INNOVATIONS IN EDUCATION AND CLINICAL PRACTICE

The Computer-based Lecture

Marcia M. Wofford, MD, Anderson W. Spickard III, MD, James L. Wofford, MD, MS

Advancing computer technology, cost-containment pressures, and desire to make innovative improvements in medical education argue for moving learning resources to the computer. A reasonable target for such a strategy is the traditional clinical lecture. The purpose of the lecture, the advantages and disadvantages of "live" versus computer-based lectures, and the technical options in computerizing the lecture deserve attention in developing a cost-effective, complementary learning strategy that preserves the teacher-learner relationship. Based on a literature review of the traditional clinical lecture, we build on the strengths of the lecture format and discuss strategies for converting the lecture to a computer-based learning presentation.

KEY WORDS: computer-assisted instruction; medical education; clinical clerkship.

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The clinical lecture is a responsibility of many clinician-educators. The efficiency of presenting information by one person (the lecturer) to many persons (the audience) is undeniable. However, cost-containment pressures and anticipated reduction in funding for medical education are forcing clinician-educators to seek even more efficient educational strategies.¹⁻⁴ With a diminishing amount of time designated to lecture preparation, the quality of the clinical lecture becomes "at risk."

The advent of the multimedia computer allows presentation of teaching materials in a manner that is both entertaining and informative. Continuing innovation in software and hardware has made computer-based tools more developer- and learner-friendly as well as increasingly inexpensive. Despite reservations to computer-based learning on the part of some medical educators, the evolution of technology and the pressures of cost containment encourage continuing exploration of the potential risks and benefits.⁵⁻⁹ Already accepted roles of the computer in enhancing the efficiency of the lecture include

generating and distributing lecture handouts and slide presentations. With this article we explore the potential for transferring the actual content of the clinical lecture to the multimedia computer.

We begin with Dr. Wolf, a seasoned clinician-educator who has lectured to medical students and residents on a variety of internal medicine topics. Recently, his department chairman approached him (via e-mail) to consider whether his lecture is suitable for a computer-based presentation. In formulating his response, Dr. Wolf has much to consider including the purpose and methods of the lecture, the advantages and disadvantages of live versus computer-based lectures, and the technical options in capturing his lecture. Consider Dr. Wolf's concerns.

PURPOSE AND METHODS OF THE LECTURE

Dr. Wolf believes that his lecture accomplishes more than simple presentation of information. It allows him to present material that is not in print or that requires synthesis from multiple sources.¹⁰ During the lecture, he communicates his personal enthusiasm about the subject matter as he engages learners. He tries hard to discern the sophistication of his audience in order that he may tailor his instruction to meet the learning levels of those present. He is wary of insulting learners who know the material and losing learners who do not. Because this is a difficult task, especially with larger groups, he often resigns to presenting enough information so that there will be something of use for everyone.

Although he has seldom received formal feedback on his teaching skills, Dr. Wolf thinks that he has developed a presentation that is attractive to his audience. After all, he continues to be asked to give his lectures. His technique is simple. He defines the objectives, provides clinical correlations with examples, and summarizes the take-home points. These techniques, he believes, best enable the audience to grasp the salient teaching points.¹¹ During the session, Dr. Wolf is careful to speak clearly, not too fast or too slowly, and to project his voice in a conversational manner so that all can hear.¹² Dr. Wolf attracts and maintains the learners' attention by offering anecdotes and posing dilemmas. He occasionally directly questions the audience by asking for a show of hands, or he brainstorms with the class using a flip chart or blackboard in order to create a collaborative learning process. Dr. Wolf uses visual aides to direct the audience attention to what he is saying, knowing that visual stimuli

Received from the Departments of Pediatrics (MMW) and Internal Medicine (JLW), Wake Forest University School of Medicine, Winston-Salem, NC; and the Department of Internal Medicine, Vanderbilt University School of Medicine, Nashville, Tenn (AWS).

Address correspondence and reprint requests to Dr. Wofford: Department of Internal Medicine, Wake Forest University School of Medicine, Winston-Salem, NC 27157 (e-mail: jwofford@wfubmc.edu).

generate recall better than verbal stimuli.¹³ But he is careful in doing this because too many slides can lead to confusion, hinder note-taking, and detract his learners from the essential information that he intends to convey.

