Introduction

In early 1990, Miller and Maserie described their belief that early approaches to computer-based decision support in medicine had been flawed in their adoption of the “Greek oracle” model of consultation [1]—computer programs to which a physician would turn for advice, answering patient-related questions but otherwise deferring to the dialog style and recommendations of the machine. The authors correctly observed that this model, adopted by many knowledge-based systems during the first decade of medical artificial-intelligence (AI) research [2], failed to capitalize on the special observational skills of physicians and failed to allow the user adequately to control the interaction, selecting the ways in which the program’s knowledge could most effectively be brought to bear in the consideration of a particular case. Their redesign of Internist-1’s interactive model in the development of the QMR system reflected their belief that the “Greek oracle” model should be laid to rest and replaced by a much more interactive and user-controlled approach to decision support.

I fully agree with Miller and Maserie’s assessment of the early approaches to computer-based consultation, but I think that the reasons for the limited success and adoption of knowledge-based tools in medicine run much deeper than the issue of their interactive style and philosophy. In this paper I will briefly summarize some of my concerns and suggest solutions that may help define an agenda for efforts during the decade ahead.

The Evolution of Medical AI Research

The first decade of AI in Medicine (AIM) research was, appropriately, largely focused on basic-research issues in the development of knowledge-based decision-support systems. Although all the work in the field was motivated by pressing real-world problems drawn from biomedicine, the research issues were largely fundamental topics such as knowledge representation, knowledge acquisition, causal reasoning, problem-solving methods, temporal reasoning, and models for managing uncertainty. All these topics remain pressing concerns in AIM research, but great strides have been made in each of these areas since the early 1970s when the field began. Ironically, many of the lessons from medical AI research during that era have subsequently been adopted by the general computer-science community, have appeared in operational systems implemented in other segments of society, and have begun to show their commercial value and effectiveness [3]. The medical world is still struggling to deliver such tools, however, and it is not uncommon to hear disparaging remarks about the “failure of medical AI” and the undelivered promises that were early touted for the field.
There is little doubt that AI was oversold in the early 1980s, in large part by the media which, in their eagerness to predict the next great technological breakthroughs emerging from the computer field, failed to understand or to convey the inherent complexities in developing and delivering knowledge-based systems. As one who has worked in the field of medical AI since the early 1970s, I have done a great deal of soul-searching about why the field has encountered the difficulties that it has and why we still do not see a medical AI industry and routine use of decision support by clinicians and other health workers. Although I believe that challenging research issues certainly remain, and there continues to be great promise for a beneficial impact of AIM on health-care delivery and its cost-effectiveness, I have become convinced that the limited use of medical AI in health care today has little to do with the quality of the products themselves; resistance to system use has occurred despite the inherent merit of the methods that have been developed. As I will argue below, many of the problems are, instead, a reflection of the disarray of our health-care system and, more importantly, its failure to build the local, regional, national, and international infrastructure for biomedical computing and communications which will be required before computer-based decision support tools can become routine elements in the clinical setting.

**AIM In Perspective**

If the 1970s were the era of basic medical AI research, the 1980s were the period of adolescence during which the field learned that its promise and effectiveness are tightly linked to other developments in computing hardware and software. I believe that it is no longer wise to view AIM as a discipline separate from other areas of medical informatics; AIM is rather best viewed as a set of methods that must be merged with other key technologies in computer science when building systems and doing research in this field. If we are driven by pragmatic goals to benefit the health-care community, AI provides one set of techniques, but we must be selective in choosing them and must understand how they complement or compare with the other options that may exist. The interdisciplinary nature of medical informatics requires a willingness to be eclectic and to avoid “religious” dedication to any single technique or set of approaches. Our group at Stanford, for example, has in the last decade explicitly attempted to broaden its perspective and expertise beyond medical AI to embrace the wide range of pertinent topics in medical informatics that may be crucial to the effective delivery of decision-support tools: database methods, human-computer interaction, classical statistics, computer graphics, distributed systems, and information retrieval (to name just a few examples). As recent work at the intersection of (for example) AI and decision analysis, AI and Bayesian statistics, AI and databases, and AI and graphical interfaces have shown, it is in the synergies between AI methods and other techniques that the greatest hope for effective systems may lie.

We must resist the temptation to blame practitioners themselves for their failure to embrace the decision-support systems that we have offered to them. In the late 1970s, when I was attending my first scientific meeting in Japan, I was encouraged to hear of an advisory system there that was in routine use by all physicians in a prenatal-care obstetrical clinic in Tokyo. I thought I had finally discovered a system that had been successfully implemented and accepted for routine use and was eager to see it in action. Then I learned the secret of this particular system: it had been developed by the clinic chief and he required all physicians in the clinic to use it if they wanted to keep working for him. Many used it grudgingly, apparently, but they felt they had no choice.