

# Information seeking of primary care physicians: conceptual models and empirical studies

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## CONTEXT OF INFORMATION SEEKING: PRIMARY CARE PATIENT MANAGEMENT

### The Complete History and Physical

As medical students, learning to do a Complete History and Physical is one of the first great challenges in the transition from being a classroom student to being a clinical trainee on the hospital wards. The Complete History and Physical, summarized in Table 1, is a highly structured, comprehensive data gathering exercise which combines open-ended interviewing techniques, letting the patient 'tell the story' of his or her illness, with focused, orderly questioning about virtually every aspect of that patient's life which might have bearing on their health. A key feature of this procedure is that, with the exception of gender-specific questions such as an obstetric history in a man, every patient is asked every question, to ensure that the database is complete. Until it is committed to memory, many students work from a detailed list of questions, often many pages in length, based on recommended examples found in widely used textbooks (Walker & Hurst, 1976, Degowin & Degowin, 1976).

This exhaustive initial data gathering activity is only the first step in the process. Once all the data have been collected and recorded, the student must organize and categorize the information into his or her Impression, a complete tabulation of the patient's health problems and possible explanations for them (Differential Diagnosis). This list of problems then forms the basis for outlining the Plan, with specific recommendations to a) resolve any remaining diagnostic uncertainty; b) effectively treat the health problems that have been identified; and c) help the patient understand what is wrong, what can be done about it, and

what to expect in the future. Finally, the entire process must be documented in the patient's medical record.

<b>Source of History and Identifying Information</b>	<b>Systems Review</b> Check all symptoms in all body systems
<b>Chief Complaint</b> patient's main concern	<b>Physical Exam</b> General Appearance
<b>Present Illness</b> detailed chronological narrative	Vital Signs
<b>Past History</b> Allergies and adverse reactions	Skin and integument
Medications and current treatments	Head Eyes Ears Nose and Throat
<b>Past Medical Problems</b>	Neck and Back
<b>Surgical History</b>	Chest and Lungs
<b>Obstetric History</b>	Heart and Cardiovascular System
<b>Childhood Illnesses</b>	Abdomen
<b>Vaccinations and Preventive Care</b>	Genitalia and Rectum
<b>Social History</b> Birthdate, birthplace, etc.	Extremities
Occupation and avocational interests	Neurological Exam
Diet and nutritional history	Cognitive Exam
Habits and risky behaviors	<b>Ancillary Data</b> Laboratory tests, xray reports, etc.
Family and living situation	<b>Impression</b> Diagnosis and Differential Diagnosis
<b>Family History</b> Family tree w/ illnesses, deaths, etc.	<b>Plan</b> Diagnostic testing
	Therapeutic & preventive interventions
	Patient education

Table 1 Outline of Complete History and Physical

Of course, although the written record of patient evaluation is usually organized with this same structure, real doctors don't actually work this way. Though it may be a necessary and important step in the learning process, this discrete, orderly, linear, structured process is not an accurate model for what happens in real life. As Sackett, *et al.* have suggested, 'all medical students should both be taught how to do a complete history and physical and, once they have mastered its components, be taught never to do one' (Sackett *et al.*, 1991).

One problem with this model is that real patient care, especially primary care, is often not a discrete one-time occurrence but rather a continuous process or series of connected episodes over time. Lawrence Weed, recognizing the progressive, evolving nature of this process, called on physicians to organize their ongoing records in a manner that would take advantage of the potential for continuous improvement. He proposed that physicians record their Progress Notes using a Subjective-Objective-Assessment-Plan (S-O-A-P) structure analogous to the Complete History and Physical (Weed, 1968). This approach is meant to facilitate ongoing reconsideration and revision of the diagnosis and treatment plan in response to new information and changes in patient status over time, and has become a widely accepted standard.

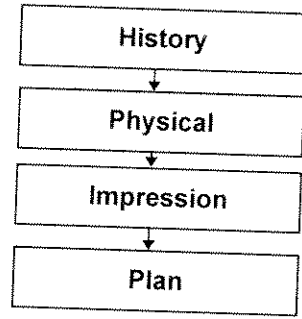


Figure 1: The Complete History and Physical

A second problem with the Patient Work Up as traditionally taught is that it is often not all that orderly either, proceeding from History to Physical Exam to Impression to Plan. In practice, clinicians often do several of these things at once, going back and forth depending on the context. For example, as the patient describes a chief complaint of a vague pain, the clinician may observe the physical state of the patient (*'She looks thinner than I remember her'*), flip through the medical record in search of specific bits of data (*'What did she weigh at the last visit? Has the diagnosis of depression been considered in the past? Have there been any laboratory test results that suggest malnutrition or cancer?'*), and redirect the history taking to inquire about other symptoms. (*'Have you been feeling sad or depressed? Are you keeping up with your gardening or golf game?'*) Barrows suggests that students not maintain an arbitrary separation of history taking and physical examination, but rather actively interdigitate the two as they evaluate the patient. He encourages them to look for physical findings as they take the history, obtain additional history as they do the physical exam, and in general seek information as the need for it becomes apparent (Barrows & Pickell, 1991).

