Trends in academic health sciences libraries and their emergence as the "knowledge nexus" for their academic health centers*

By Michael R. Kronenfeld, MLS, MBA, AHIP
mkronenfeld@atsu.edu
Director

Learning Resource Center
A. T. Still University of the Health Sciences, Mesa Campus
5850 East Still Circle
Mesa Arizona 85206

Objectives: The objective of this study was to identify trends in academic health sciences libraries (AHSLs) as they adapt to the shift from a print knowledgebase to an increasingly digital knowledgebase. This research was funded by the 2003 David A. Kronick Traveling Fellowship.

Methods: The author spent a day and a half interviewing professional staff at each library. The questionnaire used was sent to the directors of each library in advance of the visit, and the directors picked the staff to be interviewed and set up the schedule.

Results: Seven significant trends were identified. These trends are part of the shift of AHSLs from being facility and print oriented with a primary focus on their role as repositories of a print-based knowledgebase to a new focus on their role as the center or ''nexus'' for the organization, access, and use of an increasingly digital-based knowledgebase.

Conclusion: This paper calls for a national effort to develop a new model or structure for health sciences libraries to more effectively respond to the challenges of access and use of a digital knowledgebase, much the same way the National Library of Medicine did in the 1960s and 1970s in developing and implementing the National Network of Libraries of Medicine. The paper then concludes with some examples or ideas for research to assist in this process.

INTRODUCTION

In the summer of 2003, the author visited four academic health sciences libraries (AHSLs) by using funding from the David A. Kronick Traveling Fellowship, awarded by the Medical Library Association (MLA). The libraries were the Arizona Health Sciences Library at the University of Arizona (UofAZ), the Health Sciences Libraries at the University of Washington (UWash), the Health Sciences Library at the University of North Carolina (UNCCH), and the Medical Center Library at Duke University (Duke).

During my visits, I identified a number of trends that represented the transition AHSLs have been undergoing. In the past, AHSLs' primary focus was on their role as repositories of printed knowledge. This focus has changed to their role as the organizational unit that provides access to and use of an increasingly digital body of knowledge. The paper begins by looking at trends in the health care sector and their impacts on the knowledge needs and expectations of academic health centers (AHCs). This section is followed by a discussion of the need for a framework or model to facilitate the development and organization of the emerging, increasingly digital AHSL. I conclude with ideas for research that needs to be done to support AHSLs in this transition.

ENVIRONMENTAL SCAN: HEALTH CARE SECTOR

In an effort to control rapidly increasing health care costs, a strong shift occurred in the United States to managed care in the early 1990s. Despite these efforts, health care costs have continued to climb. Many em-

* This research was funded by the David A. Kronick Fellowship awarded to the author by the Medical Library Association in 2003.

ployers are now unable to absorb increases in employee health care plans and are passing on the price increases to their employees. In the period 2000 to 2002, such increases ranged from 12% to 14% in large companies to 18% to 20% for small businesses [1]. In 2000, over 40 million Americans under the age of 65 did not have health insurance coverage [2]. The costs of the war on terror and the general economic downturn of the past several years have led to increasing pressures on federal and state budgets. The sum of these effects is even greater pressures on AHCs for cost controls, as their amount of uncompensated care, their reimbursements for care, and their institutional budgets are being squeezed. For public AHCs, the squeeze is in their state budget support, and, for private AHCs, it is in the losses in their endowments caused by the dramatic financial market downturns.

The last ten years have also seen a focus on the quality of health care. A series of recent reports from the Institute of Medicine (IOM) has focused attention on these quality issues. The 1999 report, *To Err Is Human* [3], found that more people die each year from medical mistakes than from highway accidents, breast cancer, and AIDS. This report created enormous concern among the public and controversy among US physicians and physician organizations, many of whom argued that the public was becoming unnecessarily panicked about such problems. The 2001 report, *Crossing the Quality Chasm: A New Health System for the 21st Century* [4], argued that physicians, nurses, and other health professionals were doing their best to provide good quality care, but that the current system did not reward innovation and communication.

