E-Learning, Distance Learning, Online Learning in the setting of Medical Education: A Review of Current Literature

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Abstract

Electronic learning, as the name implies, is a non-traditional form of teaching where the student is not always physically present in the same time or place as the educator. Today, this largely means using the Internet to provide students with educational materials, while attempting to deliver a more personal experience that is more suited to the student's schedule and learning style. From the institution's perspective, e-learning has allowed for increased access and capacity, diversified the student population, and thereby increased market share in the educational market. With the inherent importance of a high quality medical education, both undergraduate and graduate, many have advocated against e-learning citing lack of appropriate technology, discrepancy in instructional methodology, and lack of consistency in paradigmatic institutionalization of e-learning. The focus of this review is to assess such attitudes toward e-learning, and the efficacy and benefits of e-learning in anesthesiology resident education at present.

Keywords: E-learning; Communication and information technology (C&IT)

Introduction

As technology has advanced, changed, and at times challenged traditional medical care, it has also found its way into the medical classroom. Communication and information technology (C&IT) is enabling students and professionals to learn in new and personalized ways that were not previously available. C&IT has been implemented in ways to help medical students and medical professionals at all stages of their career learn, stay current with the changes in clinical care, and to address professional's needs to address licensure and board certification maintenance.

Commonly referred to as electronic learning, or e-learning, the evolution of traditional learning in which students attend a lecturer-led class has gradually changed to incorporate learning outside of the classroom and on a computer or other electronic device (e.g. mobile device). E-learning has also been referred as Web-based learning, online learning, distance learning, distributed learning, Internet-based learning, and computer-assisted instruction [1]. As for traditional learning, it is defined as having a lecturer who is the center of the learning process, where students learn the subject and discover additional resources for further study, and are further able to test their knowledge with the teacher and other students [2]. The teacher is also able to stay in constant communication with the class and can modify the lecture content to address student needs and stay current with new information.

Given the definition of e-learning is a work in-progress due to constantly changing technology and the difficulty of incorporating this technology with traditional education, it is difficult to find a common definition of e-learning that encompasses all of its possible uses of C&IT [2]. One peer review paper defined e-learning as the use of 'Internet technologies to deliver a broad array of approaches that enhance learner's knowledge and performance' [1]. Additionally Sajeva found the most common definition of e-learning to be 'any usage of computers and networks in education, as online administration, online course information and online communication' [2].

Despite the lack of a formal definition, we have chosen to define e-learning as [1]: the ability to separate the teacher and learner throughout the length of the learning process (considered as conventional face-to-face education) [2]; the influence of an educational organization both in the planning and preparation of learning materials and in the provision of student support services (which is distinct from private study and teach-yourself programs) [3]; the use of technical media including print, audio, video, or computer to unite teacher and learner to carry the content of the course [4]; the provision of two-way communication so that the student may benefit from or even initiate dialogue (which distinguishes it from other uses of technology in education) [5]; and the quasi-permanent absence of the learning group throughout the length of the learning process so that people are more often taught as individuals rather than in groups with the possibility of occasional meetings, either face-to-face or by electronic means, for both didactic and socialization purposes [1]. Educational programs that fit this definition include but are not limited to computerized physiology simulations, clinical case simulations, virtual patient reality, indexing resources as well as recorded lectures [3].

- E-learning, synonymous with different terms mentioned above in this review, is a form of education characterized by: the ability to separate the teacher and learner throughout the length of the learning process (conventional face-to-face education);

- the influence of an educational organization both in the planning and preparation of learning materials and in the provision of student support services (which is distinct from private study and teach-yourself programs);

- the use of technical media including print, audio, video, or computer to unite teacher and learner to carry the content of the course;

- the provision of two-way communication so that the student may benefit from or even initiate dialogue (which distinguishes it from other uses of technology in education);

- And the quasi-permanent absence of the learning group throughout the length of the learning process so that people are usually taught more often as individuals rather than in groups with the possibility of occasional meetings, either face-to-face or by electronic means, for both didactic and socialization purposes [4].

With the differences in anesthesiology resident education compared to other areas such as college education, we are highlighting the use of electronic resources at one's convenience to enhance face-to-face instruction for our definition of e-learning. One benefit of promoting e-learning was the hope of providing asynchronous access to educational programs, as well as a more tailored learning experience, where the instructional strategy can better fit the time, place, and learning style of the people being educated [5]. Education for anesthesiology residents likely benefits from asynchronous learning due to growing time constraints in the operating room, and thereby placing more emphasis on online information to facilitate learning. Given the considerable fraction of time spent with faculty, we believe asynchronous learning made possible with e-learning and the valuable limited time for intra-operative and classroom teaching to be fundamental reasons for advocating e-learning in anesthesiology resident education.

