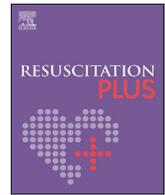




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Simulation and education

Efficacy of a five-minute compression-only cardiopulmonary resuscitation class compared to thirty-minute instruction among college students

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ABSTRACT

Objective: To determine if 5-minute compression-only cardiopulmonary resuscitation (CCO-CPR) instruction is as effective as 30-minute instruction in improving participant knowledge and comfort with performing CCO-CPR as well as teaching CPR quality and responsiveness to an Out of Hospital Cardiac Arrest (OHCA).

Methods: A prospective randomized controlled trial of university undergraduates was performed. Participants were randomized to either a 5-minute (experimental) or 30-minute (control) CCO-CPR instruction class. Pre- and post-testing was performed with a written and simulation test. Measurements collected assessed rate and depth of compressions, time to call 911, and time to start chest compressions. Prior to instruction, subjects' baseline measurements of CPR performance were evaluated during a standardized sudden death scenario using a Laerdal SkillReporter™ mannequin. The written test and scenario were repeated after either the five or 30 minute CCO-CPR instruction using the same outcome measures. Statistical tests of association for categorical variables were assessed using the chi-square test and the independent samples *t*-test was utilized for continuous variables. All tests were two-sided and the level of significance was set at $\alpha = 0.05$.

Results: Among the 59 participants, 28 received 5 minutes of instruction and 31 received 30 minutes. Fifteen (25.4%) individuals reported prior CPR training. Post intervention, all measurements reached statistically significant improvements in each group but there was no difference between the two groups improvement in depth of compressions (experimental group: 41.8 mm, 95% CI 36.6–43.4 vs control group: 46.5 mm, 95% CI 40.9–48.3, $p = 0.06$), compressions per minute (114.3 cpm, 95% CI 105.5–122.0 vs 121.1 cpm, 95% CI 115.1–131.4, $p = 0.10$), time to starting chest compressions (13.5 vs 12.4 sec, $p = 0.45$), or time to calling 911 (8.34 vs 7.65 sec, $p = 0.58$). Further, there was a statistically significant improvement in participants that said they would probably or definitely perform CCO-CPR in real life after both interventions but no difference between the groups (100% of the experimental group and 93.5% of the control group $p < 0.49$).

Conclusion: Five-minute instruction is not inferior to 30-minute instruction at teaching undergraduate students how to perform quality bystander CCO-CPR.

Introduction

The importance of quality cardiopulmonary resuscitation (CPR) in improving outcomes for out of hospital cardiac arrest (OHCA) cannot be overstated. Currently, almost 80% of cardiac arrests occur outside of the hospital, and in the United States, only 30–50% receive bystander CPR.^{1,2} Performance rates of bystander CPR vary by geographic area and remain low in certain regions despite significant efforts made to increase participation.^{2–4}

While there have been many identified barriers to bystander CPR performance, one is that people need to be formally trained.^{5,6}

Traditional classes require a course fee, a certified instructor, last hours, and can be intimidating. Chest compression-only CPR (CCO-CPR) mediates many of these concerns. Between 2005 and 2009, rates of bystanders using CCO-CPR instead of traditional CPR increased from 19.6% to 75.9%.² In recent years there has been significant research supporting CCO-CPR and its potential to improve survival in primary cardiac arrests.^{7,8}

Other barriers include appropriate early recognition of cardiac events and early activation of emergency response. Both of these factors rely heavily on bystander knowledge. Another critical factor in improving survival is the quality of CPR delivered.⁹ Training a greater proportion of

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bystanders to recognize cardiac arrests and perform quality CPR can increase the survival rates for OHCA. However, getting diverse populations to participate in time-consuming formal CPR courses is difficult.

