
Issues in Clinical Information Delivery

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ABSTRACT

ALTHOUGH THE PROFESSIONAL LITERATURE CONTINUES to be a major source of continuing education for health care providers, and although libraries are often excellent sources of information that can benefit patient care, the problems in information delivery to clinicians have not yet been solved. The ever-increasing amount of information available and the time and effort required to obtain the appropriate piece of it when required both act as barriers to information use by busy clinicians. The following library-related services are discussed as important contributors to clinical information delivery; clinical librarianship; LATCH (Literature Attached to the Chart); end-user searching of computerized databases; quality filtering of the literature; and clinical information systems that integrate internally generated patient care information, such as the patient record, with access to library and information services. An important new role for the librarian is emerging in quality improvement programs that use the literature to assist health professionals in prospectively improving patient outcomes. Ongoing research into both information needs in clinical settings and the impact of library services is required as a basis for effectively meeting practitioners' information needs.

INTRODUCTION

Clinical information needs are of special importance because they relate directly to the ultimate purpose of the health care system—the care and treatment of the patient. Clinical information needs

are different from those related to research, education, and administration because clinicians require rapid access to practical knowledge that can be applied to patient care. The purpose of this article is to review past studies of clinicians' information-seeking behavior as a basis for discussing various library programs and services designed to deliver information to clinicians. Particular attention is paid to the impact of information on clinical decisions and patient care and to developments in end-user searching of health care databases. The growing relationship among expert systems (such as decision support systems), health care data (such as patient records), and data from factual and bibliographic databases is also discussed as a future trend.

Although the discussion of clinical information delivery in this article deals with health care providers as opposed to consumers, the ideal clinical information delivery system includes service to both sides in the professional-client relationship. Informed clinicians as well as informed patients and family members are needed if the most effective and appropriate care is to be provided. Valiant efforts are being made by librarians to meet the growing need for consumer health information; however, the funding for library and information services in hospitals and other health care facilities continues to be mainly for services to providers. For a detailed discussion of consumer health information needs and services, the reader is referred to Dahlen's article in this issue of *Library Trends*.

In preparing this article, the author was reminded of the lack of research on the information-seeking and use patterns of health professionals other than physicians. Over the last two decades, librarians have responded to the trend toward interdisciplinary health care by broadening their collections and services, but this trend is not similarly reflected in the research literature. There are a great many user studies on physicians, some of which take an interdisciplinary approach, and relatively few studies on other health professional groups such as nurses, nutritionists, physiotherapists, and occupational therapists. Wherever possible, studies of these groups have been included in this article.

INFORMATION SEEKING AND USE BY HEALTH PROFESSIONALS

Within the field of library and information science, studies of information seeking and use by clinicians fall into the category of "user studies." This broad research category includes studies of what information needs are perceived, what information-seeking channels are used, as well as what information is actually applied to patient care. As might be expected, library science researchers have been

primarily concerned with studies of the use of the library and its resources and services.

In the health sciences field, there is a substantial literature dealing with information needs and uses in the context of the education of health professionals—in particular, continuing education needs and preferences. These education-oriented studies provide an opportunity for librarians to view their collections and services as one of a number of formal and informal information sources that clinicians use to meet their information needs.

The rapidly changing world of health care knowledge and the problems experienced by clinicians in keeping up to date has led to a third group of studies on methods of disseminating health care knowledge and changing practice behavior to reflect new trends and treatments. The results of these studies are also extremely valuable to librarians. Like the education studies, the practice behavior research allows librarians to examine the information sources used by health professionals as part of the change process.

The following review integrates a selection of studies from the three literatures described earlier: (1) library and information science, (2) health professional education, and (3) practice behavior change. Readers who are seeking additional references may wish to consult the reviews prepared by Osiobe (1985) and Elayyan (1988). The studies are presented in chronological order to illustrate the parallel development of relevant research from the three areas.

Studies of clinicians' information-seeking patterns and use have a considerable history. Sherrington (1965) identified 162 studies on the flow of medical information, many of which were sponsored by medical journals or pharmaceutical companies. A recurring theme in several of the early studies (Menzel, 1966; Mayada, 1969; Friedlander, 1973) was that the information use patterns of clinicians differ from those of scientists and researchers. Clinicians had very practical information needs that were often best served by informal consultation with colleagues. As a result, clinicians consulted the research literature less frequently. Scientists and researchers, on the other hand, were more extensive users of the literature and libraries because of their need to be aware of new published research findings as a basis for their own work. Mayada (1969) suggested that clinicians required information in different forms and amounts than teachers and researchers. Most clinician literature searches focused on diseases or treatments with drug information being the most frequently requested topic. Textbooks were used most frequently by medical students and residents while medical journals were preferred by staff physicians (Neufeld & Woodsworth, 1972).

A sociological study in the diffusion of innovation by Coleman, Katz, and Menzel (1966) provides a very detailed view of how physicians adopted a new antibiotic drug. Although physicians became aware of the new drug through the medical literature and from pharmaceutical representatives, this knowledge alone was not usually sufficient to persuade the physician to start prescribing the new drug. Sharing of personal experiences by physician opinion leaders in the community about prescribing the drug turned out to be a key element in the adoption process. This study had a major impact on future diffusion studies which continued to investigate the role of inter-personal networks in adopting innovations (Rogers, 1973).

Subsequent research efforts tend to confirm the findings of earlier studies. Strasser's (1978) study of practicing physicians in New York State found that involvement in research or teaching correlated with greater use of the medical literature and the library. Stinson and Mueller (1980) found that, for a group of 402 randomly selected health professionals, the literature was the most common source of information followed by information from professional colleagues. Health professionals in urban areas made more use of professional colleagues than those in rural or semi-urban areas; clinicians in institutions made more use of colleagues than those in solo or group practice; and physicians in general practice made more use of pharmaceutical representatives than did specialists. Younger clinicians were more likely than older ones to use professional colleagues as information sources.

In a study of medical students, residents, and physicians, Northrup et al. (1983) found that the participants relied heavily on their personal libraries because of convenience and the need to obtain the information quickly. A study of physicians in office practice by Covell et al. (1985) showed that physicians formulated an average of six questions related to patient management during an observer's half-day visit or about two questions for every three patients seen. One of the most remarkable findings in the study was that the same physicians had previously reported on a questionnaire that they needed information related to patient care only once a week. Of the questions raised by the physicians during the observation period, only 30 percent of the clinicians' information needs were met during the patient visit and most often by another physician or health professional. A number of barriers to the effective use of print sources were identified in the study, including out-of-date textbooks in the office, poorly organized journal articles and files, inadequate indexing of books and drug information sources, and lack of time to find the needed information.

Parboosingh et al. (1984) measured physicians' perceptions of the sources of information that helped them decide to change their clinical practice. While medical journals, continuing medical education, and communications with colleagues were most often cited as the initial source of information, an average of over three sources—or change agents as they were referred to by the authors—were required to initiate a change in practice. The sources could include hearing about a new treatment at a conference, discussing the treatment with a colleague who had used it, and reading an article from the medical literature on the treatment.

