Information Needs of Physicians

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Quantitative estimates of physician information need reported in the literature vary by orders of magnitude. This article offers a framework for explicitly defining the types of information that clinicians use and the various states of information need on which different studies have focused. Published reports seem to be in agreement that physicians have many clinical questions in the course of patient care, but most of their questions are never answered. Examination of the clinical questions themselves reveals that they tend to be highly complex, embedded in the context of a unique patient's story. The heavy reliance of physicians on human sources of information has implications for the nature of their information needs, including the narrative structure of their knowledge and the need for more than information alone when solving clinical problems. Evaluation of clinical information systems must move beyond measures of the relevance of retrieved information to assessing the extent to which information systems help practitioners solve the clinical problems they face in practice.

A man asked his large and powerful computer “Do you compute that you will ever think like a human being?” The machine set to work to analyze its computational habits, and after a time, sent its output to the printer. The man ran to the printer to get the answer and found the following words:

“That reminds me of a story. . .”
(adapted from Bateson, 1979)

The potential for information technology to help clinicians perform the complex information management tasks of patient care has long been recognized. Many promising systems that incorporate advanced information technology have been developed for clinical use, with regular improvements in availability, speed, and ease of use. Yet few of these systems have found their way onto the desktops of practicing clinicians. As Greenes and Shortliffe concluded in 1990, “Despite years of research and development, computerized aids for diagnosis and treatment still remain largely curiosities and demonstration projects, rather than tools for routine use” (Greenes & Shortliffe, 1990).

To create clinical computing tools that are useful to and used by clinicians, developers of information systems must have accurate models of the users for whom their systems are intended. An important element of this modeling is an understanding of the information needs of clinicians. What do we know about the information that clinicians use while they are caring for patients? How much information do they need? What kinds of information do they need? This article reviews research on the information needs of physicians to examine methodological problems, summarizes what is known, and suggests directions for future research.

Methodological Issues in Information Needs Research

Published studies of physicians’ information needs have reported widely disparate results, with quantitative estimates of information need that vary by several orders of magnitude. It is difficult to generalize from these studies or to make comparisons among them because of methodologic differences of four types: Definition of terms, subjects, setting, and method of data collection. Table 1 lists some published assessments of physicians’ information needs, selected to illustrate the range of quantitative estimates of the information need and the methodological issues involved. By examining these studies in terms of their methodological differences we can make progress toward refining the methodology, as well as identify common findings and patterns among the available studies.

Definition of Terms: 1ypes of Information Used by Clinicians

Perhaps the most critical problem in comparing and interpreting published studies of physician information needs is the lack of common terminology across studies. While some studies have focused on a particular type of information, such as patient data (Tang, Fachamps, & Shortliffe, 1994) or medical knowledge (Dee & Blaze, 1993; Ely, Burch, & Vinson, 1992; Gorman & Helfand, 1995), others have employed a broader approach that
TABLE 1. Some published assessments of physician information needs.

