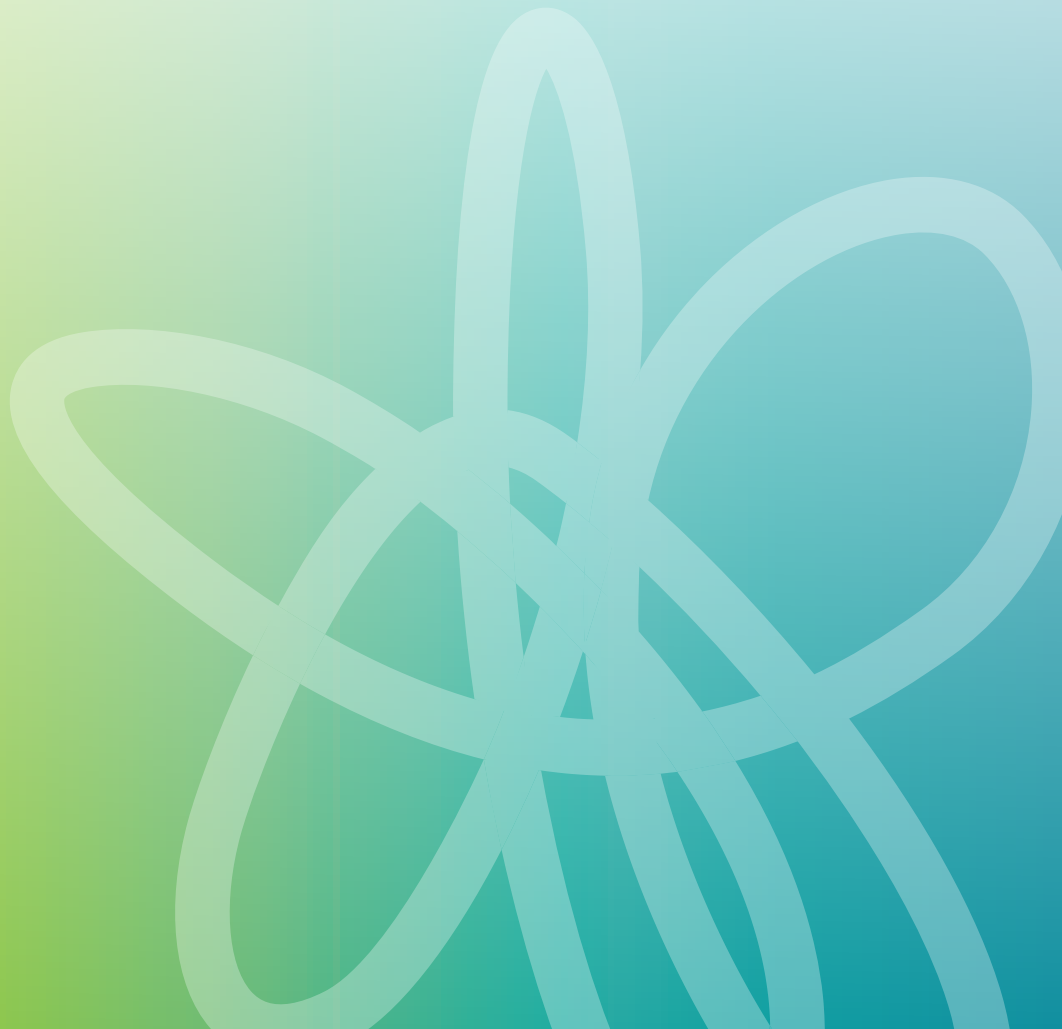The Australian Prevention
Partnership Centre
Systems and solutions for better health

A rapid review of evidence

eLearning for health professionals

A rapid review of evidence: eLearning for health professionals

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Disclaimer: This evidence review is not necessarily a comprehensive review of all literature relating to the topic area. It was current at the time of production (but not necessarily at the time of publication) and is based on sources believed to be reliable.

Contents

1. Executive summary

This systematic review has been conducted for The Australian Prevention Partnership Centre (the Prevention Centre), a national initiative aiming to identify new ways to prevent lifestyle-related chronic health problems. One of the Prevention Centre's aims is to train health professionals to deal with chronic or non-communicable diseases (NCDs), such as child obesity. This review examines a range of electronic learning (eLearning) resources that have been developed for health professionals internationally to understand what is known about effective eLearning approaches for different health professionals in different settings.

Teaching and learning can be undertaken effectively via a computer through eLearning or through blended learning, a combination of eLearning and face-to-face learning.[1] The effectiveness of any form of education, whether eLearning, blended learning or face-to-face learning, depends on a range of factors, including the topic of study, learners, teacher, educational design, instructional materials and educational setting. In terms of eLearning and blended learning, access to appropriate technology and information technology literacy are also important.

Numerous studies in health (and elsewhere) have shown that eLearning is better than no education, eLearning can be as effective as other forms of education, and participants like and dislike certain features of eLearning. The aim of this review is to move beyond this baseline knowledge to identify effective features of eLearning resources and the way in which these features can be implemented through professional development in health.

eLearning can be beneficial for professional development in health. Most notably, it enables learners living in geographically dispersed locations to access training that may not otherwise be possible and to engage with teachers and peers. eLearning can enable participants to learn at a time and place that is convenient to them. It also enables participants to pace their learning to suit their own needs and by so doing, revise, skip and extend areas of interest.

eLearning offers many features that are useful for professional development in health, including quizzes as practice activities (formative assessment), case-based learning, discussions, mentors, role play, spaced education, videos, virtual patients and webinars. These features have been highlighted here. However, many eLearning resources for professional development in health have used a combination of these features and it is often difficult to pinpoint the benefits of individual features.

Although eLearning offers many benefits for professional development in health, it is not a panacea. When considering development of eLearning, we highlight the following key points from the review:

• Knowledge is easy to change and easy to measure, especially where the baseline is low. Retention of knowledge is easier to achieve in low baseline participants, indicating a need to gather baseline data from potential participants before developing eLearning resources.

• If procedural or practical skills are the required outcome, the program needs to include actual practice of the skill through exercises and testing; skills will not be addressed only through discussion or interactivity, and transfer to practice cannot be assumed.

• It is hard to effect change in behaviour and health practice except in low baseline situations.

• Attitudes, beliefs and values, including empathy, are difficult to change but can be changed,.

• Matters in the 'professional' domain have been successfully addressed (directly or indirectly) through online programs addressing, for example, burnout, stress, dissatisfaction and comfort.

• Some interpersonal skills cannot be effectively addressed online without careful consideration of the central value of interpersonal interactions, for example, patient-professional communication, teaching and learning, and supervision. The use of role play and virtual patients may be effective, but more research is needed in this area.

• Retention of learning cannot be assumed: regular revision is needed.

• An eLearning resource developed for one group of health professionals cannot be assumed to be relevant for another group.

- Drop-out rates are often very high, especially from long-haul programs; similarly, programs that are entered anonymously without registration or enrolment are prone to drop-outs.

- There are mixed results regarding the ideal duration of eLearning resources.

- Participation and completion can be increased through incentives, ensuring relevance to learners and using online mentors/tutors.

- Consider the level of technology used by participants and their technical skills, and include an online or face-to-face orientation to the eLearning resource.

- Regarding the effectiveness of different types of eLearning:

    - Quizzes (formative assessment) with immediate feedback, case-based learning, role play and virtual patients can result in increased knowledge

    - Participants indicate high satisfaction with these types of eLearning and with online discussions

    - Interactivity for the sake of interactivity, without access to higher cognitive functions, may have little effect on learning.

    - Information transfer through PowerPoint presentations, video and text do not result in long-term retention of knowledge.

    - More research is needed into the effectiveness of multimedia, spaced learning, virtual patients and webinars.