Dr. Wolf believes that a written handout can be a meaningful supplement of the lecture. He uses the handout as a discussion aide to accompany the lecture and as a means of disseminating additional information not included in the lecture.¹⁴ Although handouts can be effective as a fill-in-the-blank exercise or a collage of illustrations,¹⁵ Dr. Wolf prefers to provide at the end of his lecture a detailed handout that outlines all of the essential information. He encourages students to use the handout to review important facts and to identify resources for further study.

ADVANTAGES AND DISADVANTAGES OF "LIVE" VERSUS COMPUTER-BASED LECTURES

The very idea that a computer presentation could substitute for his lecture gives Dr. Wolf pause. The lecture is a well-developed methodology, and he has spent years

refining his presentation. He wonders what will be his role if lectures are replaced with computers. Earlier technologies for capturing lecture content such as videotape or audiotape certainly did not supplant the lecture in medical education. Are computer-based tools more effective and efficient than these earlier technologies? Can the computer help discern the level of understanding of his students and residents in order to provide them more targeted information?

In an effort to answer these questions, Dr. Wolf performs a search of the medical literature. Searching for randomized, controlled trials with the lecture format as the comparison group seems a reasonable strategy for comparing the standard "live" lecture with technology-based lectures. (Details of the search strategy are included in the Appendix.) Even though his search strategy failed to identify any studies that specifically compared the computer-based lecture to the standard lecture, the search provided information on how a technology-based substitution compared with the "live" lecture¹⁶⁻²⁴ (Table 1).

One study compared the effectiveness of the lecture to that of an audiotape-pamphlet package, two to that of a

Table 1. Randomized Controlled Trials of "Live" Lectures with Technology-based Substitutions

Author, Year	Students (Number, Level)	Subject	Intervention*	Conclusion†
Tomlinson DR, ¹⁶ 1979	50 1st year students	Neurophysiology	Audio tape-pamphlet	Effectiveness no different. Long term recall better than lecture.
Paegle RD et al., ¹⁷ 1980	59 3rd year students	Gynecologic pathology	Closed circuit TV of lecture	Effectiveness no different. Efficiency not studied. Live lecture preferred.
Sox HC et al., ¹⁸ 1984	27 2nd year students	Clinical decision making	Tutored videotape of lecture	Effectiveness no different. Live lecture more interesting and better learning atmosphere.
Jacoby CG et al., ¹⁹ 1984	53 4th year students	Radiology — child abuse, head trauma	Computer-based text and slide viewer	Effectiveness no different. Efficiency not offered.
Bresnitz EA et al., ²⁰ 1992	111 2nd year students	Occupational health	Computer-based learning	Effectiveness comparable. Subjective impression that less efficient than lecture.
D'Alessandro MP et al., ²¹ 1993	49 staff and resident physicians	Radiology—diffuse lung disease	Multimedia textbook	Effectiveness no different. Lecture more efficient.
Santer DM et al., ²² 1995 and D'Alessandro DM et al., ²³ 1997	179 3rd/4th year students	Pediatric airway disease	Multimedia textbook (MMTB), Printed textbook (PTB)	MMTB more effective than lecture but equal to PTB. MMTB efficiency no different from lecture or PTB.
Ram SP et al., ²⁴ 1997	64 final year students	Congenital heart disease	Multimedia computer presentation	Computer more effective.

* The control group received a traditional "live" lecture.

† Effectiveness, knowledge gained; efficiency, knowledge gained per amount of time expended by the student.

video reproduction (tutored videotape, closed circuit television), and the other five studies to that of a variety of computer-based strategies (Table 1). All studies used a pretest-posttest methodology to measure effectiveness (knowledge gained). Six of the eight studies showed no difference in effectiveness, while two studies favored a computer-based strategy. Of the only two studies that examined efficiency (knowledge gained per amount of time expended by the student), one showed the lecture to be more efficient than a computer-based strategy while one showed no difference in efficiency between lecture and computer.

