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A web-based micro-simulation program for self-learning BLS skills and the use of an AED Can laypeople train themselves without a manikin?☆

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Summary
Aim: Various methods, including self-instruction, have been used to try to improve the acquisition of basic life support skills. This is a preliminary report of the effectiveness of a web-based self-training program for BLS and the use of an AED.
Methods: Sixteen volunteers completed on-line training in their own time over a period of 8 weeks. The program included theory, scenario training and self-testing, but without practice on a manikin, or any instructor input. The volunteers were assessed, without prior warning, in a scenario setting. A recording manikin, expert assessors and video recording were used with a modified version of the Cardiff Test.
Results: All 16 volunteers performed the assessed skills in the use of an AED correctly. Most of the skills of BLS assessed were performed well. Chest compression depth and rate were performed less well (59% and 67% of participants, respectively, performed correctly). Opening the airway and lung inflation were performed poorly (38% and 13% of participants performed correctly), as was checking for safety (19% participants performed correctly). There was no significant correlation between the time a participant spent on-line and the quality of performance. Only 5 of the volunteers had ever attended a BLS course or used a resuscitation manikin before the assessment; their performance scores were not significantly better than those of the other 11 volunteers.
Conclusion: These results suggest that it may be possible to train people in BLS and AED skills using a micro-simulation web-based interactive program

☆ A Spanish translated version of the summary of this article appears as Appendix in the online version at . . .

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but without any practice on a manikin. This seems to be particularly the case for the use of an AED, where performance achieved a uniformly high standard.

Introduction

The more people who are trained in basic life support (BLS) and the use of an automated external defibrillator (AED), potentially the more victims of cardiac arrest can be resuscitated.[1] Unfortunately, BLS skills are poorly acquired,[2–4] so different methods of training have been attempted, including self-instruction using video with a manikin[5–9] or without a manikin,[10,11] using voice assistance,[12–16] computers[17] and micro simulation.[18] Recent reports have suggested that self-instruction by semi-interactive DVD and the use of a personal manikin can achieve skill acquisition at least as effectively as an instructor-based course.[19,20] These studies are consistent with the recommendations of ILCOR that instructional methods should not be limited to traditional techniques.[21,22]

We hypothesised that with increased public access to a computer and the internet, a web-based training program might be effective, efficient and practical as part of a distance-learning package for BLS and use of an AED. This paper reports the preliminary results of the use of such an internet program.

Materials and methods

The web-based application could be reached from wherever an internet connection was available. The application consisted of 11 sections covering the theory of BLS and AED use comparable with a manual (Figure 1), a question section for self-assessment of knowledge, a micro-simulation section where the trainee had to react to each scenario by making the correct decisions (Figure 2), and a section for checking if these decisions were correct.

Volunteer employees were sought from a group of IT implementation and management consultants. Although the web-based program was developed within the group, the volunteers were from a dif-