Some papers from this review could be recommended reading for the Prevention Centre: exemplary instructional design,[2-4] exemplary research design,[5,6] successful attitude change,[7] relevant topics of prevention of childhood obesity[8] and eating disorders[9] and principles for eLearning design.[4,10,11]

Although the review includes some excellent papers, in general the papers in this field are of varying methodological quality:

- Many studies focus on the tests used to determine learning outcomes, rather than the instructional design of the program.

- Not all eLearning resources described in the studies have been developed based on needs assessments and/or evidence related to eLearning in health professional education.

- There is an over-abundance of small, single-institution studies of contained and relatively uncomplicated topics (eg, handwashing, procedures, fire safety), which do not advance knowledge and practice in eLearning for healthcare professionals. Some of the best studies and papers in this review deal with higher order and more complex topics.

- Rather than comparing eLearning with no education or with face-to-face teaching, more research is needed comparing different eLearning interventions to identify which elements are effective for specific health professionals, topics and settings.

- There has been an inefficient and unnecessary effort gathering data about whether research participants were satisfied with an eLearning resource, instead of gathering data to determine learning outcomes. What providers need to know could be found out through an open-text format question regarding 'any comments and suggestions' to elicit institutional and other barriers to practice change or implementation of new knowledge and skills.[12] Much of what is asked about in questions about satisfaction could be elicited through good piloting of (a) program (b) measurement instruments, including level of difficulty in test questions, before eLearning resources are implemented.

2. Introduction

The Australian Prevention Partnership Centre (the Prevention Centre) is a national initiative identifying new ways of understanding how to prevent lifestyle-related chronic health problems in Australia. This includes finding ways to support a national prevention system, communicate prevention and assist health professionals. One of the specific aims of the Prevention Centre is to train health professionals around child obesity, and, more broadly, chronic or non-communicable diseases (NCDs).

The purpose of this review is to examine models of eLearning that have been developed for health professionals to identify what is known about optimal training approaches for different health professionals in different settings.

The focus is on eLearning approaches that involve:

• A broad range of health professionals, such as general practitioners, hospital-based physicians, surgeons, nurses and allied health, of different levels of seniority and in different settings, such as primary, secondary and tertiary health care settings, community health centres, rural, regional and remote settings, and mobile health workers

• NSW Health and other health contexts.

The review addresses the following research questions:

• What eLearning approaches, both fully online and blended (a mix of face-to-face and eLearning), work with a range of health professionals in different health care settings?

• What are the enablers and barriers to effective eLearning for health professionals?

• Which forms of eLearning approaches are acceptable to health professionals?

• Which forms of eLearning approaches are feasible for providers, including cost effectiveness?

• Have these eLearning approaches been evaluated in terms of learning outcomes and/or process evaluations? For the latter, do the evaluations consider:

    - Qualitative data – whether staff like it, staff comments?

    - Quantitative data – amount of staff time involved, how many sessions made up the course, how many health professionals participated, ratings of most popular sessions, cost?

    - Are there any issues specific to eLearning approaches for health professional that target child obesity and, more broadly, non-communicable diseases?

3. Background

eLearning can be broadly defined as "any learning experience supported by information and communication technologies".[13] From an educational perspective, eLearning involves more than broadcasting electronic information via the Internet.[14] Instead, it generally aims to be flexible, engaging, learner-focused and interactive, and may involve collaboration and communication.[14] eLearning can be used in fully online courses or through blended learning, which involves a mixture of eLearning and face-to-face learning.[15]

eLearning can be used to enhance instructional materials[16] and provide visual/audio support and a facility for interactive engagement.[17,18] Within health, eLearning can enable learners to participate in problem solving or case scenarios based on authentic clinical settings, extend their learning by linking to relevant resources and interact with peers and teachers.[5] It can also enable users to learn material in their own time, at their own pace and in their preferred order, at or near the point of care.[5] eLearning is widely used in medical[19] and health professional education, both with university and tertiary students, and through continuing professional development. Continuing professional development through eLearning can provide flexibility in the timing and delivery of training, enable access for remote learners, and reduce travel time and costs[5] for participants and teachers.

The term 'online' can be used instead of 'eLearning', defined as 'a range of technologies'.[20] (p 3). It is applied to a broad range of activities or objects accessed through a connection to the Internet, such as online banking or online education, which more specifically means eLearning conducted through a connection to the Internet. Related terms include 'Internet-based', 'computer-based' and 'web-based' learning or instruction. This review uses the general term' eLearning' due to its broad applicability. By extension, the term 'eLearning resource' is used to refer to online courses or online learning and teaching material designed by educators for learners. Additionally, in this review 'online' is used in conjunction with a variety of other terms, such as 'online discussion boards', where communication takes place via the Internet.

4. Methods

The review is of sufficient breadth and depth to enable the Prevention Centre to apply the findings. The literature was searched for areas where there is strong and unequivocal evidence in relation to the research questions and identifies gaps in the evidence base.

The search was conducted in PubMed, the largest academic database with published literature from the health disciplines. The search terms were: computer assisted instruction, elearn*, online, spaced, education, train, learn, health personnel. Because the vast majority of literature on eLearning has been published this century, the search was initially limited to 1999–2014.

The search retrieved 2420 papers, which was reduced to 2271 following elimination of duplicates. The papers were systematically culled according to the inclusion and exclusion criteria (Table 1), which was compiled by the authors based on the Prevention Centre requirements. The culling was undertaken in reference to the title and abstract of each paper; where insufficient evidence was provided in the abstract to determine relevance, or no abstract was provided, full papers were accessed via the libraries of The University of Sydney and The Children's Hospital at Westmead.

A total of 135 papers were initially determined to be relevant and full papers were retrieved. All the papers were in English, apart from one in Spanish. Papers were subsequently excluded by both authors if, on closer reading, they found that they did not meet the criteria or when more than one paper reported on the same study. The year of publication was further limited to 2000–2014 because papers published in 1999 were not found to be relevant. Three additional papers were located through hand searching. A total of 110 papers were determined to have met the criteria and were included in the review.

The papers were systematically analysed to determine key themes, including authors, year of publication, country of origin, number of participants and their health profession, medical topic, health setting, research study design, description of the educational intervention received by the intervention group or the comparison group (where relevant), learning outcomes measured, any participant evaluation or comment, limitations of the study and implications, focusing on the enablers and barriers to eLearning. Studies were highlighted where they addressed child obesity and non-communicable diseases and thus would be of particular interest to the Prevention Centre.

Given the wide range of possible confounding variables in education studies, it is often difficult to isolate the influence of an intervention on learning. For this reason, randomised controlled trials (RCTs) are not considered the gold standard in education research. Therefore, we have included research reporting on RCTs, non-RCTs with pre- and post-tests, or post-tests only, with or without a control. These add to the evidence base on the effectiveness of eLearning for continuing professional development of health professionals. These studies are presented in separate categories in the following section so the reader is aware of the level of methodological rigour of the research reported.

Table 1: Inclusion and exclusion criteria

Inclusion criteria:

- Participants: health professionals
- Medium: via computer, with or without Internet access, as well as email, USB and video/conferencing if training is involved
- Teaching: computer-based, which can be in conjunction with other teaching methods and materials
- Assessment of learning: must include objective assessment
- Setting: urban, rural, remote settings, as well as developed and developing countries.

