction between instructor and learners. However, the efficacy of live tele-BLS training compared with conventional classroom teaching in CPR knowledge and skills needs to be investigated further. Therefore, researchers are interested in studying the effectiveness of live tele-BLS training compared with conventional training.

Materials and Methods

A randomized controlled trial was conducted in November 2020 as a single-day workshop based on the 2020 American Heart Association Guidelines for CPR at Nopparatrajathanee Hospital (19). The sample size was calculated using two independent means for noninferiority trial, which was obtained from previous research (20). Means ± standard deviations (SDs) per delivery method for the traditional group and videoconference group were 96.9 ± 3.3 and 95.6 ± 4.5, respectively. The mean ± SD difference between the trial group and control group was 1.3 ± 3.95. The final sample size of 56 had adequate power to detect noninferiority.

Eligible participants were aged 18–60 years. Participants who received CPR training in the past 2 years or had a disabling medical condition were excluded from this study. Participants were then randomized using a computerized block of four randomizations with an allocation ratio of 1:1 assigned to either a tele-education group or conventional group. A different researcher assigned the participants to the groups (Figure 1).

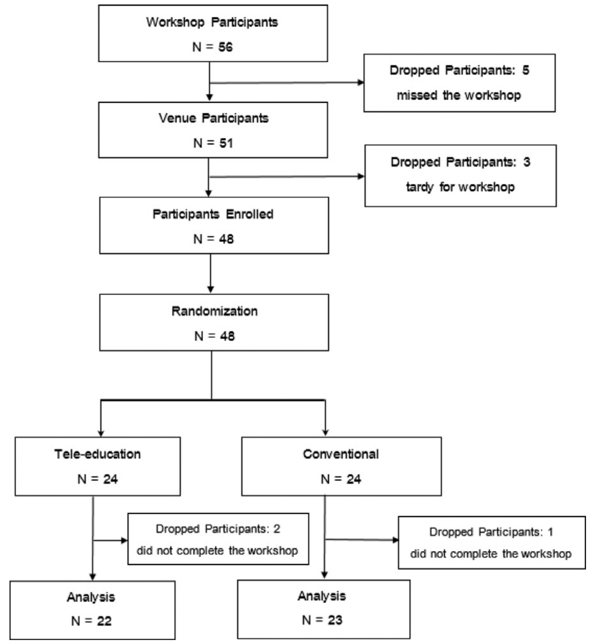

Figure 1. Study flow diagram.

The trial was reviewed and approved by the Institutional Review Board of Nopparatrajathanee Hospital (approval no. 15/2563). The trial was registered with the Thai Clinical Trials Registry (http://www.thaiclinicaltrials.org/; identification number: TCTR20210602002). This study was conducted in accordance with good clinical practice and Declaration of Helsinki guidelines. Written informed consent was obtained from all study patients at the time of enrollment.

Primary outcomes included gain in knowledge and CPR skills. Secondary outcomes included performance of individual skills, ventilation, and chest compression characteristics. Gains in knowledge and skills were assessed immediately before and after completing the training. Instructors were certified in the BLS instructor course with certification renewal in less than 1 year and had a similar number of years of experience in training. Instructors lectured on patient assessment, how to call for help, CPR, and use of automated external defibrillator (AED). One instructor lectured both the tele-education and conventional group at the same time, with the tele-education participants viewing through a live broadcast. For the manikin demonstration, the tele-education group stayed with the same instructor. The conventional group moved to a new classroom with a new instructor.

Assessment of knowledge was performed by pretest and post-test multiple-choice, single-response questions. The questions were based on the 2020 American Heart

Association Guidelines for CPR, which measured both recall and clinical problem solving (19).

Skills assessment in the conventional group was done in person and the tele-group used Zoom Meetings (Zoom Video Communications). Due to the nature of the intervention, the study could not be blind. However, we used objective measurements in this study. A checklist was adapted from the 2020 American Heart Association Basic Life Support Adult CPR and AED skills testing checklist, which used a pass/fail performance scale to collect data on patient assessment, call for help, and AED use metrics (21). The checklist for the correct action sequence was evaluated visually by the instructors, which was not disrupted by the Zoom video quality for the tele-group. Evaluation was accessed by an AmbuMan Advanced computerized CPR training manikin (Ambu). The manikin uses electronic sensors that record and compute chest-compression and ventilation characteristics. The manikin was calibrated for appropriate chest-compression rate, depth, hand positions, and ventilation volume.