Recurrent themes in studies of clinicians' use of information sources include the reliance on clinical judgment to solve patient problems because of the time pressures of the practice setting and clinicians' preferences for informal information sources such as colleagues. Nevertheless, several studies have found that reading of professional journals is cited as a primary mechanism for continuing medical education and that practicing physicians spend three to five hours a week reading journals (Currie, 1976; Curry & Putnam, 1981). Despite this reading for continuing education purposes, clinicians still report difficulties in applying the medical literature to patient care problems.

Fletcher et al. (1981) suggest that, in order for the medical literature to be useful to clinicians, it must answer questions that arise in patient care, measure clinically relevant variables, and use research designs most likely to yield valid conclusions. In a thirty year review of the medical literature covering 1946 to 1976, the authors note that, despite the rapid growth in publishing, there had not been frequent reports relating to the foremost questions asked by physicians, namely, those dealing with diagnosis, prognosis, and treatment. Other frequently asked, but infrequently addressed, questions relate the etiology of illness, the frequency of medical conditions, clinical presentations of illness and the differentiation of normal and abnormal human biology. Fletcher et al. (1981) also comment upon the lack of reports of studies that have used research designs that they consider rigorous enough for answering clinical questions. These more rigorous designs include randomized controlled trials, cohort studies, and case control studies.

Information seeking and use by physicians in particular has continued to be a topic of research interest in more recent years, and some of the same findings and problems persist. A study conducted for the New York Academy of Medicine by Louis Harris and Associates (1987) found that medical professionals and students were still primarily dependent on the printed word as opposed to the newer computerized sources of medical information, and they continued

to rely mainly on their personal collections of books and journals. Of particular concern was that office-based physicians were less well informed than those in teaching or research settings based on their reading habits and use of online medical databases.

In a study of medical information needs of internists and pediatricians at an academic medical center, Woolf and Benson (1989) found that both faculty and house staff most frequently required information related to treatment recommendations and differential diagnosis. The information needs of house staff differed significantly from those of faculty in several areas: house staff needed information more often for patient care and preferred to use textbooks and handbooks. Faculty more often needed basic science information.

Williamson and Associates (1989) conducted a survey on behalf of the Massachusetts Medical Society to determine whether, and to what extent, practitioners who were involved in primary care, such as general internists, pediatricians, family and general practitioners, and obstetricians and gynecologists, perceived a problem in managing their science information needs. Opinion leaders, including leaders of professional societies and members of certification and editorial boards, were also included in the survey. In reviewing previous studies, Williamson and his collaborators (1989) found only three articles relating to information seeking, information dissemination, and information implementation that they considered relevant and scientifically sound. The first study by Weinberg et al. (1981) on informal advice and information seeking between physicians found that colleague interaction occurred on a regular and frequent basis and was of considerable value to the clinician. A few physicians in the local county, regarded as the opinion leaders or educational influentials, were nominated by 92 percent of their peers as good sources of information. The second study by Stross and Harlan (1979) on the dissemination of information on hypertension found that journals were listed as a source of information by 80 percent of the family physicians and 50 percent of the internists. The third study by Bergman and Pantell (1986) did not relate to information sources but to the interpretation of information contained in a newly published clinical article on treatment of an infant with high fever. The authors found that physicians had difficulty in using probability data and appeared to base management decisions on intuition rather than on calculation.

The Williamson et al. (1989) study, which is one of the most methodologically rigorous to date, concludes that physicians are facing a serious problem in trying to keep up with medical advances and the expanding medical literature. The authors also state that science information management is a critical professional skill that

is not adequately taught in undergraduate medical education, and that very often clinicians "'don't know what they don't know'" (p. 159). Williamson et al. call upon education planners and information disseminators, including librarians, to make a concerted effort to help solve the information problems of clinicians. In his editorial, Huth (1989) discusses some of the reasons why the medical literature is not used more extensively by practitioners. Although the unmanageable size of the literature presents problems, Huth states that the bigger problem is that papers relevant to particular clinical issues are not concentrated in journals with subject boundaries but are scattered more widely now than thirty years ago. Huth also cites the heavy cost in time of searching and retrieving articles and the fact that much of the retrieved literature is not relevant to clinical problems. A great deal of time is required to digest and synthesize the content that is worthwhile, and most physicians do not have specialty training in critical analysis of articles which would allow them to judge the validity of the findings.

In 1991, Osheroff and his colleagues published a study analyzing questions posed by physicians during clinical teaching. The authors make the point that physicians cannot accurately estimate their own needs, and yet the majority of studies on physicians' information needs have been based on self-report. This observational study found that, on average, five clinical questions were raised for each patient discussed, a finding similar to that of Covell et al. (1985). Of the 337 requests that were gathered by the Osheroff group, 74 percent concerned patient care and answers to about half (52 percent) of the 337 questions could have been found in a medical record. Almost one-quarter (23 percent) of the questions were potentially answerable by information contained in a library, a textbook, a journal, or MEDLINE. The proportion of questions that required synthesis of patient information and medical knowledge was 26 percent. The authors suggest a framework for physicians' information needs based on the general concept of "comprehensive information needs" (p. 580). These needs are divided into three subgroups: currently satisfied information needs, consciously recognized needs, and unrecognized needs.

Another recent study of knowledge resource preferences of family physicians (Connelly et al., 1990) found that respondents used the commercial drug handbook *Physicians' Desk Reference* (PDR) more often than daily and colleagues more frequently than weekly to obtain information on clinical questions. The study found little use of *Index Medicus* or computerized bibliographic retrieval systems such as MEDLINE. A report on the reading habits of medical students (Taylor, 1992) calculated that students would spend over seventy hours a week reading if they were to read all assigned books, handouts, and class

notes. In his editorial, Kassirer (1992) comments that few medical students read journals regularly even though journals are essential for keeping up adequately with advances in medicine. These studies indicate that the habits observed in practicing physicians likely begin in medical school where the amount of expected reading is unreasonable and textbooks are relied upon for synthesis.

As mentioned earlier, compared to the amount of literature on physicians and medical students, there is relatively little written about information-seeking and use patterns of allied health professionals. Stinson and Mueller's (1980) work, discussed earlier, included several different health professions. Summers et al. (1983) study of educators as information users identified colleagues as a primary information source and indicated that availability and ease of use were major determinants of the information sources used. Salasin and Cedar (1985) published a study of information-seeking behavior in the applied research and service delivery field that includes nurses, social workers, and psychologists working in rural mental health. The authors found that the respondents rarely sought information from outside their own workplace. Of the information-seeking episodes that were identified among the rural mental health workers, 80 percent included seeking information from colleagues within the respondent's work unit and 85 percent from colleagues outside the work unit. Research reports were used in 55 percent of the episodes and journals in 65 percent. Pelzer and Leysen (1988) used a questionnaire to measure library use and information-seeking behavior of veterinary medical students. The authors cite a number of earlier studies of veterinarians and veterinary students. The results were similar to Taylor's (1992) medical student study in showing that the veterinary students relied on course textbooks and handouts.