One of the major barriers to the practice of a higher quality of care is inadequate systems and resources to support the effective use of evidence in health care. The report states:

> In the current health care system, scientific knowledge about best care is not applied systematically or expeditiously to clinical practice. An average of about 17 years is required for new knowledge generated by randomized controlled trials to be incorporated into practice, and even then application is highly uneven. The extreme variability in practice in clinical areas in which there is strong scientific evidence and a high degree of expert consensus about best practices indicates that current dissemination efforts fail to reach many clinicians and patients, and that there are insufficient tools and incentives to promote rapid adoption of best practices. The time has come to invest in the creation of a more effective infrastructure for the application of knowledge to health care delivery. [4]

The 2003 report, *Health Professions Education: A Bridge to Quality,* recommends a competency-based approach to training clinicians, with the ability to employ evidence-based practice as one of the five core competencies central to the practice of quality health care [5].

A third major trend has been the development of the Web, coupled with the increasingly rapid development of more powerful computer technology and health information applications. These developments have several important implications for AHSLs and are discussed in the Blue Ridge Academic Health Group's 2001 report, *e-Health and the Academic Health Center in a Value-driven Health Care System* [6].

One impact of these developments is the emergence of an information infrastructure that cuts the tie between the library and the physical location of knowledge-based information (KBI). Ten years ago, the majority of the body of evidence relating to clinical medicine was available only in print and thus only available in large medical libraries. Technology now supports access to KBI remotely from any location, especially at the point of clinical care. The clinician is now expected to access KBI at the point of care to support an evidence-based practice. This expectation is developing for all clinicians regardless of whether they practice in a major AHC, a hospital, or a private practice or clinic. In the next few years, this access may have an increasing legal significance, if it becomes a recognized component of the standard of care from a malpractice standpoint [7].

These new computer capabilities lead to an expectation that the new technology will support solutions to many of the problems facing the health care sector. An example that is currently receiving attention is the effort to develop and adopt computerized physician order entry systems (CPOE). When these systems are operational, they are expected to significantly reduce medical errors and therefore reduce costs, improve quality of care, and reduce the amount of time clinicians spend on what are essentially clerical tasks involved in copying or transcribing their orders. This focus on CPOE is also part of the progress being made to finally develop and implement true electronic medical record systems. Other systems beginning to be implemented to improve quality are clinical decision support systems and bar code–based systems to make data entry easier and reduce errors in everything from administration of medications to patient identification [8].

These improvements indicate that health care facilities are ready to make significant progress in facility-wide, integrated information systems (IS) to which KBI systems can be integrated. Examples of this integration of KBI are systems that automatically check the appropriateness of drug dosages and potential drug interaction problems and systems that match the patient's diagnosis and characteristics, such as age and other medical conditions, and then automatically link to appropriate KBI information. AHSLs will need to continue to lead the efforts to incorporate access to and use of knowledge, including KBI in these emerging systems and applications.

TRENDS IN ACADEMIC HEALTH SCIENCES LIBRARIES

I identified a number of trends in the AHSLs I visited that reflected the significant changes just discussed. They also indicated the change in AHSLs that has been occurring with the shift in their focus from their role

Table 1
Libraries and Association of Academic Health Sciences Libraries (AAHSL) mean electronic resources comparison, 1996–1997 and 2001–2002

Library	1996–1997 electronic resource expenditure	2001–2002 electronic resource expenditure	% increase electronic resources	1996–1997 electronic resource % of total acquisitions	2001–2002 electronic resource % of total acquisitions
University of Arizona	$16,890	$136,114	805%	2%	10%
Duke University	$59,207	$362,557	612%	7%	19%
University of North Carolina	$63,154	$564,765	894%	4%	31%
University of Washington	$37,481	$217,265	580%	2%	13%
AAHSL total	$47,838	$281,298	588%	6%	22%

as repositories of a print medical knowledgebase to that of facilitating access to and use of an increasingly digital knowledgebase. I spent a day and a half visiting each library, asking a set of questions I sent to the director of each library before my visit. Based on these questions, the directors selected key staff for me to interview. After my first visit (UofAZ), I also decided that an introduction to my project followed by a discussion of the issues I was examining was helpful. I chose these libraries based on previous work I had done with them and on their locations to maximize the number of visits I could make with the funds available from the Kronick fellowship. The following trends emerged.