Distance Learning has been implemented in traditional CME programs as well as in the education of physicians in rural settings. This is more specifically the use of C&IT, such as webcams, to allow physicians to communicate, access resources, and refers cases to other specialized physicians in more central institutions or to connect directly with patients remotely. In comparison to distance learning, computer-assisted instruction utilizes computerized multimedia for student and physician instruction [6] at the time of a live educational session as a complement to traditional lecture.

Although e-learning sought to address the deficiencies and challenges of traditional forms of learning, its own paradigmatic shift brought with it new challenges. Some have criticized the long-term retention of instruction provided by C&IT as compared to traditional lectures and instructional strategies. Although e-learning may have the deficit of physical contact depending on the educational setting, it has been shown to be efficacious. In this article we will review some work in this field that indicates advantage over traditional instruction as well as work in this field addressing the aforementioned deficits.

Primary articles were located on PubMed (http://www.ncbi.nlm.nih.gov/pubmed). Search criteria included: anesthesiology, electronic learning, residents, and e-learning, with additional articles pulled from references cited in those papers as well as related articles on PubMed.

What is the Relevance of E-Learning with Anesthesiology Resident Education?

Recent changes made by the ACGME in 2003 and 2011 in regards to resident duty hours may have had a negative impact on anesthesiology resident education [7,8]. By decreasing the maximum duty hours per week, anesthesiology residents may find themselves with less time for clinical teaching intra-operatively and in the classroom. In addition, greater production pressures in the operating rooms often result in running more rooms with fewer anesthesiologists. As a result, academic anesthesiologists often find themselves overseeing more rooms simultaneously which decrease the amount of time for them to teach residents and may also decrease enthusiasm and thoroughness of teaching [5].

In addition, it is common for anesthesiology residents to rotate at different hospitals or clinics, making it difficult for everyone to be at the same place and time for didactics [9]. According to Nast et al. [10] resident attendance at didactics have historically been fairly low and the authors tried to determine if recorded online lectures would be of benefit for the residents. The average number of residents who attended live didactic lectures was assessed and half of the lectures were recorded for online use. Sixty-six percent of residents used these lectures and 45% welcomed the opportunity to use online recorded lectures. The average number of resident attendants did not change, but however, it was already low at baseline (18%). The decreased attendance may be partly due to the availability of the residents and the location of their rotation sites, but the current generation group of millennial generation of residents expects a greater integration of technology in their education, which may have explained the favorable response to recorded online lectures [5].

Hence, the relevance of e-learning in anesthesiology resident education may be due to its strength in convenience and accessibility of content. Given the new duty hour regulations that impinge on the available time for intra-operative teaching or didactic lectures, we feel the evolution of resident education favors the integration of e-learning. As a result of changes in resident duty hours, Kurup and Hersey [9] have proposed a "Flipped Classroom" model in hopes of increasing the quality of resident education in the face of changing anesthesia education. This model aims at delivering basic anesthesia education to be accomplished outside of the operating room at the resident's free time outside of the hospital. The more complex and advanced concepts are taught face-to-face in the operating room or in the classroom. Due to the decreased duty hours, the authors felt that basic information can be acquired during the resident's free time so that their limited time in the operating room can be spent learning about more difficult concepts instead of basic information. Residents would be provided with information that requires lower cognitive skills either online or in-print to learn prior to engaging with faculty. Knowing that residents have prepared for in-person teaching, the faculty would find themselves with more time to engage residents with active learning exercises and teach more advanced concepts instead of needing to set time aside for explaining basic information [9].

Is Distance Learning more Effective than Traditional Instruction?

Does electronic learning improve medical practice? Or more importantly, is electronic learning superior to traditional classroom instruction at improving medical practice? These related questions are challenging, and it may not be possible to answer completely, but it may be evaluated in its component parts [11]. Medical education can be conceptualized as residing in 3 domains as described by Bloom: cognitive, affective, and psychomotor. The cognitive domain refers to the knowledge necessary to provide medical care; for instance, knowledge of disease processes, medications, physiology, and care delivery. The affective domain refers to the beliefs, attitudes and values involved in the delivery of health care. And finally the psychomotor domain refers to the procedures and techniques involved in the delivery of health care. This includes diagnostic and therapeutic procedures and surgeries.