<table>
<thead>
<tr>
<th>Author</th>
<th>Method</th>
<th>Subjects, setting</th>
<th>Rate*</th>
<th>Type of need</th>
<th>Type of information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covell et al., 1985</td>
<td>Mail survey</td>
<td>Urban subspecialists</td>
<td>0.013</td>
<td>Pursued (and remembered) needs</td>
<td>?</td>
</tr>
<tr>
<td>Ely et al., 1992</td>
<td>Office hours interview</td>
<td>Family physicians</td>
<td>0.068</td>
<td>Pursued needs (during interview)</td>
<td>Medical knowledge</td>
</tr>
<tr>
<td>Dee and Blazek, 1993</td>
<td>After hours interview</td>
<td>Rural physicians</td>
<td>0.333</td>
<td>Recognized (and remembered) needs</td>
<td>Medical knowledge</td>
</tr>
<tr>
<td>Gorman and Helfand, 1995</td>
<td>Office hours interview</td>
<td>Primary care MDs, Office-based</td>
<td>0.574</td>
<td>Recognized needs</td>
<td>Medical knowledge</td>
</tr>
<tr>
<td>Covell et al., 1985</td>
<td>Ethnographic</td>
<td>Academics, trainees</td>
<td>1.422</td>
<td>Observed needs (excludes teaching questions)</td>
<td>Patient data, medical knowledge</td>
</tr>
<tr>
<td>Osheroff et al., 1991</td>
<td>Ethnographic</td>
<td>Academics, trainees, Teaching rounds</td>
<td>1.826</td>
<td>Recognized (and stimulated) needs</td>
<td>Medical knowledge</td>
</tr>
<tr>
<td>Timpka and Arborelius, 1990</td>
<td>Ethnographic</td>
<td>General practitioners, Office-based</td>
<td>3.7</td>
<td>Pursued needs</td>
<td>Patient data</td>
</tr>
<tr>
<td>Tang et al., 1994</td>
<td>Ethnographic</td>
<td>Academics, trainees, Teaching rounds</td>
<td>5.044</td>
<td>Observed needs (includes teaching questions)</td>
<td>Patient data, medical knowledge, other needs</td>
</tr>
<tr>
<td>Osheroff et al., 1991</td>
<td>Ethnographic</td>
<td>Academics, trainees, Teaching rounds</td>
<td>n/a</td>
<td>Unrecognized needs</td>
<td>Medical knowledge</td>
</tr>
<tr>
<td>Williamson et al., 1989</td>
<td>Mail survey</td>
<td>Primary care MDs, Office-based Nationwide</td>
<td>n/a</td>
<td>Unrecognized needs</td>
<td>Medical knowledge</td>
</tr>
</tbody>
</table>

* Questions per patient encounter, calculated or estimated from reported data.

includes different types of information (Covell, Uman, & Manning, 1985; Osheroff et al., 1991; Timpka & Arborelius, 1990). Though sometimes defined explicitly, the type of information being considered is often left undefined. To date, no common framework has been adopted that permits classifying and defining clinical information across studies.

To allow studies of physician information needs to be interpreted and compared, a framework is required that permits classification of the information that clinicians use when caring for patients. Table 2 presents a suggested schema for this purpose. It combines into a single framework ideas developed by other researchers based on empirical data (Forsythe, Buchanan, Osheroff, & Miller, 1992; Osheroff et al., 1991; Timpka & Arborelius, 1990), as well as the author's own observations based on interviews with primary care physicians in Oregon and the United Kingdom.

**Patient Data** refers to information about a specific person. It includes items of a patient’s history, observations from physical examination, and results of diagnostic testing. Examples might include demographic information such as age, past medical history such as prior exposure to tuberculosis, recent symptoms such as cough or hemoptysis, physical findings of fever or pulmonary rales, and diagnostic test results such as examination of sputum or abnormalities on chest radiography. The usual sources for obtaining this information are the pa-

TABLE 2. Types of information used by clinicians.

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Description</th>
<th>Examples</th>
<th>Usual sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient data</td>
<td>Refers to a single person</td>
<td>Medical history, Physical exam, Laboratory data</td>
<td>Patient, family, and friends, Medical record</td>
</tr>
<tr>
<td>Population statistics</td>
<td>Aggregate patient data</td>
<td>Recent patterns of illness, Public health data</td>
<td>Recent memory, Public health departments</td>
</tr>
<tr>
<td>Medical knowledge</td>
<td>Generalizable to many persons</td>
<td>Original research, Textbook descriptions, Common knowledge</td>
<td>Textbooks, Consultants, colleagues</td>
</tr>
<tr>
<td>Logistic information</td>
<td>How to get the job done</td>
<td>Required form, Preferred consultant, Covered procedure</td>
<td>Local, Policy &amp; procedure manual, Managed care organization</td>
</tr>
<tr>
<td>Social influences</td>
<td>How others get the job done</td>
<td>Local practice patterns</td>
<td>Discussion with colleagues</td>
</tr>
</tbody>
</table>
tient, his or her family and friends, and the medical record, whether in paper or electronic form.