Exclusion criteria were studies reporting on the following, not involving the inclusion criteria:

- Non-health professional workers in health care settings, veterinary science, drivers of emergency vehicles, military, police, flight crew, day care
- Students, unless mixed with health professional staff, or if mixed with health professionals but measurement is only of student learning
- Nurse retention, nurse refresher or return-to-work course
- Characteristics of staff who use course, training needs, career choice or compliance
- Teachers, teaching, assessing, testing skills
- Selecting staff or students
- Writing, research, information literacy teaching, library, academic honesty
- Parents, patients, carers of patients; patient or carer communication education
- Online survey or tests, with no training, or survey of needs or attitudes to work
- Simulations, computerised skeletons, virtual patient, disaster scenarios or case scenarios or dental identification with no training
- Guidelines for dissemination of an eLearning resource or description of development, implementation and/or course only
- Evaluation strategies, development tips or tools for assessing quality of eLearning
- Self-evaluation, including satisfaction, confidence, attitude, belief or value; feedback on effectiveness of an eLearning resource; self-assessment of knowledge, learning, concepts
- Studies that include eLearning with other teaching methods but does not distinguish learning outcomes from the eLearning resource
- Online diagnostic tool, incident reporting, appraisal instrument, computer information system or eReferrals, data tracking
- Generic description of a health system's eLearning courses and global improvement
- Award university courses
- Lessons learned, opinion, comment, viewpoint
- eLearning via CD-ROM, DVD, video cassette

5. Findings summary

A total of 110 papers met the criteria for the search. There are constraints on drawing clear conclusions from the review. To some extent, findings are difficult to generalise because the eLearning resources in the different studies contained a wide variety of elements, which may all influence learning in different ways: very few eLearning resources were so alike as to enable a direct comparison. Also, many studies provided insufficient detail about their eLearning resources. In their focus on testing the effectiveness of the eLearning resource, many research reports failed to provide sufficient details that would determine which particular elements may have influenced learning outcomes.

In some cases, the quality of the research impacted on the degree to which conclusions could be drawn, especially where there was no pre-test to determine baseline level, or no control group to compare effects of eLearning interventions. Few studies included measures of retention of learning over time and few tested for transfer of learning to practice or the effect on patients. We believe these are important outcomes of educational interventions in health, whether through eLearning or face-to-face teaching.

Nevertheless, the results of these studies are worthy of note where appropriate care is taken in the research design. The 110 studies have been grouped under broad types of eLearning, which are listed below in alphabetical order. In each section, we highlight papers we believe will be of interest to the Prevention Centre. At the end, we outline the findings of three related systematic reviews on eLearning in health conducted in 2008, 2009 and 2010.

6. Types of eLearning

Blended learning

Blended learning, the integration of eLearning with face-to-face teaching, has been shown to produce similar increases in knowledge and skills as traditional, face-to-face teaching alone. One RCT demonstrated that nursing participants who used interactive critical care pharmacology learning modules for 4.5 hours, followed by a two-hour discussion session (intervention), had a similar increase in knowledge and similar satisfaction as participants who attended the traditional 6.5 hours of lectures (control).[21] Participants who accessed the blended learning enjoyed the ability to pace their own learning, as well as the flexibility, interaction and repeated access to information; the discussion sessions were considered valuable for clarification and to ask questions. For participants of the control group, the advantage of the lecture was primarily related to interaction: the ability to ask questions and interact with the instructor.

Another RCT compared blended learning (intervention) with no learning (control) to examine general practitioners' shared decision-making regarding antibiotic use for acute respiratory conditions.[22] Blended learning involved two hours of interactive workshops and two hours of online tutorials, both of which included videos, exercises and decision aids for communication with patients. In measuring the effect on patients, the researchers found patients of the intervention group were significantly less likely than those of the control group to decide to use antibiotics and they had an increase in confidence. However, there was no difference between the groups in terms of secondary outcomes over two weeks: decisional conflict, perception of quality of decision or regret, repeat consult and quality of life.

Blended learning has been shown to lead to significant knowledge gains in a number of studies involving pre- and post-tests and a control for comparison. In most studies this knowledge gain has been higher to a statistically significant level when compared with face-to-face teaching.[23-26] In one study with general practitioners regarding end-of-life decisions, neither participants accessing blended learning nor those face-to-face teaching greatly altered their behaviour but the participants of blended learning felt less burnout.[27] Other studies involving blended learning with pre- and post-tests and a control have found significant gains in knowledge but not confidence[28] and satisfaction[29] or sustainability of empathy.[30]

Another study with a pre-/post-test and control on tobacco cessation teaching with doctors, nurses and psychologists compared blended learning with eLearning only and a face-to-face workshop only (control).[31] The eLearning resource included a Wiki and asynchronous email discussion. There was a statistical difference in knowledge gain between those who accessed the blended compared with those who only accessed the eLearning.

Blended learning has also been shown to be effective in a number of other studies with a pre-/post-test but no control as comparison. All of these demonstrated a significant gain in knowledge[32-35] and confidence,[32] as well as transfer of learning to practice.[34] One study with physicians on stroke management[36] found 46.6% of participants failed a knowledge test following completion of an eLearning resource (readings and cases). However, following eight hours of face-to-face lectures and two workshops, including practical skills teaching, there was a significant increase in knowledge, with 96.7% able to assess images correctly. They analysed patient data and found there was a transfer to practice, with an increase in the number of patients receiving appropriate treatment.

Case-based learning

Most of these eLearning courses involving case-based learning also included a range of learning materials, for example the course on preventive practices for chlamydia screening for primary care physicians reported by Casebeer.[4] This contained cases developed on topics based on needs assessment, which were taught via problem-based learning with tailored, interactive responses to meet individual needs, the opportunity to compare responses with other participants, follow-up by experts, clinic audit data, patient brochures, screening guidelines and email reminders with links.

Online case-based learning has been consistently shown to have a positive influence on learning in a number of RCTs. Three RCTs compared case-based learning with no learning and found case-based learning led to a significant increase in knowledge.[4,37,38] One of these RCTs also showed case-based learning resulted in a better retention of knowledge, despite a large number of participants who dropped out.[37] Another of the RCTs demonstrated an increase in knowledge following a case-based program on guidelines for practice, taught via a discussion board.[38] However, standardised patient assessment, which compared participants who accessed the discussions with those who did not, found a high standard across both groups. An RCT that compared participants who accessed an online case-based problem-solving course (intervention) on bioterrorism preparedness with those who attended face-to-face teaching (control) found both groups improved significantly, although the intervention group solved more problems and requested less support, and the control group needed less diagnostic tests.[39] An orientation to the eLearning resource was included.

Studies involving pre- and post-tests comparing case-based learning (intervention) with no access (control) found case-based learning had a positive effect on learning[40,41] and participants had a strong preference for case-based than text-based eLearning.[40]

Knowledge gains through online case-based learning have also been shown in studies with pre-/post-tests but no control for comparison.[3,42-46] One of these studies found general practitioners, trainees and students who accessed an interactive case-based course on whiplash guidelines implementation in Australia (including 15% in rural and remote areas) increased in knowledge and confidence.[44] They highlight that the medical topic must be important to prospective participants. Another of the studies was a case-based course and refresher on glycaemia for hospitalists, which found initial post-test scores were higher than the scores at the refresher, indicating decay of knowledge over time and suggesting repeated, focused interventions are needed.[46] Another of these studies found nurses were satisfied with a case-based course on back pain and dermatology but wanted immediate feedback rather than just scores.[43] In contrast, other studies found no significant increase in knowledge or practice[47,48] and participants preferred a shorter course.[48]

Discussions

Online discussions were included as a feature in a number of eLearning resources, but were the focus of assessment in only one qualitative study, conducted with emergency department practitioners. It found an online discussion board, combined with clinically relevant interactive presentations, supported learning in two ways: rural practitioners were active in knowledge-seeking; urban practitioners were active in responding to others; requests for information.[49]

One study of an eLearning course on the prevention of childhood obesity for nutritionalists and health professionals focused on online discussions, integrated with other eLearning resources.[8] This study contained a pre- and post-test with a control for comparison. Course content was delivered through a slideshow 'and other format'. This was reinforced through bulletin board interactions with the course facilitator. Assessment was based on participation in two online discussion forums and a four-part course project. The bulletin board tutor gave individual feedback, led discussions, answered questions and sent reminders. The control group was participants on the wait list for the course. In the post-tests, the intervention group demonstrated significant change in knowledge, skills and self-efficacy; they were positive that the course was well organised though time consuming. These changes were significantly greater changes than the control group.

