Hands-Only Cardiopulmonary Resuscitation Education: A Comparison of On-Screen With Compression Feedback, Classroom, and Video Education

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Study objective: We compare 3 methods of hands-only cardiopulmonary resuscitation (CPR) education, using performance scores. A paucity of research exists on the comparative effectiveness of different types of hands-only CPR education. This study also includes a novel kiosk approach that has not previously been studied, to our knowledge.

Methods: A randomized, controlled study compared participant scores on 4 hands-only CPR outcome measures after education with a 25- to 45-minute practice-while-watching classroom session (classroom), 4-minute on-screen feedback and practice session (kiosk), and 1-minute video viewing (video only). Participants took a 30-second compression test after initial training and again after 3 months.

Results: After the initial education session, the video-only group had a lower total score (compressions correct on hand placement, rate, and depth) (−9.7; 95% confidence interval [CI] −16.5 to −3.0) than the classroom group. There were no significant differences on total score between classroom and kiosk participants. Additional outcome scores help explain which components negatively affect total score for each education method. The video-only group had lower compression depth scores (−9.9; 95% CI −14.0 to −5.7) than the classroom group. The kiosk group outperformed the classroom group on hand position score (4.9; 95% CI 1.3 to 8.6) but scored lower on compression depth score (−5.6; 95% CI −9.5 to −1.8). The change in 4 outcome variables was not significantly different across education type at 3-month follow-up.

Conclusion: Participants exposed to the kiosk session and those exposed to classroom education performed hands-only CPR similarly, and both groups showed skill performance superior to that of participants watching only a video. With regular retraining to prevent skills decay, the efficient and free hands-only CPR training kiosk has the potential to increase bystander intervention and improve survival from out-of-hospital cardiac arrest. [Ann Emerg Med. 2019;73:599-609.]

Please see page 600 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

Surviving an out-of-hospital cardiac arrest is highly influenced by prompt action from bystanders; survival rates more than double when bystander cardiopulmonary resuscitation (CPR) is administered.[1] In 2017, 356,461 people experienced out-of-hospital cardiac arrest in the United States, but only 45.7% of adults and 61.4% of children received bystander CPR.[2] The rate of bystander CPR is even lower in rural, minority, and low-income communities.[3,4] Low rates of bystander CPR are linked to a lack of CPR training.[5] There are many reasons for reluctance to perform CPR,[6] but barriers to learning CPR that can be addressed with creative training solutions include lack of CPR training accessibility, inability to afford training, the time commitment associated with some traditional CPR training, and personal health concerns about performing CPR.[7,8] Hands-only CPR education opportunities help address many of these barriers, given the short time commitment, lower-cost or free education and its accessibility, and lack of mouth-to-mouth contact associated with hands-only CPR and hands-only CPR education.

Multiple methods are currently used to train bystanders in hands-only CPR. The most common method is facilitator-led, practice-while-watching, in-person training primarily using the CPR in Schools Training Kit or Adult and Child CPR Anytime Kit. Compared with conventional

Editor's Capsule Summary

What is already known on this topic

Hands-only cardiopulmonary resuscitation (CPR) training may help increase the public's acceptance and ability to initiate early CPR, which can improve survival from out-of-hospital cardiac arrest.

What question this study addressed

What is the comparative effectiveness of 3 different educational modalities for teaching hands-only CPR to laypeople?

What this study adds to our knowledge

Approximately 50% of the 771 persons randomized completed the 3-month skill retention test. Results were similar for all groups. Individuals trained in the classroom or with the 4-minute video and feedback manikin kiosk practice session performed similarly and somewhat better than video-only participants during initial testing.

How this is relevant to clinical practice

Kiosk training offers an effective, quick, and easily deployable alternative to classroom learning for hands-only CPR training of laypeople.

CPR training that typically takes 3 to 4 hours,[7] hands-only CPR training can be taught in less than 30 minutes and can be self-directed through practice-while-watching training or administered by an individual who is not professionally trained in CPR instruction.[9] One hands-only CPR education intervention trained 334,610 middle school students, using teachers untrained in CPR instruction as the facilitators.[10] Showing a hands-only CPR training video is an affordable and accessible training method. Participants watching training videos ranging in duration from 60 seconds to 8 minutes have better compression rate and depth,[11] decreased time to start compressions and fewer interruptions in compressions,[12] and increased willingness to perform hands-only CPR[11] compared with untrained participants. Watching a 22-minute hands-only CPR video resulted in a compression rate similar to that after video self-instruction (video with practice on an inflatable manikin), but lower compression depth at 6 months posttraining.[13] Another effective training method uses feedback manikins or devices during conventional CPR training and hands-only CPR training to improve skill acquisition. A systematic review found that a majority of studies showed improvement in compression rate and depth and improvement in the percentage of compressions completed correctly when CPR feedback or prompt manikins were used during CPR training.[14] Specific to hands-only CPR, brief instruction and compression feedback is linked to improved skill performance.[15-17]