*Population Statistics* refers to aggregated data about groups or populations of patients. Historically, clinicians have used their personal knowledge of recent illness patterns in the community as a form of informal epidemiologic information, adjusting their practices according to local or recent experience. An example would be evaluation of a patient with symptoms of upper respiratory infection when "there's a 'flu' going around." Formal population statistics have until recently been available mainly to insurance carriers and government agencies such as public health departments which collect such information (e.g., rates of communicable diseases in a region). For most physicians, access to formal population statistics has been principally through published descriptions of disease prevalence in the medical journal literature. Unfortunately such published statistics may not be applicable to a given local population because of differences in ethnic composition, local vectors of disease, or lifestyle differences. One expected benefit of increasing the use of electronic medical records is a vastly improved capability for clinicians to obtain and analyze aggregate patient data, allowing them to better adopt medical practices to local populations (Greenlick, 1992) and to improve the quality and cost-effectiveness of medical practices (Lansky, 1992).

*Medical Knowledge* refers to information that is understood to be generalizable to the care of all patients (Timpka & Arborelius, 1990). It may exist in the form of original research and systematic overviews published in the medical journal literature. It may exist as classic descriptions of disease pathophysiology, diagnosis, and treatment found in standard textbooks. Or it may take the form of accumulated informal experience of practitioners, their "constantly expanding and reinterpreted database" (Tannenbaum, 1994). Other classifications of physicians' information needs tend to be subclassifications of medical knowledge, including 1) classic "textbook" categories: etiology, pathophysiology, clinical manifestations, diagnosis and differential diagnosis, treatment, and prevention (Osheroff et al., 1991); and 2) organ system domain categories, such as dermatology, rheumatology, endocrinology, etc. (Covell et al., 1985). When not explicitly stated, studies of information need have most often been concerned with either medical knowledge, patient data, or both, as they are defined here.

*Logistic Information* refers to local knowledge about how to get the job done, often specific to a practice setting or payment mechanism. Though often excluded from discussions of physician information needs (Ely et al., 1992; Timpka & Arborelius, 1990), Forsythe has stressed that information of this type may be as important in day-to-day medical practice as other types of information (Forsythe et al., 1992). Clinicians frequently seek the answers to such questions as:

- "Which medicines (for treating a particular condition) are included in the hospital formulary?"
- "Which consultants are on the referral list of the patient's managed care organization?"
- "Which procedures are covered by this patient's insurance plan?"
- "Which forms must be completed to obtain a needed service?"

Such information is most often obtained from local human sources such as office and hospital staff or colleagues. Though it requires much attention and effort on the part of clinicians, logistic information has received relatively little attention from developers and providers of clinical information systems.

*Social Influences* refers to knowledge about the expectations and beliefs of others, especially peers such as colleagues and consultants, but also including patients, families, and others in the community. Examples include local practice patterns and expectations with respect to prescribing of medications or performance of surgical procedures (Wennberg, Barnes, & Zubkoff, 1982). Like logistic information, little attention has been paid to social influences in discussion of clinician information needs, though evidence suggests that this type of information is quite important in determining what practitioners actually do (Mittman, Tonesk, & Jacobson, 1992).

**Definition of Terms: Types of Information Need Measured by Researchers**

In general, attempts at quantitative estimates of information needs have equated an information need with a clinical question about a patient or an aspect of patient care. But there has not been a uniform approach to defining when an information need exists. The spectrum of approaches taken to defining when an information need exists is listed in Table 3, and is included in the fifth column of Table 1.

*Unrecognized Needs* must be inferred from measurement of physician knowledge or observation of clinical practices (Stross & Harlan, 1979; Williamson, German, Weiss, Skinner, & Bowcs, 1989). Of course, the potential exists for misinterpretation, since clinical practices may diverge from those that are currently recommended for reasons other than lack of knowledge, such as clinical disagreement, patient expectations, lack of access, etc. Unrecognized needs are important, however, because information systems that depend on the clinician to seek information cannot succeed until the clinician recognizes that a need exists. Information systems designed to address unrecognized information needs can potentially overcome this limitation. Automated reminder systems are one example of an information system that addresses unrecognized information needs. Another example is diagnostic decision support systems, which may be effective in informing physicians of additional diagnostic...
TABLE 3. States of information need.

