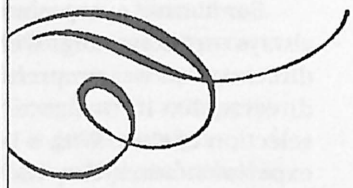
MEDICAL INFORMATICS



by Marie E. Becker

INTRODUCTION

The topic for this paper is an overview of medical informatics in the United States, what it is, how it is used in patient care, and what role librarians play in it. Medical informatics, a term first coined in Europe in the early 1970s (Collen, 1999), encompasses the disciplines of computer science and medicine. Medical informatics is a relatively new field, with its beginning in the 1950s. The first scholarly papers written in the field that was to become medical informatics are found in the literature of the engineering society, Professional Group in Bio-Medical Electronics of the Institute of Radio Engineers (IRE) (Collen, 1999). This group published papers on the term "biomedical computing" in its annual conference proceedings known as the IRE Transactions on Medical Electronics (Collen, 1999). Although the definition of medical informatics may be stated as applying the power of computers to the medical field, there are many variant definitions to be found in the literature.

WHAT IS MEDICAL INFORMATICS?

The textbook definitions of medical informatics are diverse. In the book, *Medical Informatics: Computer Applications in Health Care and Biomedicine,* Shortliffe and Perreault (2001) define medical informatics as "the scientific field that deals with biomedical information, data, and knowledge—their storage, retrieval, and optimal use for problem-solving and decision-making" (p. 21). Another definition, this one from the book *Understanding Medical Information: A User's Guide to Informatics & Decision Making,* maintains, "The tools of informatics are used for the purposes of generating huge amounts of information. Medical informatics is the application of informatics tools and purposes to medical information" (Jordan, 2002, p. 2). Still another definition of medical informatics is from Hersh (2003) who states that it is, "The discipline that focuses on the acquisition, storage, and use of information in health and biomedicine" (para. 1).

Distilling these various definitions, however, into common elements yields the fundamental ingredients involved in medical informatics. These elements are the patient and his or her medical information (input); the speed and accuracy with which computers process and store that information (processing); and making this information (output) available at the right time to clinicians for analysis and decision-making in treating patients and improving health care. Thus, the practical uses of medical informatics are the results of the practical uses of computer applications, in which the world of the computer meets the world of medicine. These practical applications began, appropriately, with the collaboration between a physician and an engineer.

THE ROOTS OF MEDICAL INFORMATICS

When John Shaw Billings and Herman Hollerith used punched cards to process the United States 1890 census data (Collen, 1995), little did they realize the far-reaching effects of their innovation. Billings, a physician and the first director of the National Library of Medicine (NLM), and Hollerith, an engineer, invented a way to process the information of about 62 million Americans. Using Hollerith's punched cards with 288 slots for data, Billings and Hollerith processed the census in 30 days with 56 machines (Collen, 1995).

That process of punching and sorting forged a future for today's computers and their myriad applications, including those for medical informatics. In fact, Hollerith's inventions were later used for epidemiological and public health surveys in the 1920s and 1930s, becoming a novel medical use for his invention (Collen, 1995). Hollerith's Tabulating Machine Company, which he started in 1896, became the International Business Machine Corporation in 1924 (Collen, 1995). Computers evolved from Hollerith's mechanical design to the Electronic Numerical Integrator and Computer (ENIAC) the first electrical, digital computer (ENIAC Museum Online, n.d.). Developed at the Moore School of Electrical Engineering at the University of Pennsylvania, this computer played an important role in World War II. After the war, advances in computers came steadily through the decades. Still, computers experienced a long evolution before they found themselves used extensively in today's medical world. With the invention

of the microprocessor in the 1970s, however, computers became more sophisticated: faster, smaller, and more widely used in the medical field.

THE USES OF MEDICAL INFORMATICS

As the breadth of computer applications and the depth of medical science grew, they intersected in a logical union. Collen (1995) writes in *A History of Medical Informatics in the United States: 1950 to 1990,* "the application of electronic digital computers to medicine first appeared in the late 1950s in the bioengineering publications" (p. 38). As mentioned previously, this date also coincides with the scholarly papers written about the field which is now known as medical informatics.

Primarily, these first computer applications were relegated to the biomedical research world. One reason for this limited use might have been the expense of using computers and the technical difficulty of doing so. Another reason might have been the lack of programming languages, the software that allows users to instruct the computer. Without flexible programming languages to provide instruction, computer applications still had a long way to go to become ubiquitous.

In 1966, however, the appearance of the Massachusetts General Hospital Utility Multi-Programming System (MUMPS) provided the impetus for wider use. Developed in 1966 by Neil Pappalardo, Curtis Marble, and Robert Greenes, MUMPS was tailored to medical applications. This language facilitated the implementation of the Massachusetts General modular Hospital Information System (HIS). The HIS became the "most commonly used hospital system in the 1970s and 1980s" (Collen, 1995, p. 193).