Corcoran-Perry and Graves (1990) studied supplemental information-seeking behavior of cardiovascular nurses. They found that nurses sought patient-specific data most often, followed by institution-specific data and domain knowledge, which included nursing knowledge and knowledge from related disciplines. Nurses needed a lot of information but of the type that would allow them to track people, equipment, medications, and reports. The authors make the point that most user studies have focused on library use on the assumption that knowledge about information needs can be translated into a service that people will use. Little research has been done on actual information needs in the work setting and the actual information-seeking behaviors of health professionals in general or nurses in particular.

In summary, the studies on clinical information seeking and use, when seen as a body of literature, do provide some consistent and

useful findings that can be used by librarians in the design of information services for clinical groups. It appears that there is still a great deal to be accomplished in providing information and information services that will meet the special needs of clinicians. In the future, librarians should consider doing additional research on the needs of nonphysician groups as well as research which examines actual information needs that occur in the clinical settings.

LIBRARY AND INFORMATION SERVICES FOR CLINICIANS

In April 1990, a symposium entitled "The Evolving Role of the Health Sciences Library in Continuing Education" (Hackleman & Bischoff, 1990) appeared in the *Bulletin of the Medical Library Association* (Hackleman & Bischoff, 1990). The symposium contains a number of papers that provide excellent guidance for developing the future role of library and information services for clinicians. In reviewing recent research that identified the context in which physicians seek information and advice from external sources, Gruppen (1990) points out that physicians vary in their information needs, preferences, motivations, and strategies for seeking information. The author remarks that, in contrast to the easy-to-use and readily accessible commercial information sources, like the *Physicians' Desk Reference*, and its Canadian counterpart, the *Compendium of Pharmaceuticals and Specialties* (CPS), institutional libraries represent something of an unfamiliar and potentially threatening environment that demands mastery of new skills and technology by health professionals. He urges librarians to consider doing "market research" (p. 165) to determine the needs, preferences, and use patterns of various targeted physician and other health professional user groups and to explore alternative methods of improving access to resources. In addition to this informational needs assessment, the author suggests two other general strategies for librarians: (1) augmenting accessibility to information for clinicians, and (2) targeting the opinion leaders.

The following discussion of specific services is intended to highlight certain approaches that librarians are currently using to meet the information needs of clinicians and to relate these approaches to the research findings that have been discussed so far in this article. The services described include:

- clinical librarian services in which the librarian joins the health care team to provide enhanced information services to clinicians;
- LATCH (Literature Attached to the Chart) services in which clinicians request literature searches and articles from the library related to a specific patient care problem;

- end-user searching of computerized databases in which clinicians can personally search MEDLINE and other health care databases in the library or in clinical settings;
- quality filtering or critical appraisal of the literature in which the librarian or clinician evaluates the quality as well as the content of the literature and its applicability to patient care;
- clinical information systems which integrate internally generated patient care information, such as the patient record, with access to library and information services.

CLINICAL LIBRARIAN AND LATCH SERVICES

Cimpl's (1985) review of the literature on clinical medical librarianship traces the origin of the services back to the early 1970s when Gertrude Lamb identified a gap between the medical literature and its application to patient care. At the time, Lamb was located at the University of Missouri—Kansas City where an innovative medical school curriculum was being developed. In this environment, Lamb pioneered the concept of the librarian as an information specialist who works in patient care settings to provide clinicians with rapid access to information related to current clinical problems. In this service model, the librarian is an important member of the health care team along with the physician and allied health professionals. Lamb continued her efforts at Hartford Hospital in Connecticut and numerous clinical librarian programs sprang up across the United States, Canada, and England in the 1970s and 1980s.

Clinical librarian programs have the advantage of being able to respond to the concerns raised by both Williamson et al. (1989) and Osheroff et al. (1991) about health professionals' unrecognized information needs. Marshall and Neufeld (1981) found that both direct and perceived information requests were met by clinical librarians. Direct requests were situations in which health professionals made a specific request for information on a particular topic and situations in which the clinical librarians perceived a need for information based on questions raised during patient rounds. The proportion of perceived requests was higher when the clinical librarians first joined a patient care team, but the proportion decreased as health professionals became more familiar with the service and the types of questions that could be addressed through the clinical librarians' services. Harmon et al. (1982) developed a series of problem-oriented preclinical primers designed to aid clinical librarians in anticipating practitioners' information needs. The authors state that their clinical librarian program placed considerable importance on the ability of the librarian to anticipate and satisfy a need for information before the need had actually been recognized by the clinician.

In his book, *The System of Professions*, Abbott (1988) argues that the claim to professional status on the part of the information professions depends, in large part, on the ability of its members to select information for their clients. Clinical librarianship appears to represent an ideal professional model in the sense that clinical librarians have learned to: identify unrecognized information needs; formulate specific searchable questions independently or on the basis of negotiation with health professionals; and provide a manageable amount of information directly related to the clinician's question. The clinical librarian role fulfills all of Gruppen's (1990) suggestions for library service: it allows for market research on the target population; it augments access through rapid searching related to clinical questions and provides document delivery; it makes use of opinion leaders or key members of the health care team for support and application of health care knowledge; and it provides a friendly face in the form of the clinical librarian who can reduce the sense of unfamiliarity associated with the use of the library and information technology.

In recent times, the growth of clinical librarian programs has suffered because of the pressures to reduce health care costs; however, many programs continue to thrive and, more important, the ideas behind this specialized clinical information service continue to inspire health sciences librarians and to guide service priorities. One of the greatest contributions of the clinical librarian role is the support that it provides for hospital librarians who want to spend at least some of their time outside the library in the settings where information needs occur. Clinical librarianship also moved the hospital library beyond the support and service role toward a more direct role in patient care. It is notable that many of the studies cited in support of the library's role in patient care are actually evaluations of clinical librarian programs.

Literature Attached to the Chart (LATCH) is another service that attempts to link relevant information contained in the health care literature to direct patient care. The service was developed at the Washington Hospital in the mid-1960s (Sowell, 1978). Librarians placed several key articles with a chart at the request of an attending health professional. This service eventually resulted in over 1,000 LATCH packages that were kept and updated in the hospital library for continuing use. The original LATCH programs did not have the advantage of direct librarian participation in patient care rounds and, as a result, the librarians did not anticipate information needs to the same extent as clinical librarians. Various permutations of LATCH and clinical librarian programs have since evolved; for example, Clevesy's (1980) activities in a community hospital combined

librarian participation with a LATCH service and, in Kansas City, a publication called *Current References* was developed as a result of a combined LATCH and clinical librarian program (Algermissen, 1974). There have also been reports of librarian involvement in practice-based continuing medical education programs which deserve attention (Christensen et al., 1978; Clintworth et al., 1979).

