Evidence-based practice*

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Evidence-based practice (EBP) is spreading in popularity in many health care disciplines. One of its main features is the reliance on the partnership among hard scientific evidence, clinical expertise, and individual patient needs and choices. Librarians play an important role in the spread of EBP because of the importance of identifying and retrieving appropriate literature from various sources for use in making health care decisions. This article gives an overview of how to search for therapy, diagnosis, etiology, and prognosis both for original studies and secondary publications such as systematic reviews, meta-analyses, and clinical practice guidelines. Understanding how this research is done, how it is indexed, and how to retrieve the clinical evidence are an important set of skills that librarians can provide for clinicians interested in EBP.

INTRODUCTION

Evidence-based practice (EBP) is an approach to health care wherein health professionals use the best evidence possible, i.e., the most appropriate information available, to make clinical decisions for individual patients. EBP values, enhances, and builds on clinical expertise, knowledge of disease mechanisms, and pathophysiology. It involves complex and conscientious decision-making based not only on the available evidence but also on patient characteristics, situations, and preferences. It recognizes that health care is individualized and ever changing and involves uncertainties and probabilities. Ultimately EBP is the formalization of the care process that the best clinicians have practiced for generations. Fuller descriptions of EBP have been published [1, 2] but this paper provides an overview of EBP for librarians. The parts of EBP that affect health librarians and the role that the health care literature plays in EBP are emphasized.

Effective EBP takes time and energy and involves five steps. The first of these is formulating the question or questions that need to be answered to satisfy the health care or other needs of a specific patient. Clinicians have reported information needs in office care settings average two unanswered questions for every three patients they see [3]. The second step is the retrieval of the necessary information to answer the questions. This can involve textbooks or a laboratory test but often requires the use of the journal literature. This is the step that is most important for librarians and the one with which clinicians often state that they need help. Reading and assessing the retrieved information to help make a clinical decision form the third step. The fourth is carrying out the decision and the fifth is evaluation of the process to ascertain if optimal outcomes have been obtained for the patient and the health care system.

Clinicians often find it quicker to rely on their own experience or advice from a colleague when they must make decisions that include some elements of uncertainty. Although efficient, this approach can sometimes have serious consequences. Two examples from the institution where the author works illustrate this point. Although the patients involved ultimately received satisfactory care, both families involved were given inappropriate information that caused unnecessary anxiety and anguish.

The first occurred when the patients of a four-day-old girl with multiple birth defects were told that their daughter was blind and deaf; would have difficulties with feeding, growth, and development; and most likely would be moderately to severely mentally retarded. The child's condition was rare and severity has ranged from almost undetectable to fatal at birth. The

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physician based his prognosis on limited clinical experience with this condition and literature that ultimately was shown to be out of date. The child, now four years old, is getting ready for kindergarten and is within normal limits for all measures of growth and development.

The other story involves an accusation of sexual abuse made by a family medicine resident after assessing what at first appeared to be diaper rash. The resident told the parents that she was 100% certain of her diagnosis of the lesions and their cause. It was not until the parents who were well educated and trained in EBP principles pushed for a second opinion that another diagnosis was investigated and confirmed. The second opinion showed that sexual abuse was not involved and, even if the first diagnosis had been correct, the skin lesions were not necessarily transmitted by genital contact.

In both situations, the parents endured unnecessary anguish because the clinicians involved, one of whom was experienced and one who was not, acted with certainty based on an outdated or insufficient knowledge base. The health care knowledge base, documented in the health care literature, is vast and ever increasing and changing. Traditionally health care professionals have acted based on their current knowledge, sought answers from their colleagues, or consulted literature that was readily available in their decision making. Clinicians who practice EBP rely heavily on the literature, viewing and applying it differently than traditional practioners; this has implications for both health care librarians and libraries.