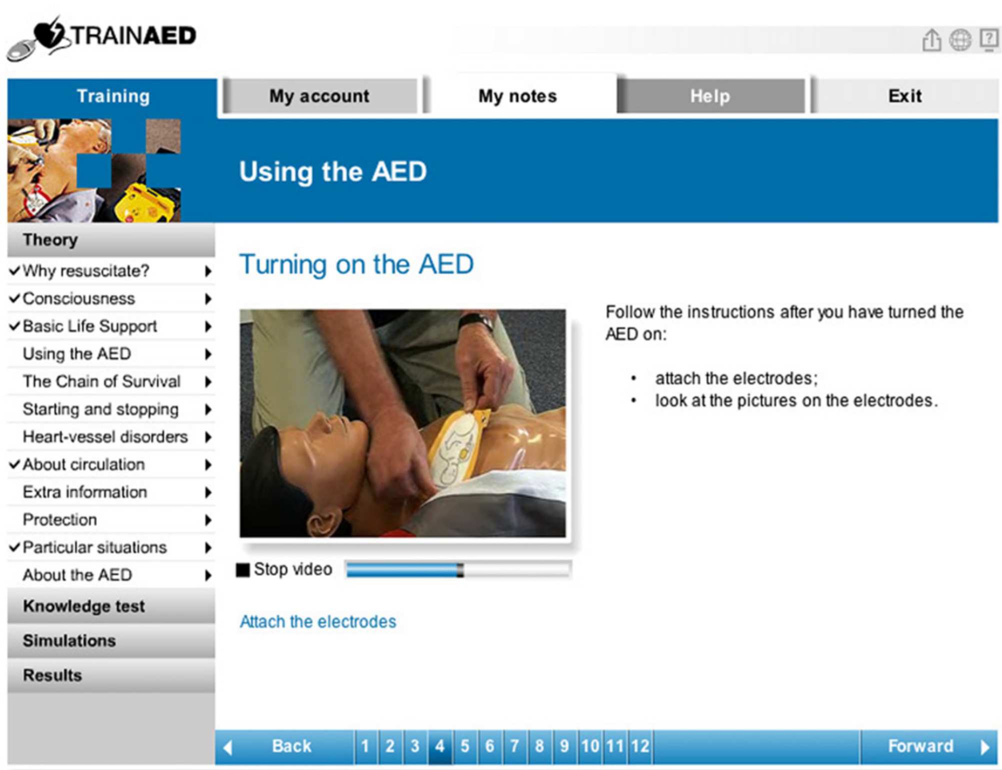

Figure 1 Example of theory section of on-line program.

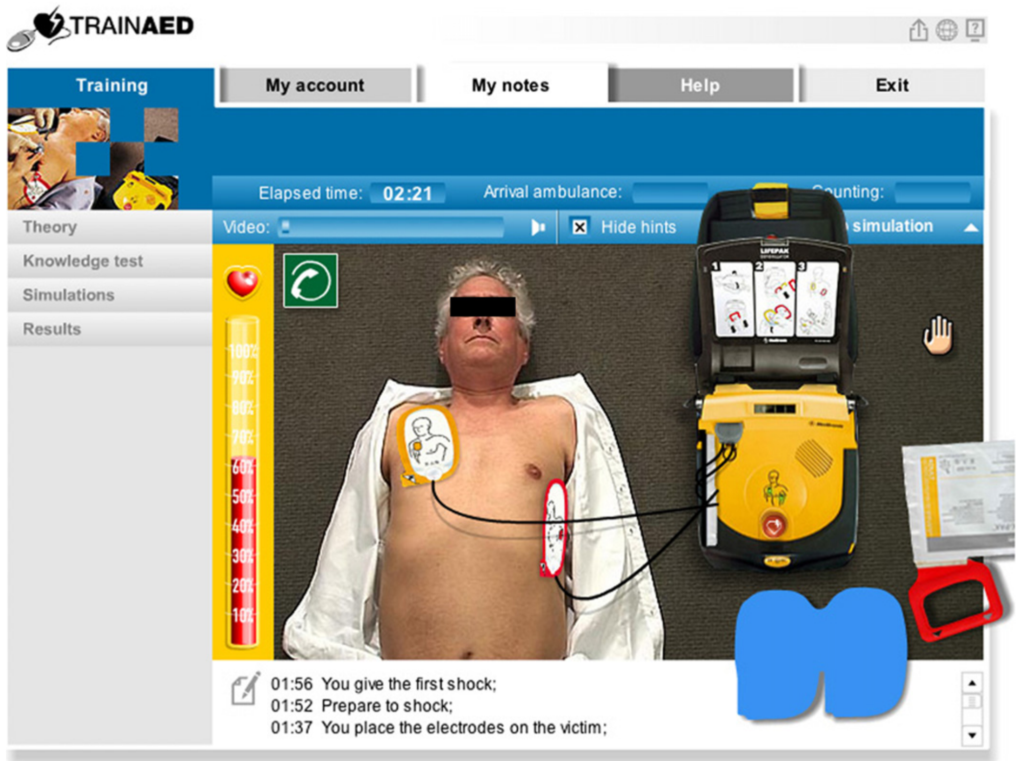

Figure 2 Example of simulation practice section of on-line program.

ferent department and not involved in any way with this development. They were all computer literate, but were not involved in programming, nor employed for higher computer skills. The volunteers were issued with a licence (in the form of a password) to access the web site and told to visit it as and when they wanted to. They were also told that they would receive additional training at their place of work 8 weeks, after being given the website licence, that would build on the knowledge they had gained from the web-based program. In the meantime, no checks were made on whether or not they accessed the web site, for how long they did so, or on what progress they were making with self-instruction.

When they attended the expected training session, the volunteers were informed that, instead of further training, they would be assessed on their BLS and AED skill acquisition to date. They were told that management approved of this assessment, and they were asked individually for their permission to be included.