Applications of these early hospital information systems centered on record keeping, tabulating and collecting data, billing, admissions and discharges, and printing and tracking reports. These systems typically "met the operational needs of the hospitals' units, initially including census management, patient billing, and general accounting," according to Perreault and Shortliffe (2001, p. 360). However, with the introduction of integrated rather than modular systems, computer usage for direct patient care became more feasible and more meaningful. The University of Utah developed such a system for the Latter Day Saints Hospital in Salt Lake City (Perreault & Shortliffe, 2001).

Called HELP, this system included decision-support logic, an important new feature for a hospital information system. The integrated-logic enabled HELP to provide patient-specific information, which was entered and then processed from the various departments in the hospital such as the laboratory and the pharmacy. For example, HELP issued medication alerts when a patient's current medication conflicted with those to be administered in the hospital. HELP also sent alerts when a patient needed to have a blood draw to monitor potassium levels if he or she were on a diuretic.

As these new systems were developed and deployed during the late 1970s and early 1980s, they proved to be integral to patient care. Physicians who became familiar with the benefits of medical informatics in the hospitals saw firsthand the power of computers in providing them with concrete information. This information could influence the accuracy of their clinical diagnoses and render positive outcomes for patients. They began adopting the technology for use in their private practices, with ever-advancing breakthroughs in technology making computers more affordable. About 80 percent of physicians "had some type of computer in their offices by the end of the 1980s" (Collen, 2000, p. 205). During the 1990s, medical informatics began to be used for quality control and management in hospitals. Medical imaging and surgical procedures were assisted by these powerful applications.

Medical informatics influenced the development of evidence-based practice guidelines and health information management. Medical informatics also fostered the growth of telemedicine (Collen, 2000). With the arrival of the Internet and the World Wide Web, patients became assertive health information seekers. The NLM instituted MEDLINE, which provided free access to health information via the Internet, GratefulMed, and PubMed (Collen, 2000). Medical informatics, a term having its roots in computers, had become defined by them.

THE LIBRARIAN'S ROLE IN MEDICAL INFORMATICS

From its earliest beginnings, in fact, librarians had a role in medical informatics. John Shaw Billings, one of the innovators of the 1860 census-processing project, was not only a physician; he also was the director of the NLM. Combining his ties with the NLM and his innovative nature, Billings began the *Index Medicus* in 1879. The first issue listed 18,000 articles (Lindberg, Schoolman, 1986). By the early 1960s, however, the *Index,* as it existed, became unmanageable. The number of listed articles continued to multiply, reflecting the growth in the body of biomedical knowledge as reflected in the published literature.

In 1964, Graphics Arts Composing System (GRACE) was used to compile the *Index* (Lindberg, Schoolman, 1986). GRACE, custom-made for the NLM, typeset pages and accepted input directly from magnetic tapes. A forerunner for the Medical Literature Analysis and Retrieval System (MEDLARS), GRACE now resides at the Smithsonian Institution (Lindberg & Schoolman, 1986).

What Billings recognized and acted upon, however,

underscored a fundamental principle of librarianship. This key aspect is that information must be organized and must be made accessible to and retrievable by the user, and that librarians form the frontline of information organization, access, and retrieval. Recognizing librarians' integral role in medical informatics, the Medical Library Association (MLA) formed the Medical Informatics Section in 1988. By forming this section, the MLA sought to work toward "establishing bridges between medical librarians and medical informatics professionals" (Humphreys, 1998, para. 4). By 1998, section membership totaled 412 and had more than $12,000 in its treasury (Humphreys, 1998). The Medical Informatics Section maintains strong ties with the Hospital Libraries and the Consumer and Patient Health Sections. Strong synergies also exist among the Informatics sections and the sections for Medical Library Education, Medical School Libraries, and Medical Society Libraries, Research, and Technical Services.

All these sections touch medical informatics in one way or another. The librarians who are involved in them exercise not only their traditional roles as organizers and retrievers of information, but assume multiple roles as educators, evaluators, and technologists. As the field of medical informatics advances, librarians will continue to assume an ever-important role in the field. Helping their clients navigate the sea of information to discover relevant information will continue to be integral to librarianship.

CONCLUSION

From its rudimentary beginnings to its sophisticated state today, medical informatics will continue to mark our lives as patients, when we become them, and as librarians practicing our profession. Although medical informatics has done much to improve health care and the way medicine is practiced, it still has much to accomplish. As Hersh (2004) states:

> Although the case for adoption of improved healthcare informatics appears quite compelling, significant barriers to its use remain ....These include cost, technical issues, system interoperability ...and a lack of a well-trained clinician informatics workforce to lead the process. (p. 2273)

However, he continues, "Health care IT is not a panacea for all that ails medicine, but it has the potential to improve the quality of care as well as the personal experience for patients" (p. 2274).

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