A Framework for Medical Information Science

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A one day workshop on the topic "A Framework for Medical Information Science" was held in October. Three issues were considered: what is Medical Information Science, what are the key research issues, and what are the educational needs. Because of the brevity of the workshop and scope of the topic, no summary conclusions were developed. Individual papers and position statements will be published. This paper reviews the workshop and some of the principal issues discussed.

Key words: Medical Information Science; Medical Education

Introduction

The use of computers in medicine has seen considerable success in the past ten years. With the availabilty of inexpensive microcomputers, there is an ever-increasing interest in how this technology can be applied to office practice. The Symposium for Computer Applications in Medical Care (SCAMC) has been holding an annual meeting to present and discuss developments in this field. The first meeting, in 1977, attracted an audience of under 200; the registration at each of the last three symposia exceeded 2,000. Attendance is equally divided between physicians and non-physicians with the following distribution: one third academic, one third private practice, and one third other health care activities.

In 1983 SCAMC sponsored a one day limited attendance workshop to discuss a framework for Medical Information Science (MISc). The primary motivation for the workshop was a desire to identify in what areas MISc was indeed a science and where it was simply the application of a tool. If this could be determined, then guidelines for a research and education agenda would follow. (An extract from the call for participation is included as an appendix.)

Attendance at the workshop was limited to persons submitting either a paper or a short position statement. The workshop itself was structured as follows:

- Individual introductions and short statements.
- Panel discussion: What is MISc?
- Panel discussion: What are the educational needs?
- General discussion.

Some forty papers were received, and there were fifty participants. Because of the broad scope of the topic and the limited time available, emphasis was placed on discussion and interaction among the individuals. There was no attempt to compile conclusions or recommendations. All participants will have an opportunity to revise their initial submissions. Publication of the workshop papers is planned for inclusion in a special issue of *Medical Informatics* to be issued in August 1984.

Although there was neither a concensus nor a conclusion, I have compiled some of the key points made during the workshop. The selection is personal, reflects my prejudices, but is generally representative.

What is Medical Information Science?

Earlier in 1983 there was a meeting in France which addressed informatics and medical education.[1] Several participants attended that meeting and provided preprints of their papers to the workshop attendees. That of J. R. Mohr (University of Heidelberg) begins with a definition.[2]

> Education in informatics has evolved into several distinct types, e.g.
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> — computer science
> — information systems
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> The computer science concepts seem to be compatible with a concept of informatics as a systems science dealing with the foundations, nature and principles of realization of algorithms. The information systems concept seems to be oriented towards informatics as a methods science dealing with the application of the concepts of computer science to the solution of problems in a particular environment, mostly business and economics. This latter approach seems also applicable to medical informatics with orientation towards solution of problems in the health care field with the methodology and technology of computer science. This concept has been adopted for a specialized curriculum which was introduced in cooperation between the University of Heidelberg and the Heilbronn Polytechnical School in 1972.

In a way it is unfortunate that the term informatics is not in vogue in the United States. We tend to use the term, "computer science" to mean both the generic area, i.e., informatics, and the narrow speciality, i.e., realization of algorithms. Of course, this avoidance of the term was implicit in the title of the workshop.

J. H. van Bemmel (Free University of Amsterdam) felt that MISc was well defined. He presented a model for medical information processing. [3] It consisted of the following six levels of processing ordered by increasing complexity and dependence on man:

1. communication, recording
2. storage, retrieval, data bases
3. computations, automation
4. recognition, diagnosis
5. therapy, control
6. research, development.

Automation has been applied to many of the lower level functions. The goal of MISc is to understand better the higher levels; computer aided support can then be built upon this new knowledge.

E. H. Shortliffe (Stanford University) made the following observation:[4]

> It can be argued that medical informatics is still in a "prescientific era." We build artifacts, our papers describe them, but an underlying theory has thus far failed to emerge. In the field of pure computer science, courses in the mathematical theory of computation exist, but even so, much of that field is characterized by individual experiments and reports of their success or failure. The field of medical informatics has underlying fundamental principles, but we tend to identify and articulate them poorly, and those basic science issues that exist are not generally recognized or accepted. Rarely are scientific activities in the field viewed on an equal level with traditional "pure science medical research."

Among his recommendations was a guideline for publications in this field.