End-User Searching of Computerized Databases

The availability of MEDLINE, as well as other computerized databases, has greatly increased the speed and flexibility of bibliographic searching in recent years. When MEDLINE was first introduced by the National Library of Medicine (NLM) in the late 1960s, the developers anticipated that physicians would perform their own searches on data terminals in their offices. Limitations on hardware availability and difficulties experienced by novices in using the early search software made this plan unworkable, and librarians began to act as search intermediaries. Librarians' familiarity with bibliographic indexing and search techniques and more frequent use of the terminals and databases continues to allow them to provide efficient and effective searches for health professionals.

While intermediary searching is still an important part of reference service in health sciences libraries, a major change is taking place in database search services. As library markets became saturated in the 1980s, database vendors began to expand their market to end-users or the persons who will actually make use of the information retrieved from the database. Health professionals are seen as an ideal end-user group because of their need for rapid access to information, the availability of microcomputers in most health care settings, and the number and comprehensiveness of health databases.

The early attempts at reaching the end-user market simply involved making training in the use of online systems such as MEDLARS, BRS, and DIALOG more widely available to end-users. For example, NLM produced a manual, *The Basics of Searching MEDLINE* (1989), for end-users as well as a self-instructional computer program known as MEDLEARN. As the new end-users, particularly those who searched infrequently, complained about the "user hostile" nature of the original command language software, a number of more "user friendly" interfaces were developed such as PaperChase, GRATEFUL MED, BRS Colleague, and DIALOG's Knowledge Index. Today, the proliferation of databases and the availability of the same databases through increasing numbers of different online systems and services continues to create a bewildering array of choices for the end-user.

In a study of early adopters of end-user online searching in practice settings, Marshall (1989a) identified a number of barriers to the effective use of online databases by busy clinicians. The clinicians found the systems more difficult, time consuming, and expensive to use than they expected. They also commented that the database content and indexing were not always suitable for their needs. Most of the clinicians in the study were also involved to some extent in administration or research. The study found a positive correlation between the amount of time respondents spent in research activities and the implementation of end-user searching and a negative correlation between implementation and the amount of time spent in patient care, suggesting that online searches were more relevant and useful in the research context than they were in the clinical context.

In an investigation of end-user searching at the New York Hospital—Cornell University Medical Center, Poisson (1986) found that 8 percent of the sixty-five physicians who responded to her survey were doing their own searches, 63 percent were interested in learning how to search, and 29 percent were not interested. Poisson's research also indicated that end-user training did not necessarily translate into frequent searching behavior. Half the staff at a rehabilitation center had attended a training session and, of those, over half had not searched. Only 13 percent became frequent searchers. Marshall (1989b) found that there was a positive relationship between the number of training events reported—use of printed guides and manuals, informal demonstrations, courses and use of online help—and the implementation of end-user searching. Variability in the implementation levels of Marshall's 124 respondents suggests that end-users are a diverse group with different information needs and different levels of searching expertise, and the various types of formal and informal training opportunities were needed by end-users.

Sewell and Teitelbaum (1986) reported on observations on end-user online searching by pathologists and pharmacists over an eleven-year period. They found that volume of searching was directly related to the convenient placement of the terminal in the workplace and that fewer than half the potential searchers actually searched on their own. Both the Marshall (1989a) and Sewell and Teitelbaum (1986) studies found that end-users tended to perform relatively simple searches using only the AND operator. Although Poisson (1986) found relatively high recall and precision ratios in a small sample of end-user searchers, a more recent study by Haynes et al. (1990) of 158 physician trainees and attending staff at McMaster University had different results. The participants used GRATEFUL MED software and were offered a two hour introduction to online searching and

two hours of free search time. Over 80 percent of the participants did 2.7 GRATEFUL MED searches per month. On comparison searches, the clinicians retrieved only 55 percent of the relevant articles found by the reference librarians and 50 percent more irrelevant articles. The authors conclude that, although searching from clinical settings is feasible with brief training, inexperienced searchers miss many relevant citations and search inefficiently. A second study by the McMaster group (McKibbon et al., 1990), comparing clinician and librarian searches, found that librarians scored significantly better than novices on both the recall and precision of their searches, and that they had equivalent recall and better precision than experienced end-users; nevertheless, there was also substantial nonoverlapping retrieval of relevant citations by searchers in the different groups. More research is needed in this area to assist in improving the quality of end-user searches and to monitor the impact of the information retrieved on patient care.

Whatever the quality of end-user searches, the trend seems unlikely to be halted. End-user searching makes more health care information accessible to more health professionals in a way that is not possible through intermediary searching alone. In the 1990s, the availability of MEDLINE and other health care databases on compact disc—read only memory (CD-ROM) is strongly reinforcing the trend toward end-user searching. CD-ROMs allow local storage and retrieval of information from large databases through the use of a microcomputer and attached CD-ROM reader. Unlike online services which charge on the basis of connect time and usage, a CD-ROM annual subscription allows unlimited access for the year. CD-ROM is ideal for the health professional's office or the small hospital library where a single user workstation is sufficient to meet demand; however, it is less than ideal in settings where there are likely to be a number of concurrent users. The use of multiple CD-ROM products on the same workstation also poses challenging technical problems for libraries. Various solutions involving "juke boxes" and access to CD-ROMs through local area networks are being tried. The use of CD-ROM MEDLINE as a mode of information transfer in clinical settings has been described by Dalrymple (1990).

Larger academic libraries are now mounting bibliographic databases as part of their online public access catalog (OPAC). Such systems may be available on a dial-in basis to clinicians affiliated with teaching hospitals. The addition of numerous local database storage options to the already burgeoning online selection once again presents a confusing set of options. While it might be expected that CD-ROM and other forms of local storage would eclipse online systems, this does not appear to be happening. The National Library

of Medicine is continuing to develop and promote its end-user GRATEFUL MED software with the addition of a document delivery service feature called LOANSOME DOC. (Burroughs, 1989). A new electronic journal, the *Online Journal of Current Clinical Trials*, is also challenging some of the traditional methods of publishing and disseminating scientific results (Kassirer, 1992). Electronic information delivery to end-users is still evolving and such services will continue to develop rapidly in the future, especially as greater numbers of professionals start accessing electronic networks such as the Internet and the National Research and Education Network (NREN).

Quality Filtering and Critical Appraisal of the Literature

Bergman and Pantell's (1986) study, cited earlier, demonstrates the difficulties that clinicians experience not only in accessing the literature but also in evaluating its content on a scientific basis. The idea that health professionals need to develop quality filtering or critical appraisal skills has been suggested by a number of authors, and guidelines have been developed (see, for example, Fletcher et al., 1982; Fowkes & Fulton, 1991; Goldschmidt, 1986; Haynes et al., 1983; Krogh, 1985; Riegelman & Hirsch, 1989). Guidelines for structured journal article abstracts have also been prepared by the Ad Hoc Working Group for Critical Appraisal of the Medical Literature (1987). The critical appraisal needs of clinicians are different from researchers because clinicians need to establish the relevance of the study findings to the care of their particular patients as well as the scientific validity of the results.

