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PROBLEMS IN IMPLEMENTING THE COMPUTER FOR CONTINUING EDUCATION

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Introduction

Although computer-based instruction has become widely available as a learning aid in medical education, few physicians interact with educational programs after they have left medical school. Some notable exceptions occur when specially prepared computer programs are made available by vendors or program committees at annual clinical meetings. Yet this kind of learning tool is seldom used by practicing physicians at other times during the year. In this paper, I would like to consider ways in which computer-based education might be more effectively integrated into the clinical activities of the practicing physician, and to outline some of the technological and psychological barriers to their successful implementation.

A Model Of Computer-Based Continuing Education

When physicians reflect on the most intense learning experience of their medical education, they typically focus on the internship year. This "intensity" refers to more than the hours worked and the sleep lost; it is generally recognized that the sheer volume of clinical exposure, despite little in the way of formal lectures or traditional classroom teaching, provides a marvelously productive educational experience. Physicians learn that they tend to retain the most new information when they must deal with problem solving for specific patient cases. A "sterile" disease, first encountered in the pathology lecture hall during the preclinical years, takes on new meaning and is much better understood when it is finally encountered in the context of a real patient for whom management decisions must be made.

This observation suggests there is a serious limitation to continuing education efforts that are based on the traditional model of journal reading and occasional courses. That approach represents a return to the preclinical mode of learning and fails to capitalize on the heightened retention of knowledge that results from problem solving in the clinical setting. Many physicians would acknowledge that they continue to get the most out of journal articles when they are driven to the library by a difficult management problem.

Traditional computer-aided instruction suffers from the same potential limitation. The physician must seek out an educational package and set aside time, separate from his or her patient care activities, in which to run the program. An alternate model would bring the computer into the physician's practice in an integrated fashion coupled to the management of specific patients. We might imagine the computer functioning as a consultant rather than as an educator *per se*. Any physician will acknowledge the educational benefits of a consultation from an articulate colleague with expertise in another area of medicine; computers serving as consultants in specialized problem areas might play a similar educational function.

There are at least two models for how this kind of computer-based "consultation" can be offered to the practicing physician. In one the physician uses the computer for some other chore (e.g., test ordering or medical record manipulations) and the computer "monitors" for problems and offers advice that may be pertinent. Sometimes the physicians interact directly with the computer terminal [1, 2], while in other systems the advice is offered on paper reports that are generated after patient information is transcribed into the computer by paramedical personnel [3]. Dr. Weed has described the PROMIS system and its potential educational impact (see this issue p.), so I will not dwell further on this kind of system.

The second model for computer-based consultations is the development of programs to which physicians will turn because they specifically wish advice about a difficult management or diagnostic problem. Drs. Myers and Lindberg have described two programs of this kind (see this issue, pp and), and a recent review article has discussed the wide range of techniques being used to develop computer-based clinical decision aids [4]. Relevant technologies include Bayesian statistics [5], decision analysis [6], and artificial intelligence [7, 8]. All have been used to develop programs that reach excellent *decisions* about diagnosis or management, but none has been well accepted by physicians. Thus, although computer-based consultations offer exciting potential for continuing medical education, there are significant barriers that must be overcome before the promise can be realized.

The Consultation Process

A consultation dialogue typically includes time during which the expert explains the basis for the advice that is given and the nonexpert seeks justification of points found puzzling or questionable. Consultants who offered dogmatic advice they were unwilling to discuss or defend would find that their opinions were seldom sought. When the consultant's advice is followed, it is frequently because the patient's doctor has been genuinely educated about the particular complex problem for which assistance was requested.

Since traditional consultations are accepted largely because they allow the primary physician to make the final management decision, it can be argued that medical consultation programs should ideally mimic this kind of human dialogue. Computer-based decision aids have typically emphasized only the accumulation of patient data and the generation of advice [4]. On the other hand, an ability to explain decisions may be incorporated into computer-based decision aids if the system is given an adequate internal model of the logic that it uses and can convey this intelligibly to the physician-user. The addition of explanation capabilities may therefore be an important step towards heightening a program's educational potential *and* effectively encouraging its use.

