Developments in Health Sciences Libraries Since 1974: From Physical Entity to the Virtual Library

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ABSTRACT

THIS ARTICLE PROVIDES AN OVERVIEW of the shaping forces in health sciences libraries during the last two decades and a discussion of selected developments which had a profound effect on their evolution from the physical entity to the virtual library. These developments include the advent of online searching, the development of integrated library systems and networked resources, the expansion of interlibrary loan and document delivery systems, and the concept of the Integrated Academic Information Management System (IAIMS). The contributions of the National Library of Medicine (NLM) to health sciences libraries and biomedical communications are described. Conclusions and observations suggest that libraries and librarians will play a greater role in information access and management than they have in the past as networked information continues to expand.

INTRODUCTION

When the Ptolemies created the Alexandria Library around 300 B.C., they could not have imagined in their wildest dreams that civilization's store of knowledge would someday reside on microchips and be instantly retrievable by computers. They created something entirely new in their day; a general reference library where scholars could come and study books they themselves could not afford in their personal collections. To create a usable library, however, they also had to invent library science, a system for organizing and cataloging the collections. This work was accomplished by appointing a chief

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librarian, Zenodotus of Ephesus (Casson, 1985, p. 162). Unfortunately, the library at Alexandria was destroyed in 42 B.C. when fighting ensued between Julius Caesar's forces and opponents of Cleopatra. The idea of the "library," however, had been born and has flourished throughout the world's civilizations until this day and will likely continue, albeit perhaps in a different guise than in the past.

The Alexandria Library was part of a complex where students could carry on varied pursuits. It had a dining hall, private studies, laboratories, and a promenade for thoughtful strolling. In short, it was a place people would want to go to learn, reflect, and study, as well as create. Until fairly recently, perhaps until the last ten years, the library was still largely considered a place. But all things change, and the library is now often referred to as the "virtual library," a term coined in 1990. A "virtual library" is described as "a system by which a user may connect transparently to remote libraries and databases using the local library's online catalog or a university or network computer as a gateway" (Saunders, 1992, p. 66). In the "virtual library," it is not necessary to come to a specific place to use the library's materials.

Shaping Forces

Libraries have undergone many changes during the last twenty years. Several societal forces which have worked to shape health sciences libraries during the last two decades are the information explosion, computer technology and telecommunications, and eeconomic pressures. The incredible rate of new scientific publications has been well documented. In *Science Since Babylon,* Price (1961) charted the growth of science in published form and found it to be exponential rather than linear. A recent article in the *Chronicle of Higher Education* stated that: "Publication of scientific journals began in about 1665.... In 1800, there were about 100 journals; there were 1,000 by 1850, and some 10,000 by 1900. Currently there are close to 100,000 journals, and, since the seventeenth century, their number has doubled every 15 years" (Gifford, 1992, p. A24).

Since no library can hope to store or purchase this vast amount of material, there is an increasing shift from ownership of materials to access—the shift from the physical entity to the virtual library. Fortunately, computing and telecommunications technologies are providing rapid electronic retrieval and document delivery systems to the vast reservoirs of knowledge available.

Advances in technologies in the 1970s and 1980s created a new infrastructure for health sciences libraries and changed the way they function and provide services. The introduction of MEDLINE in 1971, the development of end-user searching systems, and the advent of

national networks have altered the service roles of health sciences libraries radically, just as the introduction of integrated library systems changed the way internal library functions are performed. As the librarian's world has changed, so has that of the client, the researcher, the educator, and the clinician. Personal computers have become commonplace, campuses are "wired," and sophisticated computerized diagnostic tests are the norm in hospitals and academic medical centers.

Since World War II, the burgeoning health care industry and its rising costs have had a marked impact on health sciences libraries in both academic medical centers and hospitals. In 1978, the health care industry accounted for 9.1 percent of the gross national product (GNP), up from 6.8 percent ten years earlier (Crawford, 1981, p. 2237). By 1990, health spending comprised 12.4 percent of the GNP (U.S. Department of Health and Human Services, 1991, p. 4). How has this affected health sciences libraries? An analysis of several surveys (Crawford, 1983, p. 17) shows that, during the 1970s, medical school libraries increased by 25 percent from 101 to 126. Hospital libraries also increased by 13 percent from 1,727 to 1,949. Other types of health sciences libraries, such as those of state or county medical societies, decreased by 59 percent.

