

## The Future Academic Health Sciences Library

Over the next decade, some health sciences libraries will undoubtedly continue to fulfill largely curatorial roles and operate as the system-to-library facilities described earlier. These libraries gather information from the world knowledge base, they are able to access many data bases, and they draw upon other libraries to respond to user demands for bibliographic information. Information flows into the library; and because the library provides good study space for students and facilities for the use and photocopying of materials, the system-to-library type of library will continue to serve an important function in the AHSC.

Such a library might be termed an information resource facility. It deals largely with bibliographic information and with the artifacts that carry information. It serves institutional needs through its presence rather than through its services. It has limited ability to respond to the information needs of the faculty, the staff, students, or practitioners either in the present or for the future. The present need is a long-standing one—the efficient acquisition of information that supports their work. The future need, perhaps in some instances already today's need, is management of information and knowledge for use in an electronic and information centered environment. The information resource facility is not a model but a springboard for the future.

Two types of libraries might be considered the short-range goal and the long-range goal in the evolution toward an integrated network system to manage aca-

demical information resources. The two types of libraries are the (a) academic information resources services library and the (b) academic information management library. The first is a Stage 1 technology library with network linkages to other information files in the AHSC; the second is an advanced Stage 1 library, part of a well developed academic information network that is an integrated subsystem of the AHSC overall information network system.

Both these prototype libraries can be achieved with today's technologies, with today's expertise, and at a reasonable price. Some components exist in many scattered institutions. The following are a few examples.

Integrated library systems with potential network capabilities are under development at several health sciences libraries, notably at Washington University, the University of New Mexico, the University of Maryland, and Georgetown University. In the MidContinental Regional Medical Library Program, 11 medical school libraries use a telecommunications network, OCTANET, for exchange of services, including interlibrary loan information and electronic mail. At the National Library of Medicine, the catalogs are accessible to the public for online searching. Data-base management in its most fully developed form, as noted earlier, can be observed at the Library of Congress Congressional Research Service. The PaperChase system at Beth Israel Hospital in Boston, Massachusetts, provides a searching capability to a local literature file. A similar system more

integrated with other services of the library is the mini-MEDLINE component of the Georgetown University Medical Center Dahlgren Memorial Library. Research and development in the adoption of new technologies to solve information storage and retrieval problems is a strength of the Lister Hill National Center of the National Library of Medicine. Expanded education and research roles can be observed at the University of Missouri at Kansas City and the University of Southern California health sciences libraries. The health sciences library at the University of Wisconsin in Madison is experimenting with technical consulting services to faculty members and students on the bibliographic applications of microcomputers. Simultaneous remote searches of online bibliographic data bases linking libraries and physicians' offices are used in the Tucson (Arizona) Medical Center (133). The Medical Sciences Library at Texas A&M University has developed a microcomputer system that reformats and sorts retrieved MEDLINE records. It also has an answer electronic message center that faculty members can use to communicate with the library staff (134). At the Georgetown University Medical Center Dahlgren Memorial Library, the staff is being diversified with the inclusion of a physician in charge of the library's computer center.

Examples on the academic unit side exist as well. The Physiology Department at Duke University Medical Center is an integrated academic information management unit, where faculty members use a small computer to handle correspondence, manuscript text-editing, bibliographic file maintenance, course-scheduling, and curriculum management, among other things. Individual faculty members have developed reprint retrieval systems for microcomputers (135). Network participation by faculty members and scientists is demonstrated by SUMEX-AIM, which provides

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electronic mail services, data exchanges, and special software services like MORGAN. Physicians' offices, particularly in group practice settings, are being equipped rapidly with small computer systems that have potential network connections. One vendor, SEQUOIA Systems, offers MEDLINE-searching as a component service of the physician's office system.

Stage 2 development in libraries is likely to be a reciprocal of many factors in any given academic health sciences center and of the speed and direction of development in information technologies. Stage 2 components will emerge from creative interactions of staff members with individuals with many different disciplinary backgrounds and from experimentation with the technologies. Consequently, few Stage 2 features will be found in the following prototype outlines.

In this chapter the two prototypes are described in generic terms as two points on a continuum leading to the information transfer and management networks depicted in figures 5 and 6 in Chapter 3. Their principal features are summarized. Amplification of the concepts may be found in earlier chapters, the scenarios, the statement of guiding principles, and the descriptions of functions. This chapter ends with a discussion of approaches to funding restructured libraries and a consideration of the sources of support and the leadership needed to move confidently and rapidly into the future.

#### **Resource Services Library**

The AHSCs in this country share in the responsibility to build and maintain the knowledge base of science and medicine to serve the nation through their libraries. The academic information resources services (AIRS) library, therefore, has fully developed library-to-library as well as library-to-user network capabilities. The goals of this network capability are (a) to

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interface internal AHSC information systems and external information data bases by connecting individuals to desired information and (b) to provide information/data base management services that facilitate the efficient use of information in research, patient care, education, and management. Characteristics of the AIRS library are summarized in Exhibit 1.

#### PLACE IN AHSC ORGANIZATION

The AIRS library has the responsibility, authority, and resources to develop an academic information resources management network system. The director of the AIRS is one of the senior AHSC officials. A council of representatives of information network subsystems replaces the traditional library committee and is responsible for considering policies governing network development.

#### STAFFING

Diversification of the staff is a key element in the AIRS library. Needed are professionals who, by virtue of experience or cross-training in medicine, basic sciences, computer science, information science, and library science, can work across professional boundaries. Individuals capable of communicating in both the world of computers and the health sciences are relatively scarce today. They need to be sought out and their talents nurtured. The recruitment and retention of a quality innovative professional staff, always difficult, will be particularly difficult in the AIRS library unless issues of appropriate status, salaries, and career paths are deliberately attended to. Staff positions include educators in medical information sciences, systems designers and developers, information brokers, and network administra-

#### EXHIBIT 1

##### FEATURES OF PROPOSED ACADEMIC INFORMATION RESOURCES SERVICES LIBRARY

###### Goals:

- Interface internal AHSC information systems and external world knowledge bases
- Provide information and data base management services
- Develop an academic information resources management network system

###### Characteristics:

- Fully automated
- Library-to-library and library-to-user network capabilities

###### Functions:

- Curatorship
  - On-site and off-site access to information resources
  - Includes collections of materials in all media, staff, and access to other institutional resources sufficient to meet AHSC information needs established by criteria of timeliness, appropriateness of content, format, and utility
- Education
  - Support and participate in medical information systems instruction
  - Support and participate in development and maintenance of instructional information systems
- Service
  - Information transfer services
  - Information broker services
  - Information research services
  - Data base management services

###### Research

- Laboratory for study of application of new information storage retrieval technologies

###### Staff:

- Diversified and interdisciplinary
- Cross disciplinary roles
- Academic faculty

tors. The AIRS library is an innovation. Its staffing must incorporate Roberts' five functional roles of entrepreneur, idea generator, project leader, information gatekeeper, and institutional sponsor (113).

