11.5. The Use of Web-Based Instruction in Medical Education

Editorial

The United States, as one of the world's richest nations, has one of the most advanced medical health systems, but still faces major challenges in the preparation of new doctors and other medical professionals. For several reasons, detailed below, funding sources for medical education are decreasing and medical teaching faculty are being required to devote more time to revenue production and less to their teaching responsibilities. To meet this challenge, the tools of distance education are being employed: networked computers, access to clinical materials and databases through the World Wide Web, and asynchronous communication among doctors in training and their preceptors.

These distance learning solutions, as described below, have been developed to ease the plight of North American physicians-in-training. Many are now Web-based and accessible with the use any computer capable of making an Internet connection and running a browser. These resources could now be made easily accessible to isolated medical professionals, both practicing and in training, in any part of the world.

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The Use of Web-Based Instruction in Medical Education

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Abstract

Medical education is a practice-based discipline that, by definition, must be practiced in order to be mastered. The fact that medicine cannot be practiced at a distance suggests that distance education methods are ill suited for traditional medical education. Despite this, distance education methods in general, and Web-based instruction in particular, are gaining in popularity within the medical discipline.

Recent changes in the economics of medical education are in part responsible for this seeming paradox. To better understand this, the recent history of undergraduate medical education is examined in the context of these economic forces. The advantages of Web-based instruction can then be seen to meet a growing need within the field.

Undergraduate Medical Education

Medical education consists of three phases: undergraduate medical education (UME), graduate medical education (GME), and continuing medical education (CME)—all of which have seen an increase in the use of Web-based instruction over the last decade. This article describes the training needs and learning environment specific to undergraduate medical education, along with select

economic and academic forces that have impacted its structure and may have contributed to the increased use of Web-based instruction.

Undergraduate Medical Education Defined

Undergraduate Medical Education is the four years of training undertaken prior to one's receipt of an M.D. degree. UME provides a broad knowledge base intended to serve as the foundation for any future specialty training. A UME graduate must still complete a year or more of graduate medical education (residency training) to become eligible for a license to practice medicine.

UME typically consists of a pre-clinical, or basic-science, curriculum, and then two to three years of clinical curriculum. As the student progresses through the four years of UME, the instructional environment becomes progressively less classroom based and more clinic based. Basic scientists engaged in biomedical research conduct much of their teaching during the pre-clinical phase. During clinical training, learning occurs though practice and informal teaching in the apprenticeship model with a variable didactic component. Web-based instructional techniques have a place in both of these phases of education.

Economic Structure of Medical Schools

A medical school, or academic health center (AHC), is more than just a place where students are trained and research is conducted. It is unique among professional schools in that it is, by definition, a place where the profession is also practiced. This is unlike law schools or business schools—where teaching can occur in the absence of practice—because medical practice is a requisite component of a medical education (Relman 1999). This has several implications that impact how medical education is funded and structured. For example, tuition and fees at medical schools constitute only about 4% of the operating income, whereas, at law schools, tuition income is about 60% (Eisenberg 1999).

Historically, federal funding has heavily supported medical education. Over the last 30 years, the reliance on clinical revenue, compared to federal underwriting, has increased dramatically. Thirty years ago, federal monies comprised 54% of the operating budgets of AHCs. Today, federal money accounts for only 20%, with 58% of the support derived from clinical practice (Eisenberg 1999). This increasing reliance on clinical revenue has contributed to the current state of medical education.

AHCs are not in a good position to compete in today's health-care market. The cost of care is higher in an AHC than in a hospital where no teaching occurs, because faculty time is consumed not only with patient care but also with teaching and research. Additionally, more than twice as much uncompensated care is provided at AHCs than at other hospitals. These facts, taken in light of health-care finance changes of the last decades, have led many AHCs to the point of financial hardship.

In addition to clinical revenues and tuition, AHCs also receive some federal monies. While UME is not directly supported, graduate medical education is, to some degree, underwritten as part of the Medicare program through the use of direct graduate medical education (DGME) payments (AAMC 1999). Changes in the DGME payment structure directly impacts the operating budgets of AHCs and the resources available for teaching. Because it is rare for undergraduate medical education to take place in an AHC where graduate medical education does not also take place, these changes in

graduate medical education financing impact the delivery of UME as well.

Economic Changes

Recently, there have been significant changes in the economics of medicine. Medicare reforms —including a reduction in the fees Medicare pays to AHCs, the increase in managed-care contracts, and decreased funding for research—have had a significant impact on medical education.

Medicare has implemented several changes in payments to AHCs. The amount paid per resident has decreased, and limits have been put on the number of residents allowed per AHC. Limits on the duration of training for residents eligible for payment also have been enacted. As subspecialty training takes longer than primary-care training, these limits have effectively decreased support for subspecialties. Added to this, the DGME payment schedule has changed such that the rate for residents in primary-care specialties is higher than for that in specialty-training programs (AAMC 1999; AAMC 1997). This has lent economic pressure to the policy demands for more physician training in primary care than in specialty fields of medicine.