Interactive eLearning with quizzes

A large number of studies reported on interactive eLearning resources that included quizzes for learning – we differentiate practice activities involving quizzes for learning as formative assessment, as opposed to quizzes or tests of learning as summative assessment. Given the well documented research showing the positive effect of 'the testing effect' on long-term retention of knowledge,[50,51] we have created a separate category of eLearning resources with quizzes. No two eLearning resources reported on in these studies are alike. All contain different eLearning elements that are described in other sections of these findings, as well as quizzes. In addition, the amount of time participants spend on quizzes is often unclear.

eLearning resources involving quizzes have been shown to result in a significant increase in knowledge when compared in RCTs with traditional face-to-face teaching or no teaching.[52-54] A two-week eLearning intervention, including access to expert advice via a webinar, was compared in an RCT with a face-to-face interactive session for physicians.[5] A similar increase in knowledge was found in the intervention and control groups, both in the immediate and long term; however, in practice, there was a significant increase in the percentage of high-risk patients treated appropriately by those who accessed the eLearning course. Another RCT of an interactive eLearning course with quizzes on intimate partner violence for community physicians found an increase in knowledge, but there was no change in opinion on drugs, alcohol or intimate partner violence.[54] Thus, an increase in knowledge cannot be expected to lead to a change in opinion. This eLearning resource was available in different formats (audio and video) to suit participants' technology.

Interactive eLearning resources with quizzes have also been shown through pre/post-test studies to lead to a significant increase in knowledge compared to a control, which involved no training,[55-60] face-to-face teaching,[61,62] text-only eLearning[63] or unfacilitated, self-directed access to eLearning resources.[64] The latter study reported on an eLearning resource on suicide prevention that was funded at US$534,000 from 2001 to 2004, with the bulk of funds spent on the multidisciplinary development team; the cost for implementation was markedly lower. Another study reported on an interactive eLearning resource with integrated quizzes and videos for nurses, physicians and other staff on hand hygiene.[65] Although it resulted in some improvement, an elapse in time following completion of the eLearning course was associated with lower adherence to correct handwashing technique.

A significant increase in knowledge following use of interactive eLearning resources with quizzes was also shown in most studies with pre-/post-tests that did not involve a control for.[2,66-72] One of these studies reported on an eLearning course for 'stop smoking practitioners' that involved text, videos and assessment.[66] It found the time participants spent on the assessment significantly predicted their increase in score. They also found that participants who spent no or very little time on the eLearning course between the pre- and post-test improved significantly and suggest that the assessment itself led to improvement. In contrast, two studies of eLearning resources with quizzes showed no significant difference in knowledge or skills.[73,74]

Research on an eLearning resource that aimed to increase psychological support to hospital workers in preparation for pandemic influenza (using audio and video mini-lectures, notes and fact sheets, quizzes, games, relaxation exercises, individualised feedback and reflective exercises) considered three different time lengths: 111, 158 and 223 hours.[75] Drop-out rates increased between the three, although there was a significant improvement in confidence and self-efficacy and interpersonal problems were overcome to some extent. The medium length course of 158 hours was found to be best for outcomes and fewer drop-outs. The authors noted that after bearing the costs of developing an eLearning resource, there were marginal incremental costs per learner.

High post-test scores were found in two studies on interactive eLearning resources with quizzes for nurses that included a post-test only. One study on an eLearning resource on chronic kidney disease transplant care (with case studies, problem solving, graphics, animations and questions) found nurses need sufficient time, computer access, computer skills and discipline in their study habits.[76] Research on an eLearning resource on palliative care and syringe drivers (with text, multimedia, multiple choice questions to self-evaluate learning, the opportunity to ask leaders questions, a personal learning log and record of achievement) found the most inexperienced nurses gain the most, although all improved.[77] They also found many participants needed to re-read text to answer correctly and would do that if they

had the opportunity to do so and if it was an expectation, emphasising that tests are part of learning. A study on eLearning for nurses on acute pain management for older adults (with PowerPoint documents, quick reference guides, evidence-based medicine reference tables for analgesics and quizzes) highlighted technical problems that occurred, which resulted in a poor level of participation and reversion to paper copies of the course materials.[78] The authors concluded that the problems were due to a lack of computer confidence, time at work and internet access at home, as well as long download times.

Mentoring

The use of the term 'mentor' or 'mentoring' in the literature is varied; similar roles are associated with the terms 'tutor' and 'facilitator'. The use of a mentor in eLearning resources has been shown to assist learning. One RCT on patient decision support from a call centre for nurses compared an eLearning resource with a mentoring component (intervention) with no access to the eLearning resource (control).[79] The eLearning resourse involved a three-hour online tutorial, skills building workshop and feedback on performance, and the mentoring component focused on a protocol for making calls to patients. Participants in the intervention group only demonstrated a significant increase in knowledge over one month. There was also a qualitative difference in what the participants in the intervention group asked about and how they asked questions in phone calls to patients.

An eLearning resource that included mentoring also demonstrated higher participation and completion rates in a study containing a pre-/post-test and control for comparison.[80] In this eLearning resource for continuing medical education for physicians, only participants in the intervention group were telephoned by a mentor to provide encouragement and feedback. While participation rates and completion rates were low; mentored doctors were three times more likely to finish the course.

Significant knowledge gains that were translated into practice were reported in a blended learning resource on HIV and primary care for physicians, nurses and community health care workers in a study involving a pre-/post-test but no control.[81] The resource involved face-to-face workshops with online recorded lectures and discussion boards, with strong use of a mentor support throughout. The course also involved individual projects, many of which received government funding, and the best students were selected to progress through the whole program, an incentive that resulted in good retention (87% of participants).

Modules/tutorials

Many academic papers referred to the eLearning resources they implemented as an 'online module', 'online tutorial' or 'media rich IBL [internet-based learning] module'. In many cases, little information was provided to describe what these involved, but they could include text, photos, graphics, video demonstration, multiple choice questions, games, discussion boards and case-based learning. Thus, it is at times difficult to gauge which specific aspects of these eLearning resources is an enabler or barrier to learning, or to make generalisations about outcomes.

Positive gains have been demonstrated in two RCTs on online modules. One module on career identity training for stress management for nurses involved 60-minute text-based training with checklists for participants to input; the control group was delayed intervention.[82] The participants in the intervention group showed significant difference in knowledge and sense of impact on the organisation, although not on job stress. Those in the control group showed worsened career identity. A module for general practitioners and medical students on communication with patients with substance use disorders was accompanied by one hour of small group debriefing (intervention); the control group received no training.[83] Compared with those in the control group, residents, but not students, in the intervention group had more positive attitudes toward treatment efficacy and self-efficacy at follow-up and received higher scores on screening and counselling during the standardised patient interview at follow-up.

Several studies on online modules showed a significant increase in knowledge from pre- to post-tests with no control.[9,12,34,84-88] Also demonstrated was a change in attitude and belief,[12] an increase in skills, attitudes, communication and appropriate referrals[9] and an increase in desired behaviours, together with a decrease in the number and seriousness of errors.[85] However, the latter also found the module needed to be more interactive and give more frequent feedback to learners.

Multimedia and simulation training

A large number of studies reported on simulation in specialised simulation centres with computerised mannequins for procedural skills and inter-professional training. The authors excluded these studies from the review as they form a separate category of teaching that we believed would be of less interest to the Prevention Centre for the purposes of this review. One RCT that made stronger use of eLearning compared a range of teaching interventions for surgical fellows:[89]

• Multimedia: simulated surgical skills on a dummy, which were demonstrated via procedural steps in text with illustration and video, including two hours for memorisation

• Practice: two practice training sessions on a pelvi trainer

• Combination: one-hour multimedia and one-hour practice with pelvi trainer

• No training.

There was a significant difference in results: the best results were demonstrated by the multimedia group (memorisation and repetition), followed by the combination group, highlighting the importance of demonstrating procedural skills and time to memorise procedures.