#### FUNCTIONS

The operational and managerial goals of the AIRS library are carried out through four principal functions: curatorship, education, service, and research.

Requirements for carrying out the curatorial functions:

1. Physical and equipment facilities are adequate to meet the needs that a majority of users have for information and instructional materials and services. These facilities provide users with access to resources on-site and from remote locations. On-site facilities include equipment that makes it possible to use and to reproduce, within practical and legal limits, information in a variety of different forms: paper, film, tape, disc, online data bases, models, and patient simulators. Off-site access to AIRS library resources includes direct user searching of library information files and the display of text copy. Such facilities handle information in both analog and digital form.

2. The AIRS library's resources include its professional staff and the recorded public world knowledge base represented by materials on-site and by access to materials at other libraries and facilities. The criteria of timeliness, appropriateness of content, form, format, and utility are used to evaluate the responsiveness of the resources and services to the needs of the faculty, the staff, and students. The library's services and practices are guided by professionally established performance standards.

Requirements for the education functions:

1. The educator/librarians in the AIRS library work in concert with other medical

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information system professionals to develop and offer academic programs in medical information systems. They offer instruction to faculty members and students in the construction of personal information systems and provide technical consulting on network linkage.

2. The AIRS library ensures that local instructional and bibliographic files, course syllabi, reading lists, special document collections, and the like are stored on computers. These files are used by students to learn and create personal files and by the faculty for course development and content management.

Requirements for the service functions:

1. Information transfer and data base management are two basic functions of the AIRS library. Transfer services include the provision of documents through lending, photocopy or other delivery methods, and the location and transfer of specific facts and information from both the library's resources and from external sources. Data base management services include preparing information for a variety of uses, for immediate to long-range problem-solving, for decision-making, or for reducing uncertainty. Such services require the location, selection, analysis, and repackaging of information. Redactional services include the provision of software that allows for rearrangement of bibliographic elements according to the style requirements of different journals and publishers.

2. A main function of services is to encourage the unhampered flow and effective use of information for research, education, and patient care within the AHSC and between it and its community. Marketing of information services is essential. Fees for some services will be necessary. Services will need to be competitive and subject to quality reviews.

Requirements for the research functions:

1. The AIRS library is a laboratory for

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the investigation and study of information storage, organization, use, and application in learning, patient care, and the generation of new knowledge.

2. As a component of the research function, the AIRS library operates a data base analysis and management system to monitor its own services and operations.

### Information Management Library

The AHSC is evolving toward a network of homogeneous subsystems forming an integrated institutional information base. The academic information management (AIM) library is the product of the integration of the AIRS library with the organizational information resource base.

The goals of the AHSC-wide information network are (a) to institutionalize a process for bringing the best information

to bear on decision-making throughout the AHSC and (b) to make possible the sharing of information resources with other institutions.

The AIM library is an extension and development of the AIRS library. Its salient characteristics are represented in Exhibit 2. The roles and responsibilities that differ from the AIRS library are italicized. Among its curatorial roles as an advanced Stage 1 technology library, the AIM library manages an extensive system of local data files. The flow of information in the AHSC is monitored in such a way as to assemble a data base that offers the novice user guidance in selecting materials by displaying frequency of use by AHSC faculty members and practitioners. Its educational roles are augmented to include participation in developing new expert

#### EXHIBIT 2

##### FEATURES OF PROPOSED ACADEMIC INFORMATION MANAGEMENT LIBRARY\*

###### Goals:

Manage an integrated academic information resources network

*Institutional interface for interinstitutional academic information network*

###### Characteristics:

Full network capabilities

*Quality filter*

###### Functions:

###### Curatorship

Multi-access to information resources

Includes library collections, staff, and access to other institutional resources

*Maintains institutional filtered information base to support research, teaching, patient care, and management*

###### Education

Participates in medical information systems instruction

Participates in development and maintenance of instructional information systems

*Participates in development of expert knowledge bases*

###### Service

Information transfer services

Information broker services

Data base management services

Information research services

###### Research

Laboratory for study of applications of new technologies

Laboratory for developing new information technologies

###### Staff:

Multidisciplinary

Academic faculty

*Distributed throughout AHSC through joint appointments*

\* Items in italics indicate how AIM library differs from AIRS library (see Exhibit 1).

knowledge bases. More faculty members from traditional disciplinary departments join the AIM library staff. Service roles such as "brokering," information research, and data base management are extended as the library's files are more effectively linked to organizational files. Research roles that will expand the most in this stage of system development will depend heavily on new videodisk technologies and the availability of quality personnel.

The AIM library, which is the AHSC's intellectual information resources network, has become coequal with the organizational information resources component and is joined under single leadership.

#### The Support Base

The AIRS and AIM libraries are systems derived from collections of resources and from accessibility to a wide variety of additional resources. They are communications systems, basically, and their operating costs will extend considerably beyond those of present-day libraries, given their changed roles and functions. These libraries also represent innovations; both their functions and services will evolve and change with the flow of technology innovation, and this will make careful attention to their operational support essential.

Three basic sources of funds in the AHSC are stable institutional funds, special grants and contracts, and fees for services. Stable institutional funds include resources derived from state appropriations and endowments that are institutionally administered. Special grants and contracts include federal, state, private, and commercial funds available to conduct specific time-limited projects. Fees for services include all funds coming from individual students, faculty members, institutional units, and individuals and agencies in the community for procurement of specific products.

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Traditionally, libraries are funded from stable institutional funds with little or no support from fees-for-service or from grant or contract sources, except indirectly through overhead allocations. Libraries are often considered a necessary social and institutional cost overhead. In recent years, with more and more instability in core funds and reliance on variable grant and contract overhead income, many libraries are experiencing extreme swings in budgeting, as suggested by the data in Table 3 in Chapter 5. More libraries have sought grant and contract funding as a result. Others have turned to fees for services.