Perhaps one of the most articulate expressions came from M. S. Blois (University of California, San Francisco). [5]

> It is sometimes asserted that medical science is no different than any other science. I disagree strongly with this view; medicine in its descriptions, reasoning, explanation, and prediction draws upon lower level sciences, but physics, for example, does not. Because medicine derives its experimental content from an entire hierarchy of sciences (both "hard" and "soft"), its processing of observational data faces very different problems. This is why there is a "medical information science," and why there is not a "physical information science."
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> It has long been pointed out that medical computing is largely drawn by its technological applications, and that it suffers deeply from a lack of critical inquiry into its own foundations. Moreover, despite this deficiency, it is still the case that research proposals designed to inquire into the fundamentals of the field have been received poorly, and that the support has gone instead into the development of ever more elaborate application systems. As a result, MIS as a science remains more of a research program, or a hope, than a coherent set of accomplishments.

The final word was given by W. S. Yamamoto (George Washington University) in a position paper entitled, "Insisting on a Name Can Blunt Its Impact." He stated:[6]

> The idea that medical information science may constitute a discipline or a special entity in the configuration of academic endeavors in medicine is provocative, but it is superfluous. However, human beings being what they are with respect to their ambitions and their career needs, it is very probable that something called "medical information science" will come to be, and certain practitioners will form organizations, titles, journals, and distinctions in that context. As one who has been involved with computers since very early days, I would like to submit an opinion: "medical information science" would not exist in its present connotation were it not for the existence of computers. Like any other technology which is tool-driven, the essential concepts and the discovery of new understanding coalesce about the subject matter because of the physical tool. Prefix the notion of information processing with "medical" and it seems to be unique. But the human processing of information formed the very essence of the practice of medicine long before the emergence of computers. Physicians were the principal practitioners of medical information processing using the only available tool of their time, the human brain. So, if there is a discipline it differs only by machine.

It was pointed out in the discussion that medical information science has made a major contribution to medicine which is in widespread use: the problem oriented record. It, of course, is not tied to automation.

Having considered the scientific nature of MISc, the discussion turned to why it was important to have it organized as an identifiable identity. The principle issues related to career paths and competition for research and internal support. For example, it was pointed out that – while there were few intellectual differences between studying computer applications to cardiology in a MISc or cardiology organization – there were significant differences in competing for space and research support.

There is also the issue of academic advancement. One sees this in both the clinical and computer science departments. In each case there are established criteria for promotion keyed to the definition of the science or discipline. Persons attempting to work across discipline boundaries often have no basis for evaluation; they are seen as working on an applications area which is outside the interest of the home department. Thus, without an identifiable entity, work in MISc will not be encouraged, there will be few sources for research support dedicated to foster the discipline, and both training programs and the curriculum will be diffused.

What are the Educational Needs?

The discussion on education began with a review of some existing programs in Europe. Both van Bemmel and Mohr have over ten years' experience with programs in this field. The Dutch program is oriented to medical application,[7,8] while the German program is directed more to bioengineering applications. [9] In the case of the medical program, it was agreed that the isolation of a separate course was inappropriate; the material must be integrated into the curriculum. Van Bemmel reviewed a five day training program in medical informatics (Meduc), and G. O. Barnett (Harvard University) described some of the ways he is integrating computers into medical education. [10] A paper by M. J. Ball (Temple University) and R. H. Shannon (Spokane, Washington) provided a perspective in vertical and horizontal curricula; L. C. Gatewood and J. P. Glaser (University of Minnesota) presented the training needs in a broader perspective. Both papers are sufficiently complete to preclude their abstraction for this paper.

It was agreed that there was a need for trained professionals in the health care field. One projection was one Ph.D. plus five support M.S. staff for each major hospital. While this demand was questioned, it was agreed that there were no training programs which could produce large numbers of graduates. When the discussion restricted itself to M.D., Ph.D. graduates, the issue of MISc was again raised. Most graduates could not find appointments unless they completed a residency. Several training programs have been terminated. Few universities had a critical mass which was necessary to provide specialized education in this field.

In a follow-up session open to all SCAMC attendees, several people from major universities asked, "Well, what can you tell us?" The answers were disappointing. There was no concensus for teaching MISc as one more course such as, for example, molecular biology. The material must be integrated into the curriculum. But how? There are a limited number of computer supported aids for teaching decision making (e.g., Barnett and van Bemmel); they may not be sufficiently standardized nor robust enough to allow transport. And teaching how to use devices containing computers really has little to do with MISc.

The training of computer professionals to work in the medical field was only partially considered. We are in a major state of flux. Where ten years ago, the abiity to write programs defined the baseline skill for a computer professional, today that skill is being taught in the third grade. There continues to be a high degree of amaturism in the computing profession. Still, we have difficulty in defining and teaching what Mohr referred to as the information science aspect of informatics.