Importance

Although several effective methods of hands-only CPR education reduce some of the barriers to training (availability, time, and cost), little is known about the comparative effectiveness of these methods. This study is important in that it compares 3 different methods of hands-only CPR education: a facilitator-led, 30-minute, hands-only CPR, practice-while-watching classroom session (classroom session), an on-screen 4-minute tutorial with feedback manikin practice (kiosk session), and a 1-minute hands-only CPR video (video-only session). The kiosk session used in this study is a novel approach to hands-only CPR education. In 2013, the American Heart Association (AHA) installed a hands-only CPR training kiosk in the Dallas/Fort Worth International Airport to enable visitors to learn and practice hands-only CPR by using a touch screen to initiate a how-to video program and practice session. In the first 32 months, the kiosk demonstrated that this method was effective by attracting 23,478 visitors with no advertising or incentives. After the success of the airport kiosk, additional hands-only CPR training kiosks were placed in 16 airports and 14 other high-traffic public areas, providing convenient hands-only CPR education. Greater than 200,000 people have interacted with the kiosks and greater than 100,000 have completed the training. A recent study investigated the user data from the passersby at Dallas/Fort Worth International Airport who took the test after the kiosk session; 26.2% of the attempted chest compressions had the correct rate, 60.2% achieved correct depth, and 63.5% had the correct hand placement.[18] However, the efficacy of the kiosk compared with other hands-only CPR education methods has not been studied until this project, to our knowledge.

Goals of This Investigation

The objective of this research was to compare 3 different methods of hands-only CPR education, using immediate CPR performance scores from a Laerdal Mini Anne Feedback Manikin (Laerdal Medical, Stavanger, Norway).

MATERIALS AND METHODS

Study Design and Setting

This 3-arm randomized trial was conducted in Denver, CO. The study was approved as an educational evaluation

and exempt study by the Western Institutional Review Board. Verbal consent was obtained from all subjects.

The study used an experimental design with subjects randomized to 1 of the following 3 groups:

1. Facilitator-led, 30-minute, practice-while-watching, hands-only CPR classroom session (classroom session)
2. On-screen 4-minute hands-only CPR tutorial with feedback manikin practice (kiosk session)
3. 1-minute hands-only CPR video (video-only session)

The groups were supervised by research assistants trained to troubleshoot difficulties with technology. Research assistants returned for follow-up assessments after 3 months.

Participating employers and community organizations were recruited by the investigators through an e-mail invitation describing the study and the benefits to the employer or organization and their employees. A broad variety of employers and organizations were invited to participate as sites in the study to increase the generalizability of the findings. Community organizations approached served lower-income, Latino, and older adults. Employers included state and city agencies and private companies offering the training to employees with diverse age, race, education, and income.

Selection of Participants

Once employers or organizations agreed to participate, e-mails were sent to all employees or members to describe the study and solicit participation. All participants were promised a $10 Amazon gift card at the end of the education session and at a 3-month follow-up interview. Participants younger than 18 years were excluded.

Interventions

At the initial education session, all subjects began in the same room, where they listened to the description of the study and verbally consented to participation. Participants were randomized into 1 of 3 groups by colored cards, and then each group underwent education in a separate room. Researchers were not blinded to education session allocation.

The classroom session cohort received education with the CPR in Schools curriculum and manikins from the AHA (http://cpr.heart.org/AHAECC/CPRAndECC/Training/CPRInSchoolsTrainingKits/UCM_473191_CPR-In-Schools-Training-Kits.jsp). The CPR in Schools Training Kit, with practice manikins, training digital video disks, and curriculum, was designed for use in schools but in actual practice has been adopted by many communities for educating groups of adults in community organizations. The digital video disk and accompanying curriculum are designed to be presented by any facilitator, regardless of past CPR education or CPR instructor experience. Depending on the number of students and the necessity to share manikins, hands-only CPR education can be completed within 25 to 45 minutes. The curriculum does include additional modules for adult and child choking relief, automated external defibrillator use, and child CPR, but only the hands-only CPR module was presented in this study.

The classroom session was facilitated by the same research assistant for all study sites. All classroom participants practiced on the kit's 10 inflatable manikins, allowing the facilitator to circulate and provide one-on-one feedback as necessary to improve compression accuracy. If any study sites had greater than 10 participants in the classroom session, additional rounds of practice were offered so that all participants received the same amount of practice.

