

Layperson training for cardiopulmonary resuscitation: when less is better

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Purpose of review

Basic cardiopulmonary resuscitation, including use of automated external defibrillators, unequivocally saves lives. However, even when motivated, those wishing to acquire training traditionally have faced a myriad of barriers including the typical time commitment (3–4 h) and the number of certified instructors and equipment caches required.

Recent findings

The recent introduction of innovative video-based self-instruction, utilizing individualized inflatable manikins, provides an important breakthrough in cardiopulmonary-resuscitation training. Definitive studies now show that many dozens of persons can be trained simultaneously to perform basic cardiopulmonary resuscitation, including appropriate use of an automated external defibrillator, in less than 30 min. Such training not only requires much less labor intensity and avoids the need for multiple certified instructors, but also, because it is largely focused on longer and more repetitious performance of skills, these life-saving lessons can be retained for long periods of time.

Summary

Simpler to set-up and implement, the half-hour video-based self-instruction makes it easier for employers, churches, civic groups, school systems and at-risk persons at home to implement such training and it will likely facilitate more frequent re-training. It is now hoped that the ultimate benefit will be more lives saved in communities worldwide.

Keywords

automated external defibrillator, basic life support, cardiopulmonary resuscitation, manikin training, skills retention, video self-instruction

Abbreviations

| | |
|------------|----------------------------------|
| AED | automated external defibrillator |
| AHA | American Heart Association |
| CPR | cardiopulmonary resuscitation |
| VSI | video-based self-instruction |

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Introduction

One of the most prevalent causes of preventable death worldwide is sudden cardiac arrest from ventricular fibrillation and one of the key determinants of survival for these patients is prompt delivery of basic cardiopulmonary resuscitation (CPR) by bystanders witnessing the sudden collapse [1–9]. Today basic CPR not only includes the traditional skills of chest compressions and rescue ventilation, but also, when indicated, rapid on-scene defibrillation through the availability and use of an automated external defibrillator (AED) [4–6]. The main issue, however, is how to better facilitate and ensure that all potential rescuers will be trained and ready to perform these life-saving actions.

Increasing the prevalence of training

Whereas most people believe that learning to perform CPR is very important, the key problem appears to be the inevitable hurdle of getting them trained [10–12]. Many communities that have experienced a relatively high frequency of bystander CPR and accompanying high survival rates for out-of-hospital ventricular fibrillation have been communities where healthcare is a major industry or where CPR training is provided for all students in the school system [13,14]. Therefore, widespread CPR training often requires a focus on captured audiences who are required or compelled to learn CPR [10]. In turn, a promising strategy could be to require or facilitate CPR training in the average workplace. Many employers, when surveyed, agree that it creates a safer workplace and also that it is a good thing to do because the employees' families would also benefit. Simultaneously, efforts to increase CPR education should still target the generally untrained households of retirees and their spouses, recognizing that most cardiac arrests occur in the home in this population [15–17].

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Disincentives to learning and performing cardiopulmonary resuscitation

Despite the best of intentions, some of the key problems with the cited targets for training are time, logistics and money. The American Heart Association (AHA) basic life support Heartsaver course epitomizes the traditional model for training laypersons how to perform basic adult CPR [18]. Although the AHA Heartsaver course, its predecessors, and other similar training efforts have led to life-saving effects worldwide [6,18], these traditional courses have often been considered lengthy, inefficient and labor-intensive [11]. Typically lasting 3–4 h and rich in didactics, overall time for skills practice is compromised. During practice sessions, six to eight trainees assigned to an instructor must wait while each of their fellow trainees take their turn at practicing on the manikins. Moreover, considering the number of certified instructors and specialized manikins required, traditional CPR courses can pose significant logistical and financial barriers [11,12].

Educators have articulated increasingly that the primary goals of layperson CPR education should be learning to perform the first links in what is known as the Chain of Survival: identifying the cardiac or respiratory arrest, calling for help, performing the psychomotor skills of basic CPR, and operating an AED [19].

