

Classroom Versus Computer-based CPR Training: A Comparison of the Effectiveness of Two Instructional Methods

Robb S. Rehberg, PhD, ATC, NREMT*; Linda Gazzillo Diaz, EdD, ATC*; David A. Middlemas, EdD, ATC†

*William Paterson University, Wayne, NJ; †Montclair State University, Montclair, NJ

Objective: The objective of this study was to determine whether computer-based CPR training is comparable to traditional classroom training.

Design and Setting: This study was quantitative in design. Data was gathered from a standardized examination and skill performance evaluation which yielded numerical scores.

Subjects: The subjects were 64 undergraduate freshmen who never had CPR training or performed CPR. The subjects were divided into two groups. Group 1 completed the National Safety Council Adult CPR training program via traditional classroom instruction, while Group 2 completed the online version.

Measurements: After training, both groups completed the standardized knowledge examination and skill performance evaluation. Skill performance was evaluated by trained evaluators and Resusci Anne computerized CPR manikins.

Results: On the standardized knowledge examination and skill performance evaluation, Group 2 scored lower than Group 1; however, no statistically significant difference between the groups existed. MANOVA indicated there was a significant difference in the quality of CPR compressions (location, rate, depth, and release), ventilation rate and volume.

Conclusions: Computer-based CPR training may be as effective as traditional classroom CPR training in terms of knowledge outcomes. However, the computer-based CPR training method may not be as effective as traditional classroom-based training in terms of developing quality CPR performance. These results are critical, as quality of CPR effort performed on a cardiac arrest victim has a direct impact on effectiveness.

Key Words: cardiopulmonary resuscitation, emergency care, online training programs, sudden cardiac arrest, trained lay rescuer.

Sudden cardiac arrest is the leading cause of death in the United States, claiming the lives of over 330,000 people each year in the out-of-hospital setting.¹ The administration of effective bystander cardiopulmonary resuscitation (CPR) can significantly increase the chances of survival for a victim of cardiac arrest outside of the hospital.^{2,3}

Over the past decade, researchers have advocated development of alternative methods for teaching CPR to the lay public in order to reach a greater number of people.^{4,5,6} One method is video self-instruction. It appears that a one-half hour video self-instruction session is as effective in providing

information as a four-hour traditional CPR course.^{4,5,6} Older adults can learn the fundamental skills of CPR using a 30 minute self-instruction program that, if properly distributed, can significantly increase the number of trained lay responders.⁷

Another training method with great potential to teach CPR techniques is via the Internet. In January 2000, the National Safety Council (NSC) launched a line of computer-based CPR training programs, making it the first nationally recognized provider of CPR education programs to offer training and certification using a method other than classroom instruction. Learners were able to enroll and take the course online anywhere there was an Internet connection. Since that time, a number of other Internet-based CPR training programs have emerged that include online and blended training programs.

While computer-based CPR training appears promising, several questions have been posed regarding its effectiveness compared to video self-instruction and traditional classroom training. Computer-based training may be superior to classroom and video self-instruction when measuring knowledge acquisition and retention.⁸ While studies on video self-instruction have yielded favorable results compared to classroom

Dr. Rehberg is an Assistant Professor and Coordinator of Athletic Training Clinical Education at William Paterson University.
rehberg@wpunj.edu

Dr. Gazzillo Diaz is an Associate Professor and the ATEP director at William Paterson University.

Dr. Middlemas is an Associate Professor and the ATEP director at Montclair State University.

training,^{4,5,6} it is hypothesized that computer-based training may improve upon video self-instruction for CPR training. In video self-instruction, the learner passively acquires knowledge by viewing a video, whereas the computer delivery method engages the learner and forces the learner to use decision-making skills in order to complete the program. The computer program used in this research engages learners with specific scenarios where they must choose appropriate actions in the proper sequence in order to advance through the program.

While computer-based CPR training may prove more effective than other methods in knowledge acquisition, it may be less effective in producing comparable skills. In traditional classroom CPR courses and video self-instruction, learners have the opportunity to practice their skills on a CPR manikin. However, many computer-based CPR training programs do not incorporate the use of a CPR manikin during training, and there are currently no industry standard for computer-based CPR learners regarding review and/or practice of CPR skills prior to skills testing. Do they produce comparable skills?

While studies have indicated video self-instruction is as effective as traditional classroom CPR training, there have been no studies conducted to determine the effectiveness of computer-based CPR training. The purpose of this study, therefore, was to determine whether computer-based CPR training is comparable to traditional classroom training. Differences in CPR knowledge, skill sequence, and quality of skill performance were evaluated to compare the effectiveness of computer-based CPR training and traditional, classroom based CPR instruction.

