The National Library of Medicine and the American Medical Information System: A Physician's Perspective

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ABSTRACT

During the past 150 years an excellent health sciences information system has been developed in the United States. Led by the National Library of Medicine (NLM), the system grew along traditional lines until after World War II, when medical researchers, educators, and practitioners produced an enormous amount of new information. To cope with this growth, the power of computers joined traditional librarianship and MEDLARS was born. In 1965 Congress passed the Medical Library Assistance Act, which enabled NLM to lead the nation's and the world's health sciences professionals into the Information Age. Much has been accomplished by NLM, yet much remains to be done to make health information available cheaply, easily, and quickly to all who need it.

THE NATIONAL LIBRARY OF MEDICINE (NLM) and the medical information system that has evolved over the past 150 years are essential elements in the American health care system. This information system has been compared to the elaborate road and aqueduct system built by the Romans some 2,000 years ago that was such an essential element in the spread of the Roman Empire. Neither the empire nor today's health care system could have achieved their preeminence without a strong infrastructure. Yet there is a significant difference. While the Roman road system was recognized as critical to the expansion of the Roman empire, NLM and the American medical information system have remained relatively unknown and unrecognized in the United States, even to many of the health care workers for whom this resource has been so valuable.

This paper will describe briefly the reasons for the present American medical information system, then describe in more detail the relationship of the system and NLM to medical research, education, and practice. Finally, it will offer some opinions on future needs in both the medical information system and NLM. Although this paper has been written from the vantage point of the physician, many of the observations it contains apply as well to the large numbers of dentists, nurses, veterinarians, and allied health professionals who use the American medical information system.

DEVELOPMENT OF THE AMERICAN MEDICAL INFORMATION SYSTEM

Perhaps the first major reason for the medical information system, and certainly one of the most important, was that medicine itself changed radically during the last half of the 19th century. From a backward-looking, traditional profession it changed into one that looked forward, questioned everything, and sought answers through scientific experimentation. No longer was it held that "in a living organism a specific influence, the so-called 'vital force,' controls the more intimate and important physiological processes"[1]. A scientific revolution was taking place. Although it was led by the Europeans, many American physicians went to Europe to participate and to bring home new ideas and techniques. At the same time the traditional teaching functions of universities and the better medical schools began to include research functions [2]. To be useful, research needed to be published, so others could verify it and put it to use. Paraphrasing Osler, Thayer wrote in 1919 that "when you have made and recorded the unusual or original observation, or when you have accomplished a piece of research in laboratory or ward, do not be satisfied with a verbal communication in a medical society. Publish it" [3].

The researchers of America took this advice. It is interesting to note that the novelist Sinclair Lewis wrote about Martin Arrowsmith, the young physician going to work for the first time in a research institute, that "there was a department of publications, whence were issued the Institute reports, and the *American Journal of Geographic Pathology,* edited by the Director . . ." [4]. The 1910s and 1920s saw the rise of medical philanthropy in

America. This period also saw the advent of specialization and subspecialization, with many new medical organizations coming into being, often with their own publications. The published literature continued to grow.

The post–World War II era found the country optimistic about eliminating certain diseases as the cause of death. Vast sums were spent on research to find the causes for polio, measles, cancer, and heart disease. As a result, the literature again grew rapidly, more rapidly than the system then in place could handle. Lock has written, "When faced with information overload, the scientific community has always found a solution" [5]. And indeed it did. In this instance, NLM introduced the use of computers into the previously manual process of organizing and providing access to the medical literature, bringing American medicine inexorably into the Information Age. It soon became apparent that most research results were not reaching the practicing physician to improve the nation's health. To correct this problem, in 1965 Congress passed the Medical Library Assistance Act, which supported medical library development, the training of medical librarians, research in the applications of newer technologies to the provision of library services, the Regional Medical Library network, and other projects. It was at this time that the National Library of Medicine became proactive rather than reactive and began to extend access to its system, which contained essential information for the research, academic, and practice communities. It continues to work very hard, within the constraints of a federal organization, to bring the nation's health care community into the Information Age.