There are important roles for the library in quality filtering and critical appraisal. Since it is the health care literature that is being appraised, librarians can assist health professionals to develop effective literature search skills. There are also well-documented examples of library instruction geared to the needs of various health professional student groups such as nurses (Tyler & Switzer, 1991), occupational therapists (Mularski et al., 1989), physicians (Reidelbach et al., 1988; Graves & Selig, 1986), and health administrators (Smith & Salisbury, 1985). Librarians have joined a multidisciplinary team to teach a course in the selection, evaluation and application of information to patient care (Dorsch et al., 1990). By becoming familiar with critical appraisal criteria, librarians can incorporate such criteria into mediated computer searches and teach the search techniques to health professional end-users. The application of study methods terms found in Medical Subject Headings (MeSH) to critical appraisal MEDLINE searching has been described by Marshall (1992b). Librarians have also applied critical appraisal criteria to the selection of records for locally produced databases (Moore, 1989; Pugh & Moore, 1988).

Clinical Information Systems

A major trend in the delivery of information to clinicians is the integration of a variety of electronic information resources into a unified clinical information system that is capable of meeting the variety of clinical information needs described in this article. Although such systems are still in their early stages in most health care settings, a number of prototypes exist, and the National Library of Medicine (NLM) has provided development funding under its IAIMS (Integrated Academic Information Management Systems) program. The bibliographic databases familiar to librarians will form a component of these information systems together with full-text databases, factual databases, expert systems, patient records, and statistical health care data. Rennels and Shortliffe (1987) categorize medical computer systems as either communications systems which include databases, such as MEDLINE, and picture archiving and communications systems or as advice systems that provide consultation, monitoring, and critiquing functions.

Expert systems are intended to provide physicians with advice on patient problems through the use of artificial intelligence software that draws conclusions or problem solves through logical inference. NLM has several expert systems under development including AI/RHEUM. The system consists of two major parts: a diagnostic consultant system and a patient management consultant system for cases of rheumatoid arthritis. Another system, known as AI/COAG assists clinicians in diagnosing and managing problems in hemostasis, a medical specialty with few experts. The Unified Medical Language System (UMLS), also being developed by NLM, will eventually provide a basis for development of truly integrated systems by acting as a bridge between the different vocabularies used in medical settings (Schoolman, 1986). In a review of knowledge bases in medicine, Perry (1990) describes a variety of electronic information sources, such as electronic textbooks and expert systems, which she calls knowledge-based systems, rule-based systems, causal models, and hypothesis or frame-based systems.

While some aspects of integrated clinical information systems are unfamiliar to librarians, the types of information contained in the print and electronic resources traditionally provided through libraries will form an important component of such systems. As these clinical systems develop, it will be important for librarians to participate in planning and implementation and to bring their particular knowledge and expertise to bear on the content and structure of the systems. Many of the services that librarians have developed in the past—clinical librarianship, LATCH, support and training for end-user searchers, the production of quality-filtered

databases and even document delivery—provide good models for services that could be offered in a modified, more cost-effective form with the aid of electronic clinical information systems.

THE IMPACT OF THE HOSPITAL LIBRARY ON PATIENT CARE

In today's environment of cost constraint, librarians are being challenged more than ever to demonstrate both the cost effectiveness of their services and their impact on patient care. It is important that librarians continue to develop a body of research in this area so that they can evaluate the impact and develop new services to fill the gaps that exist. Fortunately, there are already a number of studies that have examined the role played by library and information services in patient care.

One group of impact studies comes from the evaluations of the clinical librarian programs discussed earlier (Roach & Addington, 1975; Scura & Davidoff, 1981; Barbour & Young, 1986; Halsted et al., 1989; Veenstra & Gluck, 1992). These studies, which have appeared periodically since the mid-1970s, have documented direct cost savings and patient care benefits. Library-supported continuing medical education programs have also documented changes in physicians' practice behavior—e.g., literature packets prepared by the librarian stimulated changes in prescribing habits (Manning et al., 1987; Manning et al., 1986). The critical incident study sponsored by the National Library of Medicine provides evidence on the benefits of timely information applied to patient care through both mediated and end-user MEDLINE searches (Wilson et al., 1989).

The clinical librarian and continuing medical education studies described previously are evaluations of specialized services or projects, however there are also studies that have examined the impact of regularly provided hospital library services (King, 1987; Marshall, 1992a). Both of these studies began as initiatives of the local health library community whose members approached university-based researchers for assistance in designing a study to address the issue of the impact of the hospital library. In the Chicago study conducted by King (1987), 310 randomly selected health professionals were asked to make a request to their hospital library for information related to a current clinical case. In Rochester, 448 physicians and residents were similarly approached (Marshall, 1992a). After receiving the information from the library, the respondents were asked to complete a brief questionnaire.

In both studies, the respondents rated the information provided highly. A large proportion of the physicians (77 percent in the Chicago study and 80 percent in the Rochester study) indicated that they probably or definitely handled some aspect of their patient care

differently as a result of the information received. The Rochester study went further to try to pinpoint specific aspects of patient care that were affected such as diagnosis, choice of tests or drugs, and advice given to the patient. Marshall (1992a) pointed out the similarity between the events that Rochester physicians said they were able to avoid with the assistance of information from the hospital library and the adverse events identified by the Harvard medical practice study (Leape et al., 1991). The authors of the Harvard study found that a high proportion of adverse events in hospitalized patients are due to patient management errors rather than the unavailability of medical knowledge and are thus potentially preventable. The results of the Chicago and Rochester studies confirm that information provided by the hospital library is frequently perceived by clinicians as having a substantial impact on patient care. The studies summarized here have begun to address the impact question, but additional studies are needed of not only hospital library services, but also of the other clinical information system components.