Another Medicare ruling, put into effect in 1996, has impacted the time that teaching physicians have to teach, and their availability to students. This ruling provides that Medicare cannot reimburse resident services when it is provided as part of training. Further, Medicare reimbursement will be allowed only if the teaching physician is present for any service or procedure (AAMC 2000). As most third-party payers follow Medicare's rulings on reimbursement, this applies to all patients seen, not just Medicare patients. Thus, not only are Medicare payments and reimbursement decreased for the support of residents, but service provided by residents generates no revenue for the AHC. Teaching physicians must now have a greater physical presence in direct patient care than previously, leaving them with less time than ever to engage in anything other than bedside teaching.

Managed care has also had an adverse impact on medical education, both in terms of financing and the quality of teaching that can occur. Because managed care does not reimburse on a fee-for-service schedule, but rather a negotiated per-patient amount, hospitals often discharge patients as quickly as possible. Any activity that detracts from clinical work (e.g., teaching or research) costs considerably more than it did under the fee-for-service plans. Also, with patients spending less time in a hospital or clinic, the student has less time to observe, interview, or examine the patient, and the teaching physician has less time to conduct bedside teaching.

Another factor that has had an impact on the economics of medical education is the decrease in research funding. On a national level, funding for medical research by the National Institutes of Health has decreased considerably since 1970 such that, by 1990, nearly two-thirds of all applications from medical schools remained unfunded (Andreoli 1999). While medical school faculty numbers also have increased over that time, this alone does not account for the shortage of research funds, as the growth has been predominantly in clinical areas. For example, in 1960, the ratio of clinical-to-basic-science faculty was 1.8:1, whereas currently the ratio is 5.5:1 (Andreoli 1999). This further supports the reliance of the AHC on clinical revenues and decreases the teaching support available for the pre-clinical curriculum.

Web-Based Instruction

Distance Education and Computer-Assisted Instruction

While several media have been used as supplemental aides in medical education, the use of distance education is a relatively new phenomenon.

Computer-assisted instruction (CAI) programs in medical education were developed as early as the 1960s (Jones 1980; Owen et al. 1965), although early programs were most often used as supplements to the traditional curriculum. Despite the early appearance of CAI in medical education, many barriers were present, including limited access to appropriate hardware and poorly designed teaching materials. Later, as CAI grew to include Web-based delivery, slow Internet connectivity and limited use of the visual and interactive capabilities of the World Wide Web presented additional barriers to its use (Friedman 1996).

In the 1990s, computers became more widely available and the World Wide Web fully emerged as a viable delivery method for educational materials. Many of the barriers to using computer technology in the medical education environment have now been overcome. Computers are readily available in most medical schools, hospitals, and clinics, and Internet connectivity is ubiquitous. Students are increasingly computer savvy and have come to expect the use of newer technologies in their education. These factors combine to make the use of Web-based instruction not only feasible, but desirable.

Web-based instruction may include some of the programs previously categorized as CAI, as many of these can now be delivered over the Web. Other modes of Web-based instruction, including videoconferencing, Web-delivered tutorials or simulations, and asynchronous and synchronous discussions, may also play a part in more traditional curriculum when used as supplemental materials.

Distance Education Methodology in Undergraduate Medical Education

Undergraduate medical education is well suited to the application of Web-based instruction. As discussed above, economic pressures are causing more physicians to be trained in primary-care specialties than in other fields. Unfortunately, the high-tech setting of an AHC is often not optimal for primary-care training, forcing physicians-in-training to gain experience in smaller communities. This separates the students from each other and from their academic institution with its human and material resources. Distance learning technology, particularly Web-based instruction, can overcome much of that isolation. Through the use of Web-based technology, remote learners can access library and database materials and can participate in discussions with fellow students at other locations and with a clinical preceptor at the AHC. In this way, the formal learning of the students can be standardized, regardless of the location of their clinical experiences.

The use of asynchronous Web-based instruction could help reverse the trend of faculty members' decreased contact time resulting from the pressure they face to increase clinical efficiency and revenues in AHCs. Students are increasingly being taught either by more-senior students or by residents (Relman 1999). Through the use of simulations and asynchronous discussions, a faculty member could oversee instruction without taking scheduled time away from his/her clinical duties. Additionally, as authoring tools become easier to use, faculty could develop their own teaching materials for use outside the clinic.

Application of Web-Based Instruction in Undergraduate Medical Education

Three broad categories of applications can be used across the undergraduate medical curriculum as outlined below.