Based on the results of his search, Dr. Wolf infers that the computer-based lecture should be no less effective than a traditional lecture, an opinion that is reflected in other (nonmedical) educational fields.^{25,26} However, the limitations of such a search comparing computer-based teaching with traditional teaching are also apparent. For one, publication bias would likely favor the more novel technologies. Second, the randomized controlled trial methodology that we have come to expect in evidence-based medicine decision-making about interventions is not commonly used in education. Third, it is difficult to guarantee in reports of media comparisons that the content and quality of the standard "live" lecture and the computer-based intervention are exactly the same, despite the best efforts of the researchers.^{27,28} As is now commonly stated in analytic studies of computer-assisted instruction, taking full advantage of the novel features of a computing platform (video, audio, hyperlinks, and other interactive features) that cannot be replicated by other methods confounds any comparison with more traditional media and makes it logically impossible to have a true comparison group.²⁹

Dr. Wolf surmises that lecturers should not give up their lectures just because there is a computer module covering the same content. There should be a role for the best of both methods. Just as lecture quality will vary among faculty, so will there be unevenness in the quality of computer-based presentations. Updating the content of the lecture is, of course, easier with a standard lecture, particularly with a field where information is rapidly changing. On the other hand, well-seasoned topics may be suited to capturing and preserving a lecture for a computer-based learning module.

The degree and types of interactivity in the traditional lecture depend on the style of the lecturer as well. Likewise, the computer offers a variety of potential interactive strategies. Interactive cases and brief quizzes as part of the lecture could reveal student's understanding of the subject. Quiz score and explanations of the answers can provide students immediate feedback and resources to improve gaps in knowledge on the topic. Online discussion could further delineate the student's progress in mastering the objectives for the lecture. Thus, the computer can serve as a diagnostic aide for Dr. Wolf to discern the impact of his lecture and to augment accountability in the learning process. Conversely, direct and formal feedback to Dr. Wolf through online evaluation forms provides him im-

portant information to improve his teaching efforts. Rather than a threat, Dr. Wolf realizes that the computer may actually assist him to perform his duties more effectively. Furthermore, a computer-based approach would free up time for him to spend time with students in more interactive activities (small group sessions or providing feedback), and a larger number of students (even students at other institutions) would be able to benefit from well-done modules on the computer.

TECHNICAL OPTIONS IN CAPTURING THE LECTURE

Now interested, Dr. Wolf turns his attention toward the technical considerations in moving the clinical lecture to the computer. Dr. Wolf considers a studio production of his lectures on videotape. In this staged "in vitro" scenario, Dr. Wolf could work with a team of producers and technicians who use a digital camera to videotape his presentation. Later they will edit the video clips and visual aids such as PowerPoint slides into the content. The finished product is transposed to an electronic platform such as CD-ROM or the Web. Another approach is an electronic movie capture of a real time lecture. In this "in vivo" scenario, a movie of the lecturer (with or without integration of visual aids) as the original lecture is given, is recorded on a digital camera and transposed to electronic form. The "in vivo" approach requires less preparation because Dr. Wolf simply gives his usual lectures as he has always done. However, content organization and presentation quality may be inferior compared with the contrived environment of the studio presentation. On the other hand, the enthusiasm and liveliness may be with the "in vivo" approach. Both approaches require large editorial resources and have the disadvantage of slow platforms on which to transmit video material.

While the visual presentation includes gestures and body language of the speaker, Dr. Wolf believes that he best conveys the emotional flavor or enthusiasm for his information through his voice. Audio recording developed in either an "in vitro" or "in vivo" setting and enhanced by visual aides such as slides provides another option. Modern speeds are better able to accommodate audio information than video information.

CONCLUSIONS

Dr. Wolf sees potential here. There will be much up-front work, but the investment will allow multiple learners access to his lecture anytime and anyplace with the possibility of dissemination to other institutions. Evaluation strategies can be integrated to better assess the quality and value of the lecture to students. Dr. Wolf is already planning to include his computer-based lecture in his curriculum vitae and promotion portfolio.³⁰ Assuming that the department is committed to the computer-based lecture project, the prospects are appealing. Dr. Wolf e-mails his response to his department chair—"yes."

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APPENDIX

In order to review the efficiency, efficacy, strengths, and weaknesses of the live lecture versus the computer-based lecture, Dr. Wolf reviewed the English language literature utilizing the MEDLINE headings, "medical education," or "teaching (methods)," and searching the MEDLINE database from 1966 to present (year 2000). As "lecture" was not a MESH heading, "lecture" was used as a text word to narrow the search. Citations were limited to English language and publication type (randomized controlled trial). With the ERIC (Educational Resources Information Center) database, Dr. Wolf used the search terms "randomized controlled trial," "random," and "controlled," crossed with "lecture."

Articles were excluded if they did not target physicians in training, did not have a lecture only as the comparison group, and did not use technology for the intervention group. Bibliographies of relevant articles were also reviewed. A total of eight articles was thus identified. Data were extracted manually from relevant publications and presented descriptively because formal quantitative methods were not applicable.