Studies have shown that people who learn in shorter amounts of time, even brief videos, are more likely to respond in an emergency and perform higher quality CPR in comparison to untrained lay persons.^{10,11} European guidelines now reflect that self-instruction videos associated with hands-on practice are supported as “an effective alternative” to formal classes.¹²

Our goal was to compare the efficacy of a 5-minute CCO-CPR instruction to a more traditional 30-minute CCO-CPR class in teaching quality CPR and bystander responsiveness to an OHCA scenario. The primary endpoint was to measure the performed depth and rate of compressions between the two groups. The secondary endpoints included determining changes in participant comfort recognizing cardiac arrests and performing CCO-CPR as well as retention of basic CPR facts (i.e. proper depth of compressions, compression rate, CPR definition) based on questionnaires administered prior to and after their instruction.

Methods

The Institutional Review Board at the University of Arizona Health Sciences approved this study. All participants signed a written consent form prior to completing the study.

Selection of participants

Between October 2017 and October 2018, students were recruited through on-campus advertising in classrooms and email listservs to attend one of five research sessions. All interested students who spoke English ≥ 18 years who were enrolled in the University of Arizona as part-time or full-time students met inclusion criteria. The exclusion criteria were any student < 18 years of age who was not enrolled at the University of Arizona. No monetary compensation or curricular credit was offered for participation.

Randomization

Participants who met the inclusion criteria were assigned to the experimental (5-minute) or control (30-minute) groups using a random number generator. Odd numbers were randomized to the experimental group and even numbers were randomized to the control group. The goal of the random number generator was to create groups with an equal number of participants. All members of the research team and participants were blinded.

Study design

After completing the consent form, participants completed a demographics survey (i.e., student identification number, email, age, self-identified gender and history of prior CPR training). Participants then responded to a pre-test questionnaire. Both the demographics surveys and pre-test questionnaire were electronic and completed by participants on their personal mobile devices. The data was collected and managed using the Research Electronic Data Capture (REDCap), a secure, web-based application designed to support data capture with validated data entry, audit trails, and automated export procedures, provided by the University of Arizona.¹³ The participants' answers were confidential and could only be identified using their study number.

The questionnaire assessed qualitative measures of the participant's CPR knowledge and comfort (Supplemental Figure 1). The questions were designed by University of Arizona Emergency Department faculty and included some questions from a prior study evaluating knowledge and willingness to perform CCO-CPR in laypersons.¹⁴

Following the completion of the demographics survey and pre-test questionnaire, participants were sent to a private room to complete a

pre-test simulation. The room contained a Laerdal SkillReporter™ mannequin on the floor and a portable automatic external defibrillator (AED) machine. A computer was oriented to video record participants with the mannequin such that facial identification was not possible.

Upon entering, an evaluator informed the participant that s/he was the first responder to a scene in which a person was unresponsive in a public place to simulate a sudden death scenario. All simulations were scripted identically and read by the evaluator to the participants to ensure a standardization (Supplemental Text 1). The trained evaluator remained present for the duration of this process but did not provide instruction or guidance after the initial script was read. The simulation lasted 2 minutes. Rate and depth of compressions were recorded by the mannequin and time to calling for AED and 911 by the evaluator. There were no actors. Participants were evaluated during the simulation, and again by another blinded, trained evaluator using the video recording (Supplemental Figure 2). The video had no identifying features (i.e. their faces) and the second evaluator received all of the videos in a random order. Any discrepancies between the two evaluations was sent to the principle investigator, an attending Emergency Medicine physician. All participants completed the same simulation.

Once the initial evaluation was completed, participants were directed to a room based on their designated number. Instructors entered once all participants had entered their respective rooms. The instructors were medical students who had completed over 45 hours of CCO-CPR training in the community.

Randomized participants received either a 5-minute or 30-minute intervention. Both interventions were pre-scripted based on information provided by Sarver Heart Center and University of Arizona Emergency Department faculty. The 5-minute (experimental) intervention included a written script that the instructor read to the participants while demonstrating CCO-CPR on a mannequin (Supplemental Text 2,3). The 30-minute (control) instruction is the standard instruction that medical students use to teach lay persons CCO-CPR at formal sessions. It consists of a PowerPoint explaining CCO-CPR followed by participants practicing on the mannequin (Supplemental PPT). Both scripts highlighted the three “C”s: “Check, Call, Compress,” appropriate use of an AED, and correct rate and depth for CCO-CPR. All participants were asked to perform hands-on CCO-CPR on the mannequin with instructor assistance.