1. A shift of acquisitions expenditures from print collections to digital collections

In all four of the libraries I visited, there has been a major shift in expenditures from print to Web-based digital content in spite of difficult budget constraints. Table 1 shows the increase in collection expenditures over the most recent 5 years, according to the statistics published annually by the Association of Academic Health Sciences Libraries (AAHSL) [9, 10]. In a time span when AHSLs' acquisitions budgets were increasing modestly, the amount spent on electronic resources increased between 580% and 894%, with the average increase for all the AHSLs in the statistics at 588%.

As an indication of the impact inflation has on the AHSLs' acquisitions budgets, the American Libraries Online article on price increases in 2002 [11] presents data on the increase in prices of 182 journals in medicine. From 1997 to 2002, the prices of these journals increased 71%, while the average acquisitions budgets for AAHSL members only increased by 27%. All 4 libraries in this study had a significant decrease in terms of actual dollars spent on print monographs (Tables 2 and 3), while the average increase in spending on monographs for this period for all AHSL libraries was only 2%. These figures clearly indicate the major shift in acquisitions from print to electronic KBI. An example of this shift is at UofAZ, which recently acquired online access to the full Elsevier list of medically related journals and dropped the print subscriptions to these titles.

2. A shift in the duties of professional staff from traditional "in the library" duties, such as reference desk time and collection development time, to "out of the library" liaison activities, such as curriculum development and faculty instructional support

In all four libraries, I found efforts to shift the professional librarians from traditional, ''in the library,'' reference services to liaison activities with the AHC schools and programs the AHSLs serve.

AHSLs are noting a decrease in the use of mediated reference services. This decrease appears to be concurrent with the development of reference tools that are appropriate for end users. However, it appears to have preceded (and helped encourage) the shift of librarians to curriculum development and faculty support.

Each of the libraries was at a different stage of this shift. UWash had gone the furthest with the liaison role being the primary focus of its professional staff. At UofAZ, one librarian had primary responsibility for outreach to the schools served, but the reference department staff were also beginning to work more closely with the schools as opportunities arose. The public services coordinator indicated that the next step would be the establishment of a more formal liaison program. At UNCCH, the efforts of librarians to move out of the library to work more closely with the schools and programs in the health sciences center has been based on opportunities for collaboration as they have occurred rather than on a coordinated plan. The

Table 2
1996 to 1997 acquisitions expenditures by format

Library	Print serials	Print monographs	Electronic resources
University of Arizona	$713,060	$170,777	$16,890
Duke University	$826,900	$229,125	$59,207
University of North Carolina	$1,356,818	$161,154	$63,154
University of Washington	$1,436,547	$178,721	$37,481
AAHSL	$694,861	$116,516	$47,838

Table 3
2001 to 2002 acquisitions expenditures by format

Library	Print serials	Print monographs	Electronic resources
University of Arizona	$1,122,387	$92,528	$136,114
Duke University	$1,340,808	$145,901	$362,557
University of North Carolina	$1,147,597	$102,851	$564,765
University of Washington	$1,449,274	$47,003	$217,265
AAHSL	$881,221	$119,366	$281,298

librarians are interested in expanding the liaison program and including it in the library's formalized planning process. Library administration is interested in the liaison role, including collaboration in grant preparation and in research, to both increase the library's funding and to strengthen the quality of the institution's research by more effective use of KBI. At Duke, the liaison program with specific library staff working with specific schools began in 1999/2000. The staff see the key to success in the liaison program as the ability it gives them to customize services to both better meet the specific needs of each school and to give the schools a greater sense of participation in and ownership of the library services. They see this ability as an important part of their vision: ''The Best Way to the Best Information.''