Another way in which hospital libraries can have a positive impact on patient care is related to current attempts to control health care costs. A U. S. General Accounting Office report (1991) stated that, in 1989, health care costs consumed 11.6 percent of U.S. national income even though millions of Americans were uninsured. In Canada, where the problems of uncompensated care, the burdens of catastrophic illness on families, and the problems created by large groups of uninsured have been largely avoided through a national medicare program, the cost of the system in 1989 still consumed 8.9 percent of the national income. As government officials and policymakers strive to control health care costs, quality management programs, in particular continuous quality improvement (CQI), are being adopted to address the cost issue while, at the same time, improving patient care. The goal of quality management programs is to maximize the probability of desired patient outcomes and to reduce the probability of undesired outcomes given the current state of health care knowledge (Joint Commission on Accreditation of Healthcare Organizations, 1988, 1991). CQI efforts require that the current state of health care knowledge be ascertained and one of the major mechanisms for this is very familiar to librarians—the literature search. A quality improvement program developed by Christane Jones, librarian at the Veterans Administration Medical Center in Biloxi, Mississippi, uses the literature prospectively as an educational tool for health professionals to improve patient outcomes. This program was described in the 1992 satellite broadcast sponsored by the National Library of Medicine entitled *Information Stat: Rx for Hospital Quality*. The librarian evaluates the quality improvement

data, determines information needs based on those data, and develops information packages. The use of such information by health professionals can result in corrective actions as well as the prevention of future occurrences. The steps in the quality improvement process involve: identifying patient care processes in need of improvement; analyzing the process; making the problems in the process apparent to the health care team; improving the process; and holding onto gains once improvement is achieved. The availability of accurate and up-to-date information supplied by the librarian is a key part of the quality improvement process. Since the state of health care knowledge is constantly changing, quality improvement is a continuous process which requires the librarian's skills on an ongoing basis. A major role for the hospital librarian in the future may relate to the CQI process and the use of the health care literature to develop clinical practice guidelines.

SUMMARY

This discussion of clinical information delivery has described clinicians as a group with different information needs from those of researchers and educators. In reality, the distinction among clinicians, researchers, and educators as mutually exclusive types working within the health care system is often a false one. Many of today's health professionals combine clinical practice with teaching or research or both. Thus, when speaking of the information needs of clinicians, it is best to define these needs not according to the individual but according to the setting in which the needs occur—e.g., a clinical setting—and the purpose for which the information is required—e.g., for application to patient care. From this perspective, the dynamic that occurs among clinical care, education, and research, particularly in teaching settings, becomes evident. For example, the same health professional might initiate an information request relating to clinical, research, or teaching activities at different times and information resources provided in response to one type of request could eventually be used for another purpose. The multiple roles played by health professionals and the uses of information at various points in time does not alter the different and special character assigned to the clinical information needs mentioned at the beginning of this article.

Although reading continues to be a major source of continuing education for professionals and although libraries can often provide information that benefits patient care, the information problems of clinicians have not been solved. The ever-increasing amount of information available and the time and effort required to obtain the appropriate piece of it when it is needed both act as barriers for

busy clinicians, particularly those in solo practice or those outside of major centers. Studies such as the Harvard medical practice study cited earlier (Leape et al., 1991), indicate that meeting the information needs of physicians who must apply new medical knowledge to the care of their patients is critical to maintaining and improving the quality of health care. The work of Osheroff and his colleagues (1991) suggests that information services for clinicians should take into account consciously recognized needs as well as unrecognized needs. The need for patient-specific and institution-specific data, particularly by allied health professionals, suggests that these types of information requirements need to be considered as future clinical information systems are developed. Osheroff et al.'s (1991) finding that over one-quarter of clinical questions require synthesis of patient information and medical knowledge indicates that integration of internal and external information sources into clinical information systems is desirable.

The importance of colleagues as information sources for clinicians needs to be considered in the context of developing future information systems. It seems unlikely that practicing professionals will stop consulting colleagues no matter how effective the formal information system, and it may be possible to incorporate some of the advantages of the colleague connection into clinical information systems as they develop. Menzel (1981) explains the practical advantages of informal communication with colleagues such as the promptness of the response; the screening, evaluation, and synthesis function carried out by the colleague; the possible extraction of action implications which can be explored through discussion; the transmittal of informal "know-how" based on personal experience with a particular procedure or technique; and the opportunity for instantaneous feedback and interaction that can be used to modify or facilitate the information exchange. Greene (1978) had words of caution about the limitations and pitfalls of verbal communication alone as a means of obtaining accurate information for application to patient care. He cites several examples in which false information was verbally transmitted along with accurate information and points out that, while there are established controls, such as peer review, over the information published in books and journals, there are no such controls over the content of informal conversations. Another lesson from the literature review is that, in order to apply information from the health care literature appropriately, health professionals require help in organizing their own personal libraries, identifying and synthesizing useful knowledge, and developing critical appraisal skills.

A number of library and information services for clinicians have been discussed in this article including: clinical librarian and LATCH

Dissemination of Medical Information: Organizational and Technological Issues in Health Sciences Libraries

NANCY K. RODERER

ABSTRACT

THIS ARTICLE DESCRIBES five programs that have been particularly significant to the evolution of biomedical communications over the last twenty years: the National Network of Libraries of Medicine (NNLM), Integrated Academic Information Management Systems (IAIMS), National Research and Education Network (NREN), Unified Medical Language System (UMLS), and the electronic journal. In addition to the changes that these programs have already brought about, each will continue to have major implications for health sciences librarianship.

INTRODUCTION

From a patient's bedside, a physician calls up the patient's chart, orders tests, consults a clinical data system, and examines relevant professional literature. Back at the office, the same physician consults with colleagues from the same institution and around the world with equal ease, sharing pertinent records and images, and consulting with the literature as needed. Carrying out research is facilitated by easy access to patient data, research calculations and findings, and the descriptions of earlier research results. To keep up to date, the physician reviews a personal database tailored to his or her interests that contains such things as notices of grants, new research findings, new reviews of clinical and research issues, and news of the institution. As large or small information needs arise, these too are met by the