PowerPoint slides containing text information

A small number of studies in the review reported on eLearning interventions involving didactic text information via lecture PowerPoint slides. On the whole, these interventions resulted in only some,[90,91] or no,[92] improvement in knowledge. In one study, immediate post-test scores were higher than pre-test scores, but six months later the scores were the same as the pre-test scores.[93] This study is particularly instructive because the long lapse of time between the eLearning intervention about a new clinical tool and actual implementation of the clinical tool meant the participants had forgotten what they had learnt from the eLearning intervention. As a result, participants were offered an additional face-to-face class involving an interactive question and answer session. This study shows the lack of retention of knowledge that results from delivery of information, whether via eLearning or face-to-face teaching.

Role plays

eLearning resources involving role play have been shown to improve health professional communication and interpersonal skills. One RCT about an eLearning resource featuring role play demonstrated a significant improvement in participant knowledge.[94] The resource, for dentists on domestic violence, required participants of the intervention group to work through a tutorial for only 15 minutes in which two actors played the role of the dentist and patient, participants selected questions and statements for the dentist to make and these solicited different responses and actions. The control was a wait list design. Although knowledge increased in the intervention group participants, there was less effect on beliefs and attitudes, and the research found knowledge was not dependent on empathy.

A well-documented controlled experimental study described an eLearning resource for general practitioner trainees on nutrition that included role play.[6] Participants in the control group accessed the standard training program, while those in the intervention group accessed an eLearning resource featuring simulated, interactive videos of patient encounters. Those in the intervention group demonstrated significant improvement in knowledge and performance compared to those in the control group.

Similarly, an eLearning resource for physicians that involved role play using Second Life, an online virtual world, and Skype resulted in a significant change in proficiency.[95] In this eLearning resource for primary care physicians on motivational interviewing for colorectal cancer screening, participants undertook an online tutorial on the philosophy and concepts of motivational interviewing, viewed a model interview, and then engaged in role play with feedback from their tutor and peers. Participants had a high acceptance of Second Life and showed significant improvement in motivational interviewing skills and in empathy, autonomy, collaboration and their evocative response.

Research into a multinational, blended learning course involving role play demonstrated significant learning gains but these diminished over time.[96] In this eLearning resource on radiation accident

preparedness for emergency medical personnel, time sensitive and site specific information was communicated live among participants in six countries using email, fax, phone and computer so participants could respond as the exercise unfolded. The authors recommended the transfer of knowledge and skills could be promoted through, for example, protocols and job aids such as videos of best practice to compare performance during the exercise.

Screensavers as 'billboards'

Representing an innovative use of everyday technology, screensavers on emergency department computer terminals were used as a means of providing eLearning to first-year residents and senior medical students on bioterrorism.[97] This involved rotating images at five-second intervals, with a teaser question and interactive toolbar linked to the project website for content for different professional groups in a case scenario format. The pre-/post-test with no control found the number of correct responses to post-test questions increased in the post-trial phase, but not in the trial phase.

Spaced education

Spaced education is a relatively new use of eLearning, in which participants in health professional courses are emailed a patient scenario with a multiple choice question, which they answer to obtain immediate, detailed explanation. If a question is answered correctly, it is repeated after a long interval (e.g. 20 days) and if answered incorrectly, after a short interval (e.g. eight days). When a question was answered correctly on more than one successive occasion, it is retired. One pre-/post-test study of spaced education with control was conducted on a spaced education program for oncology trainees.[98] Those in the control group had access to the bank of questions. At the post-test, those in the intervention were found to have significantly higher scores than those in the control. The course was well accepted but only 55% completed it. This form of eLearning demonstrates the testing effect and spaced education effect, but needs to be goal directed to enhance completion.

Videos

eLearning resources featuring videos have been reported in the literature with varying results. In an RCT on a smoking cessation course for nurses, participants in the intervention group accessed video vignettes of a model intervention with different populations, with supporting information and case studies.[7] The control was a wait-list design. At three months those in the intervention group were more likely than those in the control to increase their behaviours and advice and assistance to parents; they also had increased positive attitudes and self-efficacy in providing interventions and a decreased perception of barriers. The intervention was seen as cost effective for less than three participant hours.

However, results were mixed in a study using pre-/post-tests with control for comparison on a genetics education program for interviewing skills for physician assistants.[99] This eLearning resource involved a web-based educational program for those in the intervention group only, before a videotaped standardised patient session. Those in the intervention demonstrated more complete family histories and detailed cancer histories, but did not make more genetics referrals and used less patient-centred interviewing than those in the control. This highlights that unintended consequence can result from educational interventions, and the need for practice sessions for the development of communication and interpersonal skills.

Mixed results have also been shown in two studies of eLearning resources with video on hand hygiene involving pre-/post-tests with no control for comparison. A three-week eLearning resource for health care workers was developed as a self-guided course with three online sessions involving instructional videos with facts and practices, followed by self-assessment and self-improvement plan, with information tips and motivational messages emailed to participants.[100] Participants showed a significant increase in knowledge and were positive about the program. In contrast, an eLearning resource involving a video and PowerPoint demonstration only resulted in a significant improvement in knowledge for doctors and medical students but not nurses and none of the participants showed an improvement in practice.[101] Inclusion of interactivity, in particular making use of the testing effect and spaced education, would likely improve the outcome.

Virtual patients

Virtual patients have been defined as "interactive computer programs, based on real clinical cases, that have the benefit of being engaging, emphasising decision-making and allowing for presentation of clinical situations not commonly encountered in real life".[102] They have been included in this review when integrated with training materials but not if they were in a stand-alone simulation exercise. An eLearning resource on substance abuse management with virtual patients has been conducted as a pre-/post-test with three participant groups.[102] The first intervention group accessed five virtual patient scenarios with 17-20 interactive problem solving exercise; the second intervention group accessed written and audio commentaries as the case progressed, then managed the remaining three cases; the control group had no intervention. Feedback was provided at the end of the program. Neither intervention group improved in their skills in managing substance abuse; the mean time was 125 minutes: longer on the unworked group. The intervention groups might have improved their performance if feedback had been given after each management decision was made.

Virtual patients were included in an eLearning resource on diabetes and medication management for pharmacists and students, with research conducted as a pre-/post-test with no control.[103] The eLearning resource included a PowerPoint tutorial and patient electronic record. Participants demonstrated increased knowledge and believed they had improved skills and confidence; however, they did not improve attitudes or a sense of changing professional expectation or habit. The intervention was time consuming to develop (100 hours) and for participants to use (4-5 hours).

Webinars

There are few reports of the use of webinars for professional development of health professionals. An exception is research using a post-test with control on a webinar for nurses on HIV rapid testing.[104] The 90-minute webinar involved entering results into electronic medical records and a demonstration of how to run the procedure, including one 'do as you watch' segment. Compared with participants in the previous face-to-face teaching (the control), participant satisfaction and post-test results were the same but there was a three-fold increase in HIV testing in practice following the webinar.

7. Previous systematic reviews

Cook et al conducted a meta-analysis summarising the effect of Internet-based instruction for practising and student health professionals compared with no intervention and non-Internet interventions, finding 201 eligible studies.[10] Most studies involved tutorials for self-study or virtual patients; over 25% required online discussion with peers, instructors or both; 29% involved blended internet and face-to-face instruction. Most used multiple choice questions to measure outcomes, 10% used self-report of knowledge, confidence or attitude. There was often a loss of 25% of participants to follow-up. Similar to our review, Cook et al found inconsistent results due to heterogeneity (learners, instructional methods, other aspects), many studies failed to describe the context, instructional design or learning outcomes, and the quality of research design was often low.

They found Internet-based learning is associated with large positive effects compared with no intervention across a wide variety of learners, learning outcomes, clinical topics and learning outcomes, but generally small effects compared with non-Internet based, traditional instructional methods. Effect sizes for knowledge change was greater in Internet-based courses using discussion compared with no discussion, and for longer courses. They did not show that high levels of interactivity yield larger knowledge effects. They also found Internet-based learning needs a practice component for skills change outcomes, not just interactivity, repetition or discussion. They recommend future research should compare different Internet-based interventions.