<table>
<thead>
<tr>
<th>Type of need</th>
<th>Description</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrecognized needs</td>
<td>Clinician not aware of information need or knowledge deficit</td>
<td>Inferred from assessment of knowledge; external action required to correct (e.g., reminder systems, self-assessment programs)</td>
</tr>
<tr>
<td>Recognized needs</td>
<td>Aware that information needed; may or may not be pursued</td>
<td>Articulated by clinician or inferred by observer</td>
</tr>
<tr>
<td>Pursued needs</td>
<td>Information seeking occurs; may or may not be successful</td>
<td>Observed or recalled information-seeking behavior</td>
</tr>
<tr>
<td>Satisfied needs</td>
<td>Information seeking succeeds</td>
<td>Recalled information-seeking successes</td>
</tr>
</tbody>
</table>

possibilities not initially considered by the clinician (Berner et al., 1994).

Recognized Needs are those articulated by the clinician, and may or may not result in pursuit of new information. Studies which attempt to identify information needs recognized by the clinician in the course of patient care have either recorded questions in response to a prompt (Covell et al., 1985; Gorman & Helfand, 1995) or without any prompting, as they occur naturally (Osheroff et al., 1991; Tang et al., 1994). Where prompts are used, there is greater potential for bias in the form of experimenter effect, where the presence of the interview may stimulate more apparent information need than would normally occur. Where observation alone is used, there is the potential for information needs that are recognized but not spontaneously articulated to be omitted. With either approach, the potential exists for overestimating information need, since neither provides a means of determining whether the information in question is actually necessary to benefit either the patient or the practitioner.

Pursued Needs are those which for which some information seeking behavior is either observed (Ely et al., 1992) or recalled at a later time (Covell et al., 1985). This approach excludes, by definition, those information needs which clinicians do not pursue. Little is known about how the questions that physicians pursue differ from those which they choose not to pursue, how physicians choose which questions to pursue and which to leave unanswered, or how the availability or use of information resources affects this information seeking behavior. A more restricted approach to assessing information needs is to infer them from the use of a particular information source. Like circulation counts in library settings, this approach can only provide a very limited description of a user's total information needs. Satisfied Needs, a subset of pursued needs, refers to instances in which the pursuit of information is successful.

Subjects and Setting: Whose Needs Are We Talking about?

It is no surprise that studies of information needs produce differing results depending on the clinical setting and subjects involved. Information systems designed to meet the needs of users in one setting may be of much less use to those in other settings.

In academic institutions during teaching exercises, questions about medical knowledge or patient data may be asked to promote discussion or to assess the knowledge of trainees (Osheroff et al., 1991), purposes that are unique to teaching settings. Members of the clinical ward team (attending physician, senior and junior residents, interns and medical students) frequently obtain patient data from one another rather than subject their patients to repetitive questioning, increasing the frequency with which expressions of need for patient data will be observed. Studies that include trainees, who rely more heavily on basic science knowledge in their clinical reasoning (Patel, Evans, & Groen, 1989; Schmidt, Norman & Boshuizen, 1990) and clinician-researchers, whose professional interests go beyond the purely clinical aspects of a case, may identify different types of information need than studies performed in nonacademic settings.

In small offices and clinics, whose paper medical records are close at hand, access to patient data may be much less of a problem than in modern large health systems, where patient data originates in various clinics and ancillary testing centers, often dispersed in multiple locations across a medical center campus and poorly incorporated into the patient's medical record. Tang et al. have reported on the poor availability of patient data in medical records in large academic institutions (Tang et al., 1994).

In traditional community-based primary care settings the patients, office staff, and physicians are often more familiar with one another than their counterparts in secondary and tertiary referral settings. As a result, there may be less direct need for patient data, because the patient is better known to the clinician, and there may be less indirect need for information in general, where a sound physician-patient relationship reduces the need for efforts to reduce uncertainty, such as ordering additional diagnostic tests. Also important in the primary care setting are referral: Sending the patient to a consultant obviates the need to pursue information on one's own; and deferral: Seeing the patient again in follow-up may clarify the disease process or response to treatment and make pursuit of other information unnecessary.
These options are likely to play less of a role in academic and sub-specialty settings than in primary care.

Specialists, on the other hand, have been shown to require less information when working within their specialty domain than non-experts, asking half as many questions to reach a diagnosis, for example (Kassirer & Gorry, 1978). When specialists do require information, most of their questions of medical knowledge were found by Covell et al. to fall outside of their own specialty domain (Covell et al., 1985). It is not clear what questions would be considered to be outside the domain of primary care physicians.