Most comparative research between distance learning and classroom instruction is focused on the cognitive domain. Flores et al. [12] analyzed distance education in diarrhea case management in several South American countries, in order to determine if such an educational supplement would improve patient care. The program, instituted by Ministry of Health, the Pan American Health Organization (PAHO) and Institute of Nutrition for Central America and Panama (INCAP), sought to improve diarrheal disease case management, a common diagnosis in that part of the world.

Participants were doctors and nurses who participated in a 10-month mail in course, which included tutoring and evaluations. 1381 doctors and nurses completed the course, with a completion rate of 89%, throughout Guatemala, Honduras, El Salvador, and Nicaragua, with 66 completing the course in Guatemala where the efficacy of the course was analyzed. To evaluate performance, participants were observed by trained physicians termed INCAP observers for a pre and post survey, and all participants were given a written knowledge test at the beginning and conclusion of the course.

The study found that scores on the pre-course knowledge test for both control and program groups were roughly equivalent, with a 40.1% correct in the program group and 38.9% in the control. After the course, analysis showed assessment and classification of cases improved significantly between control and program groups, although total correct assessments by the program group only reached about 60% correct. Authors concluded that the course was able to improve diarrhea assessment, although they were not able to conclude whether the effect was due to the course itself, the tutoring, or any other specific variable within the course. Overall authors viewed this low-tech and cost-effective distance learning as a viable and productive substitute for on-site in-service training, which is not often available in remote regions of these countries.

Kurup and Hersey [9] further supported e-learning by summarizing a meta-analysis with 1000 studies with several key findings: students that took all or part of their course online did better than traditional face-to-face learning and students who took both face-to-face learning and the online course did better than either alone. The authors further concluded that "online material works best when it addresses lower order cognitive skills".

Furthermore, when comparing e-learning with traditional learning, the strengths of e-learning may become apparent; but more importantly, combining the strengths of each form of teaching helps us see the benefits of incorporating e-learning into resident education. Having material online for students to learn does not constitute teaching until it is reviewed in person and furthered with active learning exercises and teaching of complex and more advanced information. Thus, the face-to-face component of the model, which can be argued to be a component of traditional learning, is key to fostering understanding of the subject [9]. The results from various papers have illustrated several distinct advantages that make it a valuable tool for medical education. Several areas that are addressed from these studies include: access to education, cognitive engagement, permanence, and addressing learner needs. Access to education focuses on proximity, since not everyone can be in the same place at the same time, especially in the medical world. Proximity also includes prohibitive costs that can be circumvented by avoiding travel and room/board costs associated with remote educational opportunities. Cognitive engagement relates to learning most efficiently when people are cognitively at the point when they can accept new information and retain it. Permanence illustrates the advantage of less teacher intensity when it comes to translating the content. This frees the instructor to focus on what the learner is acquiring to reinforce concepts and build upon that information to maximize the efficiency of learning. Lastly, addressing learner needs illustrates how the millennial generation is accustomed to and expects to be doing much of their learning on the computer.

Does Access to E-Learning enhance Cost and Time Efficacy?

Traditionally, didactic sessions are scheduled in blocks of time that attempt to balance the student attention span, and the average amount of time it typically takes to deliver a given topic.. While dedicated blocks of time may give the perception that attending class helps to obtain all the knowledge that is presented within that time period, e-learning provides a

unique approach that condenses and concisely records topics to maximize learning for the user. While condensing the material can also be done for traditional didactics, the issue e-learning addresses the fear of lecturers under- or over-teaching a topic in a classroom. Theoretically speaking, overseeing the content to be delivered via a carefully and thoughtfully recorded lecture is easier, more standardized, and likely more cost effective than orienting a group of constantly changing academic anesthesiologists over the years. Additionally, the advantage of e-learning is the ability for the user to access resources online at his or her own convenience, and as much as needed in order to learn effectively. Hence, this allows for access to the material for those who cannot be present at the same time and place where lectures traditionally take place such as those on vacation, post-call, and off-site. In a study by Munch-Harrach et al. [13], audio podcasts were produced in a cost-efficient timely manner by a student, teacher, clinician, and technical assistant on core topics in biochemistry. Each podcast contained scripted presentations from each person and was limited to 20 minutes. Results of the study showed that they were used extensively by medical students and evaluated very positively by non-student listeners. Even though the podcasts were created specifically for medical students to better handle intensive topics, the study reported that the podcasts were downloaded by the public as well. Interestingly, the positive results from non-student listeners support the unique advantage of e-learning. The time spent carefully scripting the content is more than simply to deliver the topic as quickly as possible, but to maximize the understanding of the material and the ease in which it is learned or internalized in a short period of time.