THE LITERATURE WEDGE

Health care literature can be pictured as structured in a wedge-shaped manner consisting of reports from four different stages or levels of development. The largest stage consists of the earliest level of evaluation, comprised of reports that deal with communication of ideas among researchers and clinicians. The reports are often letters, editorials, thought pieces, broad general review articles, and case reports. Upon discussion and initial testing, some of these ideas are thought to be valuable and worth continued testing. These are then tested and reported in papers that comprise the next stage of research. This second stage is smaller and includes reports of studies and investigations done in laboratories with test tubes, cells, tissue samples, and often animals. Some of the laboratory-studied ideas are shown to be unworthy of continued testing and are abandoned, while others can be moved on to the third stage of evaluation. The third stage is the first stage that involves humans. Very often volunteers are used and only a few persons are tested in each investigation. Although numbers are hard to estimate, one researcher approximates that for every 5,000 ideas that go into testing only five are validated and sent on to the fourth or final testing phase [4].

Reports of the final testing stage can be considered to be the point of the wedge both because of the step nature of the research process and the relatively small numbers of trials that are shown actually to improve patient care. The testing in the final stage is done in large, expensive, long-term trials with actual human patients, often in real-life situations. The rest of this report will refer to this stage of testing as the clinical research stage or clinical research. For every five interventions such as a new therapy or diagnostic test or an etiological hypothesis, only one or two are proven and become ready for governmental approval and implementation into routine patient care [5].

Clinicians who practice traditional patient care use information from each of the four stages of the health care research process. In contrast, those who practice using EBP principles rely on information from the clinical research stage if available for making clinical decisions. Evidence from reports in the clinical research stage is not available for all situations in health care but if information exists in this final testing stage, this information should be used.

Because clinicians who practice EBP rely more on evidence found in the literature base than on clinical experience and pathophysiology alone, librarians play a key role in the advancement of EBP. In fact, librarians are in an ideal situation to become stronger partners in the improvement of health care. To accomplish this, librarians need to learn about the kinds of studies and trials that comprise the clinical research. With this understanding, they can help clinicians identify and retrieve this information for patient care. They can also structure library services to improve retrieval speeds and provide more full-text access.

The clinical research stage includes both reports of original research trials and studies and secondary reports that collect, analyze, and present findings from multiple studies. These secondary or compiled reports include economic evaluations, systematic review articles, meta-analyses, and clinical practice guidelines. All of the material in this clinical research stage is also divided into categories of therapy, diagnosis, etiology or harm, and prognosis or natural history of disease and conditions.

The literature reporting clinical research is unique, and therefore can be differentiated from reports in the other three stages of research because the studies have been completed using methods common only to clinical research. Searchers can therefore use index terms and textwords based on these methods to retrieve only clinically relevant material. The rest of this paper briefly describes the methods used in each category (therapy, diagnosis, etiology, and prognosis) for original studies, systematic reviews and meta-analyses, and clinical practice guidelines.

EBP concentrates on using evidence from a very small portion of the health care literature for clinical decision making. Standard MEDLINE, EMBASE, or other systems can be searched using strategies that filter or retrieve citations from the clinical research stage using methodology-based searching. This methodology-filtered searching in MEDLINE has been validated by Haynes and colleagues [6]. Search strategies were developed using Medical Subject Headings (MeSH), textwords, and phrases and were tested compiled in single and complex strategies. The search strategies were run and measured against a hand search of ten core medical journals for both 1986 and 1991. Similar search strategies have been developed for other systems such as EMBASE [7] but these strategies and systems have not been tested in as rigorous a fashion as for MEDLINE.

The Internet is not the best source of information for EBP. The Internet currently has 150 million Web pages and is projected to have a billion by 2000 [8]. Few of the sites however, contain health care information reports on clinical research, which are best suited for EBP. Librarians have produced excellent summaries of EBP for the Internet. Model examples from the United Kingdom include that produced by Andrew Booth at www.shef.ac.uk/uni/academic/R-Z/scharr/ir/netting.html, from the United States that produced by Jean Sullivant for the New York Academy of Medicine at www.nyam.org/library/eblinks.html, and from Canada that produced by Jeanette Buckingham for the University of Alberta at www.med.ualberta.ca/ebm/.

A better source of clinical research information is the Cochrane Library produced by the Cochrane Collaboration. The collaboration is a world-wide volunteer organization and network of health care professionals, patients, and members of the public who are dedicated to compiling citations to reports of clinical research for therapy studies, collecting original and producing enhanced abstracts to systematic reviews and meta-analyses of therapeutic studies, and authoring and updating high-quality systematic reviews in all areas of health care. Fuller descriptions are available on the Internet at hiru.mcmcaster.ca/COCHRANE.