Some library administrators and AHSC officials consider fees for library services a repugnant and undemocratic concept. The tradition of free information is deeply rooted in the American public library system, which is unparalleled in the world. As more and more information is locked into fee-for-service electronic systems, fears are expressed about the disadvantage of the less affluent in gaining access to information, so important in an open society. However, information in all forms is the result of enormous investments in human and economic resources, the cost of which should be shared by all who benefit. Costs need not be passed directly to the individual user. They can be dispersed through other accounting approaches. Some subsidization of services may sometimes serve institutional purposes better than direct user fees. At a national level, many interests are grappling with the formulation of public policies regarding the relative responsibilities of the public and commercial entities engaged in information data base development and marketing. There is no question that effective information systems are costly. At the local level, each institution will have to determine its policies regarding the allocation of costs and income for services generated through the use of external data bases as

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well as the potential side effects of these centers, support is difficult for innovation.

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well as those developed within the AHSC. As the AIRS library develops, it has the potential to market valuable services outside its host. Libraries are potential income centers, but reliance on income fees to support basic operations may make it difficult for libraries to respond to needs for innovation and change.

Few libraries depend heavily on grant or contract sources. The experiences of specialized clearinghouses and information centers in the late 1970s, which were wholly supported on special contract funding, suggest why such dependence is unwise. Instability of funding affected the recruitment and retention of technical staff of high quality. Commitment to the special purposes of the center took precedence over serving institutional needs for services. A long-range institutional commitment to the staff and the program was difficult to develop. Consequently, innovative programs flowered only to wither, at great costs of energy and talent and often with little remaining of permanent value.

The ideal funding model is a balance among these sources; each has some value. Adequate and stable funding fosters recruitment and retention of highly qualified professional and technical staff members and the maintenance of state-of-the-art technology systems. Some fees-for-service funding encourages attention to quality services. Grants and contracts and some institutional research funding permit the systems to experiment with innovation without distorting or jeopardizing the quality of basic services and programs.

Advancement in AHSC information management depends on a strong and clear commitment to the importance of managing a critical and basic resource in an academic institution—its intellectual resources. Libraries and their services are not luxuries; they are necessities. Academic information management is not an

elective burden; it is one that all must share.

### Resources To Support Change

Over time, with adequate institutional planning and with careful structuring of the appropriate funding bases for these new services and operations, academic health sciences centers could develop their individual systems without external support. But time is short, and there is a great deal of ground to be gained. The need is urgent, the pathway is clear, and the goals are in the national interest. New resources are required to accelerate the growth of state-of-the-art systems. These resources could be secured if the many parties concerned with the science knowledge base were to join forces. A coalition of industry, foundations, professional associations and societies, and the federal government is needed.

Institutional systems are only the first stage in the effective use of new powerful information technologies. Interinstitutional networks are the next stage. A centrally and strategically placed national agency working in conjunction with professional associations and organizations can serve as the catalyst and provide the leadership to link the AHSCs into a national network system.

The National Library of Medicine is an international resource. It has made unique and significant contributions to the management of biomedical information. The NLM transformed an essential bibliographic citation retrieval resource, the *Index Medicus*, into a technologically advanced system used throughout the world. It created innovative systems for information and data retrieval, such as TOXLINE and the Laboratory Animal Database. It has created expert knowledge bases. It has developed crucial and pivotal new support technologies and record controls systems

for use by libraries throughout the world. NLM administrators saw the need to educate a new genre of professionals for the new era and responded with a unique program to support biomedical computing in medicine. Besides developing a unique Regional Medical Library Network to support information transfer through document delivery systems, the NLM has nourished networks that provide access to computer-based instructional resources and to peer-reviewed audiovisual information resources.

The National Library of Medicine is in the forefront of changes in information technology. Its resources, its services, and its roles are fundamental to the nation's biomedical information systems and to the responsible management of tools to access the world's knowledge base. Its importance in maintaining the thrust of technology development and utilization for information management should be fully recognized and appreciated. It has achieved remarkable goals with limited resources and support from the scientific community.

The National Library of Medicine is the logical and natural leader in the develop-

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ment of a national biomedical information system. Its record of achievement is great, but its resources are inadequate to the magnitude of the tasks demanded and expected of it. New support and collaborative efforts are essential. The NLM needs to be in a position to make new commitments in a new era and to use its unique and central position in the health community to spearhead efforts that (a) identify national academic health information data-base needs and (b) encourage both the public and the private sector to develop prototypes in academic health-information handling that respond to health professional information requirements.

The effects of technological change on academic centers will be far-reaching. Shouldering the burden of developing and financing adaption to these changes and of training and developing the staff, the faculty, and students to function productively in the new era should be a common cause shared by the industrial and academic communities as well as by public and private agencies. The management of the knowledge base of the health sciences is a national concern of vital public interest.

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## Chapter 7

### Recommendations for Action

The purpose of this report is to present the rationale for the long-range development of integrated institutional information management networks; to describe how such networks can be achieved through the development of a technologically sophisticated library; to explain why a new library concept is essential in the emerging electronics-dominated information environment; to describe the benefits to faculty members, clinicians, and students of a retooled and reoriented library; and to show how the library of the future can be achieved with today's technologies and within today's financial constraints.

The recommendations are directed to three major sectors responsible for biomedical research, the education of health professionals, and the provision of health services in this country: (a) academic health sciences centers, (b) professional associations and societies, and (c) public and private agencies.

The first recommendations are addressed to the academic health sciences centers because they are the essential source of continuing excellence in the health sciences and of growth in the world's biomedical knowledge base. Although each sector is challenged individually, concerted and coordinated action by all are essential to prepare an adequate response to the demands of the new era being shaped by the rapid adoption of communications and information technologies.

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Maintaining old and inadequate technologies to manage academic information re-

sources is a waste of scarce and valuable resources and seriously impedes the access to information essential to state-of-the-art medical care, education, and research. Even though financial resources are scarce, the faculty and senior executives of academic health centers must have the vision to allocate resources to begin to network their information files, to integrate academic information into the education process, and to use the knowledge base in medicine and science better, faster, and less expensively.

Institutional productivity and effectiveness in all areas—attracting and retaining high quality staff members and students, providing superior education and services, conducting leading-edge research, providing leadership in medical practice—are keyed to the use of state-of-the-art information technologies. The AHSC needs to redefine, retool, and reorient the traditional information-handling unit, the library, because it is pivotal to an integrated network system for academic information management. The potential return on a judicious reallocation of resources and investment of a modest level of additional resources significantly outweighs the cost.

