INTRODUCTION TO "REPRESENTATION OF MEDICAL KNOWLEDGE"

William C. Mohler, M.D.

Division of Computer Research and Technology
National Institutes of Health

The topic of "Representation of Medical Knowledge" in computers is identified with a subset of computer science called Artificial Intelligence (AI). This field began in the 1950s, emerged in the 1960s and now has its own monographs(1,2) journal (Artificial Intelligence), biennial international conferences (IJCAI) and its own subcategories (Q334 and Q335) in the Library of Congress cataloging system. Major academic foci of AI were located in Cambridge at MIT, in Palo Alto at Stanford, and in Pittsburgh at Carnegie-Mellon.

In the early 1970s links developed between some people in those schools and individuals at neighboring medical centers. These collaborations were prominent at the First Annual A.I.M. (Artificial Intelligence in Medicine) Workshop which took place at Rutgers in 1975 on the theme of Knowledge Based Systems.(3) This same lineage appeared last year at the First Annual Symposium on Computer Applications in Medical Care in the session on Clinical Executive Decision and Knowledge Bases. (4) These applications dealt largely with diagnostic and therapeutic consultation systems.

Knowledge representation, knowledge acquisition, knowledge engineering and related subjects are still active topics in the AI and AIM communities. Anyone who wants to dig into the intricacies of networks, frames, productions and other knowledge representations will find much active research in this area.(5,6)

However, it seemed appropriate this year at this symposium to look at the problems of representing medical knowledge from another perspective. Three computer-based systems were chosen for this session to illustrate three rather different approaches to the task of making medical knowledge useful in the care of patients.

The first presentation, by Dr. Bernstein and associates at the National Library of Medicine in Bethesda, Maryland, attacks the problem of evaluating, organizing and presenting the essence of a large, complex and dynamic area of published knowledge. Their prototype medical information bank system is designed to provide up-to-date, authoritative answers to questions posed about viral hepatitis by medical practitioners. They organize knowledge as a hierarchical tree structure of text paragraphs, illustrations and citations. This knowledge bank resides on a minicomputer to be purveyed by a variety of output devices.

The second system was created by Dr. Weed and co-workers at the University of Vermont Medical Center in Burlington. Their Problem Oriented Medical Information System (PROMIS) is designed to aid practitioners in collecting and recording information about an individual patient and to organize, integrate and aid in the review of that information. Knowledge about the diagnosis and treatment of disease is built into the content of, and links among, display frames presented on the screen of the computer terminals in their system.

The third presentation comes from Dr. Warner and associates at the Latter-day Saints Hospital in Salt Lake City. Their HELP system (Health Evaluation Through Logical Processing) is designed to examine the significance of new data entering a patient-oriented, computer based medical record. The evaluation occurs in the context of knowledge about the patient already in the record and is performed by logical decision rules, called sectors. Medical knowledge in this system is specified by these decision rules. The results are communicated at various levels of urgency as reports, alerts or alarms.

Each of these systems has rather well defined purposes. Each system is operational and in addition to serving the environment for which it was designed, each can make a valuable contribution in answering two important, interconnected questions:

(1) What kinds of medical knowledge are worth "computerizing"?

(2) What are the design criteria for building useful computer-based systems that will improve the application of various kinds of knowledge to medical care?

Trying to answer these questions is still a bit like trying to decide in the year 1900 how to apply the internal combustion engine to the transportation of goods and people. There are a few recognized successful applications and a number of intuitively attractive projects under development. But there is a great need for documented experience with systems operating under field conditions. Experience is the only sound basis for the design of reliable, efficient, useful production models and for making informed judgements about who needs them and who is actually likely to pay for and use them.
More generally, one can say it is not news that the success of biomedical research and more recently medical technology has created a "knowledge problem."(7,8) The growing mass of information strains human abilities to organize, store, locate, communicate and use the information in caring for individual patients and in managing the delivery of health care. The only way to find out whether putting some of this knowledge into computers will improve medical care is to try. The only way to do this efficiently is to carry the trials to the point where the reasons for success and failure are discerned and documented well enough to guide subsequent efforts reliably.

The literature covering experience with computer applications for the representation of medical knowledge is still a bit sketchy. There are summary papers close to the general field of Artificial Intelligence,(9) and to the use of computers as consultants in diagnosis, prognosis and therapy.(10) The computer application offering the greatest body of experience is undoubtedly diagnostic electrocardiography(11) but there has been little effort to integrate experience from specialized applications like this into a more general body of knowledge and theory about the representation of medical knowledge.

In fact, one of the open questions in the medicine/knowledge/computer business is how much useful generality can be achieved. There are provocative discussions in the literature (3,9,12) but there again only time and hard work will provide experience to indicate the degree to which it will be practical to develop knowledge representations and process models that can adapt easily and well to a wide variety of applications.

Progress toward resolution of these kinds of questions will come from small rather technical workshop meetings and from collaborative projects among investigators with congruent interests. Meanwhile at more general symposia we can admire the work and benefit from the experience of people such as Drs. Bernstein, Warner and Weed, who forge ahead to build and use computer applications in the real world. This experience can be very helpful in guiding research on knowledge representation techniques and in deciding where to place the emphasis in design of new systems and the evaluation of systems in field trials.

3. Proceedings of the Annual AIM Workshops (Sridharan, D., ed) published by The Department of Computer Science, Rutgers University, New Brunswick, New Jersey, 08903