Several major differences between these podcasts and traditional didactic sessions are the brevity of the recordings and the scripted presentation of each podcast. Unlike didactic presentations where extraneous information can be presented, these podcasts were carefully worded to maximize delivery of the information and to limit time burden. Generally speaking, steps taken over the years to limit didactics to a shorter duration with greater emphasis in delivering high yield information have most likely occurred in response to student feedback across institutions. However, to emphasize an earlier point, e-learning aims to achieve the same goal but has an added advantage of increased accessibility anytime and anywhere at the resident's convenience. Unlike traditional classroom-based sessions, e-learning provides a unique form of education by enhancing cost-efficiency and delivery of course materials, which are especially valuable to students who cannot be present at any given place and time.

Enhanced learning delivery without compromising knowledge

Enhanced learning delivery [4] includes:

- increased accessibility to information,
- ease in updating content,
- personalized instruction,
- ease of distribution,
- standardization of content, and
- Accountability.

With e-learning, access to instructional materials is more efficient as it can be organized in user-friendly fashion with information arranged according to topics, the lecturer's preferences, difficulty, and even format (e.g. video, Podcast, and electronic textbook). Increased accessibility can also enable students, such as those with full time jobs or family obligations, to take classes remotely while securing or maintaining employment or housing at a distant location. In terms of anesthesiology residents, this would apply to those rotating off-site, on vacation, sick-leave and post-call. Learners juggling busy schedules with education can better adapt

to e-learning due to the flexibility of time and location. Additionally, instructors can update course content in real time ensuring that students have access to most current content. Improved learning delivery can be achieved without comprising knowledge gained.

In one study, 74 occupational physicians were randomly chosen from a mental health meeting. They were split into four groups where two groups received a lecture-based teaching while the other two groups received individual e-learning. The groups did not differ much in baseline characteristics except the e-learning group had, on average, more years of experience. A test was administered to each group before and after the teaching. Two versions of the test, X and Y with each containing 30 questions, were generated from a pool of 66 questions. Within the e-learning group, one group had test X before the teaching and Y after the teaching. The other group had test Y before the teaching and X after the teaching. The same pattern was applied to the two groups in the lecture-based teaching. The post-test results did not show significant difference between the two teaching approaches (lecture based: 63.8 & 64.9, e-learning: 64.9 & 65.3). All showed improved knowledge in the participants. The study therefore concluded that e-learning is just as effective in enhancing knowledge as lecture based teaching without compromising knowledge. With this in mind, e-learning has been shown to be a good approach for continuing medical education (CME) while allowing physicians to learn at their own convenient place and time, save travel cost, and have access to standardized lectures [8].

Will Customizing E-Learning to Each Learning Style enhance Cognitive Engagement?

One possible advantage of electronic learning is the ability to tailor the program to individual learning styles in the hopes of improving participant learning and increasing class efficacy. Proponents of e-learning suggest that it will increase the effectiveness of learning while others question the amount of time and resources needed to make it a valuable method of instruction. One paper [9] sought to determine whether individualization of web-based learning (WBL), synonymous with e-learning, would facilitate increasing learning outcomes in a WBL course on complementary and alternative medicine. Two studies were conducted on a total of 89 medical students and residents from the University of Illinois at Chicago School of Medicine and the Mayo Medical School and residents in the Mayo-Rochester internal medicine and family medicine residency programs.

The first study addressed the types of questions used in WBL courses; citing Kolb's learning model of active versus reflective learners, in which active learners prefer application and reflective learners prefer information internalization. Researchers hypothesized that these learning styles could be reflected and utilized in the types of questions used in WBL. Active learners were therefore to learn best if given multiple choice questions, and reflective learners with reflective questions. In addition, active learners would be provided with immediate feedback following their questions, while reflective learners were not [9].

The second study addressed the format of WBL. The strategy of how the information is presented is thought to be important to improving learning outcomes. Utilizing Riding's classification [10] of cognitive styles as holistic and analytic, holist learners were provided with a review activity to compile and summarize information, while analytics were not. Both studies randomized participants to match or mismatch their learning style. These studies utilized two post-tests to determine knowledge, one immediately following the conclusion of the course, and a second three months after completing the course. An end of the course survey was also utilized in each study to determine course satisfaction as another primary outcome. Results indicated no significant difference in either post-test evaluation between matched and mismatched learners.