Each participant was taken individually into a room where there was a manikin (AMBU Man C-AMBU AS, Denmark, with CPR Software Kit 2.3), an AED (Lifepak CR Plus training device-Medtronic PhysioControl Corp., Redmond, USA), and a 'bystander' who, they were informed, could not perform CPR or use the AED. They were told to ignore the two assessors standing at the side of the room. Assessment started as each participant entered the room. The AED was programed for a single-shock scenario, and the assessment was stopped after the 'stand

Table 1 Results of the trainees on-line

	Average[a] (min; max)	Median
Age in years	44.1 (18; 54)	47.5
Total minutes on-line	189 (38; 408)	202
Minutes per session	103 (9; 404)	72
Number of sessions	2.63 (1; 5)	2.00
Time span of training in days	8.13 (1; 39)	2.00

[a] *n* = 16 instead of 18, 2 trainees who did not activate their license were removed.

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Table 2 Correlation between the theoretical and knowledge assessment, and the steps of BLS/AED technique

Steps of Cardiff Test	Range of acceptable performance	Without students without on-line training				Performed, correct or effective	Mean (min.; max.)
		Percentage theoretical		Percentage knowledge assessment			
		Pearson correlation	*P*	Pearson correlation	*P*		
STEP 1; Safe approach		0.124	0.647	0.070	0.796	3/16 (19)	
STEP 2; Check Responsiveness: Talk		−0.067	0.806	−0.116	0.669	15/16 (94)	
STEP 2; Check Responsiveness: Shake		−0.098	0.719	−0.071	0.793	14/16 (84)	
STEP 2; Check Responsiveness: Shout for help		[a]		[a]		16/16 (100)	
STEP 3; Airway and Breathing: Open airway		0.043	0.875	0.041	0.880	6/16 (38)	
STEP 3; Airway and Breathing: Check breathing		0.188	0.485	0.185	0.492	6/16 (38)	
STEP 4; Phone 112	Phone ambulance	[a]		[a]		16/16 (100)	
STEP 5; Perform CPR as advised by AED		[a]		[a]		16/16 (100)	
STEP 6; Hand positioning for chest compressions: Hand position area		−0.131	0.629	−0.102	0.707	14/16 (88)	
STEP 6; Hand positioning for chest compressions: Total number of correct compressions delivered/minute		0.324	0.239	−0.146	0.603		28.8 (0; 60)
STEP 7; Compression: Average compression rate	90–110	0.293	0.289	−0.082	0.770	10/17 (59)	83.1 (56; 115)
STEP 8; Compression: Average compression depth	38–51 mm	0.155	0.582	−0.238	0.394	10/15 (67)	41.6 (12; 55)
STEP 8; Compression: Return to base line		−0.071	0.800	0.081	0.775	14/15 (93)	
STEP 9; Ventilation: Average inflation volume (in litres)	0.4–0.6 l	0.268	0.335	−0.159	0.570	2/15 (13)	0.2 (0; 0.6)
STEP 10; Ventilation: Average number of correct inflations delivered/minute	2–5	0.155	0.582	−0.053	0.850		0.5 (0; 3)
STEP 11; Ratio: Compression to Rescue breath ratio 30:2		−0.067	0.806	−0.138	0.610	15/16 (94)	29:2 (15:0; 32; 2)
STEP 12; Switch on AED		[a]		[a]		16/16 (100)	
STEP 13; Remove clothing		[a]		[a]		16/16 (100)	
STEP 14; Time interval receipt AED to switch on (in seconds)		[a]	0.000	0.062	0.849		11.6 (3; 48)
STEP 15; Defibrillator electrode pads attached correctly		−0.098	0.719	−0.071	0.793	16/16 (100)	
STEP 18; Time interval receipt AED to attach electrodes (in seconds)		[a]	0.000	0.212	0.508		48.3 (21; 126)
STEP 20; Shock button pushed as directed and shock safety		0.149	0.582	−0.421	0.104	16/16 (100)	
STEP 21; Time interval receipt AED to first shock (in seconds)		0.277	0.299	0.308	0.246		70.0 (42; 152)
STEP 24; Breathing		[a]		[a]		16/16 (100)	
STEP 25; Chest compression		[a]		[a]		16/16 (100)	

[a] Cannot be computed because at least one of the variables is constant, which means that all trainees had the same score.