After completion of their respective courses, participants repeated the same pre-test questionnaire and were given the same sudden death scenario including a 2-minute simulation test to allow for data comparisons (Supplemental Text 4).

Outcomes

The primary outcomes were 1) evaluation of chest compression per minute (cpm) 2) compression depth in millimeters (mm) both determined directly from the Skillrecorder™ mannequin and 3) time to calling 911 determined by evaluator visual assessment. Secondary outcomes included responses to survey questions (i.e. ability for early recognition of an OHCA and likelihood of performing CCO-CPR).

Statistical analysis

Data analysis was performed by a statistician (TN) blinded to the time of data collection (pre/post). We tested an experimental or control CCO-CPR instruction class between study periods (pre/post) for the following outcomes: 1) chest compression rate and depth, time to calling 911, and time to start compressions. Categorical data is presented as percentages and continuous data as means and 95% confidence intervals (CIs). A comparison of demographic characteristics and outcomes between the pre and post intervention subjects was conducted using Student's t-test or Fisher's exact test as appropriate. All statistical analyses were performed using Stata version 15 (StataCorp, College Station, Texas). A power calculation for several of the outcomes was performed. The power calculation showed a power of 0.72 (N = 60) in the difference in mean

post test scores among the control and intervention groups and a power of 0.58 (N = 60) for the difference in mean time to calling 911 between the control and intervention groups.

Results

Seventy-three students signed up for the study. Fifty-nine students participated in and completed testing (Fig. 1). The demographics of the randomized participants demonstrated a mean age of 20 years with 35 (59.3%) identifying as female and 17 (28.8%) having prior CPR training (Table 1). Twenty-eight participants randomized to the experimental group and 31 to the control group. There were no statistically significant differences between the demographics of the two groups (Table 1).

Baseline performance

Prior to intervention, participants in both groups performed chest compressions at a rate less than the optimal goal range of 100–120 cpm⁴ (experimental group: 91 vs control group: 98 cpm, p = 0.49) (Table 3). Additionally, the depth of compressions was below the goal depth of at least 5 cm (50 mm)⁴ (30.1 vs 37.4 mm, p = 0.05) (Table 4).

Clinical performance

There was a statistically significant improvement in the pre and post intervention compression rate within each group (p = 0.003 vs p = 0.003) (Table 3), as well as the depth of compression (p < 0.001 vs p < 0.001) (Table 4) but there was no statistically significant difference between the two groups in depth of compressions (experimental group: 41.8 mm, 95% CI 36.6–43.4 vs control group: 46.5 mm, 95% CI 40.9–48.3, p = 0.06) (Table 4), compressions per minute (114.3 cpm, 95% CI 105.5–122.0 vs 121.1 cpm, 95% CI 115.1–131.4, p = 0.29) (Table 3), time to starting chest compressions (13.5 vs 12.4 sec, p = 0.45), or time to calling 911 (8.34 vs 7.65 sec, p = 0.58).

Pre-intervention questionnaire

The initial questionnaire demonstrated that participants in both groups had an understanding of the definition of CPR (experimental group: 92.9% vs control group: 80.7%) but were not certain of the proper steps to assess a person prior to initiating CPR (32.1% vs 38.7%) (Table 2). Both groups demonstrated an understanding of the depth

Table 1
Participant characteristics.

	Total Population (n = 59)	5 min group (n = 28)	30 min group (n = 31)	p-value
Age in years, median (range)	20 ¹⁸⁻²⁵	20 ¹⁸⁻²⁵	20 ¹⁸⁻²³	0.59
Gender				0.46
Male	23 (39%)	11 (39.9%)	12 (38.7%)	
Female	35 (59.3%)	17 (60.7%)	18 (58.1%)	
Other	1 (1.7%)	1 (3.6%)	0 (0%)	
Prior CPR Training	17 (28.8%)	7 (25.0%)	10 (32.3%)	0.37

Table 2
Questionnaire responses.