In addition, evaluation of the course did not differ significantly between these two groups. Similarly, learners using active questions did not score significantly different than those who were asked reflective questions. The only significant difference in the first study was learners using active questions rated them as more effective. Analysis of the second study found no significant difference in learning outcomes between the holist and analytic groups.

Overall, the studies concluded that the lack of a cognitive learning style (CLS) effect on the learning outcomes may be due to the course's effectiveness and design. However, the evidence in these two studies still concludes that CLS adaptations of WBL do not significantly improve learning outcomes. Hence, a possible concern about the high degree of customization needed to tailor to each type of learning style for proper cognitive engagement is not likely to be relevant to the success of e-learning. Thus, e-learning may not need to be developed to as high of a degree as some may have originally believed, and combined with its already-proven benefits, may be beneficial to those who may not have the time to be present in the classroom.

Does E-Learning as an Adjunct improve Collaboration and Interaction among Learners?

Electronic learning can be more stimulating and encourage more critical reasoning than a traditional large instructor-led class because it allows the kind of interaction that takes place in small group settings. It can allow students who are intimidated by a large class and fast pace instructor led teaching to participate during e-learning sessions. They are able to retry because e-learning can eliminate the embarrassment of failing in front of a group. Additionally, these situations tend to be more applicable in different learning environments such as group discussions that occur online. Stimulating collaboration and interaction among students better suits a non-resident education setting such as a college course where students can learn about the background of a topic via e-learning (e.g. controversial topics, debates, ethical dilemmas) and come together to discuss their thoughts to facilitate even more learning. In terms of anesthesiology education, residents typically attend lectures with most or all of the residents in their year as opposed to small didactic sessions. However, the enhanced collaboration and interaction from e-learning is likely to be reflected in the more advanced areas of anesthesiology.

With the goal of greatly reducing the time needed to learn basic techniques by accessing online resources from home, e-learning as a tool could place residents further ahead in their education by spending their comparatively limited time on discussing the more advanced areas of anesthesiology. Part of the curricula in many training programs involves a simulation component in which residents learn to work together to manage various case scenarios. We believe one benefit of e-learning is to bring anesthesiology residents up to speed for basic management scenarios and to be better prepared to master complicated situations, especially for simulations that require group collaboration. E-learning in this instance would conceivably be favored for those who cannot be present for didactics and ideally creates more time for residents to learn more advanced management. In essence, e-learning can teach the concept and technique, but the greater advantage is drastically shortening the time it takes to reach educational stepping stones to allow residents to focus on the more difficult topics of anesthesiology with their limited time.

Does Electronic Learning enhance Internalization?

As defined earlier, permanence illustrates the advantage of making content available at all times rather than relying on the time and generosity of the teacher. Comparatively, the instructor is then freed up to focus on what the learner is acquiring and how they are structuring the knowledge in their knowledge bases (consistent with the constructivist theory)to

maximize the efficiency of their learning. Similarly, in any educational setting, learners may have one or multiple preferences for internalizing information. E-learning is another modality to fulfill those preferences when the teacher understands what material is important, by providing that information in a more preferred form, and by allowing the educational materials to be internalized in a more efficient manner.

In a study by Matava et al. [14], Canadian anesthesia residents were surveyed on podcast use and content preferences. The study enrolled 443 of 659 residents and surveyed their patterns of podcast use, preferred format, preferred content, and perceived increase in knowledge. The study found no significant difference for preference between audio, video, or slide podcast formats. However, there was a difference for physiology (88%) and pharmacology (87%) as the most requested topics. These topics are traditionally taught as didactic sessions but appeared to be preferred as podcasts as they are fundamental pieces in the field and are readily available for future revisions. For procedural, clinical, and professional topics, the study found that regional anesthesia (84%), intensive care (79%), and crisis resource management (89%) were the most requested respectively. Additionally, the study concluded a preference for presentations between 5-15 minutes as opposed to less than 5 minutes and more than 15 minutes. Between different years of training, residents appeared to have defined preferences for content, as more senior residents requested podcasts on pediatric anesthesia [10].

Being able to tailor the educational material or program to address the preferences of the learner and by making those resources available will maximize the potential of e-learning. By understanding the preferences for certain topics and the duration on recorded media, e-learning material could be created to better accommodate residents who learn more efficiently in this manner, and hence, hypothetically enhance internalization. This would presumptively promote more focus on reinforcing basic knowledge and building upon that information with academic faculty, instead of dedicating limited time to basic material.

Does Distance Learning meet Learning Preferences and Enhance Internalization?