The kiosk session for this study simulated the AHA's hands-only CPR training kiosk (https://cpr.heart.org/AHAECC/CPRAndECC/Programs/HandsOnlyCPR/UCM_491195_Hands-Only-CPR-Training-Kiosks.jsp) (Figure 1). The kiosks are all AHA owned, operated, and maintained as part of an AHA initiative to train more people in the lifesaving skill of hands-only CPR. The kiosks are placed as part of a sponsorship model and organizations do not purchase the kiosk outright. Because the kiosk features learning of chest compressions only, there are no mouth-to-mouth breaths taught or practiced, which eliminates most concerns in regard to infection. The manikin, or rubber torso, used for compressions is wiped down daily by an onsite cleaning crew. A sanitation station is provided with every kiosk, which includes wipes for cleaning the manikin and hand sanitizer. Given that the kiosk is a single, heavy unit and not easily portable, this research study used the same components separated into 2 pieces: a portable feedback manikin (Resusci Anne QCPR; https://www.laerdal.com/us/doc/2404/Resusci-Anne-QCPR) and a touch-screen laptop.

The video clips in the kiosk session contain a 3-dimensional animation of a woman explaining the benefits of hands-only CPR and how to perform it. The video shows the woman performing the steps of hands-only CPR in a simulated airport environment. After the video, the kiosk session presents a learn-and-practice module in which users practice compressions with background music, with the correct compression beat and 3 feedback meters on screen showing their compression depth, rate, and hand position. The meters have visual and audible indicators if the compressions are in the desired range for each component. Users are able to practice compressions for as

Figure 1. AHA hands-only CPR training kiosk.

long as they want before touching the screen to continue to the next component, a 30-second test that is part of the kiosk interaction. During the test, music with the appropriate beat for compression rate is played and feedback meters are displayed. After the test, users see a feedback screen that shows their total number of compressions, total score, number of incorrect depth compressions, number of incorrect rate compressions, and number of incorrect hand position compressions. When users touch the screen to move on, there is a final video segment summarizing the steps to hands-only CPR, introducing how to use an automated external defibrillator, and telling users that they now have the skills to save a life. In this study, there is an additional 30-second research test that does not include music or feedback.

The video-only session cohort viewed a 1-minute, 11-second hands-only CPR educational video from the AHA (https://www.youtube.com/watch?v=O_49wMpdews). This video is the same animated one used in the kiosk session video segments but does not include any of the practice or feedback opportunities of the kiosk. Participants watched the video individually on tablets with earphones.

Methods of Measurement

After completion of their education session (or initially for the kiosk cohort), all participants used a touch-screen laptop to navigate through participant characteristics input and the testing scenario through the kiosk software loaded onto 4 laptops attached to feedback manikins. The 4 laptops and manikins were spread out in large rooms, and all participants faced the laptop and manikin with a wall behind them. They wore earphones to ensure a personal experience with minimal interference from others or noise. All participants first entered demographic information and then selected the kiosk session or research test only (for users who completed the classroom and video-only sessions). These instructions were printed on their colored group randomization card, and research assistants were present to ensure they made the correct selection. If only the research test was selected, participants were given a 3-2-1 countdown and then performed compressions on a manikin for 30 seconds, with no visual feedback or music to accompany compressions. If the kiosk session was selected, participants completed the full kiosk session, including the standard 30-second kiosk test with visual compression feedback and music. After completion of the kiosk session, a second research test started, in which participants were given the 30-second research test without any feedback meters or music.

Participants were e-mailed after their initial participation and asked to return for a follow-up interview at the same site as their initial training. To minimize the chance of subject preparation or review of hands-only CPR before the 3-month follow-up session, participants were told they would be interviewed about their hands-only CPR education session and whether they had performed CPR in the interim. At the follow-up session, participants were given a $10 Amazon gift card. They were then informed that they would be assessed with another 30-second research test and that their participation was voluntary. All participants were then offered additional hands-only CPR training if desired. These follow-up methods are similar to those used previously.[13]

Outcome Measures

The training kiosk software program reports the following outcomes measures:

1. Primary outcome: Total score can range from 0 to 100 and represents the percentage of compressions in which all measured components (depth, rate, and hand position) are correct.

2. Secondary outcomes: Scores for each of the 3 individual components can range from 0 to 100 and represent the percentage of compressions in which depth is correct, rate is correct, and hand position is correct.

The kiosk training software scoring system is unique to the kiosk and has not been validated in other published research. However, comparative success of each of the 3 education methods can be measured because we used the same scoring system with each group. The feedback manikin provides an all-or-nothing type of scoring system, so if a compression is only 1 mm too shallow, or 1 compression per minute too fast or slow, that compression is considered incorrect on that measurement. Recognizing the difficulty in obtaining perfect compressions for all 3 components on every compression of the test for the layperson, we conducted a small evaluation of the average scores achieved by emergency medicine professionals regularly practicing and performing chest compressions. The median total score of 39 emergency medicine nurses and emergency medical technicians was 3.0 (interquartile range [IQR] 1.0 to 56.0). The median compression rate score was 8.3 (IQR 1.5 to 63.8), compression depth score was 100 (IQR 100 to 100), and hand position score was 100 (IQR 100 to 100). These results provide a reference score for the achieved scores of laypersons in this study.