Shortly after this report appeared, Cook et al published a systematic review and meta-analysis of Internet-based learning compared to another Internet or computer-assisted intervention for practising and student health professionals.[11] In the 51 papers extracted, approximately 50% of participants were physicians or medical trainees. Seventy-five per cent reported knowledge outcomes, 57% reported satisfaction, 8% reported behaviour or patient effects and 6% reported skills.

The best learning results came from eLearning resources with formative assessment that provided detailed feedback rather than only the correct answer. They found adaptive navigation was advantageous, allowing learners to skip particular sections, making the intervention more time efficient and providing autonomy for learners. In blended learning studies with participants who self-selected into Internet or face-to-face discussion groups, participants in Internet groups achieved higher course results. Studies of different forms of interactivity were not conclusive in terms of learning but demonstrated good levels of satisfaction. Similarly, eLearning with online discussions resulted in higher participant satisfaction but were not conclusive in terms of learning. Use of self-assessment questions resulted in higher knowledge outcomes, whether a response was required or not. Asking participants to write summaries was effective if it was a summary of a case but not a summary of didactic material. Spaced education was shown to be effective only where long videos were broken into short clips, in which case learners showed increased knowledge outcomes. Promoting learner participation resulted in improved outcomes, for example, through printed course guides, improved learner support, screen set up to promote participation in online forums and integrating the course into the curriculum.

Overall, the researchers found better learning outcomes were associated with interactivity, practice exercises, feedback and repetition. Higher participant satisfaction resulted from interactivity, online discussion and use of audio.

Lam et al conducted a review of RCTs assessing the effectiveness of electronic continuing education (ECE) in the health professions.[105] They accessed three databases, with studies from 2004 to 2007. Of 15 papers retrieved, six compared ECE with no intervention or placebo. Four of these studies showed a significant advantage of ECE and two showed no difference; two compared ECE to lecture, only one of which showed an advantage; two compared ECE to small group interactive intervention, where the ECE group outperformed others; two compared multicomponent ECE to one based on text, where the multimedia ECE was more effective; and two demonstrated a statistically significant effect on practice patterns. Overall, they found that the positive effects on knowledge persisted for up to 12 months, and effects on practice for up to five months.

8. Comparing eLearning with other forms of teaching

Comparing eLearning with face to face

A large number of studies have compared eLearning with face-to-face interventions. It is difficult to make broad generalisations from these studies because there is such a large variety of ways in which teaching can be conducted, both through face to face and eLearning. Many different variables can also affect learning outcomes and satisfaction, such as adequate needs analysis and piloting before development of learning and teaching curriculum and materials, learner readiness, motivation, time for learning and, specific to eLearning, access to appropriate technology and technology literacy. Limitations in research design may also affect results, such as studies with no pre-test or control.

Most of the eLearning/face-to-face comparison studies in this review have shown that where sound principles of teaching and learning are employed and the medium of instruction is used appropriately, both forms of teaching result in roughly equivalent learning outcomes. Similarly, many studies showed that both forms of teaching and learning result in similar levels of learner satisfaction. For example, Maloney et al compared face to face and a series of integrated eLearning activities – reading, formative quizzes, iterative skills practice with feedback opportunities, online discussion, upload video of skills mastery to be viewed by web-based tutor, and tutor-selected exemplars of student performance.[106] The study found comparable results and satisfaction, although those doing the eLearning were initially apprehensive.

On a broader level, it appears that different health professions and disciplines have compared eLearning and face-to-face teaching specific to their own subject matter and learners. In this regard, Maiburg et al commented that, "Although the value of CBI [computer-based instruction] has been generally established and accepted, we still had to prove the effectiveness of the newly developed CBI on nutrition."[6] (p. 1019S)

Some studies have found slightly different results. Leu et al, for example, found that face-to-face teaching resulted in higher learner satisfaction but participants learnt more through eLearning.[107] On the other hand, when comparing eLearning with face-to-face teaching, Chang et al found the two yielded similar results for some topics but not others; similar results were obtained for topics on knowledge-based case

study, career development and nursing and law, but face-to-face teaching resulted in superior results on teaching communication and teaching and learning.[108] Thus, it appears some topics may require more interaction, either face-to-face or through online discussions to complement self-directed eLearning.

Fordis et al compared online and live continuing medical education.[5] The online intervention could be completed in multiple sessions over two weeks and involved didactic presentations (using video, audio, text only and slides), interactive cases and a single 45-minute live web conference. The participants in the control group attended a single, live, small-group, interactive workshop (lecture with opportunity for question and answers, and cases with facilitated practice). All participants could also email questions to faculty members. Knowledge increase in both groups was similar, both immediate and long term (12 weeks); however, there was a significant increase in the percentage of high-risk patients treated appropriately by participants of the online intervention. Neither group phoned or emailed facilitators, but 85% of the online group did attend the web conference.

Comparing blended learning with face to face

Similarly, only a small number of studies have compared blended learning with face-to-face learning in this continuing health professional education. Sherman et al compared 4.5 hours of interactive critical care pharmacology learning modules, followed by a two-hour discussion session, with the traditional 6.5-hour lecture.[21] Both showed significant increases in knowledge and similar levels of satisfaction. Participants in the blended course enjoyed the facility to self-pace their learning, as well as the flexibility, interaction and repeated access to information. The discussion sessions were considered valuable for clarification and to answer questions. For those in the lecture format, the advantages were the ability to ask questions and interact with the instructor. There were no differences between the groups and no significant differences associated with age, gender, education, nursing experience or computer learning experience.

As noted earlier, other studies demonstrated that blended learning can lead to significant gains in knowledge that is higher to a statistically significant level than participants who experienced face-to-face teaching,[23-26] with increased confidence,[28] satisfaction[29] and attitude, self-efficacy and empathy.[30] Other studies found participants of blended learning felt less burnout than those accessing face-to-face teaching.[27]

Comparing blended learning, eLearning and face to face

Llambi et al compared three interventions: eLearning; face-to-face workshop and blended learning (where participants accessed both formats) with doctors, nurses and others on tobacco cessation. They found a statistical difference between those who did the blended compared with only the eLearning.[31]

Comparing eLearning with no teaching

Roter et al compared two groups of physicians on interviewing skills for genetics education.[99] Only the intervention group accessed eLearning, then both groups participated in a session with simulated patients. The intervention group took more complete family histories and detailed cancer histories, without making more genetics referrals; however, they used less patient-centred interviewing than the control group. Thus, there may be unintended consequences of education programs that need to be considered.

Pelayo et al compared physicians in two groups: one group accessed Moodle with PowerPoint presentations, self-guided questions, websites, images, diagrams, videos, interactive (Intervention); the other group accessed the traditional training of 20 hours, or no training.[53] The intervention group demonstrated high satisfaction and significant differences in knowledge and confidence in symptom management and communication, but not in symptom management in practice. The control group had a decline in knowledge but an increase in symptom management in practice.

Comparing eLearning with eLearning

Only two of the 110 studies in this review offered comparisons of different eLearning interventions. Durkin compared the effectiveness of interactive materials: games, cycles of repetition, text with graphics, animations, links, review questions (intervention) and text only (control).[63] Both groups showed an improvement from the pre- to the post-test, but only the intervention group showed a significant difference in results and higher retention. This demonstrates the benefits of the testing effect,[50,51] as well as interactivity and engagement on learning.

Pape-Koehler et al's research with surgical fellows compared four different teaching and learning interventions:[89]

- Multimedia using simulation on a mannequin and instructions via text, graphics and video

- Practice for two hours on a mannequin

- Multimedia plus one hour of practice

- No training.

The best results were demonstrated by participants taught through the multimedia training, followed by the combination of multimedia and practice.