Whereas didactic information provided in traditional courses may have clear educational value, it may also dilute and even confuse the central message of CPR skills acquisition [20]. Furthermore, since individual laypersons will witness an out-of-hospital cardiac arrest infrequently, if at all, during their lifetime, they have little opportunity to practice these skills as professional rescuers would. Therefore, retentions of skills and frequent re-training are important factors for performance. One recent study found that only a minority of CPR-trained individuals performed CPR when confronted with a cardiac-arrest situation if they had not been re-trained in the previous 5 years [21]. Therefore, reinforcement and retention of CPR skills may also be a factor in the low frequency of bystander CPR performance, likely because it leads to diminished confidence.

Overcoming the disincentives

Recognizing these barriers to learning and performing CPR, alternative methods of CPR instruction have been proposed to make training shorter, more accessible, inexpensive, more focused on individuals practice, and require less resource utilization than traditional courses [22]. The question therefore is whether such alternative methods would be just as effective as traditional methods in terms of skills performance and long-term retention of those skills.

The concept of video-based self-instruction (VSI) for CPR training was developed originally using innovative principles of adult learning involving so-called synchronous self-instructional learning; in essence, a watch-while-you-practice approach. Focusing solely on the critical psychomotor skills for CPR and more hands-on practice than traditional counterparts, the most recent VSI offerings expend less than half an hour [23,24]. Total instruction time for basic CPR (chest compression and rescue breathing) is now only 23 min and the trainee is actually practicing CPR skills almost continuously for 17 min. Accordingly, there is more practice time and an intensive period of uninterrupted exercise to reinforce the skills.

Contributing to the problem of less practice time for traditional courses are the resource demands. Not only can the availability of both certified instructors and the larger, less-portable traditional manikins pose limitations, both financially and logistically, but subsequent practice-time allotments are dependent on those resources.

Beyond shorter course length, in the latest CPR VSI courses, trainees get their own individualized inflatable manikin and then watch a video together, practicing simultaneously. Therefore, time-efficiency for individual practice increases dramatically (as much as 8-fold) since the students can practice continuously and concurrently with other trainees. Also, through the video, when appropriate projection and audio aids are available, mass training can be more readily facilitated, even with nominal numbers of instructor-facilitators.

Effectiveness and long-term retention of video-based self-instruction

Preliminary studies comparing VSI to traditional CPR training have all found VSI training to be at least as effective as, if not better than, traditional CPR training in terms of learning the key psychomotor skills, even when re-assessed at 3 months [23,24]. Moreover, such courses have been found to be less labor intensive for training personnel [20,24–29].

A recent prospective head-to-head trial was conducted to evaluate long-term retention of CPR skills with an abbreviated VSI format. The training in basic CPR, AED operation and also choking procedures were all conducted within an ambitious 30-min time frame. This trial, involving laypersons of various educational levels, backgrounds, and ages, demonstrated that the shorter course was just as effective as the traditional 3–4-h training in terms of skills performance in CPR and AED use, and, even superior in some measurements. Most importantly, the retention of these CPR and AED skills at the critical 6-month mark was not significantly different and there were strong trends indicating

Table 1 Contents of the video-based self-instruction for basic cardiopulmonary resuscitation (CPR) techniques

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|---|
| Introduction (2 min, 30 s) |
| Instructions for assembling Mini-Anne manikin (40 s) |
| Instructions and practice for chest compressions (2 min) |
| Instructions and practice for opening airway and delivering ventilations (2 min, 45 s) |
| Review and practice step 3–4 together, four cycles of CPR (2 min, 20 s) |
| Instruction and practice on 'shake and shout', calling for help, checking for 'signs of life', and four cycles of CPR (4 min, 25 s) |
| Practice complete cycle with eight cycles of CPR (3 min, 30 s) |
| Practice of complete cycle with eight cycles of CPR and assistance of CPR coach (3 min, 50 s) |
| Conclusion (1 min) |

Total number of CPR cycles: 24.

Exact time elapsed: 23 min, 25 s.

advantages for the shorter course [29]. Five of every six persons trained in the 30-min course were judged to be performing adequately at 6 months and 93% were still performing chest compressions well, and also still operating the AED appropriately. Program contents of the DVD used are summarized in Table 1. The study also used facilitator-instructor demonstrations of the abdominal thrust (choking maneuver) and AED use. The latest versions of these VSI courses now incorporate these components as well.