Primary Data Analysis

Microsoft SQL Server for Windows (version 2016; Microsoft, Redmond, WA) was used for database management, and Stata (version 13.1; StataCorp, College Station, TX) was used for statistical analysis.

Similarity between initial education groups was assessed with ANOVA for age and χ^2 tests for categoric demographic variables, with a significance level of $P<.05$. Similarity between initial participants and participants returning for follow-up was assessed with a t test for age and z score comparisons for categoric demographic variables, with a significance level of $P<.05$.

Because of nonnormality and bimodal distribution of the initial training outcome score variables, bootstrap analysis was used. Using a bootstrap with 2,000 replications, we ran multivariable mixed-regression models accounting for correlation within training session cohorts and adjusting for age, sex, and time since last CPR course, which were the only covariates used in the models because of hypothesized influence on hands-only CPR scores related to body size and strength and knowledge retention. The classroom session was used as the comparison group for the regression models.

Three-month follow-up testing scores were analyzed by using the difference scores from initial test to follow-up test with multivariable mixed-regression models accounting for

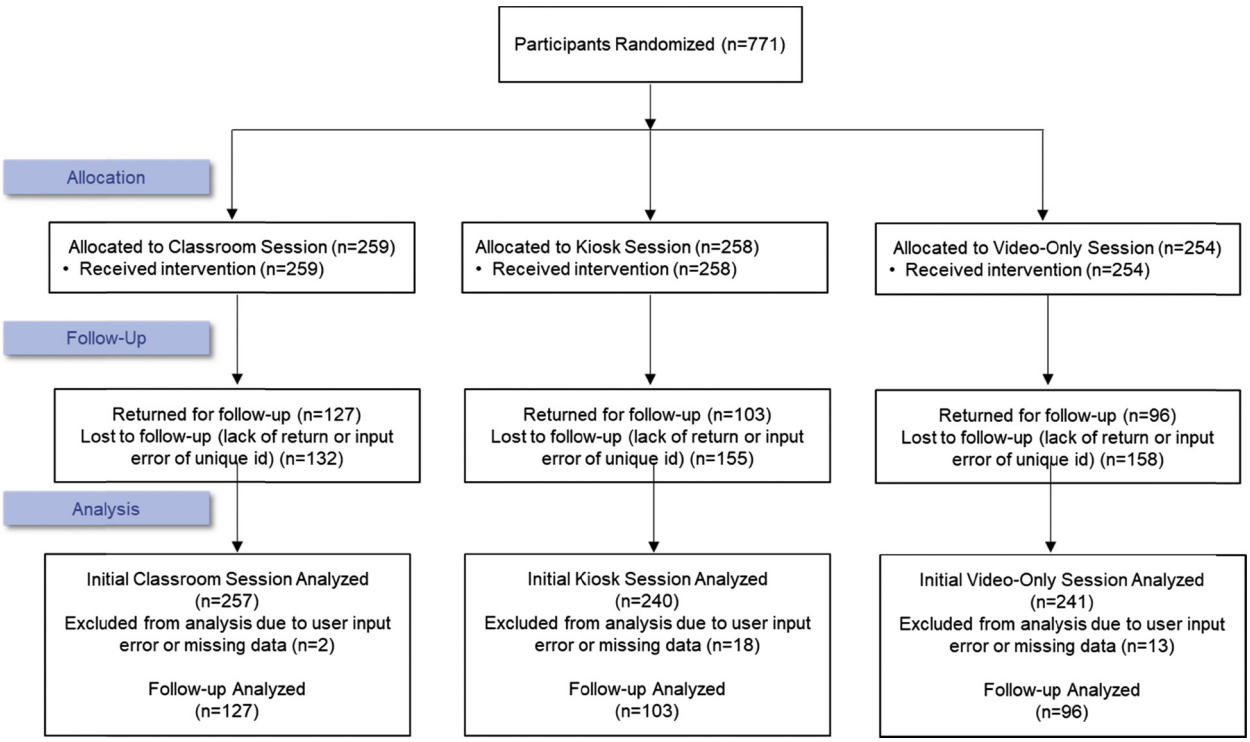

Figure 2. Study randomization flow diagram.

correlation within training session cohorts and adjusting for initial scores, age, sex, and time since last CPR course.