Through inaction in a fast-moving technological environment, an institution risks the erosion of its current intellectual resources. At greater risk is the state-of-the-art of health care, for as more faculty members concentrate more time and effort on the provision of health care and less energy is devoted to expanding the knowledge base of medicine, the importance of a reliable and dependable flow of information from the research front to the health practitioner becomes greater.

## THE GOAL

An immediate response from academic health sciences centers is called for leading to two goals:

1. The development of an academic information resources management network with linkages to operational information systems in the academic health sciences center and medical practice loci to facilitate the flow and use of the world's knowledge base in carrying out the functions of education, research, patient care, and management.

2. The development of academic programs that equip the faculty, the staff, and students with computational skills and information management techniques essential to effective functioning in a complex electronic health information environment.

## THE RECOMMENDATIONS

To accomplish these ends:

*It is recommended that institutions immediately support their health sciences libraries to strengthen their technological capabilities and develop the means to integrate the processes of academic information management with the processes of professional health education.*

To carry out this recommendation, the following actions are essential:

1. All managerial and operational functions of the library should be automated to provide the basis for networking capability both within the academic health sciences center and between libraries.

2. Using this networking capability, the library should serve as the institution's bridge to external public data bases by providing information about these sources, providing access to them, and facilitating the flow of digital information and data between systems.

3. Using this networking capability, the library should interface with other func-

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tional academic health sciences center information systems.

4. The library should use data-base management concepts to organize, format, package, and deliver information in forms and through techniques that augment and enhance existing processes for decision-making, education, and learning at all levels in the academic health sciences center and in medical practice.

5. The library should extend its technical information management services to all academic health sciences center personnel.

6. The library should, in association with other educational programs, become a focus for ensuring the computer literacy and information-handling capabilities of the academic health sciences center faculty, staff, and students.

*It is recommended that institutions designate an individual to spearhead efforts to develop and implement a corporate institutional academic information resources transfer and management network policy and an academic program in medical information science.*

This individual should be a senior academic health sciences center official whose experience and standing reflect the authority to ensure the development of institutional policy and the power to implement programs and projects that express these policies. The individual should have the complete and unswerving support of top AHSC management.

*It is recommended that institutions develop plans for students, faculty members, staff members, and practicing physicians and implement programs that actively interface them to academic information systems throughout the health education continuum.*

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tion, institutions will need to define policies for network communication systems that provide computational services and support and health information sciences education. The formulation of these two policies depends largely on the responses institutions make to the following questions on the basis of their unique organizational structures.

*Network systems services and support*—What are the academic information resource services that support education, research, management, and patient care? How are these services to be further developed and delivered? Who is responsible for the design, coordination, and operation of network systems? How are the systems to be supported? What is the source of capitalization for systems development, and what is the appropriate balance for funding of institutional services and systems? What is the institution's relationship to other institutions and other network systems and computational services?

*Medical information sciences education*—What are the institution's educational responsibilities and goals for developing computer literacy in faculty members, staff members, students, and practitioners? What are the computational skills and knowledge base needed by competent health professionals practicing in a highly technical information environment? How far beyond formal graduate education are these responsibilities to extend? How are the knowledge and competencies to be taught? How does the library information network system relate to learning processes and support the continuing acquisition of new knowledge in health care practice? What resources are needed to accomplish desired institutional goals and educational objectives? Who is to be responsible for organizing these educational programs and for coordinating the integration of academic information management in the education and practice continuum?

*It is recommended that institutions collect information to aid in a strategic planning process for the development of an academic information resources management network with linkages to operational information systems.*

In order to carry out this recommendation, institutions should conduct at least two self-studies involving key people, such as the top academic health sciences center executive staff member, directors of information-handling units—health sciences libraries, biomedical communications centers, computing centers—and representative faculty members and students.

The first self-study should inventory current information technology capabilities for forming an academic information resources management network in the academic health sciences center. This includes assessing (a) the technological status of libraries in health professions schools and teaching hospitals, (b) the use of computers in research laboratories and offices to maintain bibliographic systems, (c) the use of computers for text-editing and processing for publications, (d) the use of computers for interinstitutional and intrainstitutional exchange of communications and data, (e) the availability of human resources and skills in computing, (f) the network capabilities of existing units, (g) the identity of the institutional "information gatekeepers" and the systems that support them, and (h) the use of existing networks by the faculty, students, the staff, and practitioners.

The second self-study should assess short- and long-range academic information system needs and requirements. Institutions should (a) analyze the uses made of academic information resources in the academic health sciences center, (b) chart the flow of these types of information uses and unmet needs, and (c) identify the technologies that could improve productivity,

effectiveness, and economy of these practices.

This investigation includes the assessment of the potential applications of information technologies to (a) manage the knowledge base used in the educational process, (b) facilitate the flow of information between sources of information (for example, between the library and individuals, between and within department offices, among individual information gatekeepers and their sources, and between and among computing facilities, institutions, and associations), and (c) train faculty members in the use of information technologies. The study should also project the potential impact of possible applications on areas of intensive information-processing and use and on areas of high priority and need.

*It is recommended that institutions, their faculties and staffs, vigorously encourage agencies and organizations that foster research to support academic information management network systems development.*

The generation of new knowledge and its dissemination, storage, and management go hand in hand. The neglect of academic information management systems will weaken the quality of the knowledge base on which education, health care, and research depend. Increased resources to enable the National Library of Medicine to carry out research and develop systems that provide faculties with improved biomedical information services should be energetically supported.

#### Professional Bodies

Professional associations and societies play critical roles in ensuring and maintaining the highest standards of quality in health professions education and health care practice. They influence and guide na-

#### *Information in Academic Health Centers*

tional health policy development, encourage and promote the observance and maintenance of quality standards, and maintain significant and sometimes unique reservoirs of data about institutions, organizations, and individuals that they represent.

The time is ripe for these national bodies to exercise their unique leadership positions to foster better understanding of the significance of information technologies to the health care enterprise. The faculties of the academic health sciences center are largely unaware of the implications of the changing information technologies for their future professional lives. Programs are needed to educate, rapidly, the health professions to the opportunities and the threats that new communications technologies pose to the future structure of health education and health care.