		5 min group (n = 28)	30 min group (n = 31)	p-value
Correctly identified the definition of CPR (%)	Pre	92.9	80.7	0.26
	Post	96.4	100.0	0.48
Correctly identified order of events as check- call- compress (%)	Pre	32.1	38.7	0.79
	Post	89.3	100.0	0.10
Correctly identified the number of chest compressions needed per minute (%)	Pre	42.9	54.8	0.44
	Post	82.1	100.0	0.02
Correctly identified the appropriate compression depth (%)	Pre	82.0	71.0	0.37
	Post	92.9	93.6	1.00
Correctly identified elbow position during compressions (%)	Pre	64.3	54.8	0.60
	Post	100.0	83.9	0.05
Comfort recognizing a cardiac arrest (% responded medium or high)	Pre	25.0	61.3	0.01
	Post	96.4	100.0	0.48
Likely to perform CPR (% responded possibly or definitely)	Pre	57.1	74.2	0.18
	Post	100.0	93.5	0.49

Table 3
Chest compression rate.

		5 min group (n = 28)	30 min group (n = 31)	p-value, intergroup
Mean compressions per minute (95% CI)	Pre	91.0	98.4	0.49
	Post	114.3 (105.5–122.0)	121.1 (115.1–131.4)	0.29
p-value, intragroup		0.003	0.003	

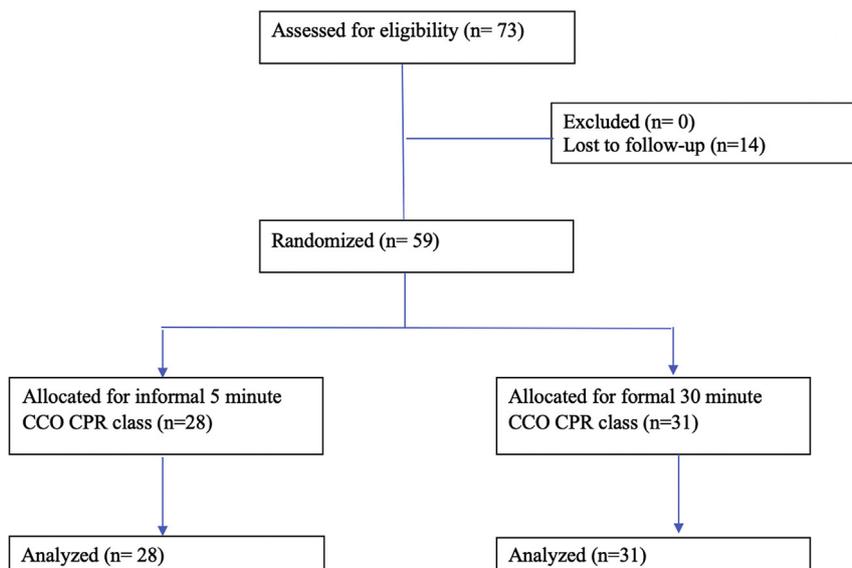


Fig. 1. Consort flow diagram.

Table 4
Chest depth.

		5 min group (n = 28)	30 min group (n = 31)	p-value, intergroup
Mean depth (mm) (95% CI)	Pre	30.1	37.4	0.05
	Post	41.8 (36.6–43.4)	46.5 (40.9–48.3)	0.06
p-value, intragroup		<0.001	<0.001	

required for each compression (82.0% vs 71.0%), however, were uncertain of the number of compressions required per minute (42.9% vs 54.8%) or if elbows needed to be locked to perform compressions (64.3% vs 54.8%) (Table 2). Participants were also uncomfortable identifying a OHCA (50.0% vs 38.7%) and stated they were not likely to perform CPR if required (0% vs 25.8% reported they would definitely perform CPR) (Table 2). There were no statistically significant differences in the pre-intervention responses between the two groups, except for comfort recognizing a cardiac arrest (Table 2).