Another excellent source of clinical research is a series of evidence-based journals recently produced by various publishers. Each journal has taken on the task of sifting through current journals, collecting reports of clinical research, producing structured abstracts of the important advances, and providing a commentary on the study by a clinical expert. *ACP Journal Club* produced by the American College of Physicians was the first, started in 1991 and designed for general internists. The second is *Evidence-Based Medicine* published jointly by the American College of Physicians and the BMJ Publishing Group. Both of these journals have been combined into a computerized product called Best Evidence. With just over 1,000 articles on therapy, diagnosis, etiology, prognosis, economics, and quality improvement, Best Evidence has become a useful tool for clinical decision making in medicine. *Evidence-Based Cardiovascular Medicine* is published by Churchill Livingston; *Evidence-Based Health Policy and Management* is published by the Institute of Health Sciences at Oxford University in the United Kingdom; and in 1998 *Evidence-Based Nursing* is published by the Royal College of Nursing and the BMJ Publishing Group, and *Evidence-Based Mental Health* is published by the BMJ Publishing Group.

MEDLINE, EMBASE, and other large bibliographic databases are currently the main sources of clinical research information for EBP. Pubmed at www3.ncbi.nlm.nih.gov/PubMed/ is a very good MEDLINE searching tool for clinicians because of two features. The "find related" button and the built-in clinical filters that use the data from Haynes and colleagues [9] are both rapid techniques for identifying clinical research.

THERAPEUTIC INTERVENTIONS

Most of the studies in clinical research stage report on trials of therapies—studies that evaluate a new drug, surgical technique, counseling program, educational event, or any other intervention design to improve health, decrease suffering, or reduce costs or service use without adverse effects on outcomes. Therapeutic interventions are studied using a randomized controlled trials method. Researchers start with a group of patients, all of whom have the disease or condition of interest.

Taking the study by Mangano and colleagues [10] as an example, all of the patients studied had risk factors for coronary heart disease and were scheduled for elective surgery. The investigators wanted to evaluate whether atenolol, a new cardiac drug, given before and just after surgery would reduce the rate of myocardial infarctions in patients during the next two years. Half of the patients were allocated to receive intravenous and oral atenolol and half were randomized to receive a placebo. The placebo was saline solution for the intravenous atenolol and a look-alike, taste-alike pill for the oral medication. All patients were followed for the specified two years to ascertain the number of cardiac events in each group. To remove or reduce biases, these cardiac outcomes were counted and assessed by the research staff without knowing which patient received atenolol and which patient received placebo. This is called blinding.

This example by Mangano and colleagues shows some of the features common to evaluation of therapeutic interventions:

- random allocation
- single-blind, double-blind, or triple blind method
- placebo
- clinical trial

- randomized controlled trial

These features can be translated into specific searching strategies in databases such as MEDLINE or EMBASE. Hayes and colleagues [11] report the best single term strategy in MEDLINE is clinical trial (publication type). They include more complex strategies in the report of the study.

DIAGNOSTIC TESTS

Diagnostic tests are evaluated in a different manner and therefore must be searched using alternate strategies. Researchers and clinicians evaluate new diagnostic tests to ascertain which are more accurate, faster, less expensive, and less invasive than existing diagnostic tests. Good diagnostic tests must provide positive results when the patient has the disease or condition *and* negative results when the person studied does not have the disease and condition. The initial population for diagnostic test evaluations must include persons who have the full spectrum from no disease at all through mild and severe disease. In contrast to the therapeutics evaluation, all persons involved in a new diagnostic test must receive the standard test, for example, stomach biopsy for celiac disease, laboratory culture for pneumonia, or a full night in a sleep laboratory to evaluate apnea. They must also have the new test that is thought to be less expensive, less invasive, or faster. The results indicating the number of positive and negative test results are compared with the results of the standard test, often called the "gold" standard, for agreements with both positive and negative results. Four different pairs of measures and one single value are used to assess various aspects of these positive and negative agreements.