As part of this shifting of librarians to direct liaison services, UWash, UNCCH, and Duke have merged their reference and circulation desks into single information desks. At UWash, it is staffed by paraprofessionals with professionals available for support. At UNCCH, the reference desk and the circulation desk were staffed by two to three people during busy times. The combined desk is staffed by one professional and one paraprofessional during busy times and primarily by paraprofessionals on nights and weekends. At Duke, the information desk is staffed by one professional and one paraprofessional during weekday hours and by paraprofessionals on nights and weekends. Full reference support (called information and education services) is only provided during the hours the desk is staffed with a professional librarian. At UofAZ, the one library still maintaining a separate reference desk, it is staffed primarily by professional librarians. I was told that one problem they have is the faculty's perception that they receive the same services as students, when they expect a higher level of service and support.

While all four libraries are shifting their professional librarians from traditional, library-based services to direct support of units served, they are all still in an early stage of this change. They are exploring and experimenting with what actual services they can provide. A major concern was with the level of staffing that would be required to effectively move the librarians out of the library to better meet the institutions' knowledge needs.

3. A shift in use of library space to support building "community," to provide more group workspace with knowledge-based information (KBI) access, to provide an increasing number of computer stations, and to support the accessibility and use of these stations

The theme of community was common at all four libraries. UofAZ and UNCCH are both in the process of installing coffee shops in their libraries. Staff at UofAZ are concerned that remote users of library resources are losing the connection with the library. This concern has driven the shifting of a computer instructional space into a coffee/Internet café to encourage faculty and students to congregate and network in the library. Other space is also being redesigned to facilitate group study, a growing need mentioned at all four libraries.

UNCCH is undergoing a major remodeling of the entire library. This renovation has several objectives that strive to build an environment supporting community:

- The basement is wall-to-wall compact shelving, and the bulk of the collections will be moved there to free up space on the other floors for staff and users and to make the library more welcoming to patrons.
- Technology is strongly emphasized with a strong computer support infrastructure built into the building. A space has also been set up for technology development with strong connectivity and flexibility to be used as a development space for UNC faculty and students as well as library staff.
- The library is designed to be a user-friendly space and to provide an environment that encourages study (no hard edges, lots of free flowing open space, pastel colors, etc.) and to provide more group study space in rooms with strong connectivity.
- Staff space is designed to encourage team building and work; for example, each department's space has a meeting room to facilitate meetings designed for the size of the department and to provide a space to encourage collaboration among staff.
- The library is designed to provide an environment creating a sense of community among it users—this includes the coffee shop and open central spaces that enable users to see and communicate with each other.

These objectives clearly reflect the shift from the library's repository role to that of a hub for community with a focus on access, organization, and use of knowledge.

At UWash, the staff agree about the importance of providing more collaborative group study space. The facility is 30 years old and not adequate for a modern, high-tech, heavily used regional library. While preliminary work has begun on planning a new library, staff are not optimistic about how quickly the resources to build a new facility will be available. Every foot of available space has been used for computers. One section is dedicated to checking email, with computers set at a standing height to encourage short sessions. Another section is for accessing library resources and a third section for general productivity, with Microsoft Office applications including word processing and spread sheets, as well as Web access. In spite of the reduction in journal subscriptions over the past five years from around 3,000 to 2,000 and the emphasis on online digital resources, the library staff do not feel that they can free up significant additional space for patron usage by weeding of journal back files. These back files are still heavily used for interlibrary loan support of other libraries in that region.

Duke has a library facility recent enough not to justify major renovation but old enough not to provide the computer access and group space desired today. They use opportunities that arrive from relatively mi-

nor renovation projects, such as new carpet in certain sections, to change space usage. Recent changes include the elimination of the reserve collection and the combination of the reference desk and circulation desk into a single access point to provide space for additional computers for patron use.

4. Work on the development of a new generation of Websites that not only provide easy access to the new collections of full-text KBI, but also provide improved means to manipulate the content to increase access to specific information rather than just specific articles or monographs

At all four libraries, strong Websites provide access to a vast array of bibliographic and full-text KBI. All four are also in various stages of developing major redesigns of their Web pages to more readily meet their patrons' needs to quickly locate needed KBI on specific topics. They have discovered that the current Websites provide access more closely reflecting the librarians' approach to organizing information by format rather than by subject. In the last five years, the rapid increase in full-text content has driven the Web development process, as the need to provide an infrastructure capable of providing large numbers of users with authenticated access to large collections of digital resources has been the main focus in Website and infrastructure development. Now that this has been accomplished, the libraries are looking to improve the ability of their patrons to effectively access this content.