Methods

The participants of this study were 64 volunteer undergraduate college students who were in their freshman year of study. They were seeking CPR training for personal enrichment purposes and not as a requirement for employment. To strengthen the internal validity of this study, volunteers were limited to freshman undergraduate students between the ages of 16 and 19 years of age. Students who had any prior training in CPR or who had ever performed CPR were excluded from participation in the study. Informed consent was obtained from all participants, in accordance with Institutional Review Board standards.

A quasi-experimental static group comparison of two groups, consisting of 32 students each, was conducted. Group 1 was the control group and participated in traditional classroom CPR training. Group 2 was the treatment group and participated in online CPR training. All subjects reported for initial CPR training at a specified date and time. At the beginning of this session, students were randomly assigned to either the control group or the treatment group. Balanced randomization of groups was achieved by drawing of unordered, unlabeled envelopes from a box.

Training

Subjects in Group 1 were administered the NSC Adult CPR training program via traditional classroom instruction.⁹ The program was taught by certified instructors, and combined the use of lecture, videotape and skills practice. Each subject was issued a NSC Adult CPR student manual. The training program followed the NSC suggested course outline for adult CPR, with a student to instructor ratio of eight to one.

Computer-Based Training

Subjects in Group 2 were administered the online version of the NSC Adult CPR training program (Jones and Bartlett Publishers).¹⁰ The interactive program presented subjects with the same content found in the classroom-based CPR training. Subjects viewed a series of screens that delivered narrated and animated content for each of the training modules. Subjects were able to navigate backward and forward through the program to review the narration and animation if necessary. At the completion of each module, a series of learning activities called “interactivities” were presented, which the subject was required to successfully complete in order to move to the next module. Once all modules were completed, subjects could advance to a series of simulations where subjects were required to indicate the correct CPR procedures in order. The program provided feedback for correct and incorrect actions. Only after all simulations were successfully completed could the subject advance to the knowledge examination. Following completion of the knowledge examination, and in accordance with NSC guidelines, subjects observed a five-minute CPR demonstration by an instructor, followed by 20 minutes of practice with a CPR manikin.

Subjects from both groups were administered an NSC Adult CPR training program standardized knowledge examination, consisting of 20 multiple choice questions. Group 1 subjects were administered the examination on paper, and asked to circle the letter of the correct answer for each question. They were instructed to choose the best single answer for each question. Instructors were not permitted to give advice or provide additional information to the subjects during the examination. Once completed, subjects were informed of their grade, but were unable to review the examination they submitted. Examinations were graded by both an instructor using an answer key, and a by the researcher to ensure accuracy.

Group 2 subjects were administered the knowledge examination online. This examination was identical in content to the examination administered to Group 1. Subjects were unable to review content from the computer-based program during the examination. Subjects were instructed to use their computer mouse to click on the correct answer to each question, and then click a submit button at the completion of the examination. Once the examination was submitted it was immediately graded by the computer program, and the results were displayed on the screen. Subjects were not permitted to review the examination once it

was submitted. Exam scores for each subject were automatically sent via electronic mail to the researcher.

Skill Performance

After completing the knowledge examination, subjects were brought to a skill evaluation room in groups of two, where they completed the performance-based portions of the CPR examination. Both control and treatment groups remained in separate rooms after training as they waited to complete the skills evaluation. Students in each room were instructed to sit quietly in their seats, and not communicate with each other. Each room was supervised by an instructor to ensure compliance.

Skills performance was measured by an evaluator using a 14-item CPR skills checklist (figure 1) based on the one developed by Brennan, et al.¹¹ Two evaluators were assigned to each subject, and completed one checklist for their assigned subject. Evaluators were instructed to enter a value of "1" next to the skills the subject successfully completed, or a "0" next to each skill the subject completed incorrectly, completed out of sequence, or failed to complete. A score was issued for each subject by adding the total number of correct items on the checklist.

To increase interrater reliability, evaluators were familiarized with the skill evaluation procedure via a training session prior to data collection. None of the evaluators used for skills evaluation had prior contact with the subjects, and evaluators were blinded as to which method of instruction a subject received. Each skill evaluation was videotaped and reviewed by the researcher to ensure proper evaluation had taken place.