- sensitivity and specificity
- positive predictive value and negative predictive value
- false negative reaction and false positive reaction
- likelihood ratio of a positive test and likelihood ratio of a negative test
- receiver operator characteristic curve (also known as ROC curve)

For full definitions, see standard texts [12, 13]. These are the features and terminology that are associated with diagnostic test evaluation. They can be used to formulate searching strategies for EBP retrievals. Haynes and colleagues have shown that most effective single term for MEDLINE searching is sensitiv: as a truncated textword [14].

ETIOLOGY

Etiology, too, has its own set of unique methodologies to assess whether something causes disease, for example whether asbestos leads to lung cancer or specific genetic markers or the presence of aluminum in diets are associated with Alzheimer's disease. Two methods predominate: The one with the strongest weight of evidence is the cohort study. Cohort means small group and comes from the Latin word for the smallest unit in the Roman army. In cohort studies, persons with exposures, for example silicone breast implants, are followed forward in time to assess outcomes such as connective tissue disease [15] and these results would be compared with a similar group of women who did not receive the breast implants.

The second method for testing etiology is more common but carries less weight of evidence because of a larger potential for biases [16, 17]. This second method is called case-control. In the example of silicone breast implants and connective tissue disease case-control studies have also been done. Researchers who undertake a case-control study evaluate two groups of participants. One group would be women with connective tissue disease and the other women without connective tissue disease. Both groups are studied using medical records, interviews, and other methods to assess who has had exposure to silicone breast implants in the past. Memory and researcher beliefs are potential sources of bias—humans often see and report what is expected rather than what really happened in the past or is happening now. Responses in both groups are tallied to ascertain if a higher proportion of women with the disease or condition, in this case, connective tissue disease have had exposure to the causative agent, the silicone breast implants.

In summary, etiology or causation issues can be studied using cohort studies, which are less common and more difficult to carry out but carry more weight of evidence, or case-control studies, which are more often done and more easily carried out even though they carry a lower weight of evidence. The following methodology and issues terms and phrases can be used in the preparation of searching strategies for retrieval of citations useful for EBP questions:

- cohort studies
- case-control studies
- follow-up studies
- risk

The most effective single-term strategy for MEDLINE retrieval is risk: truncated [18].

PROGNOSIS

Prognosis is the study of disease process or progression, i.e., now that the disease or condition has been diagnosed, what will likely happen to a specific patient over the short and long term. Few prognosis studies are done in comparison with therapeutic studies and diagnostic evaluations. For those that are done, the progression of disease, such as rheumatoid arthritis, is studied using the cohort study method. This cohort

study design is the same as for etiology studies except that in etiology studies persons with risk factors are followed to ascertain if disease occurs and in prognosis studies patients with disease are studied to ascertain progression. The unique aspect of testing for prognosis is that the population at the start of the study should all be at a uniform point of time in the disease, and as close to the initial diagnosis of the disease as possible. This is termed an inception cohort study by some researchers. An example of a well-done cohort study on the progression of disease is one done at the Mayo Clinic that studied patients with optic neuritis [19]. Researchers postulated that individuals with optic neuritis were more likely to develop multiple sclerosis. Patients were studied for up to forty years and researchers found that quite often these patients did develop multiple sclerosis. To search for prognosis studies, concepts that can be used in search strategies are:

- cohort studies
- incidence which is defined as the number of new cases in a given period of time
- prevalence which is defined as the number of current cases at a specific point in time
- follow-up studies
- disease progression

The most effective single-term strategy for MEDLINE is explode cohort studies, using the MEDLINE explode terminology to group like terms together for searching.

These four categories complete the description of original studies included in the clinical research stage as well as effective terms associated with each category of therapy, diagnosis, etiology, and prognosis. The clinical research strategy also includes secondary studies that collect, summarize, and make recommendations based on multiple original studies. A special class of review articles has been developed in the past twenty years. These systematic review articles and their subset meta-analyses have been described in a series in the *Annals of Internal Medicine* [20].

Systematic review articles differ from traditional review articles in that they must include the specific clinical questions they were designed to address, an explicit statement of the methods the authors used to identify the studies to be combined such as search strategies, databases searched, and years studied. If the combined analysis can be done using mathematical and statistical calculations, the systematic review also becomes a meta-analysis; if the combination of data can only be in a narrative form because mathematical combination is not possible for logistic or other reasons, the systematic review stays a systematic review article. European systematic reviews are also called overviews.