RESULTS

Characteristics of Study Subjects

There were 771 participants recruited for participation at 27 sessions across 15 sites (Figure 2). Thirty-three of the recruited participants were excluded because of missing data resulting from duplicate birth dates at a site (study unique identifier) or entering their birth date differently in the software and on the education type log. Their complete data could not be linked by a unique identifier using site and birth date. A total of 738 skills assessments and demographic data were recorded: 257 randomly assigned to the classroom session, 240 randomly assigned to the kiosk session, and 241 randomly assigned to the video-only session. Three hundred sixty-two participants returned for the 3-month follow-up, of whom 36 were excluded because their birth date (unique identifier) did not have a match in our data set. This was likely due to employers' advertising the follow-up to all employees originally registered for the study, some of whom never completed the initial training. It could also have been due to a participant's erroneously entering different birth dates at the 2 sessions. A total of 326 skills assessments (44% of initial participants) were recorded at the 3-month follow-up: 127 from the original classroom session, 103 from the kiosk session, and 96 from the video-only session.

Main Results

Characteristics and demographics of the 738 participants in the initial sessions (Table 1) were similar across groups, with exception of time since last CPR course. For time since last CPR course, a higher percentage of classroom participants and lower percentage of kiosk participants had taken a CPR course in the last year (classroom 11.7%, kiosk 4.6%, and video only 6.6%). Participants completing the initial education sessions had a mean age of 45.2 years (SD 13 years), and 499 of 738 (68%) were women. Of participants initially enrolled, 531 of 738 (72%) had never taken a CPR course or had been trained 3 or more years ago.

Characteristics of participants returning for follow-up (Table 2) were similar to those of initial participants (Table 1). Participants completing the follow-up sessions had a mean age of 44.4 years (SD 13 years), and 231 of 326 (71%) were women. Of participants initially enrolled, 224 of 326 (69%) had never taken a CPR course or had been trained 3 or more years ago.

After completion of initial hands-only CPR education, compression skills scores showed variation across the 3 groups for all scores assessed (Table 3). Regression models (Table 4), which hold all potential confounding variables constant, showed that the video-only group had a significantly lower total score (–9.7; 95% confidence interval [CI] –16.5 to –3.0) than the facilitator-led classroom group. We did not detect a difference between the classroom group and the kiosk group on total score.

Scores on compression rate, depth, and hand position for the initial training session are considered secondary outcomes because they imply how total score is affected by each component of the total score. Follow-up total scores and follow-up rate, depth, and hand position scores are also considered secondary outcomes.

After the initial education session, the video-only group had significantly lower compression depth scores (–9.9; 95% CI –14.0 to –5.7) than the facilitator-led classroom

Table 1. Participant characteristics (N=738).

Characteristics	Classroom Session (n=257)	Kiosk Session (n=240)	Video-Only Session (n=241)
Mean age, (SD), y	44.7 (14.3)	45.2 (12.9)	45.9 (12.5)
Sex			
Men	73 (28.4)	87 (36.2)	79 (32.8)
Women	184 (71.6)	153 (63.8)	162 (67.2)
Highest education			
Middle school	2 (0.8)	1 (0.4)	2 (0.8)
Some high school	2 (0.8)	1 (0.4)	0
High school diploma	15 (5.8)	8 (3.3)	12 (5.0)
Some college	56 (21.8)	49 (20.4)	58 (24.1)
Bachelor's degree	110 (42.8)	114 (47.5)	92 (38.2)
Graduate degree	72 (28.0)	67 (27.9)	77 (32.0)
Race			
White	168 (65.4)	155 (64.6)	160 (66.4)
Black	15 (5.8)	13 (5.4)	17 (7.1)
Latino/Spanish/ Hispanic	46 (17.9)	45 (18.8)	42 (17.4)
Asian	23 (9.0)	13 (5.4)	14 (5.8)
Native American or Alaskan Native	1 (0.4)	3 (1.3)	5 (2.1)
Pacific Islander	0	1 (0.4)	0
Other or multiple races	4 (1.6)	10 (4.2)	3 (1.2)
Previous CPR training			
No	60 (23.4)	72 (30.0)	60 (24.9)
Yes, <1 y ago	30 (11.7)	11 (4.6)	16 (6.6)
Yes, 1–2 y ago	35 (13.6)	21 (8.8)	28 (11.6)
Yes 2–3 y ago	23 (9.0)	26 (10.8)	17 (7.1)
Yes, >3 y ago	109 (42.4)	110 (45.8)	120 (49.8)

Data are presented as No. (%) unless otherwise indicated.

Table 2. Characteristics of participants returning for follow-up (N=326).