Pass criteria was determined by two factors—passing the minimal pass level (MPL) and having no critical errors. MPL was calculated using the Angoff method by setting cut scores for each skill. Critical errors included not performing chest compressions and not delivering shock.

Statistical Analysis

Data were analyzed using Stata software, version 14 (StataCorp) and SPSS software, version 22 (IBM Corp). Group characteristics were compared using χ^2 test and Fisher exact test for categorical variables, and two-sample *t*-test for continuous variables. Group means were compared using paired *t*-test. A p value < 0.05 was considered statistically significant. Per-protocol analysis was used in this study.

Results

Among the 56 participants that were enrolled in this study, 5 did not report to the workshop and another 6 were not enrolled due to various reasons (Figure 1). A total of 45 participants were analyzed in the tele-education (n = 22) or conventional (n = 23) groups.

In the tele-education and conventional group, most participants were female (90.9% and 82.6%, respectively). Mean age was 30.27 years (interquartile range [IQR] 23.5–36.5 years) and 31.57 years (IQR 25–35.5 years), respectively. There were no significant differences in baseline characteristics (Table 1).

Mean ± SD pretraining knowledge scores for the tele-education group and the conventional group were 3.50 ± 2.18 and 4.35 ± 1.70 points, respectively ($p = 0.151$). Mean ± SD post-training knowledge scores for the tele-education group and the conventional group were 7.91 ± 2.14 and 8.52 ± 0.90 points, respectively ($p = 0.502$) (Table 2). Mean pretraining and post-training knowledge scores had no statistical significance between groups. In both groups, mean post-training knowledge scores were statistically significantly higher than mean pretraining knowledge scores ($p < 0.001$) (Figure 2).

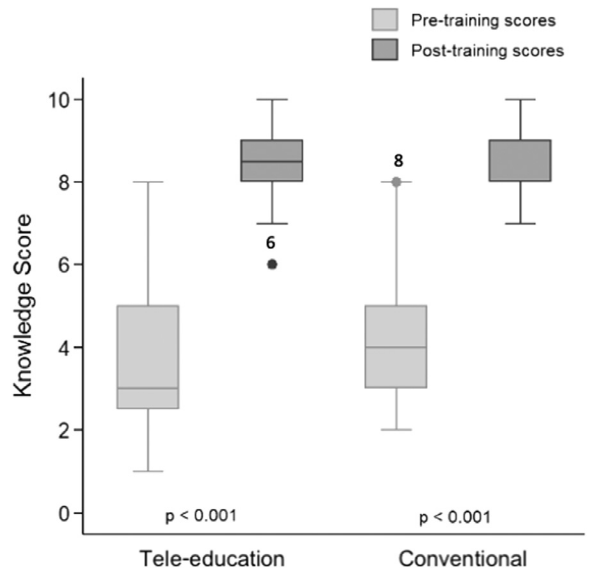

Figure 2. Knowledge Score.

Overall skill performance passing score was 65 (MPL > 65). In both groups, skill scores were not statistically significant different ($p = 0.579$), with a mean ± SD skill score of 78.30 ± 6.77 in the tele-education group and 79.65 ± 9.93 in the conventional group. The percentages of participants in the tele-education group and in the conventional group who passed the skills test were 95.5% and 91.3%, respectively ($p = 1.000$) (Figure 3).

The skillset scores, which included assessment, activation, and use of AED skills, were comparable in both groups. For the high-quality CPR performance metrics, the conventional group performed better than the tele-education group for compression rate and compression ventilation ratio ($p = 0.042$ and $p = 0.017$, respectively). Results were comparable in other metrics of the high-quality CPR performance (Table 3).

Discussion

Results suggest that tele-education training was not inferior to the conventional classroom CPR training across outcomes assessed at the conclusion of the course in a randomized experimental design. Comparable results were obtained by Todd et al. in CPR training by video self-

Table 1. Baseline Characteristics of Participants.