One other critical finding was that several individuals randomized to the longer course left early, reporting scheduling difficulties, underscoring the premise that many will not devote several hours to CPR training [29]. The study also reinforced the concept that chest compressions and rescue breathing are psychomotor skills that improve with more practice, particularly in terms of retention through the process of repetition.

Concurrently, it was demonstrated that AED operation can be learned and retained long-term in a 5-min facilitator-demonstrated session that simply instructs the trainees to: '(1) recognize the problem, (2) open the box and turn it on, and (3) follow the instructions'. Impressively, with only the one-time use of the AED during initial posttraining testing, based only on this simple three-point spoken instruction and accompanying demonstration, AED use was retained by more than 90% of the lay trainees 6 months later [29]. The implications are that AED training may be feasible by employing simple VSI techniques, either DVD- or Internet-based, without the presence of an AED.

The latest AHA-marketed VSI package (called *Family and Friends CPR Anytime*) is a light-weight, textbook-sized kit, available to the public at a nominal price (<http://aha.channing-bete.com/family-friends/cpranytime.html>). It contains a personal CPR-practice manikin and a DVD that now includes AED instruction, choking actions, and

infant/child CPR. Based on the retention study, the AED VSI material will very likely suffice.

Other aspects of self-instructional training

In addition to shorter length, long-term retention, enhanced large-scale training and diminished resource and logistic barriers, the main advantage of DVD- or even corresponding Internet-based training is its convenience, allowing an individual to take a CPR or AED course at his or her own time schedule and in their chosen place of instruction [30,31[•]]. Additionally, using an online resource, this medium might also translate into savings, not only in terms of the cost of traditional printed books, cumbersome manikins, and instructor resources, but also videos and other tools that can become quickly outdated [30,31[•]].

On the downside, a recent investigation tested the effectiveness of training nurses in CPR instruction via the Internet with results showing that the nurses did not perform as well as in traditional methods, suggesting that online courses should be supplemented by hands-on manikin training (as shown in other studies) [31[•]]. Also, although it may make CPR training far more accessible to the public in general, not being a captured audience, the potential trainees may procrastinate indefinitely. School- or employer-imposed requirements for online mandatory certification of completion (and recertification) with certain deadlines may be one mechanism to capture some of that audience.

On a positive note, the Internet has also been used successfully to target healthcare providers who need to maintain certification. Trainees are able to quickly navigate to the most up-to-date, pertinent facts and take online CPR pretests [32[•]]. For the public at large, however, this may not address the issues reinforcing psychomotor skills though repetitious physical performance. Moreover, new technologies are coming to the marketplace that will demonstrate how well CPR is being performed, a concept that may dovetail into the concept of fine-tuning muscle memory. Therefore, for the layperson at large, the current VSI kit approach may still be the most effective approach.

Adjuncts to improve the quality of cardiopulmonary resuscitation and training

Recent investigations have demonstrated that persons trained to provide CPR may not be performing it very well in the actual patient-care scenario [33,34]. When CPR was quantitatively assessed as it was performed out-of-hospital by paramedics and in-hospital by cardiac-arrest response teams, ventilations were too frequent and chest compressions were too slow, too shallow, and interrupted all too often [33,34]. These findings may help to explain, in part, the typical poor survival rates that

currently exist for victims of out-of-hospital cardiac arrest.

Devices with real-time feedback or audio prompts have been found to improve the quality of CPR, both during an actual resuscitation effort and in training [35]. Wik *et al.* [36] observed that potential rescuers trained in CPR skills, without the assistance of automated feedback, typically regressed back to pretraining levels of performance within 6 months. Conversely, with automated feedback, their skills at both 6 and 12 months were more consistent with levels achieved after initial training. Automated feedback, which can be applied to AEDs, monitors, or even cell phones, may also improve resuscitation efforts, even in those without previous feedback experience [35].