Data Collection Methods: How Are We Counting? Who Is Counting?

A final methodological issue involves the methods used to collect data about information needs. These methods, ranging from ethnographic participant observation to mail surveys, are listed in the second column of Table 1. A detailed discussion of the advantages and limitations of these various methods of data collection is beyond the scope of this article. Each approach has limitations that can be expected to bias the results in relatively predictable ways. Forsythe et al. have stressed the importance of broadening our view of physicians’ information needs and expanding the methodological repertoire used to examine them (Forsythe et al., 1992). To obtain an accurate and complete picture of the information needs of clinicians in a given clinical setting, a multi-method approach to data collection and analysis is essential.

Clinical Questions

A common approach taken in information needs research has been to equate information needs with the questions asked by physicians. Quantitatively, this has meant counting the questions that arise as physicians see patients or as they review the patients’ medical records in a research setting. One challenge with this approach is finding a way to collect every question that occurs without either missing some that are not articulated or artificially stimulating additional questions beyond what would naturally occur. A second counting problem involves the multi-factorial nature of the questions themselves. Although some are simple and direct, others contain questions within a question (see Appendix). These questions are more difficult to count, especially when taken out of context. How many questions are being asked in these cases? How many answers are required? While information needs studies have focused on counting individual questions asked by clinicians, this is to some extent an artifact of study. It must be remembered that for the physician, the unit of analysis is not the question but the patient.

Two conclusions about the quantity of physician information need appear warranted, in spite of these methodological issues. First, questions about optimal patient care are frequent, with many questions occurring each day for a typical physician. Second, as the data presented in Figure 1 demonstrate (Covell et al., 1985; Gorman & Helfand, 1995), most of these questions are never pursued, much less answered.

To learn more about clinical information needs requires examination of the questions themselves, and the context within which they arise. The Appendix contains a sample of typical questions asked by primary care physicians during routine office practice in an Oregon study of information needs (methods are described in [Gorman & Helfand, 1995]). It can be seen that although some of these questions are fairly simple and direct, many of them are complex, multidimensional questions embedded in the context of the individual patients. These clinical questions may involve multiple clinical domains, interdependent issues of diagnosis and treatment, and personal and social details specific to the patient (and perhaps the practitioner).

The complex, patient-, problem-, and practitioner-specific nature of many clinical questions is evident in the common use of stories or narratives to communicate them. As Hunter noted, “Neither biology nor information science has improved upon the story as a means of ordering and storing the experience of human and clinical complexity. Neither is likely to” (Hunter, 1991). Indeed, in my own interviews with primary care physicians, an unexpected but highly consistent observation has been the use of stories to communicate clinical questions. In spite of frequent reminders that the interview process was meant not to interfere with the flow of patients, time after time, when asked whether they had any questions, physicians would first tell the patient’s story, setting the context for understanding the questions that followed. These narratives often included information belonging to several of the categories listed in Table 2.

![Knowledge Resources of Physicians](image)

**FIG. 1.** Use of knowledge resources by physicians as reported in two studies of physician information needs. Data adapted from Covell et al. (1985) and Gorman and Helfand (1995).
The reliance on stories to communicate information need, because of their complexity and patient specificity, may be one reason for the consistent finding that physicians rely heavily on human sources of information to meet their information needs. This reliance is evident in Figure 1, where consultants, colleagues, and other human sources of information, taken together, are the most often utilized knowledge resource (Covell et al., 1985; Curley, Connelly, & Rich, 1990; Ely et al., 1992; Gorman & Helfand, 1995).

The preference of physicians for human sources of information has other implications as well. Forsythe et al. note that clinical questions such as "What do you do for the treatment of breast cancer" may indicate a need not for medical information in the usual sense, but rather express a need for information about how to cope with the frustration of caring for a patient who is beyond treatment (Forsythe et al., 1992). It follows that the information seeking choices of physicians may be determined in part, by needs other than the need for medical knowledge. These may include the need for commiseration, affirmation of professional relationships, feedback about one's own knowledge and practices relative to those of others, etc. Discussing a case with a colleague or consultant may thus involve two-way transfer of information about the patient, the practitioners, and their relationships, information which extends beyond the categories of clinical information that are usually considered in information systems development or evaluation.