Until this year, UofAZ's Website has focused on effectively tying together a rapidly increasing number of digital resources. But over the last year, the library staff has realized that they cannot assume that ''if we build it, they will come.'' The library needs to provide utility and value beyond a collection of digital resources supplementing print resources. Two examples of this change in focus are: the decision to drop all Elsevier print subscriptions for electronic versions, as the print and digital collections are now considered together and not as separate entities, and the Web committee's reexamination of their Website to begin developing a more robust information architecture to better support specific user applications and needs.

Website development at UWash has led to a specific user-type-based structure. Pages for bioresearchers, care providers, grant seekers, instructors, public health affiliates, social workers, and students are at the top level. Within each of these, access is by user group or use. For example, the Care Provider page has links to PrimeAnswers (a point-of-care–focused site), nurses, pharmacists, patients, clinical specialists, evidence-based practice, and two links to clinical support systems that are specific to UWash. This organization facilitates access to an array of digital resources, specifically tailored to the specific type of users' needs.

Duke's Website design is led by the Web Steering Committee. In 2000, the committee had open staff forums to get wide input on the design of the sites. It then focused on maintenance but has now been looking at revamping its Website, having discovered that patrons did not access KBI in the same manner as the librarians did. Duke is partnering with UWash in a trial to adapt UWash's PrimeAnswers Website to test this approach to organizing access to KBI for primary care clinicians at the point of care. The Web Committee is also reviewing other sites and surveying users to help guide this process.

UNCCH has focused on the use of the Web for access to KBI resources for almost fifteen years. It began organizing access to its digital resources in its initial development of the UNCLE electronic health information resource in the early 1990s. With the emergence of the Web in the mid-1990s, they quickly moved UNCLE from a telnet-based, on-campus resource to a database-supported Web resource organized to facilitate selection and access of relevant digital materials by subject, format, and resource title. The library's goals and objectives for 2003 to 2008 place a heavy emphasis on the continued development of electronic tools both to support the KBI needs of the health center and of the population of North Carolina.

While the current UNCCH Web presence is a rich one with various access points by user group, topic, and format, the library aimed to move to a new Web interface by the end of 2003. This new Website will further support access to digital resources to match specific user group's KBI needs. For clinicians, the new site will focus access on a core set of resources able to efficiently and effectively answer clinically based questions with a focus on point-of-care access. To support the research activities in the health sciences campus, the new Website will expand access to KBI by providing integrated access to both the digital resources provided by the health sciences library and those provided by the main campus academic library.

5. A shift of document delivery from print to digital format

Electronic delivery of interlibrary loan (ILL) began in 1991 with the introduction of Ariel. For the next ten years, this was the primary method of electronic ILL and was limited primarily to large AHSLs. In the last several years, the increased access to digital full-text KBI and the increased capability of and decreased cost of scanners have led to a rapid increase in the use of digital document delivery by smaller medical libraries. This increase has lowered the delivery time from a week to a day or two and led libraries receiving documents in a digital format to begin forwarding them to their patrons digitally. This practice is leading to increased patron expectations for electronic document delivery, both to save them a trip to the library and to obtain the needed documents more rapidly. An example of this increased expectation has recently been occurring at UNCCH. During a major renovation, much of the journal back files were moved into an off-campus storage location with a system for pulling, scanning, and sending needed material in digital format to faculty within three days. As the library staff prepared to return the journal back files to the library, they found that electronic delivery of library-held jour-

nal articles had become popular and that it could not be easily ended. They are now instituting a trial to continue this service, even though the materials are again accessible for patrons.

This trend has several significant implications for future development of AHSLs. It further reduces the need for AHSLs to focus on their role as a depository for KBI. The location of the materials is no longer relevant, if access can be provided within a day or two. This makes possible the development of regional or national systems of cooperative retention of back files to free up valuable space for other applications. This move toward digital delivery is another piece in moving the library from a place to a knowledge center impacting and supporting access to and use of information throughout the institution, including at the point of care.