Research

The American medical information system has evolved in response to the need of health care professionals for quick, easy, and affordable access to information. For much of its existence, NLM has responded to the needs and the output of medical researchers, both basic and clinical, whether Ph.D.s or M.D.s. This is not to say that the library has not served its other constituents well, but its existence is predicated upon the collection, organization, and distribution of the scholarly literature in the health sciences, much of which is produced by the medical researchers of the world. It was no surprise, then, when in 1959 construction of the new NLM building was begun on the campus of the National Institutes of Health, the nation's largest governmental agency outside the Department of Defense.

Until World War II, medical research was generally carried out in one or another of the medical disciplines: a basic science, such as physiology, or a clinical discipline, such as cardiology. Laboratories did not need to be elaborate, and good medical libraries organized their collections and some of their services according to the medical disciplines. In the late 1930s and 1940s there were many changes in medicine, including the development of antibiotics, antimalarials, and plasma expanders. It was during this era that American science and technology, including medicine, changed from the traditional discipline-based system to systems that crossed discipline lines [6]. Following World War II there came mission-based "big science," which set out, for example, to put a man on the moon and to eradicate smallpox. A decade or so later came the problem-based system that sought to alleviate, if not eliminate, certain conditions in our society—poor housing, environmental pollution, and inequality of job opportunities. Although the discipline-based organization of information and traditional libraries served the earlier system well, they often did not serve the mission-based and problem-based systems as well. Our traditional libraries had focused on the major biomedical disciplines because they represented major needs and consumed enormous resources. More importantly, information and science technologies did not yet have effective methods for linking or moving among the discipline-based information sources for interdisciplinary research [7].

Information transfer among researchers is also affected by competition and its inherent secrecy. Competition among researchers has always been present, but today there are projects in health sciences laboratories that may potentially be patented for large economic, if not honorific, gain. Nelkin has written that while patents were intended to avoid secrecy and encourage invention, in some instances they lead to secrecy, because of competition for priority [8]. This is particularly true today with regard to genetic engineering and the production of vaccines against various heretofore unknown viruses.

A significant area for research is the potential for collecting, storing, and making available vast amounts of raw data electronically. Morowitz editorializes wryly on storing DNA sequences of various organisms, up to and including pachyderms, on electronic media [9]. His instructions for making an elephant are to "go to the library, check out the floppy disk that says Elephant, Asian (*Elephas maximus*). . . ." A less frivolous example might be

storing all the raw data from the Framingham longitudinal study on the incidence of cardiovascular disease. Indeed, it might be possible to publish electronically the entire human genome, a feat that at first seems as remote as counting the world's molecules. Databanks of genetic information that provide pieces of the puzzle are in existence.

The ultimate research subject in the Information Age is information itself. A great deal needs to be learned about systems for acquiring, organizing, storing, and distributing the world's knowledge about health and disease. Vast and fundamental changes are being made in methods of scholarly communication. These changes are evolving principally through the marketplace. They urgently need scientific examination.

Education

Osler said it as well as anyone: "A physician who does not use books and journals, who does not need a library, who does not read one or two of the best weeklies and monthlies, soon sinks to the level of the worst cross-counter prescriber . . ." [10]. Osler's opinions were certainly not unique for his time. The medical education revolution, in which he participated so actively, brought students into the hospital's wards and laboratories, where they were participants in the learning process, developing their capacity for thinking critically, not merely memorizing facts [11]. Clearly, the emphasis was shifting from didactics to practical instruction, as in the German system. As early as 1904, leading medical colleges were urged to provide students with adequate instruction in methods of bibliographic research in order to prepare them to use libraries for the rest of their careers [12].

During the next half century, subspecialties proliferated, learned societies were organized to promote education in the subspecialties, and the medical knowledge base grew enormously. Each medical school department felt compelled to deliver large amounts of information considered essential for the student. Alan Gregg, sensing the return of didacticism, wrote in 1957 that "no school of medicine is worthy of the name that does not teach its students how to learn from experience . . . , how to observe and reason wisely, and how to compare their work with what has been observed and thought elsewhere, by others and in other times" [13].

In the Alan Gregg Lecture for 1980, Tosteson carried this idea one step further. He noted that "the goal of education is to promote learning, acts of learning, and style of learning and not just the storage of important files of information" [14]. He emphasized that faculties for medical schools should direct more attention to how, rather than what, students were learning. He added, "Increasingly, medical information will be stored not in the minds of doctors or in written records but in computers. Medical students must become comfortable with these new tools."