Not all academic health sciences centers have the environment or the resources to develop immediately full-scale integrated academic and organization information resources management networks. Prototypes are needed to minimize development costs and to demonstrate the capabilities and powers of integrated information systems in a variety of settings and at a variety of levels.

Joint ventures are needed to develop prototypes. A coalition of professional associations and societies in many related health disciplines, public and private agencies, and business and industry in both health and information sectors can form the critical mass of human and financial resources necessary to spark a major evolutionary thrust toward more effective management of the health sciences knowledge base and its linkages to medical education, health care, and practice.

The recommendations to the academic health sciences centers in the previous section call for an immediate technological upgrading of libraries and a broadening of

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## Recommendations

their roles and functions, leading to the development of academic information resources management networks linked to the operational management networks to form integrated academic health sciences center information systems, and the development of academic health sciences center academic programs in medical information sciences education. The recommendations in this section call upon professional bodies to assist academic health sciences centers toward these goals.

### THE GOAL

The professional associations and societies are called on to organize a coalition of the leadership in business and industry, academic institutions, and professional associations and societies related to health education, professional practice, research, and information management to marshal the necessary resources to support programs leading to a strong national network system for sharing intellectual and organizational information resources, beginning with the development of prototype academic information resources management networks.

### THE RECOMMENDATIONS

In order to accomplish these ends, the following immediate action steps are recommended:

*It is recommended that the Association of American Medical Colleges, the National Library of Medicine, major health related and information industries, and other health related organizations and professional societies join in a health information coalition to assist the academic health sciences centers in adapting and utilizing state-of-the-art information technologies that strengthen the flow of information be-*

*tween academic centers and medical practice in a strong national network system.*

In order to carry out this recommendation, the following actions are essential:

1. The Association of American Medical Colleges should begin the planning process immediately, with aid from appropriate funding sources, to identify the potential participants in the coalition and the agenda of issues for action. These issues should include goals for (a) medical information sciences education programs in support of faculties, staffs, students, and practitioners; (b) AHSC academic information management network prototype development; (c) academic information network linkages to practitioners, other institutions, and teaching hospitals; and (d) national academic and organizational information network systems.

2. The Association of American Medical Colleges should convene the key leadership as soon as initial planning is completed to explore areas of common interest from which immediate program initiatives can be implemented and an agenda for integrated health information system networks over the next decade can be developed. This body should accept responsibility for (a) stimulating the development of standards and guidelines for academic information resources management network systems in relation to other developing networks and (b) speaking authoritatively to legislative bodies, the federal executive, and public and private agencies on the needs for superior biomedical computing technologies to support scientific and medical knowledge bases.

In conjunction with these collective efforts, individual organizations and associations should take steps to improve the ability of the academic health sciences centers to adapt newer technologies wisely as well as speedily.

*It is recommended that the Association of American Medical Colleges, the Association of Academic Health Centers, the American Medical Association, the American Hospital Association, the Medical Library Association, the Association of Academic Health Sciences Library Directors, and other health organizations and professional societies assist the academic health sciences centers to adopt and utilize appropriate information technologies by sponsoring programs that promote (a) the rapid acquisition of technical skills in computer-based academic information systems and networks on the part of faculties, staffs, students, and practitioners and (b) the planning and development of integrated library systems and academic information management networks.*

*It is recommended that the Association of American Medical Colleges, the Association of Academic Health Centers, the American Medical Association, the American Hospital Association, the Medical Library Association, the Association of Academic Health Sciences Library Directors, and other health organizations and professional societies demonstrate the capabilities of advanced communications and information management technologies to improve the economy and effectiveness of their own information services and functions.*

The types of information services and functions common to these organizations include:

*Maintenance of significant data bases—*These data should be collected using advanced network technologies that (a) provide appropriate and adequate protection of private and confidential data and (b) minimize the level of effort demanded from the academic health sciences centers,

#### *Information in Academic Health Centers*

the educational institutions, and the individuals who supply the data. Wherever possible, redundant collection of data should be avoided through the use of networks.

*Dissemination of information—*Electronic mail, facsimile transmission, and teleconferencing technologies should be utilized when appropriate. The existing Veteran's Administration conference network is an example of "hot-line" type of information dissemination; so is the Regional Library Network use of an electronic mail system for routine communications between the regional library directors.

*Provision of authoritative subject information—*Organizations maintain authoritative bibliographic files and information services. Such systems when linked to academic health sciences center libraries could provide rapid responses to individual information needs. Access to information about recommended resources that support the Association of American Medical Colleges' Management Advancement Program is an example.

*Producing and disseminating scholarly information—*Organizations that publish journals should use the most advanced technologies for text-editing, text retrieval, and publishing and should encourage faculties to adapt to and exploit the advantages of these technologies. The American Chemical Society's use of electronic mail for manuscript peer-review is an example. Organizations should sensitize their members who are authors to the complex ownership issues in data-base development and use in order to protect their unhampered access to the knowledge which they have generated and shared with the scientific community through online text systems.

In order to respond to the recommendations addressed to both the academic health sciences centers and the profes-

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sional associations and societies, a significant talent pool in the area of health information and library sciences is needed.

The responsibility for the maintenance and the management of the recorded knowledge base in science and medicine lies principally with academic health sciences libraries. The appropriate professional skills to carry out this responsibility in the current and future academic health sciences center milieu must be continually developed.

*It is recommended that professional health library and information science associations and organizations, in conjunction with academic health sciences center libraries, with the support of the National Library of Medicine and other agencies, enter into formal agreements with at least four major accredited schools of library science, information science, and/or management sciences (a) to develop appropriate curricula and a variety of methodologies and approaches to train health information specialists with the knowledge and skills necessary to develop, manage, and improve technologically advanced academic health sciences center libraries and academic information resources management networks, (b) to develop and offer opportunities to retrain and to retain talented mid-level career librarians to function as academic information network entrepreneurs and developers, and (c) to recruit and train a cadre of health information specialists who can bridge the disciplines of the health sciences and information sciences and serve as teaching and research faculties in developing academic health sciences center medical information sciences education programs.*

In order to carry out this recommendation, the following actions are essential:

1. The Medical Library Association in collaboration with the Association of Academic Health Sciences Library Directors should begin a planning process immediately, with aid from appropriate funding sources, to develop a program proposal to initiate these training programs. A planning committee should be formed that includes the disciplines of library science, information science, medical science, and management science and individuals from the education, business, and health sciences communities. The committee should establish educational objectives and establish training priorities and types of training mechanisms, both long-term and short-term.