Characteristics	Classroom Session (n=127)	Kiosk Session (n=103)	Video-Only Session (n=96)
Mean age (SD), y	43.7 (13.9)	45.1 (12.8)	44.7 (12.8)
Sex			
Men	32 (25.2)	35 (34.0)	28 (29.2)
Women	95 (74.8)	68 (66.0)	68 (70.8)
Highest education			
Middle school	1 (0.8)	0	1 (1.0)
Some high school	0	0	0
High school diploma	6 (4.7)	3 (2.9)	5 (5.2)
Some college	23 (18.1)	17 (16.5)	18 (18.8)
Bachelor's degree	58 (45.7)	51 (49.5)	38 (39.6)
Graduate degree	39 (30.7)	32 (31.1)	34 (35.4)
Race			
White	88 (69.3)	74 (71.8)	64 (66.7)
Black	9 (7.1)	4 (3.9)	6 (6.3)
Latino/Spanish/ Hispanic	19 (15.0)	18 (17.5)	20 (20.8)
Asian	10 (7.9)	3 (2.9)	5 (5.2)
Native American or Alaskan Native	0	0	1 (1.0)
Pacific Islander	0	0	0
Other or multiple races	1 (0.8)	4 (3.9)	0
Previous CPR training			
No	27 (21.3)	25 (24.3)	19 (19.8)
Yes, <1 y ago	16 (12.6)	5 (4.9)	11 (11.5)
Yes, 1–2 y ago	19 (15.0)	10 (9.7)	11 (11.5)
Yes 2–3 y ago	14 (11.0)	8 (7.8)	8 (8.3)
Yes, >3 y ago	51 (40.2)	55 (53.4)	47 (49.0)

Data are presented as No. (%) unless otherwise indicated.

Table 3. Hands-only CPR skills assessment after initial training (N=738).

	Initial Skills Testing		
Hands-Only CPR Scores	Classroom Session (n=257)	Kiosk Session (n=240)	Video-Only Session (n=241)
Total	35.0 (3.0–91.0)	48.0 (3.0–95.5)	7.0 (1.0–78.0)
Rate	50.0 (6.7–94.2)	60.0 (5.9–97.2)	28.6 (1.6–87.7)
Depth	100 (100–100)	100 (100–100)	100 (96.2–100)
Hand position	100 (100–100)	100 (100–100)	100 (100–100)

Data are presented as median (IQR). HO CPR scores range from 0 to 100 and indicate a percentage of the total compressions performed that were correct on the item indicated.

group. The kiosk group performed significantly better than the classroom group on hand position score (4.9; 95% CI 1.3 to 8.6) but significantly worse on compression depth score (–5.6; 95% CI –9.5 to –1.8).

At the 3-month follow-up session, compression skills scores showed variation across the 3 groups for all scores assessed, with most scores showing decrease over time (Table 5). Regression models (Table 6) showed that the changes in total score were not significantly different for the 3 groups. There was a significantly larger change in compression depth score for the video-only group compared with the classroom group (–4.7; 95% CI –9.3 to –0.2).

LIMITATIONS

This study used a 30-second compression test, which may not accurately represent skill performance if compressions were performed for several minutes in a real emergency. However, this also mitigates the effect of fatigue, which would not be expected to improve with education. We assessed retention at 3 months after the initial education session, but we did not assess longer-term retention, an important aspect of any hands-only CPR initiative. Additionally, we had low participant follow-up (44%), which could have resulted in response bias and limits the accuracy and generalizability of the follow-up findings. The hands-only CPR testing occurred within a simulated environment. We do not know how participants would perform in a real emergency. We included only English-speaking participants in this study and therefore cannot draw conclusions about these education methods delivered in other languages. We included only adults in this study. Because many states are now including legislation for middle school and high school students to be trained in hands-only CPR, an investigation of children's performance of hands-only CPR skills is warranted. Confidence in hands-only CPR was not assessed in this study but could be an important indicator of willingness to act in a cardiac arrest emergency.

Randomization was not performed with concealed allocation. However, participants were instructed to line up on their own before receiving colored randomization cards. Participants did not know which education method corresponded to each colored card, and therefore this likely resulted in few differences in group characteristics.

There was a difference between initial groups in regard to time since last CPR course. The significant difference between groups was in a higher percentage of classroom participants and lower percentage of kiosk participants with CPR education in the last year. However, this difference had minimal influence on the study because CPR

Table 4. Bootstrap multilevel regression analysis of initial hands-only CPR scores separated by score type.

	Total Score		Compression Rate		Compression Depth		Hand Position	
	Fixed-Effect Coefficient	95% CI*	Fixed-Effect Coefficient	95% CI*	Fixed-Effect Coefficient	95% CI*	Fixed-Effect Coefficient	95% CI*
Training type								
Classroom session	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Kiosk session	5.0	(−1.8 to 11.8)	4.0	(−3.0 to 11.0)	−5.6	(−9.5 to −1.8)	4.9	(1.3 to 8.6)
Video-only session	−9.7	(−16.5 to −3.0)	−6.3	(−13.2 to 0.6)	−9.9	(−14.0 to −5.7)	0.7	(−3.5 to 4.9)
Age	−0.5	(−0.8 to −0.3)	−0.3	(−0.6 to 0.1)	−0.3	(−0.5 to −0.2)	−0.2	(−0.4 to −0.1)
Sex								
Women	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Men	2.1	(−4.1 to 8.3)	0.5	(−5.7 to 6.8)	9.4	(6.0 to 12.7)	−6.0	(−10.0 to −2.0)
Last CPR training								
<1 y	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Never	−21.4	(−33.1 to −9.7)	−19.9	(−31.9 to −7.8)	−6.3	(−12.9 to 0.3)	1.6	(−5.3 to 8.5)
1–2 y ago	−8.9	(−22.2 to 4.4)	−8.9	(−22.3 to 4.4)	−0.3	(−6.7 to 6.1)	−0.3	(−7.9 to 7.2)
2–3 y ago	−6.8	(−21.2 to 7.7)	−9.2	(−23.3 to 4.9)	1.3	(−5.0 to 7.7)	2.7	(−4.9 to 10.3)
≥3 y ago	−12.6	(−24.2 to −1.1)	−11.8	(−23.0 to −0.6)	−1.2	(−6.8 to 4.5)	2.2	(−4.6 to 9.0)
Observations	738							
No. of groups	27							
Average observations per group	27.3							