In the previous two paragraphs, the paper illustrated the benefits of understanding the particular topics that were of most interest to the anesthesia residents. With this information, e-learning serves as an advantageous method of instruction as it serves as a set of resources to match those interests. With the added benefit that an instructor does not need to be present to deliver the basic material, learning the mentioned subjects would be more efficient for anyone who does not have the time to be present for a didactic session. Additionally, the presence of desired resources likely makes internalization more efficient as it can be accessed at any time and can be carefully scripted and delivered to facilitate internalization.

A method of standardized skill acquisition

Traditionally, skill acquisition (psychomotor domain) is obtained in person and at a defined facility. E-learning provides a method to obtain that knowledge at one's own time and schedule without compromising the quality of education, but instead, by complementing it. Thus, E-learning enhances learning in a way that is unique from the traditional method of skill acquisition and meets the learner's preference of knowledge acquisition by serving as an alternate method of learning. In a study by Warnecke and Pearson [15], medical student perceptions on the usefulness and effectiveness of an E-learning package designed to deliver consultation skills was evaluated at the University of Tasmania. The package contained audio-video recordings outlining the content of the consulting skills program, a video of a third year student consulting with a patient, an experienced physician consulting a patient, and feedback

content after each encounter. 67 out of 108 participants provided their input on the program. 60 (92.3%) of these participants rated the program as enjoyable, 59 (90.8%) of them perceived an increase in their knowledge about consults, and overall 49 (75.4%) reported an improved perception of their performance on consultation skills. As a resource, students perceived it to be effective in increasing their performance.

Skill acquisition in anesthesiology has a considerable visual component that can be complemented with e-learning. For many new anesthesiology residents, a myriad of techniques are partly learned and refined by observation. For instance, intubation may be understood conceptually without much difficulty, but minute details including tongue displacement and correct maneuvering into the 'sniffing position' may require troubleshooting with more experienced anesthesiologists. Not uncommonly, a resident who finds his or herself at a road block may take longer to learn the technique. After observing and gathering advice may a resident finally discover the fundamental error to refining and mastering the skill. As an advantage of e-learning, providing as many suggestions, approaches, and advice as possible into an online resource such as a recorded video aims to reduce the time necessary for troubleshooting.

E-learning in terms of skills acquisition in this manner is unique from classroom-based sessions because it provides unique resources that are difficult or impossible to find in the classroom. Being able to view others as they would interact with patients at one's own time, and as many times as needed, provides additional insight on individual skills and performance that one cannot easily find in the classroom. In terms of anesthesiology resident education, having the option of observing procedures as often as needed for troubleshooting reasons or preparing for an upcoming rotation would comparatively increase the efficiency of learning given time constraints.

What are the Challenges to Effectively Deliver Distance Learning?

As with any new modality or media, there are always challenges that arise and limit its effectiveness. Among such difficulties are the lack of physical instruction, lack of peer review, need for quality content to match the needs of the target group, and overall efficacy and retention.

Lack of physical instruction

Physical instruction has always been thought of as pivotal in education. Butterworth et al. [16] designed a study to determine if mentors improve learning outcomes in distance learning continuing medical education (CME) for both rural and urban physicians in Nepal. The stratified randomized control trial involved four modules which 26 of 64 enrolled physicians completed in a six month period. Participants were randomly assigned to either receive a mentor or be assigned to the control group. The group receiving mentoring had an equal number of urban and rural physicians, and in addition, there were no significant demographic differences between the mentored and non-mentored groups. Mentors were to contact their mentees once a month. Participants were evaluated on each module and after 6 months took a questionnaire on their mentoring experiences. Analysis of both groups computed an odds ratio suggesting mentored physicians were three times more likely to complete their modules, and also suggested that mentoring, rural practice, and younger age were associated with completion of the post-CME reflection; however, these conclusions were not statistically significant, possibly due to the small sample size and the low completion rate. Authors concluded that mentored doctors appear to be more likely to complete their CME, however, further research was suggested into how to improve the quality of the mentoring relationship in order to more effectively impact learning outcomes.

Even though e-learning can lack a physical component that is made up through online correspondence, anesthesiology resident education has a unique perspective on this aspect. Given the educational structure of the specialty, residents have always experienced a degree of physical absence. As with most if not all specialties, self-study prior to clinical exposure and teaching is not new to medicine. Residents have always dedicated part of their time to learning in their own time prior to didactics or clinical teaching. Hence, the lack of physical instruction may be a disadvantage for e-learning, but the unique situation for anesthesiology education is independent of this issue. Highlighted earlier in this manuscript, components of e-learning include learning from provided online resources with correspondence with an instructor. This method of learning might imply that the learner never sees the instructor in person and can learn at home with an interaction that occurs online. However, the correspondence seen in anesthesiology resident education is most often through face-to-face instruction.

