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# The Computer and Medical Decision Making: Good Advice is Not Enough

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# THE COMPUTER AND MEDICAL DECISION MAKING:

# GOOD ADVICE IS NOT ENOUGH

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## Editorial

Much of the training of physicians is designed to facilitate optimal, informed clinical decision making. Yet the challenges of diagnosis and treatment planning have become particularly severe as medical knowledge has grown and the need for specialization has increased. Why, then, has the successful clinical use of decision support systems proved difficult to achieve, despite the computer's vast storage capacity and computational capabilities?

The experience of the last two decades has shown that there are several significant barriers that remain to be overcome before we will see the effective implementation of computer-based medical decision making systems. Influential critical reviews have provided useful analyses of many of these challenges [2],[7]. However, remarkable strides have recently been made [15], and those working in the field have reason to be optimistic about the chances for the technology to be successfully applied in the decade ahead.

Investigators must contend with a variety of conflicting forces. On the one hand, there is a "show me" attitude expressed by a profession which has heard the potential of clinical computing extolled for more than 10 years but has yet to see a widely accepted decision support system. On the other hand, there are indications that the environment is changing, with an increased acknowledgment that clinical decision making research can validly contribute to medical practice. For example, we have seen significant clinical changes result from theoretical work in clinical decision analysis

(e.g., the recent American Cancer Society recommendations regarding mammography and PAP smear screening), and the development of an ambitious well-received journal in the field [11]. Studies of physician attitudes [17] have also shown that there is a growing curiosity about computers and a heightened faith in their potential. This phenomenon has been further demonstrated by the emergence of doctors with home computers and customized office systems, and by the success of educational programs designed to introduce physicians to computers for both business and clinical applications.

Medical decision making research in the 1960's emphasized the use of the computer to deal with probabilistic information, to recognize patterns using numerical techniques, to model physiological processes that were amenable to mathematical simulation, or to encode algorithmic approaches to routine clinical chores. The field was then in its first decade as an identifiable area of research, and the emphasis was on how to get machines to make decisions that were both accurate and reliable. Formal statistical approaches that had been impractical before computers became available were, quite naturally, the first techniques to be tried as physicians and engineers began to appreciate the computer's potential as a clinical tool.

In the 1970's, however, there was a shift in research direction. Investigators increasingly realized that there are several key problems that escape attention if the research focuses solely on the development of techniques for reaching good decisions. These include:

1) the problem of data acquisition -- i.e., how to acquire, encode, and

control for variations in the descriptors that define patients and populations;

2) the problems of knowledge acquisition and representation -- i.e., how to acquire and encode the kinds of judgmental perceptions, and the common sense approach, that characterize expertise in the clinical decision making areas being modeled;

3) the problem of explanation -- i.e., how to build decision support programs that not only give advice but are able to defend their decisions in terms physicians can understand; and

4) the logistics of integration -- i.e., how to design and implement computer-based decision aids that fit smoothly into the daily routine of physicians' practices, that acknowledge their hectic schedules, and that seek to demystify and simplify the mechanics of the human-computer interface.

Several successful early approaches to these problems were developed during the last decade. Large patient databases have been constructed and used to aid in defining prognosis fo new cases [6],[8],[12]. Investigators who depend on valid statistics to support their decision making systems have begun to look at geographical variations in populations in order to assess the transferability of programs [4]. Hospital information systems have become increasingly common and provide promising early models for the way in which relevant data will eventually be routinely acquired [10]. There has also been complementary work in the development of large computer-based

text documents designed to bring up-to-date knowledge of a domain to the practicing physician [1].

During the same period, non-numerical approaches based on artificial intelligence techniques have become prominent [16] and these have suggested several new methods for encoding uncertainty, representing expert knowledge, and modeling the reasoning processes of accomplished clinicians. The symbolic reasoning techniques have suggested ways decision making programs can explain their reasoning to physicians, thereby allowing the user to decide whether to follow the system's recommendations [14]. Interactive techniques have been developed which also allow experimental systems to interview experts and to acquire new knowledge directly from them [3].

Finally, there have been several notable experiments which have sought new ways to encourage physicians to interact with computer programs. These have included systems using light pens [19] or touch screens [13], and decision support programs integrated into large scale hospital information systems [18]. These efforts and others have demonstrated that physicians will learn to use computers and accept their role if the benefits of the technology outweigh the costs of learning how to use the device and integrating it into one's normal routine.

A litany of recent accomplishments partly serves to emphasize the significant problems still remaining, however. Many of the experiments cited above are only first steps towards the development of clinically useful tools. As is true with any developing science, the development of short term solutions tends to lead to a new understanding of the nature of the remaining

problems and helps define the research directions for the future. Current results suggest that the following problems are among those requiring attention in the decade ahead:

1) additional psychological studies, similar in motivation to some of the pioneering studies of the 1970's [5],[9], that will provide new insights into optimal methods for simulating expert decision making performance and may suggest novel approaches to the organization of knowledge and its interaction with probabilistic information;

2) improved techniques for representing and using causal and mechanistic relationships (because expert decision making behavior depends in large part on an ability to reason from "first principles" rather than to rely on empiric associations between observations and hypotheses);

3) enhanced explanation capabilities, ideally guided by an improved understanding of how human beings explain things to one another and, in particular, how they adapt their explanations to the knowledge and experience of the individual requesting advice;

4) experimentation with new machine architectures (e.g., parallel processing or networking of multiple coordinated processors) that may permit an optimal assignment of languages and interfaces for the individual subtasks required by high-performance decision making programs;

5) experiments that seek to provide an optimal melding of symbolic

techniques drawn from artificial intelligence research and the analytic techniques of formal statistics, pattern recognition, and decision theory; and

6) research into novel ways that developing technologies for personal computing and graphics might heighten both the acceptability and cost effectiveness of systems to aid physicians with their decision making tasks.

There is little doubt that additional challenges could be added to this list, and some readers may quibble with those I have chosen to include. But it is clear that two additional issues stand foremost on the medical computing agenda for the 1980's -- 1) there must be improved education of medical students and practicing physicians regarding computers and decision making, and 2) there must be an enhanced acceptance of medical computer science as an intrinsic component of the modern academic medical environment. The financial and academic support necessary for tackling difficult tasks such as those outlined above will be made available only if there is improved recognition of the fundamental research questions that exist for the medical computing community.

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