*CIs resulting from bootstrap regression.

education within the last year did not have a significant effect on any of the CPR score outcome variables.

Given the novelty of this scoring system and simulated nature of the assessments, we do not know whether the scores in this study would make a difference in patient outcome. Also, given that we did not assess confidence or willingness to perform CPR, the relatively low average scores of study participants compared with a traditional grading scale, in which less than 60% is considered failing, could discourage participants from performing hands-only CPR in a real emergency. Study participants tended toward higher education levels compared with the general US population, and thus the study findings may not be generalizable across education levels. Future studies should examine practice time and accuracy of practice compressions as predictors of kiosk success.

DISCUSSION

In this multisite study comparing 3 methods of hands-only CPR education, we have demonstrated that a facilitator-led practice-while-watching classroom session and on-screen tutorial with practice and feedback (kiosk) yield better immediate skill performance than a 1-minute video. To our knowledge, this is the first study to evaluate this kiosk concept relative to previously studied education methods, and the findings have important implications for reducing some of the barriers to educating laypersons about CPR. Given that barriers of time and cost are commonly cited for obtaining training,[7] this study showed that a free, 4-minute kiosk session facilitates accurate hands-only CPR chest compressions of laypersons. The AHA currently has free kiosks in 30 high-traffic public locations, which have been able to train thousands of people quickly and efficiently. The hands-only CPR approach decreases rescuer concerns about mouth-to-mouth contact and simplifies the skill for lay rescuers.[19-21] Hands-only CPR has been found to be at least as effective as conventional CPR with ventilations for adults in cardiac arrest.[22-26] This study shows that educating laypersons about hands-only CPR through a classroom or kiosk session results in a higher total score than watching a 1-minute video. Although the total score for the kiosk group was slightly higher than that of the classroom group, we did not detect a significant difference. Thus, it seems that CPR education professionals can continue to pursue classroom education opportunities to disseminate hands-only CPR education while pursuing novel on-screen, practice- and feedback-driven methods to reach even larger audiences.

The kiosk session resulted in skill acquisition similar to that of the classroom session in total score and compression

Table 5. Hands-only CPR skills assessment at 3-month follow-up (N=326).

	3-Month Retention Skills Testing		
	Classroom Session (n=127)	**Kiosk Session (n=103)**	**Video-Only Session (n=96)**
HO CPR scores			
Follow-up total	16 (2.0 to 83.0)	25.0 (1.0 to 76.0)	11.5 (1.0 to 77.5)
Follow-up rate	34.4 (4.8 to 94.1)	52.0 (8.2 to 92.5)	50.1 (3.0 to 89.5)
Follow-up depth	100 (100 to 100)	100 (98.3 to 100)	100 (100 to 100)
Follow-up hand position	100 (85.3 to 100)	100 (65.4 to 100)	100 (71.0 to 100)
HO CPR change scores			
Change in total	−3.0 (−48.0 to 13.0)	−5.0 (−51.0 to 1.0)	0 (−21.5 to 13.0)
Change in rate	−0.3 (−35.5 to 19.7)	0 (−35.7 to 17.0)	0 (−21.5 to 18.5)
Change in depth	0 (0 to 0)	0 (0 to 0)	0 (0 to 1.9)
Change in hand position	0 (−2.3 to 0)	0 (−34.6 to 0)	0 (−4.1 to 0)

Data are presented as median score on variable (IQR) and median change score (IQR). HO CPR scores range from 0 to 100 and indicate a percentage of the total compressions performed that were correct on the item indicated. HO CPR change scores indicate initial score subtracted from follow-up score.

rate, and better skill performance on hand position. The kiosk users had poorer performance on compression depth, indicating a potential improvement area for the kiosk instruction video and feedback meters. Given the efficient delivery of the kiosk for users, it seems to be a good option for hands-only CPR education, but the kiosks are not yet widely accessible. Classroom or practice-while-watching sessions are also feasible options for skill acquisition, although the time for training and costs to the user are higher than those of a kiosk interaction. The poorer performance of classroom participants compared with kiosk participants on hand position could inform curriculum improvements to the hands-only CPR classroom education curriculum. The video-only session, although not showing skill performance similar to that of the kiosk session or classroom session in total score, still raises awareness and spreads a message that action is important in a cardiac arrest emergency. The video-only session resulted in poorer

Table 6. Multilevel regression analysis of follow-up hands-only CPR change scores separated by score type.