Reference Materials

Medical students rely heavily on the use of reference materials, such as atlases and teaching slides, to learn the extremely large amount of medical information. The availability of reference materials online, including journals and texts, is a valuable resource. Additionally, anatomic materials, such as gross anatomy specimens and microscopic slides, can now be made available outside the teaching laboratory setting through the use of digital imaging and Web-delivery technology (Abrahams et al. 2000; Candler and Blair 1998; Johnson and Sudheimer 2000).

Simulations and Case Studies

The use of simulations has application across the UME curriculum. In the pre-clinical phase, for example, physiology simulations can be used to supplement or supplant traditional laboratory teaching. The use of simulations has an even greater application in the clinical curriculum. Here, simulations can be used to give the student access to patient populations and disease states that would otherwise not be experienced through geographic, demographic, or chronological constraints (Grundman, Wigton, and Nickol 2000; Kamin et al. 1999). For example, as some diseases, such as croup and influenza, are seasonal, students may not have access to a cross-sectional patient population at their scheduled times on a given clinical rotation. Simulations also impart some ability to standardize the student experience and assure that all graduates have experienced a core body of cases, either virtually or in the clinic. Additionally, the ease of creation of teaching materials makes it easier for physicians to share with students the teaching aspects of “interesting” cases without detaining the patient (Taekman, Kingsley, and Shelley 1996).

Using Web-based instruction for simulations has benefits both for students located at the AHC and for those distant to the medical school, as simulations can be used in a formal teaching setting or be made available for independent study. Web-based instruction, compared to CD-ROM, is more readily authored locally and considerably easier to modify as the need arises. It also is available from any computer with an Internet connection, making it potentially more accessible for students. At the same time, password-protection limits access.

Communications

Distance education technologies can enhance communication when students are distributed over broad geographic areas for their training. Tools as simple as e-mail enhance student education while on community rotations (Gephart et al. 1998). The use of asynchronous discussions is also beneficial for both for simple student communication and for group learning associated with teaching cases and simulations (Kamin et al. 1999; Klemm 1998).

Summary

Barriers

Web-based instruction is well suited for use in undergraduate medical education, particularly given recent economic changes in medicine and their impact on training. Despite its increased use, barriers to its acceptance still exist.

The ease of use and variety of authoring environments allows faculty physicians, with little intervention, to author teaching materials for student use. This creates another set of problems, however. By allowing anyone at any time to create teaching materials, Web-based instruction has little or no standardization. Also, the wide variety of formats and architectures available limits the use of such teaching materials outside the setting for which they were initially designed (Candler and Andrews 1999). While this is partially offset by the ease of generation of teaching materials, the field risks creation of another manpower shortage if this trend continues.

Medical education financing remains largely driven by clinical revenues. Additionally, in many places, clinical performance and research productivity still determines tenure and promotion. This de-emphasis on teaching serves to limit faculty motivation to create or evaluate new teaching materials.

Another barrier is that many newer Web-based instructional materials are poorly integrated into the formal curriculum of the medical school (Friedman 1996). As such, their content is often not tested, thereby limiting student motivation to use the new materials.

Finally, there is a paucity of evaluation and outcomes research in the use of distance education methods in medical education. Until these methods are shown to have educational or economic benefits to medical training, little demand for their use can be expected—particularly since the field of medicine is based largely on evidence-based decision making.

Opportunities

Clearly, if the trend continues, distance education methodologies will play a growing role in the delivery of instruction and facilitation of group learning in medical education. For efficiency, it is desirable that materials be developed in a way that allows multipurpose use. Web-based instruction, particularly database-driven materials, allows for exactly that conservation of effort. Media can be developed in basic units (e.g., images, animations, video or audio clips) and stored for future use in a variety of applications. Instructors creating new teaching materials could draw from the media collection to build their instruction. Database repositories often are available at local institutions, but even more important is the development of national repositories (Sneiderman et al. 2000; Besa 2000). The difficulty with national repositories will be in assuring appropriate peer review of materials and keeping content current with the state of medical knowledge and practice.

While advances are being made, other advantages of the technology remain to be fully utilized. Even when instructors are aware of the technology used to author materials, what remains to be exploited is the ease of collaboration on authoring materials. Clinical and basic-science faculty members could work together to incorporate elements of both areas in a simulation or case presentation (Ivanovic, Koethe, and Krogull 1997). The educational potential of combining the clinical context with the basic science is significant and would have required considerably more effort before the current technology

became available.

Finally, in order for these methodologies to be mainstreamed into medical education, administrators of the curriculum must be convinced of their need. Materials must be part of the standard curriculum, and not used merely as a supplement. Evaluation of educational and economic efficacy of distance education methods in a medical education setting would help facilitate the inclusion of the methodologies into the mainstream of medical education.

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