2. The Medical Library Association in collaboration with the Association of Academic Health Sciences Library Directors should convene a conference on academic information management for the purpose of initiating the planning committee's recommendations by identifying potential training mechanisms, training sites, and potential faculty members.

3. Within a year of the initial planning effort, agreements for formal training programs should be formalized. A rapid response to the problem of severe skill shortages is desirable to avoid lengthy transition and development periods in the academic health sciences center library.

#### Public and Private Agencies

Access to information is a hallmark of a democratic society. In science and medicine, the unhampered flow of information is crucial to continuing progress and advancement in the understanding and the treatment of the human organism. Traditional bibliographic storage and retrieval systems and newer text-searching and retrieval systems are the keys to accessing relevant portions of the world's recorded and public information base. In the United States most of these large and expensive

systems have been developed and maintained with public funding as a public service in the public interest by professional organizations and federal agencies.

The advent of the newer technologies has fostered an information industry involved in creating new and complementary services that provide access to the public academic information base. Where these newer approaches to information dissemination and attitudes toward information as a commodity will lead is unclear. Unforeseen problems in ensuring textual integrity, demarcations of responsibilities for archival storage and retrieval, extent of copyright privileges, funding of research and development of systems, and responsibilities for inclusiveness, information quality, authority, and reliability are some of the complex public policy issues beginning to emerge.

New understandings need to be forged that balance the public interest and the welfare of a new emerging information industry. Different coalitions and shared responsibilities for the world's knowledge base are needed now as never before between those public and private agencies with responsibilities for the nation's welfare and the professional and commercial organizations with responsibilities for the generation of new knowledge and its enlightened use for the public good.

The first set of recommendations in this chapter called upon the academic health sciences centers to take immediate steps to strengthen the technological capabilities of libraries to handle digital information in more flexible and productive ways. This is the first step toward achieving an academic information network to facilitate the flow of recorded information as directly and in as useful a form as possible to individual faculty members, students, and practitioners.

The second set of recommendations called upon professional associations and

### *Information in Academic Health Centers*

organizations to assist the academic health sciences centers to take the next steps to link the two main information components, academic and organizational information bases, through a network that is capable of interconnections with teaching hospitals and individual practitioners, thus strengthening the interactions among education, research, and patient care so essential to sustaining the quality of health care nationally. While academic health sciences centers can develop, have developed, and will continue to develop individually along these directions, the maintenance of the biomedical knowledge base is a shared national responsibility. Furthermore, the magnitude of the resources needed to ensure an appropriate technological position to keep up with the rapid pace of change worldwide suggests the wisdom of exploring alternative strategies.

#### THE GOAL

Industry, foundations, federal and state agencies, the federal executive, and the Congress of the United States are called on to accept the responsibilities of sharing in the development and support of state-of-the-art information technologies to ensure that the world's biomedical information base is accessible to faculties, students, and practitioners through academic health sciences center libraries and networks.

The remarkable achievements in sciences and medicine in this country were made possible through joint efforts in the public and private sector. Now more than ever collaborative efforts are called for.

#### THE RECOMMENDATIONS

To act upon these responsibilities the following immediate actions are recommended:

*It is recommended that private agencies, foundations, and corporations, as well as federal and state agencies, col-*

#### *Recommendations*

*laborate close associations and development of information management and integrated academic information systems.*

*It is recommended that foundations, federal agencies, and state agencies be given top priority to introduce information management techniques into health professions as a key component supporting life science programs and offered to medical education and learning and professions.*

*It is recommended that in conjunction with other public, private, and academic entities, establish academic health sciences center libraries that attract and retain academic health sciences center faculty members and students through programs such as the Robert Wood Johnson Foundation Policy Fellowships that are*

*It is recommended that the National Library of Medicine be given priority to work with industry, professional associations, and organizations to develop academic health sciences center libraries and information management techniques and intramural services to probe the*

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*laborate closely with professional as-  
sociations and societies to support the  
development of prototype academic in-  
formation management networks and  
integrated academic and organization  
information system networks.*

*It is recommended that private agen-  
cies, foundations, and corporations, as  
well as federal and state agencies, give  
top priority to funding projects that  
introduce information and knowledge  
management skills throughout the  
health professions education continuum  
as a key component in stimulating and  
supporting lifelong learning. Special in-  
centive programs should be developed  
and offered to encourage rapid integra-  
tion of information technologies in the  
learning and practice of the health  
professions.*

*It is recommended that private agen-  
cies, in conjunction with federal, state,  
other public, private, and commercial  
entities, establish and fund programs in  
academic health sciences centers that  
attract and retain qualified people in  
academic health information and  
knowledge base development. Pro-  
grams such as the Markle Scholars  
and the Robert Woods Johnson Health  
Policy Fellows are prototypes of pro-  
grams that are needed.*

*It is recommended that the National  
Library of Medicine, in collaboration  
with industry, professional associations  
and organizations, academic health sci-  
ences centers, and other national li-  
brary agencies, foster and develop  
state-of-the-art medical information  
management and transfer technologies  
and techniques through its extramural  
and intramural research support  
branches. It should be the lead agency  
to probe the fertile conjunction of bio-*

*medicine and communications technol-  
ogies.*

In order to respond to this recommen-  
dation:

1. The National Library of Medicine  
should be empowered and authorized to  
promote the improvement and advance-  
ment of academic information manage-  
ment network systems through intramural  
as well as extramural research, training,  
development, and demonstration pro-  
grams with staffing and appropriations ad-  
equate to bring about substantial improve-  
ment in the academic health sciences center  
network system.

2. The National Library of Medicine  
should operate state-of-the-art informa-  
tion systems that support the academic  
information systems in the nation's insti-  
tutions of higher education.

3. The National Library of Medicine  
should (a) support the efforts of profes-  
sional associations, organizations, schools,  
and agencies to train individuals in  
biomedical information resources manage-  
ment at all levels of the health information  
chain and (b) foster the formation of in-  
terdisciplinary groups for the purposes of  
planning, developing, and implementing  
programs that create more widespread un-  
derstanding of the uses of the information  
network concept through symposia, con-  
ferences, study groups, demonstration  
projects, and personnel exchanges. Pro-  
grams in each of these two categories  
should be initiated immediately and be  
continued as long as they are productive.