One model for non-medical participation was based on that of the pharmacist in the health care process. He has specific knowledge and skills, interacts with providers as a professional (and responds professionally) and has his intellectual roots tied to a combination of pure science, medicine, and professional applications. Yet it is probably too early to formalize a parallel profession in the medical information processing field.

Conclusion

The workshop had a large number of participants and a limited amount of time. There was a great deal of interaction, many ideas were presented, and there was a general concensus. This paper attempts to present some of the flavor of the workshop. The revised papers will represent another dimension. If there was a conclusion to be drawn, it might be this:

> It is too early to say exactly what we mean by MISc, where it fits in the academic structure, or who needs to know what. It also is clear that the use of the computer will continue to have a major impact on medicine and health care delivery; furthermore, persons knowledgeable in both medicine and computer science will be required to guide the associated research and development.

One suggestion was that MISc is where biomedical engineering was a decade or two ago. It is in the process of establishing an identity based upon demonstrated results. If this is true, then we have no choice other than to be pragmatic and wait ten years.

To close on a positive note, let me point to some signs of encouragement which may be found in the growing number of texts and collections which are beginning to appear. Branzino has an introductory text;[11] Shortliffe, Wiederhold and Feigenbaum are preparing a text for their medical informatics course, and I am writing a text on clinical information systems. Collections of papers are available from Artech House, Mosley has a series, Springer-Verlag has just issued a series entitled Computers and Medicine, and several other collections or series are in the process. The availability of this literature will facilitate course development and aid in the growth of computer literacy for those who did not get it in the third grade. Once that baseline is established, we should be able to identify what must be presented in further detail.

Post Script

This paper reports on a workshop designed for the medical computing community; it is being presented at a meeting with interests in computer science education. A few comments may improve its relevance to this audience.

The use of computers has grown significantly in medical applications. The initial use was limited to data processing and data analysis. Statistical packages are now routine, data processing for laboratories and administration standard, and computational support for quantified physiology commonplace. The next generation of applications dealt with information processing. This is now the backbone of the hospital information system, database networking, and many of the smaller computer (and microcomputer) applications. Current emphasis is on medical decision making and artificial intelligence. Medical knowledge (and diagnostic methods) are very well suited to symbolic analysis; over a quarter of all expert systems deal with medicine.

From this appraisal, it is clear that parts of MISc are simply applications of computer technology to a specific area, while other parts involve advances in both medicine and computer science. Of course, this situation is not unique; similar statements could probably be repeated for management science, legal services, and many other application areas. Thus, one challenge to the computer science community is to educate students to be professionals who apply their expertise in many different applications areas. Further, there also is need to recognize that there are some multidisciplinary areas which involve both computer science and a host discipline. In the case of medical computing, the ACM has played a major role in coordinating these two activities.[12,13]

As computer knowledge diffuses, many disciplines will find computing to be an essential, integral component. Each field will have to establish what to teach and who should teach. And the computer science community will also have to determine how it will interact with those other disciplines. This paper addressed only medical science. But the issue is not restricted to MISc; it is the natural outgrowth of the phenominal success of our field.

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Appendix: Extract from Call for Participation

Medical Information Science (Medical Informatics) has grown from visionary concepts to practical realities. With the widespread diffusion of computer technology, improvements in computer science, and growth of a market for medical computing applications, there is a need to reestablish what is meant by Medical Information Science. Without a framework for the discipline, it will be impossible to define an agenda for research or identify educational needs.

The objective of this one day, limited attendance workshop is to work toward a framework for Medical Information Science. Three major issues will be considered:

- What is Medical Information Science? Does it differ from the biomedical sciences and computer science, or is it a speciality area in each? Is the computer simply a tool which facilitates the accomplishment of the scientific objectives, or does it fundamentally alter the discipline? Can the field be stratified into a hierarchy which goes from research through the application of accepted knowledge?
- What are the principal research issues? Given a structure for Medical Information Science, what are the major avenues for disseminating existing knowledge (i.e., avoiding the reinvention of the wheel), and developing new knowledge (i.e., research)? What research issues are purely in the area of the biomedical science, computer science, and medical information science?
- What are the key educational needs? What knowledge is required of Medical Information Science professionals, medical students, computer professionals in the medical field, clinical practitioners, clinical researchers, and other health care professionals? How are these needs being met, and what alternate strategies should be explored?

Clearly, the scope of the meeting is too broad to suggest resolution in a one day workshop. Nevertheless, it should be possible to establish a framework for a continued dialogue.