Table 3 Comparison between the trainees with and without on-line training

Steps of Cardiff Test	Range of acceptable performance	Trainees with on-line training		Trainees without on-line training	
		Performance correct or effective	Mean (min.; max.)	Performance correct or effective	Mean (min.; max.)
STEP 1; Safe approach		3/16		**0/2**	
STEP 2; Check Responsiveness: Talk		15/16		**1/2**	
STEP 2; Check Responsiveness: Shake		14/16		**0/2**	
STEP 2; Check Responsiveness: Shout for help		16/16		**2/2**	
STEP 3; Airway and Breathing: Open airway		6/16		**0/2**	
STEP 3; Airway and Breathing: Check breathing		6/16		**0/2**	
STEP 4; Phone 112	Phone ambulance	16/16		**1/2**	
STEP 5; Perform CPR as advised by AED		16/16		**1/2**	
STEP 6; Hand positioning for chest compressions: Hand position area		14/16		**0/2**	
STEP 6; Hand positioning for chest compressions: Total number of correct compressions delivered/minute			28.8 (0; 60)		58.0 (23; 93)[a]
STEP 7; Compression: Average compression rate	90–110	10/17	83.1 (56; 115)	0/2	41.0 (3; 79)
STEP 8; Compression: Average compression depth	38–51 mm	10/15	41.6 (12; 55)	0/2	15.5 (0; 31)
STEP 8; Compression: Return to base line		14/15		2/2	
STEP 9; Ventilation: Average inflation volume (in litres)	0.4–0.6 l	2/15	0.2 (0; 0.6)	**0/2**	**0**
STEP 10; Ventilation: Average number of correct inflations delivered/minute	2–5		0.5 (0; 3)	0/2	0
STEP 11; Ratio: Compression to Rescue breath ratio 30:2		15/16	29:2 (15:0; 32; 2)	0/2	
STEP 12; Switch on AED		16/16		1/2	
STEP 13; Remove clothing		16/16		**1/2**	
STEP 14; Time interval receipt AED to switch on (in seconds)			11.6 (3; 48)		**9.5 (0; 19)**[b]
STEP 15; Defibrillator electrode pads attached correctly		16/16 (100)		0/2	
STEP 18; Time interval receipt AED to attach electrodes (in seconds)			48.3 (21; 126)		**33.0 (0; 66)**[b]
STEP 20; Shock button pushed as directed and shock safety		16/16 (100)		1/2	
STEP 21; Time interval receipt AED to first shock (in seconds)			70.0 (42; 152)		**46.0 (0; 92)**[b]
STEP 24; Breathing		16/16 (100)		1/2	
STEP 25; Chest compression		16/16 (100)		**2/2**	

[a] One student performed chest-compression-only CPR.
[b] One student did not ask nor go for an AED.

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clear' prompt, 2 min after the first shock was delivered.

The Cardiff Test,[23] revised to achieve consistency with Guidelines 2005,[24] was used as the assessment tool. The two authors (W.d.V. and A.J.H.) used a score sheet to record steps 1, 2, 3, 4, 6, 12, 13, 15, 20, 24 and 25 of the Cardiff Test (Table 3), the manikin recorded the quality of performance of steps 7, 8, 9, 10 and 11, and a video (Panasonic NV-DS60EG) was taken of each participant's performance from the time of entering the room. This video was used to calculate steps 14, 18 and 21, and for verification of any missing or disputed data.

The overall time each participant had spent online, the percentage of this time on each of the different parts of the program, and the duration of each on-line session were derived from the management system of the application.

All participants were asked if they had followed a BLS or AED course previously, and if they had been familiar with a CPR manikin before the assessment.

Statistics

Significance was accepted when a two-sided *P*-value was <0.05, or confidence intervals did not include unity. All statistics were performed in SPSS® 12.0.1 for Windows (SPSS Inc., Chicago, USA).

Results

Twenty-three participants received a licence and were free to use it as often as they wished, or not at all. Five were unable to attend the assessment meeting; they were not assessed at a later date because they would have been pre-warned of the test.