Variables	Tele-Education (n = 22)	Conventional (n = 23)	*p* Value*
Gender, n (%)			0.665
Female	20 (90.9)	19 (82.6)	
Male	2 (9.1)	4 (17.4)	
Age, y, mean (IQR)	30.27 (23.5–36.5)	31.57 (25–35.5)	0.624
Highest level of education, n (%)			0.330
Undergraduate	7 (31.8)	4 (17.4)	
Bachelor's degree	14 (63.6)	15 (65.2)	
Master's degree	1 (4.5)	4 (17.4)	
Position, n (%)			0.003
Finance and accounting officer	2 (9.1)	1 (4.3)	
General service officer	4 (18.2)	3 (13.0)	
General administration officer	13 (59.1)	3 (13.0)	
Human resource officer	0 (0.0)	2 (8.7)	
Public relations personnel	0 (0.0)	1 (4.3)	
Plan and policy analyst	0 (0.0)	1 (4.3)	
Finance and accounting analyst	0 (0.0)	1 (4.3)	
Professional, supply analyst	0 (0.0)	2 (8.7)	
Practitioner, supply analyst	0 (0.0)	1 (4.3)	
Professional, public health technical officer	0 (0.0)	1 (4.3)	
Practitioner, public health technical officer	1 (4.5)	5 (21.7)	
Research assistant	0 (0.0)	1 (4.3)	
Service staff	0 (0.0)	1 (4.3)	
Telephone operator	2 (9.1)	0 (0.0)	
Underlying disease, n (%)			0.666
No	16 (72.7)	18 (78.3)	
Yes	6 (27.3)	5 (21.7)	
Prior CPR training, n (%)			0.279
No	14 (63.6)	18 (78.3)	
Yes	8 (36.4)	5 (21.7)	
2–5 y	7 (31.8)	3 (13.0)	
> 5 y	1 (4.5)	2 (8.7)	

CPR = cardiopulmonary resuscitation; IQR = interquartile range.
* *p* Value corresponds to independent samples *t*-test, χ^2 test, or Fisher exact test.

instruction training program, Ricci et al. in effectiveness of tele-education in training the health care providers at distant sites, and Bertsch et al. in medical students education (18,22,23).

No differences were found between groups in terms of knowledge assessed by a pretest and post-test multiple-choice questions, with a significant gain in knowledge in both groups. Similar results were reported in Haney et al.'s study comparing conventional lectures with tele-education for delivering wound care; they concluded that there were no significant differences between groups in the written examination and a statistically significant gain in knowledge in both groups (24). In addition, Weeks and Molsberry's study of Pediatric Advanced Life Support re-training instruction via videoconferencing vs. receiving instruction in the traditional format resulted in no difference in knowledge (20).

CPR skill scores and AED skill scores had no statistically significant differences in both groups. Overall, the skill scores were comparable, although the conventional group had better scores in compression rate and compression to ventilation ratio. However, the difference had little practical significance due to overall training resulting in comparable skill set scores and the number of participants who passed the skill test had no statistical difference. Similar results were reported in Jain et al.'s trial of neona-

Table 2. Comparison of Knowledge and Skills between Groups before and after Training.

Variables	Tele-Education (n = 22)	Conventional (n = 23)	*p* Value*
Knowledge score, mean ± SD			
Pretest	3.50 ± 2.18	4.35 ± 1.70	0.151
Post-test	7.91 ± 2.14	8.52 ± 0.90	0.502
p value†	< 0.001	< 0.001	
Skill score, mean ± SD (MPL = 65)	78.30 ± 6.77	79.65 ± 9.93	0.597
Test results, n (%)			
Fail	1 (4.5)	2 (8.7)	1.000
Pass	21 (95.5)	21 (91.3)	

MPL = minimal passing limit; SD = standard deviation.
* *p* value corresponds to independent samples *t*-test or Fisher exact test.
† *p* Value corresponds to Wilcoxon signed-rank test.

Table 3. Comparison of Skillset Scores between Tele-Education Group and Conventional Group.