*It is recommended that the National  
Library of Medicine develop state-of-  
the-art network communications  
throughout the Regional Medical Li-  
brary Network for the purpose of trans-  
ferring documents in digital as well as  
analog forms.*

In order to respond to this recommen-  
dation, the National Library of Medicine

will need to work closely with other national libraries, industry, and library groups to develop appropriate archival storage and retrieval devices and systems and to intensify research efforts in developing appropriate technologies to improve information transfer and utilization mechanisms.

*It is recommended that the National Library of Medicine, in collaboration with professional associations and other public and private agencies, assist in the development of prototype integrated library systems and academic information resources management networks in at least seven selected AHSCs.*

At least one prototype network system should exist within each of the regions of the Regional Medical Library Network. These systems should serve the following purposes: (a) demonstrate the state-of-the-art technologies in integrated library management systems; (b) demonstrate network linkages possible between different systems by linking these prototype systems in a network; (c) provide leadership within the Regional Medical Library region to develop subsystems and linkages between and among academic health center libraries, teaching hospitals, and community hospitals to meet the information needs of health care practitioners; (d) foster regional resource development to meet identified regional information needs; and (e) serve as laboratories for research and development in medical information management and transfer technologies and techniques.

#### The Future

Biomedical information is an invaluable national resource, the appropriate management and disposition of which carry serious and wide-ranging implications for

#### Information in Academic Health Centers

the nation. Through joint efforts in the public and private sector, the United States maintains world leadership in biomedical research, medical education, and health care, as well as in communications technologies. The accomplishments in biomedicine are made possible in no small part by the development of academic health sciences centers as foci for the generation of new knowledge and its use in the practice of medicine and in the training of future health care practitioners. Underpinning these efforts and essential to their success are the capture and efficient dissemination of the world's biomedical knowledge base. This remarkable and somewhat unheralded achievement is accomplished through public and private sector cooperation, predominately through the National Library of Medicine and a national network of academic health sciences center libraries.

A crisis in biomedical information management is developing. The continued application of inadequate techniques and technologies in academic health sciences centers to the management of the world's academic knowledge base in science and medicine puts at risk the rate of advancement and the unequalled leadership position of the United States in biomedicine. A unique opportunity exists today to combine the strong positions in biomedical research and communications technologies and shape the biomedical information environment.

In this report, some critically needed adaptations to the academic medical information base are suggested. The proposed action steps require modest financial investments in relation to the national benefits that can accrue. They do require, however, concerted and coordinated action by multiple organizations and institutions in the public and private sectors.

"Knowledge is power." The equation

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that led Francis Bacon in the 17th century to argue that the expansion of individual human mind, to

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that led Francis Bacon to that observation in the 17th century has changed. Knowledge has expanded well beyond the capacity of individual institutions, let alone the human mind, to store and recall effec-

tively. Today, power lies in the wisdom to manage knowledge so as to augment the power of the human mind to use knowledge. That is the challenge before the biomedical community today.

## Glossary

**AAHSLD:** Association of Academic Health Sciences Library Directors. Formed in 1978, its goals are to advance the development of health sciences libraries in support of the biomedical sciences and health care through publications, research, and programs. Annual meetings are held in conjunction with the annual meetings of the Association of American Medical Colleges.

**AHSC:** Academic health sciences center. Used to denote a university-centered complex of health professional schools and teaching hospitals dedicated to research, education, and health care.

**Artificial intelligence research:** Investigation of the nature of intelligence as information-processing by designing computer programs that replicate the knowledge and reasoning processes of highly intelligent specialists.

**AVLINE:** An online data base of the National Library of Medicine. Acronym for Audiovisuals Online, representing bibliographic and review data for nonprint materials in the health sciences.

**Bibliographic data bases:** Files of bibliographic citations that are document surrogates. Citations usually include information on author, title, publisher or place of publication, volume, year, and pagination and frequently include subject headings that characterize the document and brief abstracts of the content of the document.

**Biomedical computing:** A term that characterizes the use of computers to store, manipulate, and retrieve information derived from medical research and medical care.

**BIOSIS (BIOSciences Information Service):** An online abstracting and indexing information service covering the life sciences and biomedical literature (136).

**CADUCEUS:** "A computer-based diagnostic consultation system for problems in internal medicine that models expert clinicians' behavior concerned with formulating composite problem hypotheses." (137)

**CATLINE:** The National Library of Medi-

cine's Catalog Online representing bibliographic information on all serials and monographs cataloged by the NLM since 1965 and appearing in its printed *Current Catalog*.

**CBE (computer-based education):** The use of computers to provide individualized instruction. CBE strategies include tutorial, drill and practice, simulation and games, and inquiry. CBE methods are CAI (computer-aided instruction), CAT (computer-aided testing), and CMI (computer-managed instruction) (99).

**CML (clinical medical librarian):** Sometimes referred to as clinical librarian. The librarian who provides medical information needed for patient care to physicians and patient care teams on the basis of participating in patient rounds or reading residents' reports (78, 79).

**Communication:** The transfer of meaning.

**"Communications":** A term coined by Oettinger to characterize the new technology resulting from the fusion of computer and communications technologies (138).

**Data:** Generally numbers or unit facts used as a basis for calculation, reasoning, or discussion.

**Data bank:** A collection of data organized for rapid search and retrieval by computer.

**Data base:** A set of structured records consisting of data or other information bits coordinated for retrieval of specific elements. A generic term applied to varieties of information retrieval systems, for example, bibliographic data base, census data base, hepatitis data base.

**Data-base management:** The process of selecting and organizing a set of structured records so that responses can be given to specific information needs or specific types of information-seeking questions.

**Data-base searching:** The process of locating and retrieving information from a specific file of structured records.

**Data communications:** The movement of computer-encoded or digital information by

means of electrical transmission systems, usually among and between computers and terminals.

**Document delivery:** The provision of documents, for example, articles, books, or papers, using some common carrier, such as the mails, courier, or telefacsimile devices.

**EDUNET:** An international computing network for higher education and research, which provides 173 member institutions with access to a variety of resources at any of 17 university computer centers. An activity of EDUCOM, a nonprofit consortium of over 350 colleges and universities founded in 1964 to promote the use of computing, communications, and information technology in higher education.

**Electronic journals:** Journals that are stored in computers in digital form and can be accessed via remote terminals for display on a screen or printed on paper, the text of which can be searched by concepts and terms (139). The American Chemical Society "publishes" its 16 journals in both paper and electronic form.