9. Studies of potential interest to the Prevention Centre

Category	First author	Relevance to the Prevention Centre
Type of eLearning	Butterworth[80]	Use of online mentoring potentially of interest for participants in rural or remote areas.
	Curran[49]	Use of online discussion board to share resources; participation rates reflect interest in and need for resources in particular clinical areas.
	Durkin[63]	Shows testing effect.
	Fitzpatrick[101]	Multidisciplinary participant group: physicians, nurses and students.
	Fordis[5]	Compared eLearning (didactic presentations and single 45-minute, live web conference) or single, small-group, interactive workshop. Shows little email interaction with facilitators but active participation in web conference with fellow participants.
	Harris[24]	Large program for professional group and emphasised multidisciplinary approach.
	Mitchell[95]	Novel use of Second Life and Skype; high acceptance of Second Life.
	Sherman[21]	Blended study group assigned 4.5 hours of interactive modules and a two-hour discussion session; control group attended traditional 6.5-hour lecture with discussion. Both discussion sessions were considered valuable for clarification and to answer questions.
Instructional design	Burke[2]	Exemplary explanation of instructional design.
	Casebeer[4]	Exemplary explanation of instructional design; tailored interactive responses to meet individual needs; based on available evidence at the time of what works in eLearning.
	Gordon[7]	Rewards: require minimum score for certificate/continue to further activity.
	Irving[77]	Found many learners need to re-read text to answer correctly and will do that if the opportunity and expectation is there; emphasises that tests are part of learning.
	Navarrete[36]	Eight one-hour lectures, followed by knowledge test, which was failed by 46.6%. After two workshops, 96.7% passed theoretical and practical tests. Included analysis of patient data to see if there is an increase in the number of patients receiving treatment.
	Maunder[75]	Studied three different time lengths: 111, 158 and 223 hours. Concluded medium-length course is best for outcomes and fewer drop outs.
	Pape-Koehler[89]	Studied four different methods (multimedia, practical, multimedia + practical; nothing). Best results by multimedia (memorisation and repetition), then multimedia + practical.
	Pelayo[53]	Noted hours of input, tutor and administration (p9); 6500 Euros to develop.
	Pullen[109]	Highlight design and pedagogical issues in eLearning (p231): importance of immediate feedback, opportunity to apply new knowledge to clinical practice or question type responses.
	Short[54]	Audio used, not video due to bandwidth issues: adapted to technology available. Outcomes measured over six and 12 months. Course not enough alone to change outcomes for patients: conclude re need for policies, advocacy and more physician and multidisciplinary education.
	Sranacharoenpong[25]	Barriers to translation to practice: heavy workload, lack of time. Use of incentives: participants needed to achieve something to enrol and move to next stage, or to be able to attend face-to-face class.
	Tamler[46]	Course and refresher. Improved clinical outcomes (patient records) but initial intervention scores on post-test were higher than the refresher, showing decay of knowledge over time needs repeated, focused interventions.
	Vaidya[48]	Participants found very relevant but wanted shorter course.

Topic/ subject	Cucciare[32]	Motivational interviewing to promote health behaviours.
	DeBate[9]	Prevention of eating disorders.
	Legare[22]	Shared decision-making about using antibiotics for acute respiratory condition.
	Stacey[79]	Coaching skills over telephone for nurses on patient decision support from call centre.
	Stark[8]	Prevention of childhood obesity using ecological approach: addressing multiple factors in environment that influence and support individual behaviour.
Other con-siderations	Hites[33]	Adapted existing program for tribal (and non-tribal) community health care workers to cater for American Indian learners' preferred approaches.
	Sisson[45]	Program built into medical training curriculum, although still only 30% participation.
	Stone[64]	Noted major costs for development, less for implementation, although time needed for facilitation, workshops, updating, technical problems, administration for CME points.
	Vidal-Pardo[26]	Baseline results used to develop intervention: focus on a few issues with low compliance.

10. Enablers and barriers to making eLearning effective

This rapid review highlights a range of measures that can make eLearning resources effective for learning. We have named these measures 'enablers' and categorised below according to the relevant phase in eLearning design and development in which they occur, which are most commonly in planning and instructional design. Following this are a number of challenges, which we have labelled 'barriers', and ought to be avoided.

ENABLERS

PHASE 1: Planning and instructional design	There is evidence that the best learning outcomes are achieved by those with lower baseline, so that group is where education should be aimed. This implies the need for pretesting of sub-groups (or other methods such as patient data) to identify where the need is greatest.
	Establish baseline knowledge, skills and attitudes and practices before designing an eLearning program. Baseline testing may provide motivation to improve, and successful completion can mean participants are more likely to enrol in another course.
	Maintain the focus on the changes desired, especially if low baseline factors have been identified: the simpler the change, the more likely it will be achieved.
	The effect size is greater for knowledge change if the program includes online discussion and if the program is of adequate duration for the topic under study. While the amount of time spent on a program can indicate the amount of learning, lengthy programs can lead to high drop-outs.
	Pilot all program elements and measurement tools. This avoids unnecessary evaluation activity.
	To bring about practice change, provide participants with tools to use in practice, such as guidelines, protocols (e.g. for interviews or coaching) and references, as well as trouble shooting tips and expert contact details.
	Email enables teachers or course leaders to follow up with and/or send reminders to participants. Reminders to participants can also be made through phone calls.
	Build in incentives and rewards, such as a certificate for completion, achieving a specific result or score before being able to progress to the next section or a more attractive part. Other incentives include progress certificates, CME points and money.

	Provide opportunities for participants to devise their own action plans, which can then form part of the follow-up for practice-change outcome measurement.
	Tailor programs for professional groups, but not necessarily for different levels of seniority in the profession because often the knowledge level of the more senior practitioners is found to be not much better than their juniors.
	Ensure material is context-relevant particularly through use of clinical cases.
	Participants need interactivity and practice exercises, detailed and immediate feedback and repetition; participants like interactivity, online discussion and use of audio.
	An orientation activity is efficient, either through an initial workshop or an initial explanation of the program accompanied by a recording and/or student guide with screen shots.
	Relate the program to other training; for example, make it connected through an introductory session or integrate it into other education programs via a series of modules.
	Project-based learning works well online, as it does in live groups, especially if workable and funded projects are the outcomes.
	Institutional endorsement and support is required, particularly in the form of time and computer access. The credibility of the organisation/s providing the eLearning is also important.
	Some form of assessment or self-assessment is important: it raises awareness and/or knowledge of the topic or area being addressed. It also ensures use of the 'testing effect', which has been demonstrated to improve learning, particularly long-term retention.[51] Spaced education, where learners are repeatedly tested over a period of time, can also aid retention of knowledge.[98]
	Providers should know and communicate with professional groups about the knowledge or practice deficits and ommunicate the need for education.
	Providers should know whether potential participants are ready to change before instituting eLearning (or other) programs.
	An online facilitator/tutor/mentor/expert, who is properly trained for the role and provided with adequate time to enact the role, is important. This person can encourage participants to engage with the program and communicate with others, and can troubleshoot technical problems and answer questions.
	Self-pacing, self-directed programs offer autonomy for the learner: to start/stop, forward/back, repeat, skip, etc.
	Learners will re-read and repeat an activity to get an answer correct if this is the expectation (and reward) and there is opportunity for this.
	Ensure the eLearning program provides for ease of use and navigation, and is designed for the lowest level of technology and Internet access that likely participants will be using.
	Break large amounts of content into manageable chunks or components, as occurs in face-to-face programs.
	Provide links to additional information, websites and resources.
	Participants often like face-to-face contact through blended learning, where possible and appropriate.
PHASE 2: Implementation	With eLearning there is an opportunity to build a professional network or community among participants remotely distributed, which should not be missed.
	The number of participants could be limited to achieve more active interaction, both among participants and with the facilitator. This is particularly relevant given that one of the major advantages of online learning is that the learning becomes available to geographically isolated practitioners.
	In-service activities should be included to ensure participants put new knowledge and skills into practice and emphasise their clinical application. The timing of this application is important: a long time lapse could erode new knowledge.
PHASE 3: Evaluation	The collection of evaluation or satisfaction data and time-used data can be automated, requiring no extra collection effort.

