The effect of pre-course e-learning prior to advanced life support training: a randomised controlled trial

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Abstract

Background: The role of e-learning in contemporary healthcare education is quickly developing. The aim of this study was to examine the relationship between the use of an e-learning simulation programme (Microsim™, Laerdal, UK) prior to attending an Advanced Life Support (ALS) Course and the subsequent relationship to candidate performance.

Methods: An open label, multi-centre randomised controlled study was conducted. The control group received a course manual and pre-course MCQ four weeks prior to the face to face course. The intervention group in addition received the Microsim programme on a CD. The primary outcome was performance during a simulated cardiac arrest at the end of the course. Secondary outcomes were performance during multiple choice exams, resuscitation skills assessments and feedback to Microsim programme.

Results 572 participants were randomised, (287 Microsim, 285 control). There were no significant differences in the primary outcome (performance during a standard cardiac arrest simulation) or secondary outcomes. User evaluations were favorable. 79% would recommend it to colleagues. 9% stated Microsimcould replace the entire ALS course, 25% parts. Over 70% of participants' perceived that Microsimimproved their understanding the key learning domains of the ALS course.

Conclusion

Distributing Microsim to healthcare providers prior to attending an ALS courses did not improve either cognitive or psychomotor skills performance during cardiac arrest simulation testing. The challenge that lies ahead is to identify the optimal way to use e-learning as part of a blended approach to learning for this type of training programme.

Introduction

Substantial healthcare resources are invested in resuscitation training. Currently the two / three day European and UK Resuscitation Councils Advanced Life Support Course[1-2] trains over 20,000 healthcare professionals in advanced resuscitation techniques each year. The curriculum design uses a variety of educational strategies to develop competency in resuscitation based around knowledge, skill and behavioral development. Current practice incorporates written material (a course manual issued four weeks prior to the course), interactive lectures, small group teaching, group discussion and cardiac arrest simulation exercise.

A recent review by the International Liaison Committee for Resuscitation (ILCOR) indicated the modifiable factors that influence outcome from cardiopulmonary arrest.[3] Along with guideline quality and the local chain of survival, the importance of educational interventions was highlighted. In particular, the role 'novel technologies' can play in enhancing learning requires further exploration. E-learning is one such strategy and can offer multiple benefits over 'classical' learning techniques such as wide access and availability. Its use is rapidly expanding in health-care training and is already integrated into many aspects of pre and post graduate training. It has already been utilised in areas as diverse as basic surgical skill ascertainment[4] to the diagnosis of anaemia[5], or improving management of epistaxis.[6] Whilst evidence from randomised controlled trials conducted has been generally positive there is a lack of clarity over whether the purported theoretical benefits will translate from research into clinical improvements.[7] This however is not unique to e-learning, as it has proven extremely difficult to establish this causal relationship.

Interest in e-learning and alternative educational strategies targeted at resuscitation training has benefited from the ILCOR statement, the challenge now is establishing the potential efficacy of such novel interventions. Reported positive outcomes[8-9] do not seemingly dilute concerns about how this then directly leads to improved practical performance[10] and knowledge.[11] Thus embedding such a blended learning approach as common place and a viable alternative to traditional learning methods requires further study.

Microsim (Laerdal, Stavanger) is a multi-media computer simulation programme which provides structured training and feedback on medical emergencies and advanced resuscitation. Different modules cover each of the five ALS learning domains (recognition of the critically ill patient and prevention of cardiac arrest, rhythm recognition, resuscitation skills, resuscitation treatment algorithms, post resuscitation care) and interactive simulations present the user with a virtual patient in or at risk of cardiac arrest, requiring them to lead a resuscitation team in their assessment and management. Detailed structured feedback on performance is provided, and links to the course manual help underpin learning.