6. The emergence of new, digital, nontraditional KBI formats

Before the emergence of the Web, KBI was primarily composed of monographs and peer-reviewed journals. Since the emergence of the Web in the mid-1990s, new KBI resources have emerged that exist only in Web format. UpToDate and the Cochrane Database of Systematic Reviews are two examples of such resources. The new resources expand on the role played by monographs in the print-only era by synthesizing current knowledge on a topic to provide easily accessible, state-of-the-art information on a clinical topic. In using the Web format, these resources can be more comprehensive and much more current than their print equivalents. Some are explicitly taking an evidence-based medicine approach (Cochrane, PIER), while some are implicitly doing so (UpToDate). Three of the four libraries I visited have subscribed to UpToDate, even though it is very expensive. Because of its focus on answering clinical questions, it is very popular among clinicians, especially from point-of-care locations.

7. A shift of the academic health centers to create an increasingly standardized and integrated computer-based operation that impacts all aspects of the institution

Examples of computer-based operations include: the computerized patient record, the increasing capability of clinical and management information systems to aggregate information for quality control and research, and the increasing need for ''point of care'' and ''just in time'' access to KBI for clinicians. This shift is still in an early stage at the institutions I visited, but the libraries are watching and beginning to think about their roles in an increasingly integrated, knowledge-driven online environment.

EMERGING FRAMEWORK FOR ACADEMIC HEALTH SCIENCES LIBRARIES IN A DIGITAL ENVIRONMENT

In my visits, I found the shift of the libraries from a print knowledgebase to a digital knowledgebase well under way. This finding was reinforced in a review of new services being implemented by AHSLs across the country in response to the changing information and technology environment presented by AAHSL in Building on Success: Charting the Future of Knowledge Management within the Academic Health Center [12].

While AHSLs are in this transition, they are feeling their way without a relevant roadmap. Even though the Web facilitates the construction of a national or international infrastructure, these efforts are occurring at isolated sites, with each site having to pay rather steep fees to create their systems de novo. So, why can't medical libraries (including AHSLs) leverage the power of electronic delivery to compose a national or international infrastructure whereby all facilities benefit? Not only would this infrastructure result in increasing effective use of the digital knowledgebase, it should have a strong payoff in terms of our health care dollar in increased quality of practiced medical care.

In the previous system that emerged from the National Library of Medicine's (NLM's) implementation of a national system for access to and use of KBI in support of clinical education, research, and practice in the 1960s and 1970s, the key role for AHSLs was as regional repositories for KBI, which at that time only existed in print formats. Through the development of MEDLINE, DOCLINE, and the National Network of Libraries of Medicine (NN/LM), NLM created an infrastructure that enabled medical libraries to quickly create subject bibliographies on clinical topics and quickly (for the technology of the times) locate and obtain copies of that material. The impetus for that infrastructure was the need to provide a better means of managing and providing access to the exploding knowledgebase coming from the government, AHCs, and the industrial medical research complex, which had emerged from the rapid expansion of the National Institutes of Health (NIH) and its research funding base that began in the early 1950s. NLM, NIH, and AHSLs recognized that a better system for accessing and using this rapidly expanding knowledgebase was necessary to maximize its impact on the quality of health care being practiced, although that was not the terminology used at the time. The system implemented was the state of the art for the technology of the time.

As I have discussed in the first section of this paper, the rapid emergence of the Web in the mid-1990s, followed by the rapid increase in the availability of digital, full-text information resources, has made the system implemented by NLM obsolete. We need to develop a new model or framework to facilitate the most effective access to and use of the increasingly digital knowledgebase at all levels of the health care sector.

AHSLs also need to work together to explore how they can work closely with their AHCs' schools and programs to most effectively integrate access to and use of KBI and knowledge into all aspects of the AHCs' operations as part of an exploration of this new model for improved access to KBI. Some areas for significantly greater impact of access to and use of knowledge in the AHCs include:

- develop a high level of information literacy and knowledge-based medicine competency in clinical program graduates
- support the knowledge component of research in writing funding proposals and in performing the actual research
- proactively work in the AHC to develop more efficient systems to provide point-of-care access to knowledge in support of quality health care
- work with the AHC administrative and information services units in integrating access to and use of KBI into institution-wide integrated information systems.