During the 1980s, however, the trend in growth of hospital libraries began to reverse. Changes in patterns of health care delivery, from hospitals to outpatient centers, for example, in combination with limits on hospital income caused by government regulations, began to decrease the money available to support library services. At the same time, the spiraling costs of publications and the increased use of computer technology raised the costs of running hospital libraries. A recent survey (Glitz et al., 1992, p.179) indicates that, in the period 1984-89, hospitals have closed their libraries or cut library staff and services in an attempt to control costs. Hospital libraries today must continually struggle to define the role of the library and its contribution to health care and to the bottom line.

Although academic health sciences libraries have not been eliminated to control costs, they have been forced to reduce purchases of books and journals, and, in some cases, staff, to balance their budgets. Increased pressure to purchase new electronic services and products adds an additional burden.

This situation has been well reported in the literature and has been a topic in the *Chronicle of Higher Education* on numerous occasions during the last several years. For example, "Rising Costs and Dwindling Budgets Force Libraries to Make Damaging Cuts in Collections and Services" (Nicklin, 1992, P-A1) and "Setting Budgets for Libraries in Electronic Era" (Gherman, 1991, P-A36) reflect the

concern of the world of higher education as the recession forced higher education to reduce and control expenditures.

Analysis of the 1992 periodical price index shows an increase of 12.2 percent in the average price of U.S. periodicals over 1991 (Carpenter & Alexander, 1992, p. 22). The costs of science materials have risen particularly sharply. A brief look at the *Bowker Annual* in 1971 and 1991 shows a remarkable upward spiral during those twenty years. The average price for a medical periodical in 1971 was $27 (Henderson & Schick, 1973, p. 330) compared with $249.94 in 1991 (Barr, 1992, p. 483). Another study shows the average price per *Index Medicus* title as $280.92 in 1992, up from $184.20 in 1988 (Fortney & Basile, 1992, p. 8). Is it any wonder that libraries are now discussing access issues rather than collection-building issues?

Developments in the Evolution of Health Sciences Libraries

The previous brief overview touched on several of the major societal forces which influenced the development of health sciences libraries over the last two decades. In this limited space, it is not possible to review all the factors which have had an impact on their evolution. What will be examined in this article are several selected developments which had a profound effect on their evolution: the advent of online searching, the development of integrated library systems and networked resources, the expansion of interlibrary loan and document delivery services systems, and the concept of the Integrated Academic Information Management System (IAIMS). Other developments, such as the growth of instructional and educational services and clinical library services, are discussed elsewhere in this issue.

Special attention must be given to the leadership and the contributions made by the National Library of Medicine (NLM) to health sciences libraries and to the world of biomedical communications throughout the years. The role of the NLM will be included as appropriate in various issues discussed as well as in a section devoted solely to it.

The Online Revolution

When MEDLINE was introduced by the National Library of Medicine in October of 1971, no one could have predicted the revolutionary impact it would have on access to health sciences information. Today the most remote corner of the world, with a telephone line, can access a multitude of databases. The decade of the 1970s was one of rapid growth in the online industry; new vendors emerged, databases were developed, timesharing and new communication

methods reduced access costs, and search and retrieval systems were improved.

Initially, MEDLINE was made available through the Regional Medical Libraries. In 1981, there were more than 1,800 users of the twenty MEDLARS databases. By 1991, 60,000 access codes had been assigned to access the now more than forty databases (Lindberg, 1992, p. 1). Additionally, commercial vendors such as DIALOG Information Services and Bibliographic Retrieval Services (BRS) offered hundreds of databases in many subjects.

For the health sciences librarian, proliferating online information resources created a whole new role—that as a search intermediary. To some, online searching provided increased visibility and respect for librarians as professionals. In the early 1980s another revolution occurred with the introduction of user-friendly systems which allowed the end-user to perform database searches with little or no training. Even though the NLM did not introduce its own system for end-users, GRATEFUL MED, until 1986, the phenomenon had become widespread through such commercial systems as BRS AFTERDARK, Dialog's Knowledge Index, BRS Colleague, and Paperchase, an NLM grant-developed system.