The preference for human sources of information may also result from a need for higher-order information than descriptive medical knowledge. For some questions, purely descriptive medical knowledge may be sufficient, such as that found in medical textbooks and journal literature. In other situations, however, the practitioner may require higher-order information, such as confirmation, explanation, analysis, synthesis, and ultimately judgment—judgment which takes into account the complexity of the patient's case and combines it with an expert's understanding of the issues involved. Evans and Gadd comment on the importance of the shared understandings that make "curbside consultations" so prevalent in medicine: "Experts share knowledge not only of the details of their domains, but also of the structure and goals of their discourse" (Evans & Gadd, 1989).

Perhaps most important in determining the preference of physicians for human sources of information is the fact that their colleagues and consultants understand best what is needed in practice is not information relevant to a query, but an answer to a patient care problem. While relevance, according to Webster, means "having significant bearing on the matter at hand," answer "implies the satisfaction of a question, demand, call, or need" (Mish, 1990). For clinicians, an abundance of relevant information may be of little use, while a small amount of information, or indeed no information at all, may provide the answer to a clinical problem (Gorman, 1993). Either way, the task of the clinician is not to know about medicine, but to care for patients. Hunter characterizes this dilemma well when she says of physicians, "They must continue to learn. . . But they need equally to preserve an ability to act, even though scientific advances mean that today's action might have been contraindicated a decade ago and will be outdated a decade hence. . . . The physician, however learned and aware, must continue to act" (Hunter, 1991, p. 121).

Evaluating Information Systems: Impact on Information Need

Although patient and societal outcomes are clearly the most important outcomes to assess, with few exceptions (Johnston, Langton, Haynes, & Mathew, 1994; Tierney, Miller, Overhage, & McDonald, 1993) the goal of demonstrating information system impact on clinical endpoints has been elusive (as it has been in the business domain [Landauer, 1995]). Large variations in clinical practices and the often small-effect sizes of medical treatments have made large clinical trials necessary to demonstrate or disprove an effect of treatment. This is compounded in information system evaluation by the fact that a system may be successful at informing the practitioner but have no effect on clinical decisions, clinical actions, or patient outcomes. For example, clinicians often seek information to confirm (raise their certainty about) what they believe to be true. They also may pursue a question out of curiosity when the information will have no impact on therapy or outcome. Consultation with a colleague may provide interaction that increases professional satisfaction, but has no apparent effect on patient care. In each case, an information system may be successful in meeting the information needs of clinicians without direct impact on medical practices or patient outcomes. For these reasons, assessment of information systems by examining their effects in the clinical domain is problematic. As Friedman and Wyatt suggest, "The relationship between an information resource and patient outcome is usually quite remote when compared to more standard medical interventions, such as drugs. In addition, the actual function of an information resource and its impact may depend critically upon feedback from patients and or healthcare workers. It is thus unrealistic to expect, and evaluate for, quantifiable changes in patient outcome following the introduction of many information resources, and wiser to look for changes in the structure or processes of healthcare delivery" (Friedman & Wyatt, in press).

An alternative approach is to assess the effect of information systems on the outcome of information seeking itself. This assessment is more directly relevant to information system development and evaluation, and addresses the immediate system objectives: Meeting clinical information needs and increasing the flow of new medical information to practitioners. By considering the immediate objectives of the system in the clinical setting, that is, by asking from the perspective of the user, "what...
TABLE 4. Some candidate variables for information system assessment.