A study of simple audio prompts found that these adjuncts improved the chest compression rate, diminished 'no-flow' time, and reduced inappropriately prolonged intubation attempts [37]. Although such prompts have generally been targeted for professional rescuer use, voice-assisted manikins used in training also appear to prevent decay of compression and ventilation performance over time. CPR performance is known to deteriorate, particularly in the middle of a resuscitation attempt, due to rescuer fatigue. It is possible that with prompting by a voice-assisted manikin during the half-hour VSI training courses, the real-time feedback with repetitious practice may actually lead to better retention of those life-saving skills later used in a true rescue situation. Future studies should specifically examine this likely effect that real-time feedback loops during repetitive training will improve actual clinical performance.

Retention

Although the recent retention study from Dallas demonstrated adequate performance among most subjects taking the half-hour VSI course at 6 months, retention of CPR psychomotor skills using traditional methods has been shown to decline in some trainees as early as 2 weeks after initial training, even in individuals thought to be motivated [38,39]. However, though applicable to a small number of individuals, Chamberlain *et al.* [40] found that re-training could provide protection against the decay of skills when trainees were tested 6–9 months later. Based on this study and others' experiences, 6 months has become the recommended re-testing interval suggested by the Utstein guidelines [22] and it was the follow-up period defined by recent definitive studies of VSI and AED training conducted in 30 min [29].

Among a myriad of variables that may explain the traditional poor retention of CPR psychomotor skills, inadequate practice time and too much time spent on cognitive material stand out [41,42]. Conversely,

simplification of skills, an increase in repetitive practice time, and the resulting so-called muscle-memory have been found to improve long-term retention [43–46]. Although there was no difference in the quality of CPR, one study comparing an eight-step sequence with a simplified four-step training sequence in 48 lay volunteers found that subjects in the four-step group were significantly better at later remembering the sequence of skills [47].

Accordingly, by truly standardizing the correct training, focusing more on skills practice, simplifying the steps, and reinforcing them in reiterative manner, the half-hour CPR format has many of the components that would clearly enhance the retention of the psychomotor skills. Furthermore, training strategies that are easily accessible, short in duration, and logistically easy to set up will also increase opportunities for regular re-training, thus further enhancing long-term retention [40].

Another component that may enhance retention is having a sense of confidence that one does not need to remember very much to perform the actions. As previously discussed, learning how to operate an AED is mostly a cognitive skill that can be taught simply with a three-point verbal instruction and demonstration that the AED will provide them with the necessary instructions. As a result, trainees have some assurance that they can manage the event when it does occur.

Conclusion

Considering all factors, VSI CPR training techniques will likely increase the numbers of persons who will learn the skills and, in turn, actually perform CPR and operate an AED in an emergency. It is hoped that such compelling improvements in CPR and AED education will make employers, churches, civic groups, school systems and at-risk persons at home more apt to not only implement such training, but also to undergo more frequent re-training in these life-saving skills. In turn, it is also hoped that the ultimate benefit will be to increase survival chances for the millions worldwide every year who require CPR.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 353–354).

- 1 American Heart Association News. Noteworthy numbers from heart disease and stroke statistics-2003 update. Statistical update base on 2000 numbers. <http://www.americanheart.org/presenter.jhtml?identifier=3007338>; 2003.
- 2 Gallagher EJ, Lombardi G, Gennis P. Effectiveness of bystander cardiopulmonary resuscitation and survival following out-of-hospital cardiac arrest. *JAMA* 1995; 274:1922–1925.
- 3 Holmberg M, Holmberg S, Herlitz J. Effect of bystander cardiopulmonary resuscitation in out-of-hospital cardiac arrest patients in Sweden. *Resuscitation* 2000; 47:59–70.