Post-intervention questionnaire

Based on post-intervention surveys, participants in both groups demonstrated improvement in all categories (Table 2). Participants increased their ability to define CPR (experimental group: 96.4% vs control group: 100%), correctly identified check-call-compress steps prior to initiating CPR (89.3% vs 100%), recognized the correct number of compressions per minute (82.1% vs 100%), the depth of compressions (92.9% vs 93.6%) and proper elbow position during compressions (100% vs 83.9%) (Table 2). There were no statistically significant differences in the post-intervention responses between the two groups, except for identifying the number of chest compressions needed per minute and appropriate elbow position (Table 2).

Participants felt more comfortable identifying an OHCA (experimental group: 96.4% vs control group: 100%, $p = 0.48$) (Table 2). Further, 100% of the experimental group and 93.5% of the control group would probably or definitely perform hands-only CPR in real life after both interventions ($p = 0.49$) (Table 2).

Discussion

Multiple studies have demonstrated the survival benefit of bystander CPR as well as the increase in mortality with delays in CPR delivery.^{15,16} Though significant efforts have been made to increase bystander CPR rates, the rate of bystander CPR performance in many geographic areas is low.^{2–4} One intervention to increase provision of CPR has focused on teaching CCO-CPR to laypersons. Studies have demonstrated that CCO-CPR is at least as effective as conventional CPR for adults who suddenly collapse.⁵ This approach has been integrated into guidelines published by both the American Heart Association (AHA) and European Resuscitation Council with the goal being to increase public awareness and education to increase performance of lay bystander CPR for OHCA.^{1,6} The most important determinant for neurologically intact survival in OHCA is whether bystander CPR was initiated.¹⁷

Both groups of study participants, regardless of length of instruction provided, demonstrated statistically significant improvements in rate and depth of compressions that approached but did not reach AHA guidelines.⁴ These findings help validate that it is feasible to teach CCO-CPR in shorter periods of time without loss of quality. Moreover, this data suggests that using brief intervention increased CPR quality and responsiveness, which may positively impact outcomes in OHCA.¹⁸

This research showed that participants achieved compression depths closer to AHA guidelines but neither group reached the AHA target.⁴ Though participants in both groups demonstrated statistically significant improvement towards the 50 mm target (41.8 and 46.5 mm), participants in the control arm reached a depth more consistent with goal

guidelines.^{3,19} This difference between the groups was not statistically significant, however it may be clinically relevant and is noteworthy (Table 4).

Participants demonstrated an improvement in qualitative and quantitative measures, likely due to the hands-on component in each group, which helped to develop the psychomotor skill that may not occur when watching a video. Previous studies have demonstrated that providing mannequins to trainees improves bystander CPR responses, which in turn improves the quality of bystander CPR leading to improved survival outcomes.²⁰ Contrastingly, several brief video CCO-CPR studies without hands-on components were unable to demonstrate improvements in compression depths.^{21,22} This further re-emphasizes the importance of hands-on training in achieving quality CPR.²³

Participants also demonstrated a significant increase in qualitative outcomes, specifically comfort recognizing a cardiac arrest and likelihood of performing CPR (Table 2). Although a statistically significant difference was noted between the pre-test groups in participant responses to comfort recognizing a cardiac arrest, post-test groups demonstrated no statistically significant differences. A slightly higher percentage of participants in the control arm (32.3% vs 25.0%) had prior experience performing CPR which may have contributed to the high baseline comfort (Table 1). The improvement in both groups is crucial, as the most important first steps in cardiac arrest care is recognition of the event, summoning for help and immediate action. The current AHA guidelines advise that bystanders recognize OHCA and begin treatment if the person has no movement and no regular breathing including agonal gasps.²⁴ The fact that this information can be conveyed sufficiently in both 5-minute and 30-minute instruction may help improve bystander CPR rates.