In addition to the above objectives, NLM and AHSLs need to play a key role in the development of new systems for the translation of research-based evidence into clinical practice as called for by the IOM and by the call in a recent issue of the *Canadian Medical Association Journal* for the creation of more effective systems of technology-driven knowledge translation [13]. In both proposals, the bottom line is that the primary value and reason for the access to and use of knowledge in the health care setting is to improve the quality of that care. New KBI formats—including clinical guideline databases; meta-analysis-based best-practice collections that are collaboratively produced and clinically focused; products that provide expanded, online, textbook-type overviews; and systems—must be integrated in health care facilities through clinical and management-driven information systems. These systems have the potential to dramatically change how KBI will be accessed and used by clinicians. We now have the technology to support the implementation of a new knowledge infrastructure to support rapid, uniform access to knowledge-based systems for the translation and organization of research and practice-based evidence across diverse geographical and clinical settings.

NLM, working with AHSLs, has driven the development of the use of technology to improve access to KBI for the past forty years. The development of MEDLINE, the Regional Medical Library program in the late 1960s and the 1970s, and DOCLINE in the 1980s, as parts of a national system for access to KBI, was an incredible advance in clinicians' ability to access and use KBI. The Integrated Advanced Information Management Systems (IAIMS) grants program of the 1980s and 1990s was a key driver in the development of more and more sophisticated uses of technology to improve the organization of, integration of, and access to knowledge through AHCs. NLM, working with professional organizations such as MLA and AASHL, needs to provide leadership in actively supporting the development of a new infrastructure or system to facilitate the medical library's ability to effectively provide the best possible access to and use of KBI in the increasingly knowledge-based environment.

POTENTIAL RESEARCH TOPICS TO SUPPORT THE DEVELOPMENT OF A NEW MODEL OR SYSTEM

As part of the planning for and achieving of a new system, NLM, MLA, and AAHSL need to support research and development of the tools necessary for successful implementation of this new model or system based on the key role knowledge plays in health care and in AHCs. Several areas for research come to mind.

One key development is the need to upgrade document delivery and DOCLINE. The technology now exists to support next-day or two-day delivery of ILL documents between AHSLs. Research needs to be done on what would be required to make this the norm for a significantly higher number of documents than are currently processed. Included in this research should be an examination of the costs of providing this higher level of document delivery services. If this examination can be accomplished, then NLM could lead an effort through NN/LM to support the development of interlibrary agreements to divide among AHSLs which library will retain which back files for specific journal titles. This division will enable them to then discard the back files of journals they are not required to maintain. This freeing up of significant space in AHSLs can be used to support their increasing need to serve as the center of the knowledge and information community in AHCs. In looking at the current costs of maintaining large files of print journals, not only do the direct costs in staff and utilities need to be considered, but the value of the space that could be used for more productive activities also needs to be taken into account.

Most AHCs have strong grant offices to support the process of applying for and administering grants. Many AHSLs have developed Web-based resources to support those efforts (e.g., the UWash site <http://healthlinks.washington.edu/rfs/>). In an increasingly knowledge-based environment, AHSLs need to increase their role in supporting the most effective integration of the access to and use of knowledge in the research being carried out in the AHCs they serve. One possible way of achieving this integration is the creation of knowledge offices, focused on assisting researchers in the AHCs in examining ways knowledge can be used to strengthen their research and enabling them to prepare stronger funding proposals. When appropriate, this office could encourage the inclusion of librarians on research teams looking at research with a strong knowledge component. The feasibility and make up of such a support function could be an excellent topic for a demonstration project in several AHSLs.