As libraries became more automated internally, and as librarians became more sophisticated in the use of computers to deliver services, the idea of mounting bibliographic databases locally emerged. In 1984, the NLM announced the availability of MEDLINE subsets which could be licensed for local use with either commercial or locally developed retrieval software. Early models of local systems were the mini-MEDLINE system developed at Georgetown University (Broering, 1985) and MaryMED, developed at the University of Maryland at Baltimore.

By the late 1980s more than forty such local systems existed in health sciences libraries. Another milestone was reached in 1987 when the NLM licensed MEDLINE to commercial vendors for distribution on CD-ROM products. This increased the end-user searching population even more. What has all this meant for libraries? There were, and still are, many debates about whether end-user searching would eliminate the need for librarians. As the number of mediated searches tumbled, librarians feared for their livelihood. Looking back on this debate of only a few years, one can say that their fears were unfounded. What has occurred is an enormous increase in the need for education and training of the end-user. The database search intermediary has now become the consultant, the teacher, and even the navigator through the maze of databases and networking. The need for the librarian to take on this new role is further supported

by the movement of many medical schools from traditional lecture to problem-based learning curricula.

Two reports of the Association of American Medical Colleges in 1984, *Physicians for the Twenty-First Century* (the GPEP Report), and the *Symposium on Medical Informatics* in 1986, both recognized that students must become lifelong learners. In order to do this, they must be able to locate, retrieve, and analyze new information which resides in databases and other sources. Librarians now face the challenge of becoming full partners with educators in the process so that the acquisition of information science skills will become an integral part of the curriculum.

Integrated Library Systems and Networked Resources

Goldstein (1983) noted that some of the truly pioneering work in library automation occurred within the biomedical community. The development of the integrated library system for use in a single library is such an example. Central to this concept is the master bibliographic file around which all functions, such as cataloging, circulation, and serials check-in, and the online catalog, revolve.

Experiments with large-scale integrated library systems in the 1960s were found to be too costly for individual libraries. During that time, however, two major events occurred that would have a profound effect on libraries in the future—the establishment of OCLC in 1967 and the adoption of the MARC II format and distribution service of the Library of Congress in 1968 (Goldstein, 1983). Access to networked cataloging resources, such as OCLC, allowed the cost of automation to be shared by many and changed the way internal resources for bibliographic control were allocated, facilitating the introduction of the online catalog into integrated library systems.

The advent of powerful inexpensive minicomputer systems in the 1970s spurred the development of integrated library systems, although early efforts using minicomputers focused on single functions such as circulation and serials control. The National Library of Medicine supported an early experiment with an integrated library system at Minnesota in 1972 (Brudvig, 1975). By 1978, the NLM had begun the development of an integrated library system (ILS) at the Lister Hill National Center for Biomedical Communications which was designed as a demonstration project for all sizes of libraries. This ILS was subsequently made available for purchase through NTIS, and, in 1983, OCLC decided to market the system under the LS/2000 trademark (U.S. Department of Health and Human Services, 1984). This proved to be a very popular system for medium-sized health sciences libraries as they sought to automate

their functions. The University of Maryland at Baltimore was the first academic health sciences library to install the ILS developed by NLM in 1981 (Feng et al., 1983). Additionally, during the early 1980s, both Washington University (St. Louis) and Georgetown University developed minicomputer-based integrated library systems independently—BACS and LIS respectively (Broering, 1983).

Integrated library systems have evolved over the last ten years from handling basic internal library functions such as serials control and cataloging, to systems which provide public access to numerous types of services. In addition to the online catalog, clients may find access to locally based MEDLINE and other databases, to the Internet via a gateway, and to electronic mail with services such as interlibrary loan and article reproduction. Early models of such systems include the LIS already mentioned and Electronic Access to Reference Services (EARS) at the University of Maryland (Weise & Borgendale, 1986). The idea of the "library without walls" became widespread during the 1980s as a result of new networking and telecommunications capabilities especially in academic settings. Now access to information may no longer require clients to come to the library physically—merely to access it electronically. The virtual library is definitely becoming a reality.

This thumbnail sketch of the history of integrated library systems cannot be viewed in isolation from other developments. Improvements in bibliographic control during the 1970s and 1980s allowed increased networked resource sharing and thereby improved access to information for library clients through automated interlibrary loan and document delivery systems. These developments are discussed in the following section. Furthermore, the Matheson and Cooper report (1982), also discussed in a later section, gave the impetus for health sciences libraries to become involved in information management beyond their walls and to expand automated services in Integrated Academic Information Management Systems.