These ideas were advanced yet another step when, in 1984, the Association of American Medical Colleges (AAMC) published *Physicians for the Twenty-First Century* [15]. Written by a panel of national educational experts, it responded to the perception by many that there was a general erosion in the quality of education for physicians, "an erosion that has not been arrested but is instead accelerating." The panel arrived at five major conclusions and made twenty-seven recommendations to the nation's medical educators, stressing such matters as limiting memorization, improving information-collecting skills, requiring scholarly endeavors, and incorporating information sciences into the general professional education.

The National Library of Medicine is actively engaged in programs of interest to educators. Its Lister Hill Center, in conjunction with professional organizations, is using up-to-date technology to create prototypes for assisting medical and dental schools in the education and continuing education for professionals. The computer-assisted curriculum delivery systems program has five videodisk projects under way in the areas of medical pathology, mental health, orthopedic surgery, radiology, and dental case simulation. Other branches in the Lister Hill Center develop prototype instructional products, conduct research to improve media use in education, and demonstrate programs in information transfer technology.

In the 1970s NLM and those concerned with medical education realized that faculty at the academic health sciences centers, the very people who should be teaching health sciences students how to access health information systems, had not integrated their own institutional information management systems. In 1982 Matheson and Cooper published a monograph entitled *Academic Information in the Academic Health Sciences Center: Roles for the Library in Information Management* [16], based on a study supported by NLM and AAMC. They made an excellent summary of the problems involved, defined the barriers (economic, faculty and staff anxiety about new technology, lack of interest by some, etc.), and made suggestions regarding their removal. Soon after the AAMC report appeared, NLM responded to the

recommendations by supporting a few contracts for planning institutional information systems, and in 1983 the library formally announced the Integrated Academic Information Management Systems (IAIMS) Grants Program as a new initiative in its Extramural Programs. IAIMS grants support the planning and development of integrated information systems, and research related to IAIMS. By the summer of 1986, ten institutions and professional organizations were receiving IAIMS support. NLM also promoted the IAIMS concept by sponsoring IAIMS symposia in October of 1984 and March of 1986. Clearly, a great deal of funding will have to come from sources other than the federal government if these systems are to be realized in the near future in many institutions and if they are to be linked together in a national network.

Practice

The National Library of Medicine and the medical information system have long been available to practitioners. A few have used them extensively, especially those who practiced in the most well-equipped hospitals. Yet until the last decade or two, most practitioners have not used the system, preferring instead to use their own books and journals, or to seek the advice of a colleague. Thanks to new technology and the expanded health information network of 4,000 health sciences libraries fostered by the Medical Library Assistance Act of 1965 (MLAA), many more people are now using the system.

MLAA stimulated most hospitals in the country, either individually or through consortia, to offer library services to their staffs. In addition, many now have facilities to search MEDLARS databases online at NLM and other organizations, including medical schools that lease the databases. Additionally, the Joint Commission for Accreditation of Hospitals has encouraged the availability of good information resources as a criterion for accreditation. As a result of these and other activities, the number of domestic online users of MEDLARS databases increased from 525 in 1975, four years after its beginning, to 4,280 in 1985. As of April 1986, this figure has risen to 5,556. Literature searches performed on the NLM computers have increased from 460,110 in 1975 to 2,967,597 in 1985. Over 50% of these searches were done for patient care. Direct access to the system by physicians and other health workers has grown much more slowly. Some of the reasons for this are: the general conservatism of physicians; the expense of the equipment; the complexity of the search process; the unavailability of good software packages; the unnervingly constant flux in the industry, so that a system appears to become outdated almost from the time of purchase; and the lack of adequate instruction on the use of medical information systems by many of the nation's medical schools [17]. This is being changed with new systems and software, such as BRS Colleague and NLM's Grateful Med, designed specifically for health professionals who are searching the databases themselves.