The aim of this study was to evaluate the efficacy of pre-course preparation with Microsim on the Advanced Life Support (ALS) course learning outcomes and explore user perceptions and reactions to the learning material. The data from this study have also been used to validate a scoring system for the cardiac arrest scenario test. [12]

Methodology

Design and Participants

An open label randomised controlled study was conducted. Individuals undertaking the ALS course at 9 UK Hospitals over a ten month period (March to December 2007) were eligible for inclusion. All participants provided written informed consent.

Participants were randomised at each site to the e-learning or control arm (allocation 1:1) in blocks of six. Randomisation was stratified by course centre. Participants in the e-learning arm received a CD version of the Microsimcomputer programme plus the standard supporting ALS course material four weeks in advance of the course (ALS manual, pre-course MCQ). The CD had been specifically configured to ensure consistency with the ERC / Resuscitation Council (UK) guidelines. The feedback contained hyperlinks to an electronic version of the course manual. Those in the control arm received the standard course material alone.

The study was approved by the South Birmingham Research Ethics Committee.

Outcome and Data Collection

The effect on learning outcomes was assessed by various modalities. Knowledge was assessed at the start and end of the course a pre- and post-course multiple choice paper (MCQ). The MCQ's contain 30 stems to which 4 true / false choices are presented giving 120 items in total. Internal evaluation of over 5000 MCQ papers by the Resuscitation Council (UK) found the papers are both reliable and valid assessment tools (data on file).

Airway management, patient assessment, defibrillation and CPR skills are tested using an outcome based assessment tool. Participants are allowed as many assessment attempts during the course as required to allow them to achieve the necessary standard.

Knowledge, skills and decision making are all tested during the cardiac arrest simulation test (CASTest). The focus of this is in establishing a candidates ability to lead a resuscitation team during a simulation involving the care of a critically ill patient that deteriorates into cardiac arrest.

All practical assessments were scored by instructors rating overall performance using a validated four point scale (1=unsatisfactory; 2=borderline; 3= acceptable; 4 = excellent) (see table 1).

Pass/fail decisions were made on global assessment by paired instructors utilising pre-defined criteria. Instructors were not told whether candidates had been allocated to the Microsim or control arm. Instructors evaluated performance individually and agreed a joint score by consensus between the pair. If they failed to agree on a score the Course Director acted as the final arbiter. Candidates that performed consistently well during the course were assessed by the faculty as a whole for consideration for nomination for instructor training. Judgements regarding instructor potential took place at end-of-course faculty meetings. Multiple criteria including communication, enthusiasm, interactivity and ability to function as a team member were considered.

Feedback on experiences of using the MicrosimCD was collected by questionnaire from participants in the e-learning arm at the start of the course. Candidates were asked to rate both specific aspects of programme utilisation (ease and length of use) and to provide opinions on their perceived value of Microsim.

Data Analysis

Sample size estimation: In order to determine sample size population, previous ALS course data was examined. Two outcomes were used, firstly results from over 8000 multiple choice test papers were analysed. The average pass mark for the Pre course paper is 87.2% (standard deviation 6.63) and for the post course paper is 88.1 (standard deviation 6.8). On this basis, we calculated that 40 participants in each group would be required to detect a 5% difference in MCQ score with 90% power at a significance level of 0.05. Secondly from the published CASTest evaluation[16] we established the pass rate for the cardiac arrest scenario tests was 74%. In order to realise a 10% difference in CASTest pass rate estimates a study cohort of 520, with 260 participants in each arm.

Ordinal data (performance ratings) were analysed using Mann Whitney U test. Chi-squared test was employed for categorical data. A priori a P value of 0.05 was considered significant. All analysis was performed with SPSS statistical package version 15.

Results

Six hundred and fifty seven people were screened for eligibility to participate. From this 572 people were randomized to the Microsim CD (n=287) or standard (285) arms. Of these 275 and 276 people returned data for analysis. The CONSORT flow diagram (figure 1) describes participant flow through the study.