- 4 Caffrey SL, Willoughby PJ, Pepe PE, Becker LB. Public use of automated external defibrillators. *N Engl J Med* 2002; 347:1242–1247.
- 5 Hallstrom AP, Ornato JP, Weisfeldt M, *et al.* Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med* 2004; 351:637–646.
- 6 Cummins RO, Ornato JP, Thies WH, Pepe PH. Improving survival from sudden cardiac-arrest - the chain of survival concept - a statement for health-professionals from the Advanced Cardiac Life-Support Subcommittee and the Emergency Cardiac Care Committee, American-Heart-Association. *Circulation* 1991; 83:1832–1847.
- 7 Van Hoeyweghen RJ, Bossaert LL, Mullie A, *et al.* Quality and efficiency of bystander CPR. Belgian Cerebral Resuscitation Study Group. *Resuscitation* 1993; 26:47–52.
- 8 Cummins RO, Eisenberg MS. Prehospital cardiopulmonary resuscitation. Is it effective? *JAMA* 1985; 253:2408–2412.
- 9 Emergency Cardiac Care Committee and Task Forces of the American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Part 1: introduction. *Circulation* 2005; 112:IV12–IV46.
- 10 Platz E, Scheatzle MD, Pepe PE, Dearwater S. Attitudes towards CPR training in family members of patients with heart disease. *Resuscitation* 2000; 47:273–280.
- 11 Flint LS Jr, Billi JE, Kelly K, *et al.* Education in adult basic life support training programs. *Ann Emerg Med* 1993; 22:468–474.
- 12 Brennan RT, Braslow A. Are we training the right people yet? A survey of participants in public cardiopulmonary resuscitation classes. *Resuscitation* 1998; 37:21–25.
- 13 White RD, Hankins DG, Bugliosi TF. Seven years' experience with early defibrillation by police paramedics in an emergency medical services system. *Resuscitation* 1998; 39:145–151.
- 14 Eisenberg M, Bergner L, Hallstrom A. Paramedic programs and out-of-hospital cardiac arrest: part I. Factors associated with successful resuscitation. *Am J Public Health* 1979; 69:30–38.
- 15 Litwin PE, Eisenberg MS, Hallstrom AP, Cummins RO. The location of collapse and its effect on survival from cardiac-arrest. *Ann Emerg Med* 1987; 16:787–791.
- 16 McCormack AP, Damon SK, Eisenberg MS. Disagreeable physical characteristics affecting bystander CPR. *Ann Emerg Med* 1989; 18:283–285.
- 17 Becker LB, Ostrander MP, Barrett J, Kondos GT. Outcome of CPR in a large metropolitan-area - where are the survivors? *Ann Emerg Med* 1991; 20:355–361.
- 18 American Heart Association. Heartsaver AED student workbook. Dallas: American Heart Association; 2006.
- 19 Kaye W, Mancini ME. Teaching adult resuscitation in the United States—time for a rethink. *Resuscitation* 1998; 37:177–187.
- 20 Braslow A, Brennan RT, Newman MM, *et al.* CPR training without an instructor: development and evaluation of a video self-instructional system for effective performance of cardiopulmonary resuscitation. *Resuscitation* 1997; 34:207–220.
- 21 Swor R, Khan I, Domeier R, *et al.* CPR training and CPR performance: do CPR-trained bystanders perform CPR? *Acad Emerg Med* 2006; 13:596–601.
This is a noteworthy analysis identifying reasons for bystanders not performing CPR. The most common identified reasons included panic or lack of confidence.
- 22 Chamberlain DA, Hazinski MF. Education in resuscitation: an ILCOR symposium: Utstein Abbey; Stavanger, Norway: June 22–24, 2001. *Circulation* 2003; 108:2575–2594.
- 23 Isbye DL, Rasmussen LS, Lippert FK, *et al.* Laypersons may learn basic life support in 24 min using a personal resuscitation manikin. *Resuscitation* 2006; 69:435–442.
This study compared VSI with traditional CPR instruction and evaluated retention at 3 months.
- 24 Lynch B, Einspruch EL, Nichol G, *et al.* Effectiveness of a 30-min CPR self-instruction program for lay responders: a controlled randomized study. *Resuscitation* 2005; 67:31–43.
- 25 Todd KH, Heron SL, Thompson M, *et al.* Simple CPR: a randomized, controlled trial of video self-instructional cardiopulmonary resuscitation training in an African American church congregation. *Ann Emerg Med* 1999; 34:730–737.