In an increasingly knowledge-driven clinical environment, research needs to be conducted on how to most effectively achieve a high level of clinicians' competencies in information literacy by the time of their graduation. While the four libraries I visited are all looking at how to do this, they do not have a clear idea of how to accomplish it. Research needs to be carried out to develop educationally valid strategies for achieving these competencies in clinical teaching programs. At all four libraries, their success in teaching information literacy skills depends on the library staff's ability to build individual relationships with faculty and varies greatly from program to program

in each AHC. Only nursing seems, as a profession, to have recognized the value of the systematic use of knowledge and to have seriously looked at nursing information and evidence-based practice with courses and research looking at nursing informatics issues. At all four AHSLs I visited, the liaison programs with nursing departments are the most successful. Similar research in other areas—including medicine, allied health, dentistry, and public health—would not only provide AHSLs with better methodologies for teaching these competencies but better evidence to use in convincing these other programs of the validity and value of adding competency-based instruction in information literacy to their curricula.

Another potential area for research to support this transformation of AHSLs is research in development of tools and methods to evaluate the effectiveness and use of the digital knowledgebase. While having the ability to collect usage statistics about these resources would be a good start, research on methodologies is needed to measure not only the usefulness but also the effectiveness of the digital resources and of the Websites that are being created, so that the most effective access to and use of the resources can be provided.

This is truly an exciting time to be a medical librarian in an AHSL. As I have attempted to show, we are in the initial stage of a major transition of what we do and how we do it. We have the opportunity to help create the medical library of the future as the true center for the access to and use of knowledge in an increasingly knowledge-driven environment. It has been a true gift of MLA, through the David A. Kronick Traveling Fellowship, to support my visits to four AHSLs to ask questions, ''nose around'' and see what they are doing, and be able to compare and contemplate what I have learned. I hope the trends I have found and the significance I have recognized in them help move forward our efforts to create a new vision of who we now are and who we are becoming in a rapidly changing information environment.

REFERENCES

1. Kronenfeld JJ, Kronenfeld MR. Healthcare reform in America: a reference handbook. Santa Barbara, CA: ABC-CLIO, 2004.
2. Chartbook on trends in the health of Americans/health, United States. National Center for Health Statistics (US), 2002:24
3. Kohn LT, Corrigan JM, Donaldson MS, eds., Committee on Quality Health Care in America, Institute of Medicine. To err is human: building a safer health system. Washington, DC: National Academies Press, 2000.
4. Committee on Quality of Health Care in America, Institute of Medicine (US). Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academies Press, 2001.
5. Greiner AC, Knebel E., Committee on the Health Professions Education Summit. Health profession education: a bridge to quality. Washington, DC: National Academies Press, 2003:33.
6. Blue Ridge Academic Health Group. E-health and the academic health center in a value-driven health care system. Charlottesville, VA: Blue Ridge Academic Health Group, 2001.
7. Eisenberg JM. What does evidence mean? can the law and medicine be reconciled? J Health Politics, Policy and Law 2001 Apr;29(2):369–81.
8. Hagland M. Reduced errors ahead: organizations are moving down the road to patient safety, despite bumps and curves. Healthc Inform 2003 Aug;20(8):31–40.
9. Association of Academic Health Sciences Library Directors. Annual statistics of medical school library in the United States and Canada. 20th ed. Seattle, WA: The Association, 1998.
10. Association of Academic Health Sciences Libraries. Annual statistics of medical school libraries in the United States and Canada. 25th ed. Seattle, WA: The Association, 2003.
11. Albee B, Dingley B. U. S. periodical prices 2002. [Web document]. Chicago, IL: American Library Association. [cited 27 Sep 2004]. <http://www.ala.org/Content/NavigationMenu/Products_and_Publications/Periodicals/American_Libraries/Selected_articles/U_S_Periodical_Prices,_2002.htm>.
12. AAHSL Charting the Future Task Force. Building on success: charting the future of knowledge management within the academic health center. [Web document]. AAHSL, 2003. [cited 27 Sep 2004]. <http://www.aahsl.org/document/ACF20BE.pdf>.
13. Ho K, Chockalingham A, Best A, Walsh G. Technology-enabled knowledge translation: building a framework for collaboration. CMAJ 2003 Mar 18;168(6):710–1.

Received December 2003; accepted August 2004