A good example of a systematic review is a meta-analysis done by Grady and colleagues [21]. They collected studies and analyzed the data that assessed the risks and benefits associated with hormone replacement therapy in postmenopausal women. The data were also analyzed by race, age, and risk factors such as family history of breast cancer and heart disease and bone mineral density levels. Women and their physicians can use the data to assess the evidence while deciding whether to take postmenopausal hormone therapies. Terms associated with reports of systematic reviews and meta-analyses are: meta-analysis with various spellings—metaanalysis, meta analysis, meta-analyses, and meta-analytic—and review articles with the term MEDLINE in the abstract.

Although this has not been fully tested, an effective single-term search strategy for MEDLINE would be "meta-analysis" as a MeSH heading, publication type, or textword. Note also that indexers at the National Library of Medicine do not consider meta-analyses to be review articles in their indexing and that indexing does not differentiate between traditional review articles and systematic review articles. More complex search strategies have been suggested, but not proven by Hunt and McKibbon [22]. The Cochrane Library is also a good source for identifying systematic review articles especially in the systematic reviews database, one of the five sections of the Cochrane Library.

CLINICAL PRACTICE GUIDELINES

Clinical practice guidelines can also be considered to be secondary publications. The ideal clinical practice guideline is evidence-based and produced for use in specific clinical situations. For example, Grady and colleagues [23] used the evidence in their systematic review as a starting point for the development of a clinical practice guideline for counseling United States women about hormone replacement therapy [24]. The American College of Physicians in conjunction with their working committees has produced and endorsed the guideline, which has been extensively used in health care settings since publication in late 1992. Many clinical systematic reviews and clinical practice guidelines are produced, either alone or as pairs of documents, and their rate of publication is increasing dramatically. Many institutions are starting to develop their own clinical practice guidelines and universities are starting to offer courses in the production of systematic reviews. MEDLINE can provide many clinical practice guidelines but the HealthStar database may be the best database to use to search for them. HealthStar, produced by the National Library of Medicine, was redesigned to collect practice guidelines and citations to studies and reports that can be used in the development of clinical practice guidelines. Retrieval terms for database searching include:

- guidelines
- practice guidelines

- consensus development conferences
- practice parameters

CONCLUSION

EBP is changing the way health care is undertaken. Clinicians are relying more on the health care literature in decision making and they are using a smaller proportion of the available literature—the clinical literature subset. This puts pressure on librarians to provide in-house document delivery, interlibrary loans, and full text services faster and more efficiently.

Librarians also need to develop skills in understanding how clinical research is done, reported, and indexed. For therapy studies, the study design is a clinical trial with issues of randomization; single, double, or triple blinding; and placeboes. For diagnostic studies, the issues are measurements of correct positive and negative test results, sensitivity and specificity, positive and negative predictive value, false positive and negative rates, likelihood ratios of a positive and negative test result, and receiver operator characteristic (ROC) curves. For etiology hypotheses, the study designs are cohort studies and case-control studies with measures or risk such as relative risk and odds ratios. For prognosis evaluations, the study design is a cohort study. Systematic reviews must include an identifiable description of how individual studies were found and combined in analyses. Clinical practice guidelines should be evidence based.

The traditional sources for health care literature, MEDLINE and EMBASE, are useful for EBP and need to be searched using methodology terms and phrases. If the methodology terms are used as clinical filters, MEDLINE, EMBASE, and related databases are probably the best EBP information sources. Other current sources are the Cochrane Library and six new evidence-based journals. The Internet will probably improve as an EBP information source in the next few years as it comes to terms with indexing and classification issues.

Research is needed to improve retrieval methods for EBP information. Librarians need to develop and keep their search skills strong; this is a challenge as less mediated searching is being done in most libraries. Librarians also need to learn new skills in their increasing role as teachers and trainers to help clinicians identify citations and ways to find them for clinical use as evidence-based practice spreads. Many opportunities and challenges exist for librarians and the development of EBP.

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