- 26 Atkinson PR, Bingham J, McNicholl BP, *et al.* Telemedicine and cardiopulmonary resuscitation: the value of video-link and telephone instruction to a mock bystander. *J Telemed Telecare* 1999; 5:242–245.
- 27 Todd KH, Braslow A, Brennan RT, *et al.* Randomized, controlled trial of video self-instruction versus traditional CPR training. *Ann Emerg Med* 1998; 31:364–369.
- 28 Batcheller AM, Brennan RT, Braslow A, *et al.* Cardiopulmonary resuscitation performance of subjects over forty is better following half-hour video self-instruction compared to traditional four-hour classroom training. *Resuscitation* 2000; 43:101–110.
- 29 Roppolo L, Pepe P, Campbell L, *et al.* Prospective, randomized trial of the effectiveness and retention of 30-minute layperson training for cardiopulmonary resuscitation and automated external defibrillators: the American Airlines Study. *Resuscitation* (in press).
- 30 Reder S, Cummings P, Quan L. Comparison of three instructional methods for teaching cardiopulmonary resuscitation and use of an automatic external defibrillator to high school students. *Resuscitation* 2006; 69:443–453.
- 31 Makinen M, Castren M, Tolska T, *et al.* Teaching basic lifesupport to nurses. • *Eur J Anaesthesiol* 2006; 23:327–331.
This is a provocative study demonstrating that nurses who only had Internet-based CPR education performed similarly to nurses who had no training.
- 32 Peterson R. Teaching cardiopulmonary resuscitation. *Crit Care Nurse* 2006; 26:55–59.
This is an interesting review article focusing on the evolution of computer-based training via the Internet for teaching CPR.
- 33 Wik L, Kramer-Johansen J, Myklebust H, *et al.* Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. *JAMA* 2005; 293:299–304.
- 34 Abella BS, Alvarado JP, Myklebust H, *et al.* Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. *JAMA* 2005; 293:305–310.
- 35 Williamson LJ, Larsen PD, Tzeng YC, Galletly DC. Effect of automatic external defibrillator audio prompts on cardiopulmonary resuscitation performance. *Emerg Med J* 2005; 22:140–143.
- 36 Wik L, Myklebust H, Auestad BH, Steen PA. Twelve-month retention of CPR skills with automatic correcting verbal feedback. *Resuscitation* 2005; 66:27–30.
- 37 Chiang WC, Chen WJ, Chen SY, *et al.* Better adherence to the guidelines during cardiopulmonary resuscitation through the provision of audio-prompts. *Resuscitation* 2005; 64:297–301.
- 38 Fossel M, Kiskaddon RT, Sternbach GL. Retention of cardiopulmonary resuscitation skills by medical students. *J Med Educ* 1983; 58:568–575.
- 39 Moser DK, Dracup K, Guzy PM, *et al.* Cardiopulmonary resuscitation skills retention in family members of cardiac patients. *Am J Emerg Med* 1990; 8:498–503.
- 40 Chamberlain D, Smith A, Woollard M, *et al.* Trials of teaching methods in basic life support (3): comparison of simulated CPR performance after first training and at 6 months, with a note on the value of re-training. *Resuscitation* 2002; 53:179–187.
- 41 Kaye W, Rallis SF, Mancini ME, *et al.* The problem of poor retention of cardiopulmonary resuscitation skills may lie with the instructor, not the learner or the curriculum. *Resuscitation* 1991; 21:67–87.
- 42 Brennan RT, Braslow A. Skill mastery in public CPR classes. *Am J Emerg Med* 1998; 16:653–657.
- 43 Shadmehr R, Holcomb HH. Neural correlates of motor memory consolidation. *Science* 1997; 277:821–825.
- 44 Hornstein SL, Mulligan NW. Memory of action events: the role of objects in memory of self- and other-performed tasks. *Am J Psychol* 2001; 114:199–217.
- 45 Nilsson LG, Nyberg L, Klingberg T, *et al.* Activity in motor areas while remembering action events. *Neuroreport* 2000; 11:2199–2201.
- 46 Bilger MC, Giesen BC, Wollan PC, White RD. Improved retention of the EMS activation component (EMSAC) in adult CPR education. *Resuscitation* 1997; 35:219–224.
- 47 Handley JA, Handley AJ. Four-step CPR—improving skill retention. *Resuscitation* 1998; 36:3–8.