Interlibrary Loan and Document Delivery Systems

Health sciences libraries today can choose among a variety of interlibrary loan systems and networks to obtain materials for their clients. They may, in fact, be members of several consortia or networks. The Regional Medical Library Network, now the National Network of Libraries of Medicine (NNLM), supported by the National Library of Medicine, has been the foundation for interlibrary loan among health sciences libraries since its inception in 1965. It is worth noting some of the milestones in bibliographic control which led to today's sophisticated online interlibrary loan request routing system, DOCLINE, supported by the NLM and used by members of the NNLM.

In 1973, NLM developed the SERLINE database, which originally included information on serials owned by NLM but later was expanded to include holdings information for the regional medical libraries and resource libraries (Bunting, 1987, p. 24). In 1976, NLM began to develop DOCLINE, the automated interlibrary loan request routing system widely in use since its national introduction in 1985 (U.S. Department of Health and Human Services, 1985, p. 34). The NLM had also supported the development of OCTANET in 1980-81, an automated routing system among libraries in six states in the Midwest (Johnson & Pride, 1983). The basis for the success of DOCLINE rests on the development of SERHOLD, formerly the National Biomedical Serials Holdings Database (NBSHDB), which contains the serials holding statements of all participating network libraries. Plans to create the NBSHDB were announced in 1981 by the NLM (Bunting, 1987, p. 40). The first step was to have the RMLs coordinate collection of the serial holdings from libraries in the region and submit this information in machine-readable form to the NLM. This turned out to be a time-consuming and expensive process for all concerned due to the lack of machine-readable data and the variety of formats that exist. Until now, most health sciences libraries have contributed their serials holdings via data processing centers such as the Union Catalog of Medical Periodicals in New York. Most recently, the OCLC Union List Subsystem has been used as an alternative by some libraries (Battistella, 1991, p. 370). The addition of NLM serial control numbers to OCLC records was begun in 1983 to facilitate this process (National Library of Medicine Programs and Services, 1984).

There is no doubt that the most important factors in delivering information to health professionals are speed and accuracy. DOCLINE eliminates the time-consuming steps of locating a source for the required documents. The ultimate goal however—to get the document into the user's hands directly—is still evolving. NLM's newest endeavor to create this link is LOANSOME DOC, a module of GRATEFUL MED, NLM's microcomputer-based front end for searching MEDLINE and other databases. LOANSOME DOC allows the end-user to request documents identified in a search directly from a library which has agreed to serve clients through this mechanism.

During the last several years, experiments have begun that provide direct access to journals which are in machine-readable form. Private industry, professional societies, and government all have projects in various stages of development.

The Elsevier Science Publishing Group is involved in a collaborative venture with a number of research libraries in the electronic distribution of journal articles via Internet (Wilson, 1992).

It is considered the first real attempt to make published copyrighted material available in this fashion. Known as TULIP, The Universities Licensing Program will make available forty-two journals in materials science for a trial period of three years. The purpose of the project is to study the economic, technical, legal, and behavioral issues involved in distributing journals this way.

A different approach is being taken by the American Association for the Advancement of Science (AAAS). Its venture, *The Online Journal of Current Clinical Trials,* is being published (jointly with OCLC) only in electronic format rather than simultaneous paper and electronic versions as in the TULIP project. This means that the author must be convinced to publish in a new format that is yet unproven; difficulties in attracting quality manuscripts have been noted even though it is a peer reviewed journal.

The National Library of Medicine's Lister Hill Center has also initiated a research project dubbed SAIL, System for Automated Interlibrary Loan, which would allow direct access to machine-readable databases of journal articles for interlibrary loan through DOCLINE (NLM, 1991, p. 27).

Progress in document delivery services during the last twenty years has certainly been made with the NNLM being the premiere interlibrary loan network for health sciences libraries. LOANSOME DOC has added a new dimension by providing documents directly to the end-user. In addition to this system, there are, in fact, now nearly thirty commercial companies which provide document delivery services for a fee (Khalil, 1993). The promise of full-text electronic storage, retrieval, and delivery, however, is still in the developmental stages. Issues of ownership, copyright, indexing, and fees for access are all knotty problems waiting to be resolved before this type of document delivery can become universal.