Attitudes Of Physicians Towards Computers

It is commonly argued that physicians are inherently reluctant to use computers in their practice [9, 10], and some observers have even feared that the psychological barriers are insurmountable. Recent advances in computing, in particular the advent of personal computers and the increasing use of machines for office management functions, may account for the observation that physician attitudes seem to be changing remarkably quickly. Our group recently studied the opinions of practicing physicians and medical school faculty towards the development and implementation of consultation systems [11]. We found that a significant segment of the medical community believes that assistance from computer-based consultation systems will ultimately benefit medical practice. We also studied the physicians' demands regarding desirable features for such systems if they are to be useful and clinically accepted; the resulting design considerations highlight

performance capabilities that are a challenge to medical computer scientists. Consider, for example, the six design features that physicians rated *most important* in future consultation systems:

1. they should be able to explain their diagnostic and treatment decisions to physician users;

2. they should be portable and flexible so that the MD can access them at any time and place;

3. they should display an understanding of their own medical knowledge;

4. they should improve the cost efficiency of tests and therapies;

5. they should automatically learn new information when interacting with medical experts; and

6. they should display common sense.

No current consultation system meets all these criteria, but the list does help identify both the barriers to successful implementations and the criteria for assessing new systems that may be introduced.

Guidelines For The Future

The results of our attitude survey [11], and of accumulated experience in constructing consultation systems for use by physicians, suggest that several guidelines may be useful in designing and building such programs. The educational potential of office- and hospital-based consultation systems may not be realized unless programs are constructed with the following considerations in mind:*

1. Designers should try to minimize changes to current clinical practices. The system should ideally replace some current clinical function, thereby avoiding the need for an *additive* time commitment by the physician. The system should ideally be available when and

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*The guidelines cited are adapted from a similar list of recommendations included in [11].

where physicians customarily make decisions.

2. It is wise to concentrate some of the research effort on enhancing the interactive capabilities of the expert system. The more natural these capabilities, the more likely that the system will be used. At least four features appear to be highly desirable:

- **Explanation**. The system should be able to justify its advice in terms that are understandable and persuasive. In addition, it is preferable that a system adapt its explanation to the needs and characteristics of the user, (e.g., his demonstrated or assumed level of background knowledge in the domain). A system that gives dogmatic advice is likely to be rejected.

- **Common Sense**. The system should "seem reasonable" as it progresses through a problem solving session. Some researchers argue that the program's operation should therefore parallel the physician's reasoning processes as much as possible. There is a growing body of knowledge about the psychological underpinnings of medical problem solving [12], and systems that draw upon these insights are likely to find an improved level of acceptance by the medical community.

- **Knowledge Representation**. The knowledge in the system should be easy to bring up to date, and this often puts serious constraints on the format for storing information in the computer. A challenging side-issue is the automatic "learning" of new knowledge of the domain, either through interaction with expert physicians or experience once the system is in regular use.

- **Usability**. The system should be easy to learn and largely self-documenting. The mode of interaction may be the key to acceptability, and effective methods for understanding text or spoken language dramatically increase the utility of clinical

systems. For routine activities, it is preferable that use of the system be as easy as pressing a button.

3. System builders should recognize (as physicians apparently do) that, for most problem areas, 100% accuracy is neither achievable nor expected [11]. Physicians will accept a system that functions at the same level as a human expert so long as the interactive capabilities noted above are a component of the consultation process.

4. When designing systems, it is wise to consider the concerns and demands that physicians express about consultation systems. These should be used to guide both the development and the implementation of the systems of the future. It is increasingly recognized that it takes only one shortcoming to render an otherwise well-designed system unacceptable.

The considerations outlined here place severe demands on current computing capabilities. Some of the desired characteristics cited are beyond the current state-of-the-art in computer science. These requirements help to delineate important basic research goals for future work in medical computing.

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