Performance was also measured electronically by two SkillReporter Resusci Anne® computerized CPR manikins (model 31005501, Laerdal Medical Products, Wappingers Falls, NY), connected to a laptop computer running Laerdal PC SkillReporter software. Measurements recorded by the manikin system included:

1. Compression depth – The percentage of chest compressions that were correctly compressed within the specified range.
2. Compression rate – The percentage of chest compressions that were performed at the correct rate in terms of compressions per minute.
3. Correct hand position – The percentage of compressions that were performed using the correct hand position on the sternum.
4. Correctly released compressions – The percentage of compressions that were correctly released at the completion of each compression.
5. Ventilation volume – The percentage of ventilations that were administered using the correct volume.
6. Ventilation flow rate – The percentage of ventilations that were administered at the correct flow rate.

Performance in all six areas was automatically compared to the International Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care¹² (the guidelines in effect at the time of the study) by the PC SkillReporter software. A data record of each subject's skill performance was automatically stored in a database by the PC SkillReporter software.

CPR Skills Checklist

- _____ Item 1: Checks responsiveness by touching manikin and speaking loudly.
- _____ Item 2: Calls for help or indicates help should be called
- _____ Item 3: Opens airway using head tilt/chin lift
- _____ Item 4: Checks breathing or at least three seconds
- _____ Item 5: Attempts at least two breaths in such that chest rises at least once and not more than twice.
- _____ Item 6: Checks for signs of circulation for at least 5 seconds
- _____ Item 7: Locates compression position by feeling or baring chest and looking
- _____ Item 8: Gives at least 13 and not more than 17 compressions
- _____ Item 9: Opens airway using head tilt/chin lift
- _____ Item 10: Attempts at least 2 breaths such that the chest rises at least once and not more than twice
- _____ Item 11: Repeats cycles at least four times
- _____ Item 12: Opens airway between every set of compressions using head tilt/chin lift
- _____ Item 13: Attempts breaths with at least one chest rise between every set of compressions
- _____ Item 14: Locates compression position between every set of compressions

Figure 1. CPR Skills Checklist

Statistical Analysis

Independent samples t-tests were conducted to determine if a significant difference existed between groups on the knowledge examination test and the 14-item skills checklist. A MANOVA (Wilks' Lambda) was used to determine if there was a significant difference in the quality of CPR compressions as indicated by the six skill areas measured by the computerized manikin system. Effect size was also calculated using Cohen's *d*. Statistical data analysis was performed using SPSS for Windows 12.0 (SPSS, Inc. Chicago, IL).

Results

There was no significant difference in standardized knowledge scores between groups ($t = 1.39$ $df=62$ $p=.17$, effect size $d = .35$ (small; Table 1). All subjects who participated in the study scored high enough on the knowledge examination (80% or better) to gain certification from the NSC.

An independent t-test was also used to compare subject scores between the two groups (see Table 2). There was no significant difference on the 14-item CPR checklist between groups ($t = 1.26$ $df= 62$ $p = .21$, effect size $d = .31$ (small; Table 2). Group 1 scored significantly higher in each category in quality of CPR performance (six skill areas measured by the computerized manikin system ($F = 3.75$ (6,57), $p = .003$; Table 3). Post hoc univariate ANOVA indicated that subjects in Group 2 ($p<.05$) (Table 4). Results indicated moderate to high power ($p<.05$) for all components of CPR skill quality.

Discussion

It appears that computer-based CPR training is comparable to traditional classroom training in developing student knowledge of CPR and the correct sequence of CPR skills. One might interpret these results as indicating that computer-based CPR training may be as effective as traditional classroom CPR training. However, the difference between groups on the tests measuring quality of skill performance yielded a significant difference between groups, indicating the training methods are not comparable. Collectively, these six skill areas reflect the overall quality of CPR performance. Apparently, although students learn information and sequences equally well by either method, instruction and practice of critical skills require direct contact with an instructor. The computer-based CPR training method, in its present form, may not be as effective as traditional classroom-based training in developing quality CPR performance. These results are critical, as the quality of CPR's effort performed on a cardiac arrest victim has a direct impact on effectiveness.