IAIMS and New Relationships

The concept of the Integrated Academic Information Management System was introduced in the 1982 report of the Association of American Medical Colleges (AAMC) sponsored by the National Library of Medicine (Matheson & Cooper, 1982). As originally conceived, the library was to play the lead role in bringing disparate institutional databases and systems into a single institution-wide network. In the last ten years, the idea has evolved from concentration on the library's role in information management to information management in the total organization. In fact, the concept has now gone beyond the "academic" and has been renamed Integrated "Advanced" Information Management System since it applies to hospitals and other organizations as well. The goal is to

create organizational mechanisms within health sciences institutions to manage information more effectively and to provide for a system of access to those engaged in patient care, research, education, and administration. The applications of IAIMS concepts in health sciences institutions have been significant in improving information management and in using new technologies and, as Lindberg et al. (1992) note, they have placed health sciences institutions in the forefront of information systems integration and communications networking.

Although the original intent of placing libraries at the center of IAIMS activities has been realized in only a few institutions, the significance of the concept to libraries is evident when one sees that the *Bulletin of the Medical Library Association* has featured four symposia on the subject during the last ten years. The latest, "A Decade of IAIMS," includes papers which show the continued growth of IAIMS and the library's role (Lorenzi, 1992b).

By 1991, eighteen institutions had been awarded grants or contracts by NLM to assist institutions in planning and developing models for implementation (Lindberg, 1992, p. 245). The impact of IAIMS and "IAIMS-like" developments on the organizational structure of health sciences institutions has not been fully documented. It is apparent that neither libraries nor computing centers alone are able to support the technology required for IAIMS but must have close ties with telecommunications. Some institutions have already brought libraries, computing, and telecommunications under the same umbrella. Feng and Weise (1988) discussed the evolution of this partnership at the University of Maryland at Baltimore (UMAB). Since that time, the health sciences library, academic computing, administrative computing, and telecommunications report to a single vice president for information services at UMAB. Additionally, as seen at a number of other institutions, academic computing has become a part of the library or the library and computing report to a chief information officer. Telling signs of this emerging new type of organization were the subjects at the twenty-third Annual Seminar on Academic Computing in 1992. Topics included discussions and talks on OCLC, IAIMS, new models for libraries and computer centers, and questions such as, Is there a future for academic computing?

It seems natural to pool the technical skills of computer centers with the library's skills in organizing knowledge, teaching, and marketing services. What remains unclear is how the two cultures will merge, how competition for scarce resources will be resolved, and how the gulf in the salaries of the two groups will be addressed.

The Role of the National Library of Medicine

The NLM is renowned for having the largest collection of biomedical literature in the world and for its role in organizing and indexing this literature as well as disseminating authoritative bibliographic records. Many of its contributions—such as MEDLINE, ILS, DOCLINE, and SERHOLD—have already been described. It plays an enormous role in coordinating resource sharing among its constituents through the National Network of Libraries of Medicine. Moreover, the research and development programs of its Lister Hill National Center for Biomedical Communications (LHNCBC) apply state-of-the-art computer and communications technologies to the management of biomedical knowledge.

The NLM Long-Range Plan

Like all libraries, the NLM has been affected by the societal forces that have shaped libraries over the last twenty years. It has had to consider its future role in light of the accelerated growth of the medical literature, the advances in information technology and communications, the challenges presented by the scientific revolution in molecular biology, and the advent of AIDS. In reviewing these developments, the NLM Board of Regents requested that NLM undertake a long-range planning process to develop strategies for the library's future. Five panels were appointed to address the future in each of the five domains that encompass NLM's programs and activities. The five domains were: (1) "Building and Organizing the Library's Collection" (National Library of Medicine, 1986b); (2) "Locating and Gaining Access to Medical and Scientific Literature" (National Library of Medicine, 1986c); (3) "Obtaining Factual Information from Data Bases (National Library of Medicine, 1986e); (4) "Medical Informatics (National Library of Medicine, 1986d); (5) "Assisting Health Professions Education through Information Technology" (National Library of Medicine, 1986a). The official NLM Long Range Plan (NLM, 1987) presents detailed and specific recommendations for accomplishing the library's long-range goals and includes the five panel reports on each of the principal domains of NLM programs. The plan embodies a central challenge to the NLM to "strive to be certain that health care in America and the advancement of biomedical research toward this end will benefit from the dazzling technological discoveries that are available to us now from computer and information science, telecommunications engineering, physics and chemistry" (NLM, 1987, preface). It is important to note that the report also recognizes that NLM's fundamental priority is to sustain its collections and to provide better access to its resources.