	Total Score		**Compression Rate**		**Compression Depth**		**Hand Position**	
	Fixed-Effect Coefficient	**95% CI**	**Fixed-Effect Coefficient**	**95% CI**	**Fixed-Effect Coefficient**	**95% CI**	**Fixed-Effect Coefficient**	**95% CI**
Training type								
Classroom session	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Kiosk session	−1.0	(−10.6 to 8.6)	1.8	(−8.2 to 11.9)	−4.0	(−8.5 to 0.4)	−6.6	(−16.0 to 2.9)
Video-only session	1.9	(−7.8 to 11.6)	1.4	(−8.7 to 11.5)	−4.7	(−9.3 to −0.2)	−1.8	(−11.2 to 7.6)
Initial score on this outcome variable	−0.7	(−0.8 to −0.6)	−0.7	(−0.8 to −0.6)	−0.5	(−0.6 to −0.4)	−0.5	(−0.7 to −0.4)
Age	−0.5	(−0.8 to −0.1)	−0.3	(−0.6 to 0.0)	−0.1	(−0.2 to 0.1)	−0.4	(−0.7 to −0.1)
Sex								
Women	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Men	2.5	(−6.4 to 11.3)	2.9	(−6.3 to 12.1)	2.3	(−1.9 to 6.4)	−0.6	(−9.2 to 8.1)
Last CPR training								
<1 y	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Never	1.6	(−14.2 to 17.4)	3.2	(−13.0 to 19.4)	−4.4	(−11.6 to 2.8)	−3.7	(−18.9 to 11.4)
1–2 y ago	−6.5	(−23.7 to 10.7)	−5.2	(−23.0 to 12.7)	−1.6	(−9.4 to 6.3)	−2.6	(−19.2 to 14.0)
2–3 y ago	3.0	(−15.3 to 21.3)	1.8	(−17.2 to 20.8)	0.9	(−7.5 to 9.3)	−5.0	(−22.7 to 12.7)
≥3 y ago	1.4	(−13.0 to 15.7)	0.5	(−14.3 to 15.3)	1.6	(−4.9 to 8.2)	−6.8	(−20.6 to 7.1)
Observations	326							
No. of groups	25							
Average observations per group	13							

performance on compression depth, which could inform improvements to future hands-only CPR video-only education resources. Choosing a method of hands-only CPR education delivery will vary according to people, communities, resources, and goals.

The 3-month follow-up data do not support superior skill retention in any one group. In general, scores on the 4 outcome variables declined over time, without a significant effect of training type. The compression depth scores decreased significantly more in the video-only group compared with the classroom group, but given that the video-only group performed poorly compared with groups using the other 2 education methods at the initial education session, this significant follow-up effect is not notable for promotion of one education type over another. Because the initial training scores showed similar skill acquisition from the kiosk session and classroom session and the follow-up change scores for these 2 training types were not significantly different, skill retention does not appear to be a crucial factor in deciding between implementing a classroom session or a kiosk session. Because 3-month follow-up scores did not show superiority of any one training method, some public health professionals might encourage video-only training because it is the least expensive and most efficient method. However, another interpretation is that public health professionals should advocate retraining within 3 months with a short classroom or kiosk session to maintain the higher scores resulting from those 2 methods of training. Cost and time are important factors in participant willingness to retrain. The kiosk method is short and free to passersby, which may lead to higher retraining rates.

One surprising finding is that in our additional evaluation, emergency medicine nurses and emergency medical technicians who regularly perform CPR had relatively low total scores on the hands-only CPR test. This was primarily driven by rate, and investigators present at the training noted it was a predominantly fast rate. This suggests that CPR quality could be improved by additional and repeated education in CPR skills among emergency medicine providers.

In summary, laypersons exposed to a 4-minute on-screen tutorial with practice and feedback and individuals exposed to classroom education lasting 30 minutes were able to perform hands-only CPR similarly, and both groups showed skill performance superior to that of those watching a 1-minute video. However, because of the lack of superiority of any one training method at 3-month follow-up, it is important for public health professionals to market and advocate regular retraining of participants in classroom and kiosk education sessions to prevent skills decay. Because the kiosk method is only 4 minutes long and free to passersby, training and regular retraining might be more feasible and successful with this education method. The kiosk has potential for training laypersons in hands-only CPR, increasing bystander CPR rates, and positively affecting survival rates from out-of-hospital cardiac arrest.

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