Our results differ somewhat from previous research which indicated video self-instruction yielded better performance than traditional classroom-based CPR training.^{4,5, 6} This difference

Table 1. T-test of Knowledge Examination Scores

	# of participants	Mean	SD	Standard of Mean
Group 1	32	90.63	5.92	1.05
Group 2	32	88.44	6.65	1.18

Mean Difference: 2.19; $t = 1.39$; $d = .35$; $p = .17$; $df = 62$

Table 2. T-test of Skill Sequence Scores

	# of participants	Mean	SD	Standard of Mean
Group 1	32	12.31	2.64	0.47
Group 2	32	11.38	3.27	0.58

Mean Difference: .94; $t = 1.26$; $d = .31$; $p = .21$; $df = 62$

Table 3. Descriptive Statistics for Skill Performance Between Groups

	Group	# of participants	Mean	SD
Compression Depth	1	32	63.56	34.27
	2	32	40.44	34.91
	Total	64	52.00	36.24
Compression Rate	1	32	48.62	30.24
	2	32	33.84	28.58
	Total	64	41.23	30.12
Hand Position	1	32	68.94	33.20
	2	32	41.06	41.03
	Total	64	55.00	39.60
Correctly Released	1	32	90.41	21.21
	2	32	74.53	34.44
	Total	64	82.47	29.48
Ventilation Volume	1	32	30.22	29.93
	2	32	15.88	21.42
	Total	64	23.05	26.81
Ventilation Flow Rate	1	32	60.13	39.70
	2	32	32.00	37.98
	Total	64	46.06	41.07

Table 4. MANOVA of Skill Performance Scores

Variable	F	df	Sig.	Partial Eta Squared	Observed Power
Compression Depth	7.151	1	.010	.103	.749
Compression Rate	4.039	1	.049	.061	.507
Hand Position	8.925	1	.004	.126	.837
Correctly Released	4.929	1	.030	.074	.589
Ventilation Volume	4.862	1	.031	.073	.583
Ventilation Flow Rate	8.384	1	.005	.119	.813

may be because in previous studies involving video self-instruction, subjects were able to practice CPR on a manikin during the video session. Our computer-based CPR training program, on the other hand, did not use manikin practice during the course, and allowed only limited practice prior to skills evaluation. Specifically, the skill practice component which was administered prior to skill evaluation, allowed for five minutes of book review and approximately 25 minutes of combined instructor demonstration and student practice in the technique of CPR. This may be a limiting factor to successful skill performance and must be reviewed in future research.

Although there were similarities between the two groups in the cognitive aspects of CPR training, there were significant differences in the psychomotor aspects (e.g., quality of compressions, hand placement). These differences support the need for further investigation of the roles of learning styles and multiple intelligences in the instruction and assessment of CPR. Future studies comparing student learning style to performance on the cognitive and psychomotor components of the learning process may lead to better integration of technology into the instruction of CPR.

One of the major benefits of computer-based CPR training is its ability to reach those who may not otherwise have enrolled in a traditional CPR course. Due to the computer-based format, CPR training can be taken anytime and anywhere a computer with an Internet connection is present. As a result, more of the population – those who are most likely to witness a sudden cardiac arrest – will be trained to help provide CPR. It has long been a motto of CPR instructors that “some CPR is better than no CPR.” That is, even poorly performed CPR increases a cardiac arrest victim’s chances of survival as opposed to doing nothing. Regardless of practical skill outcomes, an argument can be made that the Chain of Survival is further strengthened, since participants in the computer-based training are trained how to respond to an emergency and how to properly activate the Emergency Medical Services system. An argument can also be made that although skills of students who complete computer-based CPR are of lesser quality than classroom-trained students, the overall potential increase in the number of trained rescuers may be an acceptable risk. This question will surely be fuel for

future debate, as computer-based CPR training continues to grow in popularity.

Conclusions

The results of this study indicate that computer-based CPR training may be a viable means of educating lay rescuers. However, further research is necessary and further advancements in computer-based CPR course development must be explored. Until this research is completed and results are analyzed, computer-based CPR training should not be considered a substitute for traditional classroom-based instruction for those responders who have a duty to act in an emergency because of their occupation (such as ATs). Most importantly, while further research is needed to determine its effectiveness, it should be noted that computer-based CPR training is a powerful tool that can be used to educate lay persons who might not otherwise be inclined to attend a classroom CPR course and to increase public knowledge of CPR and the Chain of Survival. Computer-based CPR training will prove to be a useful tool in the battle to reverse sudden cardiac death.

Within the context of computer-based CPR training, the focus of future research can be placed in the retention of knowledge and/or skills over time. Retention of CPR knowledge and skills has been a concern in traditional classroom-based CPR courses.¹³ Future studies that measure the effectiveness of computer-based CPR training with regard to short and long term retention of skills and knowledge may be an area of interest. A more detailed study of the use of skills practice and its role in computer-based training is also recommended. Future research might study the effectiveness of computer-based CPR training in combination with varying levels of manikin skills practice. Such research could also study the impact of manikin skills practice available during the computer-based training versus post-course practice.

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