During the last five years, NLM has been working toward the goals embodied in its long-range plan. The plan has had a marked impact on the National Network of Libraries of Medicine (NNLM), the research and development efforts of the LHNCBC, and has led to the establishment of the National Center for Biotechnology Information. The following discussion will describe the evolution of the NLM, several LHNCBC programs, and the National Center for Biotechnology Information, all of which have important implications for health sciences libraries.

Evolution of the National Network of Libraries of Medicine (NNLM)

New health sciences librarians and information professionals perhaps take the NNLM for granted and may even be unaware of the many contributions it has made in the delivery of information to health professionals and in the introduction of technological developments to health sciences librarianship. Bunting's (1987) excellent history of the Regional Medical Library (RML) Program chronicles its evolution from 1965 to 1985; she provides a detailed account of its development that is not possible to describe here. Rather, this section will describe several major changes in programs and services as the network matured and faced new challenges through the 1970s and 1980s.

The impetus to create the RML network originated with the President's Commission on Heart Disease, Cancer and Stroke in 1965. The goal to achieve control of the medical literature concerning these diseases and to make it available to researchers, educators, and practitioners was articulated and made the responsibility of the NLM by Congress. The Medical Library Assistance Act of 1965 was enacted to assist in the achievement of that goal through the NLM by grants and contracts to the country's biomedical libraries. The early years of the RML network focused on the development of library resources, consortia, networks, training of basic library managers, and supporting interlibrary loan.

Several major shifts occurred during the late 1970s which changed the operation of the RML network and the relationships of libraries to the network and to each other. This included moving from subsidized interlibrary loan to cost sharing and finally to phasing out contract support by 1982. Also during this period, all RMLs became funded through competitive contracts rather than grants. As mentioned earlier, access to MEDLINE first became available through the RML structure, but, by 1974, the implementation of MEDLINE was initiated by local libraries, and NLM also instituted a charge for the service, prompting the online centers to pass charges on to

their users. Over the years, online training was decentralized and became a part of the responsibility of three RMLs in different geographic areas of the country. The initiation of fees for interlibrary loan and search services caused debate and controversy between the RMLs and NLM; however, these charges were deemed necessary if the funding available was to further other necessary developments.

Another aspect of the RML program, which was eventually phased out, was consultation and training for nonlibrarian managers of libraries. NLM's decision proved to be a controversial one since some felt this was a successful program and continuous training was necessary for new managers, particularly at hospital libraries.

As discussed earlier, technology significantly improved the operation of the resource-sharing component of the RML network during the latter 1970s and 1980s. A strong library network had been built during the twenty-five years of its existence; yet the primary mission of bringing equal access to information to all health professionals had not been realized. Many health professionals unaffiliated with a medical library were not informed about information services available or did not have access to them in a timely fashion. In 1987, Congress recognized this need and encouraged NLM to develop an outreach program aimed at rural and other isolated areas. The mission of NLM was also amended to add the function of publicizing its products and services.

In response to this charge and the recommendations of the long range plan, the NLM Board of Regents convened the Planning Panel on Outreach to formulate a plan to guide the library's efforts to improve access to its information services by every health professional regardless of setting.

The recommendations of the planning panel, presented in its report *Improving Health Professionals Access to Information* (Board of Regents, 1989, p. 11), targeted the following four areas:

- The individual and the RML network.
- Strengthening hospital access to national information sources through resource grants to small hospital libraries, support for the Integrated Academic Information Management Systems (IAIMS) program, and participation in the emerging national electronic communications networks....
- Expanding training, fellowships, and demonstration grants.
- Expanding intramural R&D at NLM....

The recommendations of the panel had a significant impact on the requirements of the new RML contracts covering the years 1991-1995 as 60 percent of the budget was earmarked for outreach. Moreover, the name of the network was changed in 1991 to the National Network

of Libraries of Medicine to reflect its national focus; the regions were reconfigured from seven to eight in light of the increased responsibilities in outreach.