- Coleman, J. S.; Katz, H.; & Menzel, H. (1966). *Medical innovation: A diffusion study*. Indianapolis, IN: Bobbs Merrill.
- Connelly, D. P.; Rich, E. C.; Curley, S. P.; & Kelly, J. T. (1990). Knowledge resource preferences of family physicians. *Journal of Family Practice*, 30(3), 353-359.
- Corcoran-Perry, S., & Graves, J. (1990). Supplemental-information-seeking behavior of cardiovascular nurses. *Research in Nursing & Health*, 13(2), 119-127.
- Covell, D. G.; Uman, G. C.; & Manning, P. R. (1985). Information needs in office practice: Are they being met? *Annals of Internal Medicine*, 103(4), 596-599.
- Currie, B. F. (1976). Continuing education from medical periodicals. *Journal of Medical Education*, 51(5), 420.
- Curry, L., & Putnam, R. W. (1981). Continuing medical education in maritime Canada: The methods physicians use, would prefer and find most effective. *Canadian Medical Association Journal*, 125, 563-566.
- Dalrymple, P. W. (1990). CD-ROM MEDLINE use and users: Information transfer in the clinical setting. *Bulletin of the Medical Library Association*, 78(3), 224-232.
- Dorsch, J. L.; Frasca, M. A.; Wilson, M. L.; & Tomsic, M. L. (1990). A multidisciplinary approach to information and critical appraisal instruction. *Bulletin of the Medical Library Association*, 78(1), 38-44.
- Elayyan, R. M. (1988). The use of information by physicians. *International Library Review*, 20(2), 247-265.
- Fletcher, R. H.; Fletcher, S. W.; & Wagner, E. H. (1982). *Clinical epidemiology: The essentials*. Baltimore, MD: Williams & Wilkins.
- Fletcher, S. W.; Fletcher, R. H.; & Greganti, M. A. (1981). Clinical research trends in general medical journals, 1946-1976. In E. B. Roberts, R. I. Levy, S. N. Finkelstein, J. Moskowitz, & E. J. Sondik (Eds.), *Biomedical innovation* (pp. 284-300). Cambridge, MA: MIT Press.
- Fowkes, F. G. R., & Fulton P. M. (1991). Critical appraisal of published research: Introductory guidelines. *British Medical Journal*, 302(6785), 1136-1140.
- Friedlander, J. (1973). Clinician search for information. *Journal of the American Society for Information Science*, 24(1), 65-69.
- Goldschmidt, P. G. (1986). Information synthesis: A practical guide. *HSR: Health Services Research*, 21(2 Part I), 215-237.
- Graves, K. J., & Selig, S. A. (1986). Library instruction for medical students. *Bulletin of the Medical Library Association*, 74(2), 126-130.
- Greene, N. M. (1978). Gossip and the acquisition of knowledge. *Anesthesia and Analgesia*, 57(5), 519-520.
- Gruppen, L. D. (1990). Physician information seeking: Improving relevance through research. *Bulletin of the Medical Library Association*, 78(2), 165-172.
- Hackleman, K. T., & Bischoff, F. A. (Eds.). (1990). The evolving role of the health sciences library in continuing education [A symposium]. *Bulletin of the Medical Library Association*, 78(2), 154-187.
- Halsted, D. D.; Ward, D. H.; & Neeley, D. M. (1989). The evolving role of clinical medical librarians. *Bulletin of the Medical Library Association*, 77(3), 299-301.
- Harmon, G.; Victory, M.; & Harvey, S. (1982). Anticipating clinical information needs: Preclinical primers for the clinical medical librarian. *Bulletin of the Medical Library Association*, 70(2), 239-241.
- Haynes, R. B.; McKibbin, K. A.; Walker, C. J.; Ryan, N.; Fitzgerald, D.; & Ramsden, M. F. (1990). Online access to MEDLINE in clinical settings: A study of use and usefulness. *Annals of Internal Medicine*, 112(1), 78-84.
- Haynes, R. B.; Sackett, D. L.; & Tugwell, P. (1983). Problems in the handling of clinical and research evidence by medical practitioners. *Archives of Internal Medicine*, 143(10), 1971-1975.
- Health Care Financing Administration, Department of Health and Human Services. (1986). Medicare and Medicaid programs: Conditions of participation for hospitals. *Federal Register*, 51(116) Part II, 22009-22052.

- Huth, E. J. (1989). The underused medical literature. *Annals of Internal Medicine*, 110(2), 99-100.
- Joint Commission on Accreditation of Healthcare Organizations. (1988). *The Joint Commission guide to quality assurance*. Chicago, IL: Joint Commission on Accreditation of Healthcare Organizations.
- Joint Commission on Accreditation of Healthcare Organizations. (1991). *Transitions, from QA to CQI: Using CQI approaches to monitor, evaluate, and improve quality*. Oakbrook Terrace, IL: Joint Commission on Accreditation of Healthcare Organizations.
- Kassirer, J. P. (1992a). Journals in bits and bytes: Electronic medical journals. *New England Journal of Medicine*, 326(3), 195-197.
- Kassirer, J. P. (1992b). Learning medicine: Too many books, too few journals. *New England Journal of Medicine*, 326(21), 1427-1428.
- King, D. N. (1987). The contribution of hospital library information services to clinical care: A study in eight hospitals. *Bulletin of the Medical Library Association*, 75(4), 291-301.
- Krogh, C. L. (1985). A checklist system for critical review of medical literature. *Medical Education*, 19(5), 392-395.
- Leape, L. L.; Brennan, T. A.; Laird, N.; Lawthers, A. G.; Localio, A. R.; Barnes, B. A.; Hebert, L.; Newhouse, J. P.; Weiler, P. C.; & Hiatt, H. (1991). The nature of adverse events in hospitalized patients: Results of the Harvard medical practice study II. *New England Journal of Medicine*, 324(6), 377-384.
- Louis Harris and Associates, Inc. (1987). *The future of information systems for the medical sciences: A study conducted for the New York Academy of Medicine*. New York: New York Academy of Medicine.
- Manning, P. R.; Lee, P. V.; Clintworth, W. A.; Denson, T. A.; Oppenheimer, P. R.; & Gilman, N. J. (1986). Changing prescribing practices through individual continuing education. *Journal of the American Medical Association*, 256(2), 230-232.
- Manning, P. R.; Clintworth, W. A.; Sinopoli, L. M.; Taylor, J. P.; Krochalk, P. C.; Gilman, N. J.; Denson, T. A.; Stufflebeam, D. L.; & Knowles, M. S. (1987). A method of self-directed learning in continuing medical education with implications for recertification. *Annals of Internal Medicine*, 107(6), 909-913.
- Marshall, J. G. (1989a). Characteristics of early adopters of end-user online searching in the health professions. *Bulletin of the Medical Library Association*, 77(1), 48-55.
- Marshall, J. G. (1989b). End-user training: Does it make a difference? *Medical Reference Services Quarterly*, 8(3), 15-26.
- Marshall, J. G. (1992a). The impact of the hospital library on clinical decision making: The Rochester study. *Bulletin of the Medical Library Association*, 80(2), 169-178.
- Marshall, J. G. (1992b). The process: Knowing how to start: Linking information searching process to practice (pp. 1-48). In R. M. Williams, L. M. Baker, & J. G. Marshall (Eds.), *Information searching in health care*. Thorofare, NJ: SLACK, Inc.
- Marshall, J. G., & Neufeld, V. R. (1981). A randomized trial of librarian educational participation in clinical settings. *Journal of Medical Education*, 56(5), 409-416.
- Mayada, T. A. (1969). *Information in health care: RM 1269* (Prepared for the National Library of Medicine, Bethesda, MD, under contract with the University of Pittsburgh).
- McKibbin, K. A.; Haynes, R. B.; Walker Dilks, C. J.; Ramsden, M. F.; Ryan, N. C.; Baker, L.; Flemming, T.; & Fitzgerald, D. (1990). How good are clinical MEDLINE searches? A comparative study of clinical end-user and librarian searches. *Computers and Biomedical Research*, 23(6), 583-593.
- Menzel, H. (1966). Sociological perspectives on the information-gathering practices of the scientific investigator and the medical practitioner. In D. McCord (Ed.),