**Clinical problem solving: the hypothetico-deductive model**

A third problem with the 'Patient Work-Up' as students traditionally learned it is that clinical work is not usually linear, either. Elstein, *et al.*, conducted a series of now classic studies using 'think aloud' methods to examine the diagnostic reasoning of expert clinicians (Elstein *et al.*, 1978). In their studies, physicians did not complete a broad, comprehensive data gathering process before analysing the information. Instead, physicians generated diagnostic hypotheses very early in the clinical problem solving process. By considering one working hypothesis at a time, they effectively narrowed what might otherwise be an

intractably large problem space, pursuing specific information to confirm or reject each hypothesis before moving on to the next. The findings of Elstein and colleagues formed the basis for the Hypothetico-Deductive Model of clinical reasoning, in which clinicians alternately entertain and test diagnostic hypothesis in an iterative loop until they arrive at the one diagnosis that best explains the patient's findings.

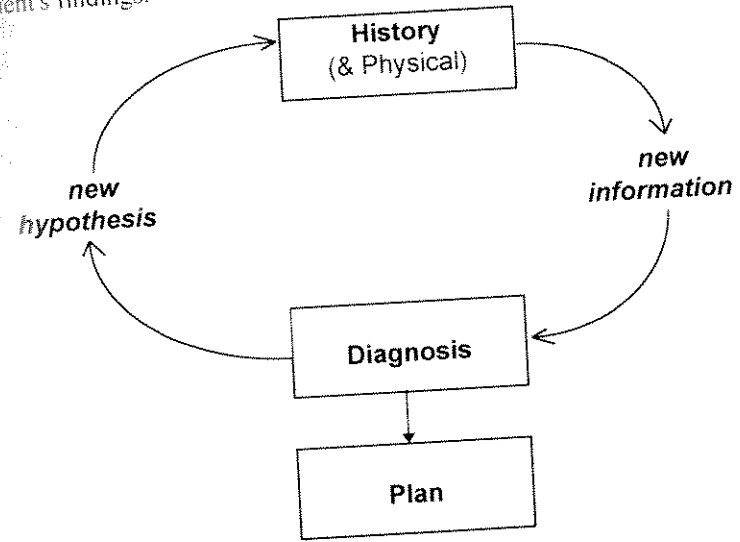


Figure 2: The hypothetico-deductive model

Others have since confirmed this now widely accepted model, and extended it by examining the amount of information acquired, the evolution of the process over time, and the organization of the information. Kassirer and Gorry found that specialists followed this highly focused hypothesis-testing pattern of information seeking when solving a diagnostic problem in their own speciality domain, while generalists, and specialists solving a problem outside their area of expertise, tended to do more 'scanning' or broad information gathering, before arriving at a diagnosis. Working in their own domain, specialists actually collected *less* information than non-specialists, following a shorter, more direct path to the correct diagnosis (Kassirer & Gorry, 1978). Subsequent work by Kassirer and Kopelman underscores the notion that diagnosis is often not a discrete event occurring in a single encounter, but a process that occurs over days, weeks, or even months, incorporating not only information obtained in the initial evaluation, but also new or additional information that becomes available as the condition evolves over time, such as in response to a trial of therapy (Kassirer & Kopelman, 1991). Others have found that physicians at different

levels of training organize information in different ways as they obtain it. Patel and colleagues, for example, found that students organized patient data according to underlying biologic and pathophysiologic models, while experienced clinicians organized information into clinically meaningful aggregates (Patel *et al.*, 1989), consistent with the hierarchical organization suggested by Evans and Gadd (Evans & Gadd, 1989) and the 'illness scripts' described by Schmidt and Boshuizen (Schmidt *et al.*, 1990). Based on these difference in organization, we might expect differences in information seeking according to level of training of the subjects studied.