There were no significant differences in demographics between the groups. In the Microsim arm 183(66%) were doctors; 48(17%) nurses; 6(2%) other; 39 (14%) did not respond to this domain. The standard group comprised 169(62%) doctors; 53(19%) nurses; 9(3%) other;

43(16%) did not respond. 62(22%) and 55(20%) described their role as senior (consultant / sister) whilst 137(49%) and 136(50%) described their role as junior respectively.

Learning outcomes

Pre- and post-course MCQ scores in both arms no CD *vs* CD were not significantly different (mean (SD) 106.2 (9.2) *vs* 105.5 (9.2), P=0.5 and 101.9 (13.8) vs. 101.4 (13.9), P=0.7).

There was no difference in overall performance ratings between groups for airway(P=0.6), initial assessment (P=0.4) and rhythm (IAR) and CASTest outcomes (P=0.8). Overall pass/fail (no CD *vs* CD arm 91.8% *vs* 93.6%, P=0.4). and identification of instructor potential (8.9% *vs* 8.2%, P=0.8).

User Evaluation:

Questionnaires were returned by 36% (n=100). Of these, 64% used the CD prior to attending the course. Three quarters (75%) of respondents found the installation process easy and were able to use the programme without difficulty. The median duration of use was 2 hours, (range 1-20h). 65% found installation easy. 79% would recommend the MicrosimCD to colleagues undertaking the ALS course, finding it useful for pre-course preparation. Only a small proportion (9%) agreed with the statement that Microsimcould replace the entire ALS course. However a quarter of users reported that the CD could replace parts of the ALS course. Participants' perceptions on the value of Microsimin improving understanding in specific learning domains are provided in Figure 2.

Discussion

Microsim represents a novel, computer-based approach to augmenting candidate preparation for resuscitation training. When used as part of the pre-course preparation for ALS it was enthusiastically received by most of the candidates. Over 80% believed Microsim improved their understanding of ALS theory and skills, a similar number would recommend the programme to colleagues and a quarter felt it could replace parts of the existing course. Despite the positive feedback, allocation to the Microsim arm of the study produced no significant improvement in learning outcomes.

E-learning offers a number of advantages over alternatives such as face to face training or learning from textbooks.[19] It is convenient, flexible and placed fewer geographical and temporal constraints on students and tutors. Standardised learning tools ensure a more consistent educational experience, as all students are exposed to similar resources (regardless of an individual centre's capabilities) and are able to learn at their own pace. E-learning systems have previously been trialled in a number of settings to facilitate resuscitation training.[11, 13] Monsieurs *et al* described the use of a CD-Rom basic life support programme. It improved users attitudes and assessment skills but compared to standard training was inferior for the acquisition of the psychomotor skills required for CPR.[13] A multi-media advanced resuscitation training course involving a video and computer game was compared to a 3 hour face to face simulation course or reading a text book in a randomised controlled trial. The multi-media course improved short term cognitive outcomes but was inferior to the face to face simulation training when performance was tested during a simulated cardiac arrest.[14] In contrast a combined e-learning / face to face paediatric advanced life support course achieved similar learning outcomes to a two-day face to face course.[15]

The approach in this study was different in that the e-learning material was used to supplement rather than replace face to face training and used mostly case-based scenarios to deliver the educational content. This approach improved upon traditional techniques which were primarily aimed at imparting purely factual information.[18] The programme utilised advanced graphics and text with high quality sound. These features are especially relevant to this type of training which can be difficult to conceptualise. This approach enables the learners to experience a highly realistic virtual reality, immersing them in interactive clinical scenarios that demand a response to patient assessment and management.. Learners can personalise their learning experience by progressing through material at their own pace with the freedom to pause, repeat or seek assistance if needed. The provision of individualised feedback based on performance allows users to identify their areas of strength and weakness, allowing focused learning that potentially maximised their development.