This left 18 participants to be tested, 11 male and 7 female, of an average age of 44 years (18—54 years). The web management system showed that two of these participants did not access the web-based training at any time. They were, therefore, excluded from the subsequent analysis. For the remaining 16 participants the average training time on-line was 189 min (38—408 min). Details of the participants' on-line attendances are given in Table 1. If a participant logged-on, but did not carry out any activities in the program, this was still registered as 'minutes on-line' and influenced the average minutes per session. Some participants visited the web site on consecutive days, whereas others left several days between visits. For this reason, probability distribution was positively skewed. The median was, therefore, also calculated.

Correlations and the results of the tests are shown in Table 2.

There was no significant correlation between the time a participant spent on-line and the quality of performance, nor between correct performance in any one Cardiff step and correct performance in any other step. In other words, performing well in one part of the BLS/AED sequence did not predict good performance overall.

All the steps assessed in the use of an AED were performed correctly by all the participants.

Most of the assessed steps of BLS were performed well (84—100% of the participants performed correctly). Chest compression depth and rate were performed less well (59% and 67%, respectively, of the participants performed correctly). Opening the airway and lung inflation were performed poorly (38% and 13%, respectively, of the participants performed correctly), as was checking for safety (19% participants performed correctly).

Five of the 16 participants had previously followed a BLS or AED course—one a year beforehand, one 3 years previously and the other 3 more then 12 years previously. These 5 were the only participants who were familiar with a CPR manikin; the other 11 declared that they had never seen one before.

We compared the differences in performance of each assessed step between the group that had previously followed a CPR course and were familiar with a CPR manikin, and the rest of the participants, using a one-way ANOVA, and found no significant differences between them.

Table 3 compares the results of the 16 trainees who accessed the on-line program with those of the two trainees who did no on-line training.

Discussion

Ideally, studies on BLS training should compare the experimental method with an instructor-based method.[25] As this was a pilot study to assess the feasibility of on-line training, however, no such control group was used.

Manikins are considered necessary when teaching chest compression and ventilation,[26] and expert opinion supports the idea that immediate hands-on practice is essential for learning BLS-skills.[27] In this study, however, the participants did not use a manikin or AED at any stage of their training, yet, when tested, they achieved 100% score in the use of an AED and performed most BLS skills well. Each step of the BLS and AED sequence of actions was performed in the correct order by all the16 participants who had followed the online training. They all checked correctly for consciousness and called for an ambulance. Although most participants were unfamiliar with a BLS manikin, they still provided correct chin lift, placed their hands correctly on the chest to deliver compressions, used the correct compression rate and depth, and returned the chest to a neutral position after each compression.

On the other hand, poor results were recorded for skills related to ventilation, in most cases because participants did not open the airway effectively. This finding is not, however, unique. Previous studies on instructor-led learning and retention have reported poor results for ventilation-related skills;[28–30] this is a training problem that has yet to be solved. It is of note that the ERC 2005 resuscitation guidelines reduced the emphasis on ventilation during CPR and supported compression-only CPR in certain circumstances.[24]

The number of correct compressions per minute was low. Of the five participants whose mean depth of compression was outside the accepted range, three were too shallow (<38 mm) and two were too deep (>51 mm). Again, this is not unique as even well-trained hospital staff show an inconsistent quality of CPR.[31,32]

Low scores were achieved for 'safe approach'. This may be partly because it was very clear to the participants on entering the room that there was no physical danger present.

This study has two main limitations. The first is that the only control group consisted of the two participants who did not use the program. It can be seen from Table 3 that their performances were very poor indeed, but the small numbers involved made meaningful statistical analysis impossible. The second limitation is that only tentative conclusions can be drawn from a pilot study with a small number of volunteers.

Conclusions

Overall, the results suggest that it may be possible to achieve reasonable competence in BLS and AED skills using a micro-simulation web-based interactive program, even before practice on a manikin can be provided. This seems to be particularly the case for the use of an AED, where skills were performed to a uniformly high standard. This is consistent with the results of previous studies which show that it is relative easy for lay people to use an AED,[33–35] and opens the possibility of mass public training via the internet. If this method were to be used, however, it would be important to overcome the problem of ensuring that participants receive sufficient incentive to follow the on-line program.[10] It should not be seen as replacing other methods of training, and practice on a manikin should be encouraged when circumstances permit. It must also be remembered that not everyone is as computer literate as the volunteers in this study.

Conflict of interest

W.d.V. is an employee of Doczero, part of the H2W-group. He is free to perform research, and his management was not involved in designing the study, analysing data or writing the manuscript. A.J.H. received travel and other expenses for this study without restrictions for research.

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