Lack of peer review

The above mentioned studies all indicate a need for further assessment of certain parameters within the study, as would be found in any manuscript, however, many of these studies construct unique surveys and follow-up evaluations in order to assess the success of the course or satisfaction of the participants within said course. As such, consistent review of studies on e-learning is problematic. An issue that has been traditionally associated with e-learning is the lack of formal peer review [17,18] that is often used to evaluate and scrutinize traditional manuscripts. Although several sets of criteria for evaluating e-learning currently exist [19, 20] a consistent model for peer review of e-learning is not commonplace within the literature, which may be due to having to review and consider the unique differences of pedagogy or learning paradigm, format, usability, navigation, interactivity, and delivery [1].

Ruiz et al. [26] go on to further describe four methods to further improve peer review of e-learning. The first of these approaches is to train peer reviewers in evaluating e-learning by educating reviewers on the unique dynamics of e-learning such as virtual patient software, electronic case simulations, and distance learning. Further, suggestions to establish evidence of scholarship included multidisciplinary peer review, development of specific guidelines for review, and offering incentives for dialogue concerning e-learning evaluation.

Addressing learner needs

As with any media for instructional purposes, challenges often arise due to the needs of the target group. In any educational setting, members may have one or multiple preferences for learning. E-learning is another modality to accomplish that task but creates its own challenges. Mentioned previously from a study by Matava et al. [14], certain recording topics were preferred by Canadian anesthesiology residents as well as the duration of the recording. Not surprisingly, implementing any new curriculum or online resource will require time and refinement. Discovering the needs and preferences of a particular student body is a challenge not unique to e-learning. Additionally, online resources for anesthesiology residents will likely cover basic and advanced information with the goal of achieving a thorough understanding of the material. This understanding may further be developed with additional online resources as well as didactics and intraoperative teaching. As mentioned earlier, the goal with the changing landscape of resident education should be maximizing the efficiency of in-person learning due to the comparatively decreased available teaching time. While this may take time and effort to implement, an argument in favor of e-learning may state, like any new system or modality, the effort to match the needs of any group with e-learning is no different than any preexisting educational method, and will improve with time and refinement.

Disadvantages pertaining to specific participants

For students, the main disadvantages include lack of direct contact with professors; for professors, the loss of the dynamics of the class and its immediate feedback; for the institution, difficulty in creating the course and designing one effectively in the midst of mixed reviews in the literature; and lastly for society, especially when pertaining to distance learning, the possibility of cultural differences not being accounted for when the course is adopted from a different country.

What are the Successes of E-Learning?

Despite the concerns and disadvantages mentioned above, e-learning courses and modules have proven successful in several studies, for both physicians and medical students. A prospective controlled study on e-learning courses in epilepsy found a significant improvement in knowledge about the genetics of epilepsy in the e-learning group, while there was no significant improvement in the control group. Wehrs et al. [21] also found no significant difference between groups consisting of 20 physicians prior to the 8 month e-learning CME course; although there were significant differences in post-course assessments and evaluations, where the majority of physicians in the e-learning group additionally rated the course as excellent or very good.

Many other such examples of successful e-learning courses exist. However, few are purpose built rather than subject built; in other words, few e-learning courses are created with the intention of addressing certain topics that students noted to be difficult rather than providing courses designed to cover all areas of a given subject. Morgulis et al. [22] constructed a module on leukemia for medical students based on student feedback as to which subjects in pathology was perceived as the most conceptually difficult. A needs analysis survey was taken for senior medical students at the University of New South Wales; in pathology, the most conceptually difficult subjects, as identified by students, were glomerulonephritis, lymphoma, and leukemia. A previously conducted study had found an e-learning on glomerulonephritis and lymphoma to be effective when compared to traditional education [23]. This course on leukemia was constructed similarly to the previous courses. Learning objectives were followed by two main sections, concepts and causes followed by case studies, such that definition, epidemiology and risk factors, clinical features, diagnosis, and staging and prognostic factors were covered for ALL, AML, CLL, and CML. Immediate feedback and evaluation was provided as well as digital videos in the module. 45 students participated in the 2 week study, and all were matched for academic ability according to weighted average mark and gender. The control group was provided with Robbins and the URL for the American Society of Hematology Teaching Cases. Both groups were given a pre and post-test as well as a questionnaire. No significant difference was found between in the mean weighted average mark or in the mean percentage on the pre-test. The study group did, however, score significantly higher on the post test (Study: 80 ± 3; Control 66 ± 3) ($t(42)=-3.591$, $P<0.0001$). It was also found that neither academic ability nor time spent studying were predictive of post-test scores.