The current emphasis of the NNLM is on outreach to health professionals in rural, inner city, and minority populations who are unaffiliated with a medical library and do not have ready access to information. The goal is to create awareness of NLM products available to them either through libraries or directly to them through such products as GRATEFUL MED and LONESOME DOC. The network is the foundation for these expanded efforts which include training for health professionals in information access, exhibiting at national and local meetings of health professional organizations, and assisting local medical libraries to develop outreach programs. The latter includes financial assistance through grants or subcontracts with the RML in its region. Additionally, the NLM has funded outreach projects directly to local libraries primarily to provide training in GRATEFUL MED.

Although the basic structure of the network has remained unchanged, it has been expanded to include health professionals as well as libraries. The strict lines of the hierarchical structure are becoming blurred as health professionals who are unaffiliated seek services from libraries at any level in the network. The mission of the network—to provide equal access to biomedical information to all U.S. health professionals in order to advance the progress of medicine and improve public health—is a challenge for not only the NNLM, but also for all health sciences libraries.

Lister Hill National Center for Biomedical Communications

The Lister Hill National Center for Biomedical Communications was established by Congress in 1968. It serves as the intramural research and development division of the NLM; its programs fall into the following three categories: (1) computer and information science as applied to the problems of the library, of biomedical research, and health care delivery; (2) biomedical image engineering, including image acquisition, processing, storage, retrieval, and communications; and (3) use of computer and image technologies for health professions education (NLM, 1992, p. 22). Several of its projects which are important to health sciences libraries, such as the ILS and SAIL, have already been mentioned. Others which are in progress and which have major implications for health sciences libraries include, but are not limited to, the Unified Medical Language System (UMLS), expert systems such as AI/RHEUM, and the Visible Human Project.

The goal of the UMLS is to give users easy access to diverse information sources through the development of "knowledge sources" that can be used to compensate for the variety of ways concepts are expressed and accessed in different sources. The three UMLS Knowledge Sources are: a Metathesarus of concepts and terms from several biomedical vocabularies, a Semantic Network of relationships among broad categories to which all concepts in the Metathesaurus are assigned, and an Information Sources map that describes the content and access available for human and machine-readable databases. Several experimental projects are underway including an NLM grant-supported effort at the University of Maryland at Baltimore which seeks to use the knowledge sources in accessing local databases. These types of applications will eventually simplify end-user access to multiple databases.

The Expert Systems Program objective is to facilitate access to knowledge through artifical intelligence techniques. AI/RHEUM, the flagship project of the program, seeks to provide an expert consultant system in rheumatology. The system currently offers online access to text definitions, still images, motion sequences, automated MEDLINE searches, and disease criteria tables which are the heart of its knowledge base (NLM, 1992, p. 23). In the future, one can imagine that the use of expert systems will become widespread in the practice of medicine and will likely be made available through national high speed networks to local health sciences libraries.

Since 1989, the NLM has been involved in undertaking the first project in building a prototype digital image library. Known as the Visible Human Project, the program will build a digital image library representing a complete normal adult human male and female (NLM, 1992, p. 31). Since images are such an important part of biomedical knowledge, it is hoped that these pictures will facilitate the understanding of biological structure and function and ultimately improve health care. They are an extremely important adjunct to the written and two-dimensional information available now in textbooks and radiographs. The goal for the future is to distribute the libraries of digital images and bibliographic and factual databases over high speed computer networks to the nation's health care practitioners, libraries, and institutions.

The National Center for Biotechnology Information

The National Center for Biotechnology Information (NCBI) was established in 1988 as a division of the NLM. Its responsibility is to create automated systems for storing knowledge about molecular biology, biochemistry, and genetics; to perform research into advanced

methods of computer-based information processing for analyzing the structure and function of biologically important molecules and compounds; to facilitate the use of databases and software by biotechnology researchers and health care personnel; and to coordinate the efforts to gather biotechnology information worldwide (NLM, 1992, p. 33).

The major project of the NCBI is to manage GenBank, the National Institute of Health DNA sequence database, and to integrate the literature component into the database. Comprehensive coverage of all sequence data, protein as well as DNA, will be provided along with MEDLINE bibliographic information and abstracts. GenBank is a key component of an integrated database system called GenInfo which will be a key source of DNA and protein sequence information. NCBI supports the research process by developing software to access the growing volume of gene data and new methods for disseminating the information to the biomedical community.

As the previous discussion illustrates, the NLM, through its various divisions, plays a leading role in the health sciences community to develop biomedical information services and systems and to make it available to libraries and health care personnel engaged in education, research, and clinical care. Health sciences librarians must be aware of these developments and use them appropriately in providing information services to their clients.