A critical mass of America's physicians has acquired personal computers; therefore, more software producers will soon find a market that is profitable for medically oriented programs. For example, an experimental program in rural Georgia called Georgia Interactive Network (GaIN), funded by a grant from NLM, links rural practitioners with a medical school library. It also provides an electronic mail system so that the practitioner can receive information rapidly from the librarian or do his or her own search [18]. There is the story (now well known in the medical information world) of the internist with a desk-top computer whose patient presented with a numb chin. As the patient was directed to another room to prepare for the physical examination, the internist typed "numb chin" to search an NLM database using BRS Colleague. The response was a reference to an article and abstract on lymphoreticular malignancies infiltrating the mental nerve, which could cause this symptom [19]. And indeed, that is what the patient had. While this example is so unusual it bears repeating, it illustrates the hoped-for future of a national medical information system. It should be an added brain, capable of storing an enormous amount of information that is rapidly, affordably, and easily accessible, day or night.

Because of the vast potential for medical information systems, the learned societies and the accrediting bodies of the medical specialties (such as the American Board of Internal Medicine) are slowly becoming involved. They are especially concerned with the use of electronic systems for continuing education. In theory, at least, a first-rate information system would eliminate much of the need for traditional continuing medical education. No longer would there be a need to return to the medical center for a three-day "brain dusting," except perhaps to learn new procedures or techniques. This obviously has serious ramifications for many medical education organizations.

What of the Future?

In retrospect, it seems that it would have been relatively easy in 1890 to predict what happened in medicine up to World War II. Thereafter, it would have been clearly impossible, due largely to profound changes in technology. Because of the current rapid acceleration of change, predictions beyond five years seem useless. Yet, a clear understanding of the accomplishments in medical information science over the last 150 years and a glimpse of the near future suggest definite needs in research, education, and patient care.

From a research standpoint, it is clear that as the health sciences enter the Information Age, vastly more needs to be known about information itself, its creation, collection, distribution, and use. There must be theoretical research and practical research, systems research and single-unit research. It is the perception of some researchers that, with the proletarianization of health sciences information that has occurred since 1965, the needs of health sciences researchers themselves have not been adequately met. This has not been validated; it is only one example of a problem that needs further investigation. Researchers in the health sciences look to NLM for leadership in this important field.

The world's health sciences researchers need information from many disciplines and interdisciplinary fields. A modern respiratory physiologist may need to read the physics literature, a medical geneticist the sociology literature. These should be accessible through the workstation used to access biomedical information. This is another area in which NLM must take the leadership role.

Academic health sciences centers, hospitals, and clinics in America need to make significant progress in integrating their information systems. This has begun; it must accelerate. Despite the U.S. leadership in bibliographic databases in biomedicine, some European countries have taken the lead in the integration of their information systems. Administration-devised data processing systems, pharmacist-devised pharmacy information programs, or technologist-devised laboratory and radiology systems are not adequate for the needs of the future. Practitioners must take an active role in forming the new integrated systems to meet their information needs.

It is now time to raise the new medical specialty, medical informatics (or medical information science), to an equal academic footing with medicine, surgery, and the other traditional departments. It is an interdisciplinary specialty, like some of the basic sciences or perhaps medical genetics. It is an important specialty for the 21st century. Instruction in the use of modern information retrieval systems must be part of a health professional's education. A few schools are doing this, but most are not. Professional associations, specialty societies, accreditation boards and librarians must help practicing health professionals acquire knowledge about what systems are available, about what works best for a particular specialty, and about specific uses of medical informatics.

From the practitioner's standpoint, searching the literature for citations—a traditional method of answering requests for medical information for the past 150 years—is not the best means of providing information. The best method is a system that gives *the* answer, or the best answer known at that time. What happens when a person taking aminophyllin is given cimetedine? Who should receive hepatitis B vaccine? These are specific questions for which specific, consensual answers are available today in the published literature. Creating systems to provide such answers is a challenge for the near future.

Some of the nation's health information problems do not fall under the rubrics of research, education, and practice. A good example is the lay health education literature, which now, as always, is in disarray [20]. Organizing it will be a large task best done by a consortium of workers, professional and paraprofessional, from all branches of the health sciences and the lay public. NLM might help with the organization of such a consortium, then offer consultative advice about collecting, organizing, and distributing the literature, something it already knows well how to do.

Finally, the National Library of Medicine's sesquicentennial year is a reminder that the value of history to learned professionals must not be forgotten. NLM's "History of Medicine" collection and similar collections in other scholarly libraries in the country must be nurtured and preserved. They are our heritage. Without them the health sciences, and medicine especially, would be no more than a trade.

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