<table>
<thead>
<tr>
<th>Category</th>
<th>Variables</th>
<th>System impact questions addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information needs</td>
<td>Amount of information need</td>
<td>Do reported or recognized needs increase?</td>
</tr>
<tr>
<td></td>
<td>Types of information need</td>
<td>Do types of information need change?</td>
</tr>
<tr>
<td>Information seeking</td>
<td>Pursuit of questions</td>
<td>Are new types of questions being asked?</td>
</tr>
<tr>
<td></td>
<td>Types of information need</td>
<td>Are different types of needs being met?</td>
</tr>
<tr>
<td></td>
<td>Knowledge resource use</td>
<td>Are more questions being pursued?</td>
</tr>
<tr>
<td>Information outcome</td>
<td>Questions answered</td>
<td>Are different types of questions being pursued?</td>
</tr>
<tr>
<td></td>
<td>Practitioner certainty</td>
<td>Are more questions being answered?</td>
</tr>
<tr>
<td></td>
<td>Quality of evidence</td>
<td>Are users more certain about actions?</td>
</tr>
<tr>
<td></td>
<td>Practitioner knowledge</td>
<td>Are questions better answered?</td>
</tr>
<tr>
<td></td>
<td>Qualitative effects</td>
<td>Do users have lasting knowledge gain?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What other changes are observed?</td>
</tr>
</tbody>
</table>

should a successful system do," relevant variables can be identified. These should include qualitative observation of other effects of the information system on practitioners and their practices (e.g. [Aydin, 1994]). Some candidate variables to be used in information system evaluation are listed in Table 4.

To move forward, what is needed are 1) an expanded view of the types of information used by physicians (Forsythe et al., 1992); 2) common definitions of these information types; 3) improved understanding of the factors that motivate clinicians to seek information, 4) recognition that the meaning and value of information provided by an information system depend not on the message itself but on the context in which it is received ( Bateson, 1979; Blois, 1984): the complex, patient- and practitioner-specific clinical problem in need of an answer; and 5) an evaluation approach that incorporates multiple methods to compensate for the limitations inherent in each. Achieving these goals represents a substantial but worthwhile agenda for future information needs research.

Acknowledgment

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Appendix: Selected Clinical Questions Asked by Primary Care Physicians

9.8 In a patient with refractory headaches, now benefiting from a calcium channel blocker, is there a specific drug or dose that has been shown to work? Is there a study showing this?

65.11 After 2 courses of antibiotics in a physician's daughter with bronchitis, what treatment is appropriate for persistent symptoms?

113.3 In an octogenarian with anemia, angina, and a history of transient ischemic attacks, with a normal creatinine, iron, and mean corpuscular volume, who refuses a bone marrow exam, what diagnostic and therapeutic options are there?

234.2 Is it safe to use ibuprofen in a 50-year-old man with a history of colon cancer, now reporting dysuria, who has cellular casts in his urine?

314.3 Does Norpace cause fatigue?

314.7 What are the cost, risk, and usefulness of dipyridamole thallium scanning in a patient with chronic obstructive lung disease, claudication, and angina pectoris?

506.1 In a woman with sclerosing adenosis on breast biopsy and family history of breast cancer, who requires estrogen therapy to control symptoms, how can the risk of breast cancer be lowered?

625.2 In an 88-year-old woman with dysphagia due to past laryngeal cancer, now in respiratory failure due to aspiration, what is the physician's role in aggressiveness of care decisions when the patient's family has unrealistic expectations?

656.1 For a child with exacerbation of steroid dependent asthma and varicella exposure, how do you give varicella immune globulin and where do you get it?

771.8 Is meclizine effective for labyrinthitis?

873.4 In a man with vague intermittent abdominal and back pain, what additional information will be most useful and what is the complete differential diagnosis?

892.3 Can aspirin or an antiplatelet agent be used as prophylaxis against pulmonary embolism (PE) in an elderly woman with unexplained oxygen desaturation and no clinical risk factors for PE (none that warrant transport 100 miles for diagnostic tests)?

892.5 In a woman with history of delivering at 33 weeks, now having Braxton-Hicks contractions at 32 weeks, on terbutaline and bedrest, in breech position, is c-section indicated if labor cannot be stopped?

892.8 How can I distinguish and manage chest pain in
an older woman with known coronary disease, status post angioplasty of the left anterior descending coronary artery, arthritis which precludes treadmill testing, esophagitis, inadequate personality which complicates history, given that dipyridamole testing is 180 miles away?

In a patient with steroid dependent chronic obstructive lung disease, does the risk of renal or gastrointestinal complications outweigh the benefit of non-steroidal antiinflammatory therapy for degenerative joint disease?

Can an insulin-dependent diabetic be certified as a commercial driver?

References


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