Conclusions

The Library

There is no doubt that the traditional role of the library has changed over the last two decades from that of a repository of information (the physical entity) to that of an information broker (the virtual library). The information explosion prohibits libraries from collecting everything; technology provides the means to access information electronically from remote locations. The role of the library is now more active rather than passive; its success can no longer be measured by the size of its holdings but rather by the quality of access and information services it provides to its clients. The role that information technology and communications have played, and will continue to play, in libraries can hardly be overestimated.

The automation of internal library functions and access to shared cataloging resources had a major impact on staffing patterns. Fewer staff are now devoted to these functions while more staff are devoted to library systems support and information services. Access services, such as interlibrary loan and direct document delivery to clients, are growing.

As networked access to information becomes more and more common, the library must play a major role in institutional planning for information resources management. The library has been accepted as the heart of the university in the past; information technology facilitates the library's role as the natural gateway to the "extremities," the remote sources.

IAIMS projects in many institutions are demonstrating that the library has the staff with the skills and capacity to provide the piloting necessary to navigate the array of disparate information sources available. National and international networks offer a bewildering array of information resources and services. It is a pity that librarians are not more involved in developing the indexing and cataloging control mechanisms to organize the overwhelming amount of information available through networks. This should definitely be a focal point for future endeavors.

During the past twenty years, health sciences libraries have been in a unique position. They have benefitted from the leadership of the NLM in providing bibliographic control of the biomedical literature, in providing access to the literature through online databases produced by the NLM, and in supporting resource sharing through the NNLM. NLM grants programs have aided many health sciences libraries to develop resources, to automate, and to link to other information sources. The research and development efforts of the Lister Hill Center, such as the ILS, have added immeasurably to the library's ability to manage biomedical information.

That is not to say that librarians have been waiting around for NLM to show the way. Librarians have developed innovative services to meet and anticipate their clients' needs as well as to take advantage of information technology.

The Librarian

It may be useful to view the library and librarians separately for a moment. In budget crises, librarians have often been considered expendable, while the library's collection was protected. Today there is a perception that administrators view information technology as more worthy of support than librarians. As a result, the last twenty years have been a tumultuous time for librarians as they perceived their positions threatened. The advent of end-user searching was such a perceived threat and, some would argue, has had a terribly damaging effect on the professional role. This is a rather narrow point of view since the librarian's role has become more and more complex.

First, librarians play an active role in incorporating information acquisition, management, and appraisal skills into health sciences curricula. Second, librarians are skilled "knowledge navigators" and

can guide users through the plethora of information sources available. Third, they must be thoroughly familiar with information systems and telecommunication to access these sources; and fourth, they are increasingly involved in institutional planning for information systems.

It is hard to imagine this as a diminished role. Librarians must aggressively educate administrators about their skills, abilities, and role in institutional information management. Where are health sciences libraries going? It is indeed difficult to predict where the next twenty years will lead. If the changes of the past two decades are any indication, librarians are in for a roller coaster ride. As the "virtual" library becomes a reality, librarians will probably play a greater role in quality filtering. A recent study indicates that librarians can recognize and select clinically useful articles as effectively as physicians (Kuller et al., 1993). Librarians should pursue this service to assume a greater role in providing value-added services to their clients. And what of the library as the physical entity? Chances are the physical entity will remain for at least twenty years with both print and electronic resources. Clients and librarians will probably find their workstation to be more and more useful as they tap into the world's information sources. The High Performance Computing and Communications Act (HPCC), which established the National Research and Education Network (NREN), will provide libraries with access to high-speed and high-capability communication facilities, but these technologies will also be accessible to many individuals and organizations in the future. Librarians must again emphasize their skills and role in developing roadmaps for these many electronic highways. They must work closer with other units in their institutions which deal with technology, whether this be academic computing, patient information systems, or telecommunications, so that the place of the library and what it has to offer will continue to be the "heart" of the information system. Health sciences librarians have a brilliant future ahead of them if they build on the past tradition of being in the forefront of innovative applications of technology.

The Alexandria Library was an idyllic place, no doubt, where scholars gathered for discourse and study. The virtual library may be such an entity if the potential of networked information and technology are harnessed as tools in the creation and dissemination of knowledge for the benefit of all.

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