BARRIERS

STAGE 1: Planning/Design	The program is too long for the topic and people drop out.
	The level of difficulty has not been correctly established as appropriate for learners.
	Undertaking and completing learning alone and online requires different (perhaps more) discipline than is required to attend workshops or courses.
	No rewards for progress or even recognition of having completed the program. In contrast, where people are present, either through online discussions, email or blended learning, this may be more likely to be addressed in the form of encouragement and group behaviour.
	Providers want to use online education to change practice but do not design the program to do more than affect users' knowledge of the subject. (This is often similar in face-to-face programs.)
	The cost of online education is mainly in the development, not the implementation or maintenance. This is often not recognised.
	Providers do not look widely to the evidence outside of their own field or profession and thus continue to reinvent and re-evaluate aspects of eLearning that have been well established.
	A lack of interactivity in an eLearning program (eg lecture PowerPoint slides with or without audio or video recording). Similarly, a lack of feedback if users make an incorrect response in an activity.
	A lack of opportunity for role plays and/or observation of participants applying skills in clinical practice.
PHASE 2: Implementation	Internet bandwidth, computer access issues and low computer skills, which often limit the quality of the material that can be provided.
	The program ends abruptly, making it a one-off event.
	A free program does not develop commitment or belonging (compared with a program where registration/fees are required).
	No time or insufficient time is offered in the workplace for the online learning to be undertaken; the 24/7 mentality prevails and burdens staff.
	Institutional barriers to change may not be addressed in online courses unless there is a built-in opportunity for them to be raised. Leadership is required if culture change is the aim.
	Using eLearning developed for one group of health professionals (or a specific level of experience) with another group, including students.
Phase 3: Evaluation	Testing/evaluation requires as much or more learner time as does the learning activity.

11. Benefits and risks of eLearning

Benefits

• Flexibility of place: eLearning is more accessible and less discriminatory, enabling participants in regional and remote areas to access training that may otherwise be difficult or impossible to access. This also reduces the time and travel costs for continuing education of health professionals, who otherwise may not be able to renew their registration.

• Flexibility of time: participants can learn at a time that is convenient for them, whether structured into their work day or after work.

• eLearning ensures standardisation of teaching for participants located across a wide range of institutions and regions; in particular, participants are not affected by specific teachers' interest and ability in the subject matter.

• Participants can choose the pace at which to learn (depending on the eLearning program): when to reinforce and extend learning, undertake practice activities to obtain feedback on learning, access related websites, references and resources, and revise learning over time.

• eLearning can enable automatic assessment, reducing workload for education staff.

• eLearning can enable participants to interact with their peers and teacher.

• Compared with printed course materials, eLearning resources can be easy to update, depending on the complexity of the development program.

Risks

• Participants need self-discipline: this is the downside of flexibility of access and pace.

• Health professionals are often implicitly expected to undertake eLearning outside of work hours or to find time within work hours. This may not be part of workplace agreements and may not be feasible.

• The expectation that change in knowledge will result in change in behaviour, without integrating activities or institutional policies that promote change in behaviour.

• eLearning is often insufficient for some content areas and/or for those needing remediation and practice. The content and participants need to be taken into consideration during planning.

• Although knowledge gains are often comparable between face-to-face and eLearning courses, participants often feel they gain more benefit from face-to-face classes, which also enable networking and socialisation with peers.

• There are few standards about the quality of content, delivery and service in eLearning programs. This variance in quality means it can be difficult for participants and organisations to know which eLearning programs to use.

• The time and cost of development can be high (due to the need for multidisciplinary development teams, including content experts, educationalists, technologists and project officers) and need to be planned for and accepted as necessary.

12. Conclusion

eLearning offers many benefits for professional development in health, most notably flexibility in time and place of learning. It can also:

• Facilitate national training programs, ensuring access and professional contact for learners in rural and remote locations

• Offer the possibility of standardisation of courses and can be relatively easily updated

• Be delivered on its own or in combination with face-to-face teaching as blended learning, and may comprise a number of features, including case-based learning scenarios, discussion boards and video.

Assessing the educational value of eLearning is a challenge because of the heterogeneity of research in this area (few eLearning resources are the same and are thus difficult to compare) and a lack of methodological rigour. Nevertheless, this review has been conducted on a number of quality papers on eLearning for health professional education, and there is evidence that eLearning can lead to significant gains, particularly in knowledge. The use of formative assessment (quizzes) with immediate feedback, meaningful interactivity and repetition have been shown to be enablers of learning. Research into the use of eLearning for change in health practice, attitudes and interpersonal skills is less conclusive.

When planning eLearning resources, we recommend adequate resources (time, expertise and finances) be assigned for development, that the evidence for educational effectiveness of eLearning is considered and that a multidisciplinary team be formed to undertake the range of specialist roles required.

13. Recommendations

Given the objectives of this review, we recommend the following considerations, most of which relate to the design/planning of eLearning:

1. Clarity of purpose is essential: an organisation needs to be clear about the educational rationale for providing eLearning resources instead of, or together, with face-to-face methods.

2. Ensure there is sufficient time and funding for multidisciplinary teams and technology for development. Educational design, content creation, investigating appropriate technology and development are time consuming but need to be undertaken before a resource is implemented; implementation is often less time-consuming and costly – and incremental costs per learner can be lower – than with face-to-face teaching. Actual costs and time depend on the complexity and length of content, technology and use of online tutors.

3. Before designing eLearning resources, a needs assessment should be conducted to establish: a) what health professionals need to learn because perception of relevance influences motivation to learn; and b) the lowest baseline at which to aim because the lowest baseline has been shown to improve the most through eLearning.

4. If a change in practice is required, a change in knowledge is not usually enough. A skills component may need to be integrated, either face-to-face or online through, for example, Second Life, Skype or similar software. Consider whether the institutional culture also needs to change, or whether policies or guidelines need to be updated or implemented so that any educational intervention has the best chance of success.

5. When designing eLearning, integrate approaches that have been proven to be effective for learning, in particular formative assessment (practice activities as self-assessment) with immediate, detailed feedback containing the correct answer and an explanation. Avoid simple delivery of information through PowerPoint slides and videos, and 'interactivity' that does not involve cognitive processing.

6. Learners often prefer to interact with others, either through face-to-face components of blended learning, or online discussions, with mentors/tutors or via webinars. Interaction is important when designing eLearning for health professionals in rural and remote areas, who may find it difficult to attend face-to-face training to maintain registration.

7. Piloting an eLearning resource before broad implementation can highlight modifications that need to be made to components that learners do not understand or do not work. Piloting can alleviate the need for some aspects of time-consuming evaluation, ensuring focus learning outcomes.

8. To maintain participation rates, ensure the eLearning resource is of sufficient length to enable learners to achieve learning outcomes but not too time-consuming or spread over too long a time span. Different forms of motivation can be integrated; for example, attaining a specific level of achievement to proceed to subsequent activities, selection of participant project ideas for funding, CPD points and financial incentives.

9. When designing eLearning for multiple health professions, redevelopment may be needed for different groups to meet different needs and relevance. Also, different groups and different levels of seniority have different access to computers and different expectations of when they undertake training.

10. Following eLearning implementation, provide opportunities for revision of learning at periodic intervals to ensure knowledge retention.

11. Conduct robust evaluation of learning outcomes from eLearning interventions. Assessing only learner satisfaction or confidence does not demonstrate achievement of learning outcomes; neither does self-assessment of learning or intention to change practice.

12. There are principles for design and implementation of eLearning programs available in the literature that we recommend to the Prevention Centre.[2,4,10,11]

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