Dichotomous Review of e-Learning

This new modality of instruction can improve knowledge outcomes, increase access to education, enable access to foreign educational resources, comparatively reduce the cost of education, increase the capacities of institutions to educate more students, and adapt the modality of the education to the specific needs of their student population [24]. On the other hand, e-learning can have faulty or inflexible technical infrastructure, lack integration with the current curriculum or needs of the learner, in addition to all the aforementioned disadvantages. The prevailing question, therefore, is should e-learning be incorporated into medical education?

A metanalysis conducted by Cook et al. [25] found that out of 126 studies surveyed, 124 reported that e-learning groups had improved learning outcomes over non-intervention control groups. The two remaining studies, it was concluded, did not show any significant benefit to e-learning as they were already added to a very intensive curriculum. Overall, all studies which measured either knowledge or skill or behavior outcomes due to e-learning were calculated to have an average effect size greater than 0.8, or an improvement of roughly 10% on any standardized exam, indicating that e-learning was certainly better than no educational intervention. When comparing e-learning to traditional instruction, using an analysis of 76 studies, it was found that there was still a statistically significant outcome improvement amongst the e-learning group, although the effect size was much smaller at 0.12, or an improvement of roughly 1%. It was noted that this outcome was also due to the large heterogeneity in the literature concerning e-learning efficacy.

Summary

Although there exists a lack of a consistent peer review model and a singular set of criteria for study evaluation, three aspects of e-learning have been consistently explored and perhaps provide the most important insight into the current uses and usefulness of e-learning. The meta-analysis by Ruiz et al. [26] found the three most commonly explored factors in studies on e-learning to be product utility, cost-effectiveness, and learner satisfaction.

Product utility, or the usefulness of e-learning, is a parameter often explored in the literature. Although most of the analysis done on e-learning utility has been conducted outside the field of medicine, the majority of studies which have been conducted within the field of healthcare have found significant gain in knowledge among participants [27]. Cost-effectiveness of e-learning has been well documented outside of the medical field, however, one study within the field of medical education found e-learning to be of greater cost than producing materials for traditional lecture based learning [27]. Lastly, learner satisfaction generally seemed to increase with e-learning as compared to more traditional forms of education, although participants largely saw e-learning as only a supplemental tool rather than a replacement [27].

Overall, e-learning has been shown to be an effective educational complement in many scenarios. It may be important to note, however, that the review of literature on e-learning is not all glowingly positive. E-learning can enable teaching to be conducted in rural areas, and can also be used to reinforce materials gained in traditional lecture or in CME. Challenges still do exist with e-learning. Principal among them are the need for more effective evaluation of learning outcomes when using e-learning. Standardizing a method of evaluation, however, is also difficult as each scenario in which e-learning is utilized is variable. Just the needs that initiated its use are variable. Perhaps the most important conclusion to be drawn from this is that the greatest strength of e-learning in medicine is also its greatest flaw; the flexibility of e-learning to address unique educational needs in unique situations makes it useful, and as seen in some studies is significantly efficacious, however, this also makes generalized analysis of e-learning outcomes difficult, thereby providing heterogeneity of results in the literature.

Perhaps the next step in understanding the potential benefits of e-learning is to treat it on the same level as standard models of education rather than to use for unique educational needs. With the growing prevalence of online resources for medical students and residents, in which some institutions may already be providing the option of replacing in-class instruction for their students, evaluating the role of e-learning as a primary source for educational purposes may be feasible in the near future. Currently, not enough evidence exists to fully support e-learning as a primary educational resource at a medical institution. Additional studies on its efficacy for medical students and doctors are necessary before its use in medical institutions can be properly supported, as analysis of generalized e-learning outcomes is difficult to apply in these settings.

However, we also know that e-learning has been demonstrated in several scenarios, although many of them unique, to be efficacious. Therefore, it is certainly not a medium to be ignored, but as Cook explains, one to be studied and evaluated for "when" and "how" it should be utilized, and not "if" it should be utilized [28]. We therefore suggest that further research in this field be conducted on how and when e-learning should be utilized, as it is already a prevalent form of education, and one that ought to be used more efficaciously in each unique scenario to which it is applied.

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