Limitations

There are limitations to the study's generalizability given only college students were asked to participate. Although we attempted to reach $N = 100$, our recruitment efforts only reached $N = 59$. A larger sample size would be beneficial as our power calculation for $N = 60$ was 0.72 and 0.58, respectively, for the primary outcomes we assessed. Additionally, differences in education, race, and training of a population may play an important role on performance of CPR. The level of education of our participants were limited to those with some higher education.²⁵

Another limitation is long-term retention was not evaluated. Participants completed the same evaluation process before and after the study to measure initial knowledge acquisition, but it is difficult to evaluate if participant comfort and skill would differ between groups over time without repeating these measures at a later date. Follow-up studies should have been completed every three months after the study completion. Due to recruitment follow-up and time constraints, this was not performed.

Finally, the testing environment was controlled as participants practiced their compressions on the same mannequins that were used in their evaluation. Access to equipment, including mannequins with the ability to record compression statistics, is generally limited outside of academic centers. Additional assessment of our data was limited as the equipment we utilized did not provide information such as the proportion of compressions that are compliant for both depth and rate. Furthermore, by utilizing a simulated scenario, it is difficult to assess how a layperson would respond in a real emergency.

Despite the limitations of the study, the findings have important implications for the potential to improve rates of CPR training. Our research demonstrates that participants could perform CCO-CPR approaching the AHA current guidelines for rate and depth.^{3,19} This means it may be feasible to add this short intervention and bring CCO-CPR instruction to large groups of people in areas of high foot traffic, such as malls, sporting events, or gyms. From a public health perspective, this may make learning CCO-CPR a more accessible life-saving skill. This approach may provide exposure of critical resuscitation skills to more individuals who have historically been less likely to

be trained, including those from lower socioeconomic groups, the unemployed, and those of advancing age.^{26–29} This may also help reduce the documented disparities in cardiac arrest survival and prehospital care between zip-codes, neighborhood socioeconomic characteristics, and household incomes.

In recent years, the AHA has adopted CCO-CPR as the advised method for resuscitation for the public.¹ Similarly, the guidelines for dispatcher-assisted instructions for untrained bystanders also emphasize the importance of quality CCO-CPR.^{20,30} This has shifted formal trainings away from focus on traditional CPR and towards widespread public education campaigns. Our research helps to validate the ability to train lay persons in less time with similar outcomes to our traditional 30 minute class in recognizing OHCA arrest and demonstrating improvements in CPR quality and responsiveness from baseline. Increasing access to training and teaching CPR in public venues may increase bystander CPR rates and develop a culture of bystander assistance.

Conclusion

Following a 5-minute CCO-CPR training, college students demonstrated statistically significant improvements in CPR quality (compression rate and depth) and responsiveness (time to calling 911, early recognition of OHCA and increased likelihood of performing CCO-CPR) that was equivalent to those taught in the traditional 30-minute session. Although, post-training depth of compressions improved, it did not reach AHA recommendations in either group. Further research should evaluate the generalizability of the data to other populations and long-term retention among participants.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.resplu.2020.100012>.

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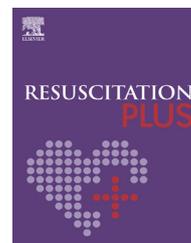
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Erratum

Erratum regarding missing Declaration of Competing Interest statements in previously published articles



Declaration of Competing Interest statements were not included in the published versions of the following articles that appeared in previous issues of Resuscitation Plus

The appropriate Declaration/Competing Interest statements, provided by the Authors, are included below.

- 1 "Efficacy of a five-minute compression-only cardiopulmonary resuscitation class compared to thirty-minute instruction among college students" [Resuscitation Plus, 2020; 3: 100012] DOI: 10.1016/j.resplu.2020.100012

Declaration of competing interest: None

- 2 "Dose optimization of early high-dose valproic acid for neuroprotection in a swine cardiac arrest model" [Resuscitation Plus, 2020; 1/2: 100007] DOI: 10.1016/j.resplu.2020.100007

Declaration of competing interest: None

- 3 "Modifiable provider-patient relationship factors and perceived illness threat are associated with poor quality of life in survivors of cardiac arrest with good neurologic recovery" [Resuscitation Plus, 2020; 3:100008] DOI: 10.1016/j.resplu.2020.100008

Declaration of competing interest: None

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