Skillset	Tele-Education Group, n (%) (n = 22)	Conventional Group, n (%) (n = 23)	*p* Value*
Assessment and activation			
Tap shoulder	21 (95.5)	21 (91.3)	1.000
Check breathing	20 (90.9)	19 (82.6)	0.665
Call for help and ask for AED	21 (95.5)	18 (78.3)	0.187
Adult compression			
High-quality compressions			
Compression rate 100–120/min	5 (22.7)	12 (52.2)	0.042
Compresses at least 2 inches	3 (13.6)	2 (8.7)	0.665
Hand placement on lower half of sternum	11 (50.0)	17 (73.9)	0.098
Complete recoil after each compression	3 (13.6)	2 (8.7)	0.665
Compression: ventilation ratio (30:2)	4 (18.2)	12 (52.2)	0.017
Open airway: head tilt-chin lift	13 (59.1)	12 (52.2)	0.641
AED			
Powers on AED	22 (100)	23 (100)	NA
Correctly attaches pads	22 (100)	23 (100)	NA
Ensures compressions during pads attachment	10 (45.5)	9 (39.1)	0.668
Clears for analysis in nonshockable rhythm	22 (100)	20 (87.0)	0.233
Resumes chest compression immediately	22 (100)	23 (100)	NA
Clears for analysis in shockable rhythm	21 (95.5)	21 (91.3)	1.000
Clears to safely deliver shock	20 (90.9)	22 (95.7)	0.608
Delivers shock	22 (100)	23 (100)	NA
Rotation of rescuers every 2 min	13 (59.1)	8 (34.8)	0.102
Ensures compressions are resumed immediately after shock delivered	21 (95.5)	22 (95.7)	1.000

AED = automated external defibrillator; NA = not applicable.
[a]*p* Value corresponds to χ^2 test or Fisher exact test.

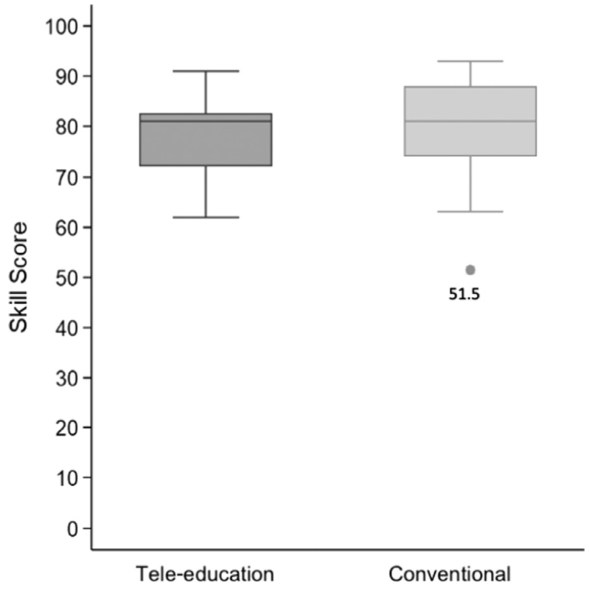

Figure 3. Skill Score.

tal resuscitation training by tele-education vs. classroom training (CT), which resulted in higher skill scores in the CT group (25). In addition, the study by Weeks and Molsberry resulted in no difference in level of psychomotor skill proficiency based on method of instruction (20).

The main strength of this study was its innovative design. To our knowledge, this is the first study assessing the use of tele-education in live BLS CPR training. The results of the study hold promise for use of tele-education CPR training, which would highly benefit training during the ongoing COVID-19 pandemic. This method of medical education would also benefit CPR training to geographically isolated remote health care providers, especially in developing countries. It is also an effective method for large-scale training. This study could serve as a basis for research to evaluate other aspects of telemedical education.

Limitations

Although the study had several strengths, there are some potential limitations that should be recognized. Some participants had prior BLS training. The retention of knowledge and skills after an interval also needs to be investigated. We recommend further studies on participants without prior CPR knowledge and follow-up assessment. During the tele-education training sessions, certain technology limitations were noted, such as unstable internet connection. Alpha testing of the system would be beneficial for detecting technical difficulties and serve as practice for instructors to use the tele-equipment.

Because there is no standard curriculum for tele-education, there are different variables for each training site. Establishing a standard training module for remote CPR training and experimenting on a larger number of participants per group would be recommended for further study.

Conclusions

CPR training by tele-education was not inferior to conventional classroom training. Learning by tele-education offers a pragmatic and reasonably effective alternative to conventional training in CPR among health care providers during the ongoing pandemic and for remote-site providers, especially in developing countries.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author on reasonable request.

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ARTICLE SUMMARY

1. Why is this topic important?

Out-of-hospital cardiac arrest (OHCA) is a major cause of death for which cardiopulmonary resuscitation (CPR) administered by a lay rescuer is a life-saving procedure.

2. What does this study attempt to show?

Tele-education benefits CPR training during the ongoing COVID-19 pandemic.

3. What are the key findings?

Tele-education offers a pragmatic and reasonably effective alternative to conventional training in CPR.

4. How is patient care impacted?

More trained lay rescuers can increase a person's chance of survival after OHCA.