- Biblioteca medica: Physician for tomorrow* (Dedication of the Countway Library of Medicine, May 26 & 27, 1965) (pp. 112-130). Boston, MA: Harvard Medical School.
- Menzel, H. (1981). Interpersonal and unplanned communications: Indispensable or obsolete? In E. B. Roberts, R. I. Levy, S. N. Finkelstein, J. Moskowitz, & E. J. Sondik (Eds.), *Biomedical innovation* (pp. 155-163). Cambridge, MA: MIT Press.
- Moore, M. (1989). Battling the biomedical information explosion: A plan for implementing a quality filtered database. *Medical Reference Services Quarterly*, 8(1), 13-19.
- Mularski, C. A.; Nystrom, E.; & Grant, H. K. (1989). Developing information-seeking skills in occupational therapy students. *American Journal of Occupational Therapy*, 43(2), 110-114.
- Neufeld, V. R., & Woodsworth, A. (1972). A survey of physician self-education patterns in Toronto. Part II: Use of journals and personal filing systems. *Canadian Library Journal*, 29(2), 104-109.
- Northup, D. E.; Moore-West, M.; Skipper, B.; & Teaf, S. R. (1983). Characteristics of clinical information-searching: Investigation using critical incident technique. *Journal of Medical Education*, 58(11), 873-881.
- Osheroff, J. E.; Forsythe, D. E.; Buchanan, B. G.; Bankowitz, R. A.; Blumenfeld, B. H.; & Miller, R. A. (1991). Physicians' information needs: Analysis of questions posed during clinical teaching. *Annals of Internal Medicine*, 114(7), 576-581.
- Osiobe, S. A. (1985). Use of information resources by health professionals: A review of the literature. *Social Science & Medicine*, 21(9), 965-973.
- Parboosingh, J.; Lockyer, J.; McDougall, G.; & Chugh, U. (1984). How physicians make changes in their clinical practice: A study of physicians' perception of factors that facilitate this process. *Annals of the Royal College of Physicians and Surgeons of Canada*, 17(5), 429-435.
- Pelzer, N. L., & Leysen, J. M. (1988). Library use and information seeking behavior of veterinary medical students. *Bulletin of the Medical Library Association*, 76(4), 328-333.
- Perry, C. A. (1990). Knowledge bases in medicine: A review. *Bulletin of the Medical Library Association*, 78(3), 271-282.
- Poisson, E. H. (1986). End-user searching in medicine. *Bulletin of the Medical Library Association*, 74(4), 293-299.
- Pugh, W. J., & Moore, G. (1988). Psych/neuro core concept database: A quality-filtered database. In *National online meeting: Proceedings of the ninth national online meeting* (pp. 333-336). Medford, NJ: Learned Information.
- Reidelbach, M. A.; Willis, D. B.; Konecky, J. L.; Rasmussen, R. J.; & Stark, J. (1988). An introduction to independent learning skills for incoming medical students. *Bulletin of the Medical Library Association*, 76(2), 159-163.
- Rennels, G. D., & Shortliffe, E. H. (1987). Advanced computing for medicine. *Scientific American*, 257(4), 154-161.
- Riegelman, R. K., & Hirsch, R. P. (1989). *Studying a study and testing a test: How to read the medical literature*. Boston, MA: Little, Brown.
- Roach, A. A., & Addington, W. W. (1975). Effects of an information specialist on patient care and medical education. *Journal of Medical Education*, 50(2), 176-180.
- Rogers, E. M. (1973). *Diffusion of innovations* (3d ed.). New York: Free Press.
- Salasin, J., & Cedar, T. (1985). Information-seeking behavior in an applied research/service delivery setting. *Journal of the American Society for Information Science*, 36(2), 94-102.
- Schoolman, H. M. (1986). The physician and the medical literature: From Index Medicus to MEDLARS to GRATEFUL MED and beyond. *Archives of Dermatology*, 122(8), 875-876.
- Scura, G., & Davidoff, F. (1981). Case-related use of the medical literature: Clinical librarian services for improving patient care. *Journal of the American Medical Association*, 245(1), 50-52.
- Sewell, W., & Teitelbaum, S. (1986). Observations of end-user online searching behavior over eleven years. *Journal of the American Society for Information Science*, 37(4), 234-245.

- Sherrington, A. M. (1965). An annotated bibliography of studies on the flow of medical information to practitioners. *Methods of Information in Medicine*, 4(1), 45.
- Smith, M. D., & Salisbury, L. (1985). Bibliographic research and critical inquiry: A learning module for graduate students in health services administration. *Bulletin of the Medical Library Association*, 73(3), 242-248.
- Sowell, S. L. (1978). LATCH at the Washington Hospital Center, 1967-1975. *Bulletin of the Medical Library Association*, 66(2), 218-222.
- Stinson, E. R., & Mueller, D. A. (1980). Special communication: Survey of health professionals' information habits and needs: Conducted through personal interviews. *Journal of the American Medical Association*, 243(2), 140-143.
- Strasser, T. C. (1978). The information needs of practicing physicians in Northeastern New York State. *Bulletin of the Medical Library Association*, 66(2), 200-209.
- Stross, J. K., & Harlan, W. R. (1979). The dissemination of new medical knowledge. *Journal of the American Medical Association*, 241(24), 2622-2624.
- Summers, E. G.; Matheson, J.; & Conry, R. (1983). The effect of personal, professional, and psychological attributes, and information seeking behavior on the use of information sources by educators. *Journal of the American Society for Information Science*, 34(1), 75-85.
- Taylor, C. R. (1992). Great expectations: The reading habits of year II medical students. *New England Journal of Medicine*, 326(21), 1436-1440.
- Tyler, J. K., & Switzer, J. H. (1991). Meeting the information needs of nursing students: A library instruction module for a nursing research class. *Medical Reference Services Quarterly*, 10(3), 39-44.
- United States General Accounting Office. (1991). *Canadian health insurance: Lessons for the United States* (Report to the Chairman, Committee on Government Operations, House of Representatives). Washington, DC: USGPO (GAO/HRD-91-90).
- Veenstra, R. J., & Gluck, E. H. (1992). A clinical librarian program in the intensive care unit. *Critical Care Medicine*, 20(7), 1038-1042.
- Weinberg, A. D.; Ullian, L.; Richards, W. D.; & Cooper, P. (1981). Informal advice- and information-seeking between physicians. *Journal of Medical Education*, 56(3), 174-180.
- Williamson, J. W.; German, P. S.; Weiss, R.; Skinner, E. A.; & Bowes, F., III. (1989). Health science information management and continuing education of physicians: A survey of U.S. primary care practitioners and their opinion leaders. *Annals of Internal Medicine*, 110(2), 151-160.
- Wilson, S. R.; Starr-Schneidkraut, N.; & Cooper, M. D. (1989). *Use of the critical incident technique to evaluate the impact of MEDLINE: Final report*. Palo Alto, CA: American Institutes for Research.
- Woolf, S. H., & Benson, D. A. (1989). The medical information needs of internists and pediatricians at an academic medical center. *Bulletin of the Medical Library Association*, 77(4), 372-380.