Given this, it is disappointing, that the use of Microsim did not lead to a measurable improvement in learning. There are a number of potential explanations for this finding. Data were analysed on an "intention to treat" basis, yet only two thirds actually used the CD. Those that used the CD did for an average of only 2 hours. This represents a relatively brief period, and likely did not allow full exploitation of the potential of Microsimas a learning tool. Equally, the assessments used to determine learning outcomes for the ALS course may not have captured subtle improvement in participants reasoning and decision making skills, which may have been enhanced by the programme.

The relatively low uptake and usage of the e-learning materials is not unique to this study[16]. Barriers to uptake of e-learning programmes include time constraints, low confidence with the use of computers, limited experience with the use of the internet, absence of social interaction

and lack of personal discipline[17-19]. The use of e-learning materials can be enhanced by providing prompts or reminders to learners to review material[20] and allowing work based study time[19, 21]. Usage is also improved if materials are well presented and easy to navigate[22], the course provides a certificate of accreditation[18], users can assess and validate their own knowledge[22] and have a mechanism for support / feedback from faculty[22].

A quarter of learners encountered difficulty with installation or technical problems whilst using the programme which may have contributed to the sub-optimal usage. This occurred despite the availability of a technical support line designed to provide assistance with these difficulties. There are a wide range of computer systems in use across healthcare sectors and few have access to the latest versions of hardware and software. The importance of protecting healthcare records and information further means that unrestricted internet access is rarely available and the ability to install programmes to computers in hospitals can be limited. It is important that these factors are considered during the development of e-learning materials.

Whilst e-learning offers a number of positive opportunities, the drawbacks must be acknowledged. Preparing e-learning materials are generally labour intensive and time-consuming to produce and render operational, yet this may be tempered by the knowledge that only incremental costs are needed to expand their use or modify them. Equally, barriers may exist with regards to integration with existing learning tools, cultural resistance from educators, and both theoretical and genuine candidate concerns over learning in isolation in the absence of social interaction.[1123] Nevertheless, despite these apparent difficulties, it is likely that with the passage of time, and greater learner and teacher familiarisation with e-learning such impediments will diminish.

Limitations and Further Work

Limitations are apparent with the study. The use of questionnaires to obtain feedback exposes the data to responder and recall bias. Only 35% of questionnaires were returned and we must assume that similar response patterns would prevail in the remainder of the group. A potential strength and limitation of the study is the fact that it was analysed on an intention to treat basis – thus reporting the effects of how the widespread distribution of Microsim would affect learning outcomes. However the study did not assess if there was a dose response relationship between the amount of time spent using the system and learning outcomes.

Further work is required to clarify whether the use of Microsim or other e-learning tools can improve learning outcomes and also in what specific competencies it's use is most effective in. Equally it will be necessary to assess whether e-learning can offer a more efficient medium for delivering certain aspects of advanced life support training, potentially replacing or modifying certain traditional learning resources utilised in the course[22].

Conclusion

The e-learning micro-simulation programme Microsim was positively evaluated by participants from advanced life support courses. In this study, distributing Microsim to healthcare providers prior to attending an Advanced Life Support courses did not improve either cognitive or psychomotor skills or performance during cardiac arrest simulation testing. The challenge that lies ahead is to identify the optimal way to use e-learning as part of a blended approach to learning for this type of training programme.

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Table 1 : Global scoring criteria for practical tests

- Excellent – Correct decisions made promptly and with confidence. An expert (instructor potential) performance.
- Acceptable – Correct decisions made; some hesitation with decision making or lacking confidence. Usual performance level for an ALS provider.
- Borderline – Minor errors in decision making, hesitant and lacking confidence in decisions, required prompting, did not perform skill but recognised error on subsequent questioning. Essentially safe management. Just about acceptable level of performance for ALS provider. Not achieved – incorrect decision / treatment, action may, or likely to cause harm; failed to demonstrate attributes required of an ALS provider.

Figure legends

Figure 1. Participant allocation and flow according to CONSORT

Figure 2. Candidates perceived value of Microsim regarding improved understanding of course elements