**Electronic mail:** A variety of systems that permit the sending of digitally encoded messages via telecommunications networks to a predetermined number of subscribers. Most network systems, such as SUMEX-AIM, have messaging capabilities.

**Free-text searching:** The ability to retrieve information from an online system on the basis of the words occurring in the titles, abstracts, or texts.

**Hepatitis knowledge base:** "A prototype computerized information transfer system aimed at supporting the health practitioner's day-to-day diagnosis, prognosis, and treatment decisions concerned with viral hepatitis." (140)

**Information:** Information applies to facts, data, news, or a signal told, read, or communicated that may be unorganized and even unrelated but informative. Information is "that which reduces uncertainty . . . and that which assists in decision making, a symbol or set of symbols which has the potential for meaning." (141) "Something . . . which justifies change in a construct that represents physical or mental experience or another construct." (*Webster's New Collegiate Dictionary*)

### Information in Academic Health Centers

**Information brokerage:** The provision of information research services; securing information that answers specific questions for an individual. The term information broker is frequently applied to an individual who provides information on a commercial basis.

**Information-handling:** A general term that includes the tasks for information management and information transfer.

**Information management:** The process of selecting, acquiring, describing, organizing, and storing information to make it accessible to meet future needs.

**Information service:** The retrieval of facts, data, documents, and so forth from a variety of sources for someone's use.

**Information system:** An assemblage of facts, data, documents, and so forth organized and stored in a retrievable form to satisfy some future need.

**Information transfer:** The action of making information available to individuals at their request by locating and delivering it in the desired format.

**Instructional technology:** "A systematic way of designing, carrying out and evaluating the total process of learning and teaching in terms of the specific objectives, based on research in human learning and communication, and employing a combination of human and non-human resources to bring about more effective instruction." (142)

**Integrated library systems:** Automated systems that handle multiple library operational functions and tasks giving multiple outputs from the one-time capture of a basic unit record. Typically integrated library systems use the same record to register procurement and billing, lending or borrowing activity, binding, and bibliographic retrieval. Such a system also provides library management information and decision support data.

**Intelligent terminals:** A computer peripheral device that permits communication to larger systems and which also has self-contained memory storage and software program development and applications. Many microcomputers once fitted with communications devices serve as intelligent terminals.

**INTERNIST:** See CADUCEUS.

**Medical Information System (MIS):** "A set of formal arrangements by which the facts con-

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provision of information for an individual who provides information on a commercial basis. A term that refers to information management.

The process of selecting, organizing, and making it accessible.

Validation of facts, data, from a variety of

combination of facts, which are organized and used to satisfy some

function of making individuals at their own pace, verifying it in the

systematic way of evaluating the need and teaching in various forms, based on a combination of resources to bring them together." (142)

Automated systems for multiple operational outputs of a basic unit library systems or procurement activity, retrieval. Such a management information system.

After peripheral information is gathered, self-contained program development. Many microcommunications terminals.

IS): "A set of the facts con-

cerning the health or health care of patients are stored and processed in computers." (143)

**MEDLINE (MEDLARS online):** An online file of bibliographic citations from approximately 3,000 international journals developed and maintained by the National Library of Medicine. MEDLINE includes information since 1966 from *Index Medicus*, the *Index to Dental Literature*, and the *International Nursing Index*. Most initial access is to the MEDLINE files for the current and most recent two years.

**Microcomputer:** A self-contained computer system that handles a limited number of peripheral input/output devices using a single integrated circuit chip.

**MOLGEN:** A decision aid available through SUMEX-AIM that advises geneticists and molecular biologists on organizing experimental techniques and design (52).

**MYCIN:** A production rule-based consultation system for the selection of antibiotics to treat infectious diseases (144).

**Network:** A system by which multiple institutions, organizations, agencies, units, offices, or individuals are linked by common communication and information transfer carriers.

**OCLC (Online Cataloging Library Center; formerly the Ohio College Library Center):** Originally a centralized system for generating printed tailored library catalog cards based on authoritative Library of Congress cataloging. The acronym now denotes a group of online services for cataloging, interlibrary loan, and serials control available to subscribing libraries throughout the United States.

**Online:** Data are online when they are accessible and manipulable using a terminal connected to a remote computer via communication lines.

**Online searching:** The process of dialing a remote data-base system using communications protocols and standard computer terminals to search the files for desired information while connected to the remote computer.

**Online systems:** Data bases that can be accessed through dial-up procedures.

**Online system vendors:** Firms that market on-

line access to multiple data bases.

**PROPHET:** A National Institutes of Health-sponsored biological-chemical information system. It is a tool for drug researchers that incorporates interactive graphics, molecular model-building, computational support, and data management (51).

**Research services:** A term used to characterize "intelligence functions" in information services. These functions include assembling, screening, evaluating, and organizing information into a decision-support document for immediate application. It encompasses summarizing data-base output and transforming the information into useful briefs.

**SCISEARCH:** The online search service of the Institute for Scientific Information Science Citation Index data bases.

**SDILINE (Selective Dissemination of Information Online):** A National Library of Medicine service which permits recurrent automatic search and retrieval from the monthly issue of the *Index Medicus* prior to publication. A current awareness service available through health sciences libraries.

**SERLINE:** An online bibliographic file representing about 35,000 serial titles cataloged or on order at the National Library of Medicine and including about 6,000 titles owned by 120 resource libraries in the Regional Medical Library network system.

**SUMEX-AIM:** The Stanford University Medical Experimental Computer (SUMEX) for Artificial Intelligence in Medicine (AIM). A national computer resource connected to the TYMNET and ARPANET data-communications networks that supports more than 20 independently funded research projects, including clinical diagnostic decision-making, cognitive modeling, and molecular structure interpretation and synthesis (52).

**Telemail:** An electronic message service offered by GTE Telenet for the transfer of personal messages in digital form through communications networks.

**Teletext:** A TV broadcast technology that permits selection and display of text on adapted home television sets.

**User friendly:** Computer systems that are approachable and usable by inexperienced, untrained, and technologically unsophisticated persons.

**Users:** Generic term for individuals who try to satisfy information needs by consulting resources and services in a library or other data base.

**Videotext:** Sometimes called Viewdata. Online interactive text reading system using adapted domestic television sets coupled to telephone networks. Available in Canada, France, and the United Kingdom.

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