As a result of studies like these, our ideas about diagnostic reasoning and the information seeking that supports it have evolved into increasingly complex models, recognizing that the amount of information gathered and the order in which it is obtained are less important than the kind of information acquired, the context in which it is understood, and the manner in which it is organized and reorganized as the patient's condition, and the clinician's understanding of it, evolve over time.

**Patient management in primary care: beyond diagnosis**

These models go a long way toward improving our understanding of the diagnostic reasoning process, but they fall short of a comprehensive understanding of patient management. First, they generally operate under the assumption called Occam's Razor, or the Law of Parsimony. This rule states that a single diagnosis should be sought to explain all the patient's symptoms. But clinicians know better than to adhere to this rule, because many patients, especially the elderly, suffer from multiple conditions simultaneously. In some cases this represents multifactorial disease, where multiple diseases interact to produce one symptom or syndrome. In other cases, coexisting diseases may not cause the patient's symptoms, but must be kept in mind because of potential impacts on diagnosis, treatment, or prognosis.

A second shortcoming of these models to understanding of the clinical process is their focus on diagnosis, which is only one step, and not always the most important step, in patient management. Although there is evidence that merely knowing the diagnosis, even when it has no treatment implications, can actually improve patient outcomes by reducing the patient's uncertainty about what's wrong (O'Connor *et al.*, 1994), in most cases, the goals of patients and clinicians are to relieve suffering and cure or prevent illness. Making a diagnosis is only an initial step in patient management, one that often does not need to be completed in order to help the patient. In primary care, especially, the evaluation process may proceed only until enough is known to permit decisions to be made about prevention, treatment, and prognosis, similar to decision making heuristics such as Simon's 'satisficing' (Simon, 1955).

**INFORMATION SEEKING OF PRIMARY CARE PHYSICIANS**

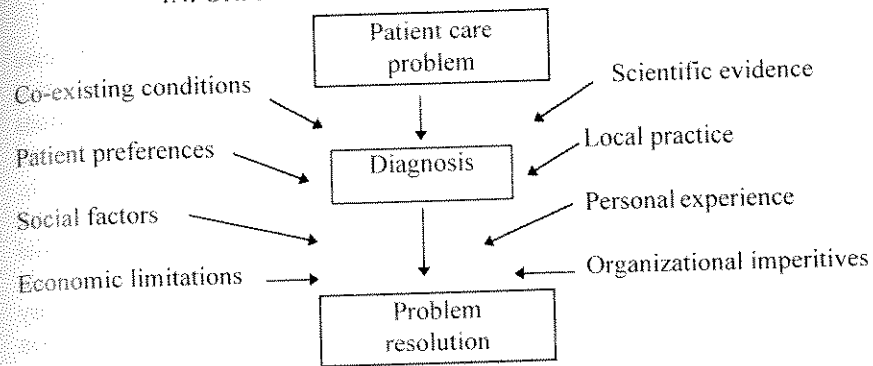


Figure 3: Patient management in primary care

Furthermore, the medical facts of the case are not the only facts, nor even the most important facts, in decision making. Many other types of information must often be incorporated by patient and clinician in order to decide on a management plan. These may include patient preferences, economic limitations, social considerations, local logistic factors, institutional or organizational policies, local practice patterns or standards of care, and the individual clinician's experience or preferences. To be successful at predicting and providing for clinicians' information needs, a model of information seeking in primary care patient management must incorporate the need for these additional types of information.

Examination of some clinical questions collected from clinicians in the course of patient care will help to illustrate these points. These questions, listed in Table 2, demonstrate the degree of complexity that may be present in primary care patient management, where multiple interdependent issues of diagnosis, treatment, patient values, social impacts, and other types of information may need to be considered in order to reach a decision.

**A MODEL OF INFORMATION SEEKING IN PRIMARY CARE**

To be accurate, a model of information seeking in primary care must take into account the fact that the primary goal of the clinician and the patient is not to obtain information but to find some resolution of the patient's health problem. As in other problem solving contexts, information seeking must be seen as secondary to the 'necessary distraction,' of the decision maker's larger, primary goal. (Lee Buchanan, Deputy Director of DARPA, quoted by Ron Larsen (Larsen, 1998)). Success is not measured in terms of the amount, the relevance, or the quality of information retrieved, but by the extent to which the problem is resolved.

To be useful for research, the model of information seeking in primary care must be composed of components that can be operationalized in a way that allows for meaningful description and measurement. Only then can observations be used to validate (or invalidate) and extend the model, its components, and their relationships.

We have been using a simple model of information seeking in primary care that is meant to meet these criteria and be both accurate and useful. The model recognizes that the central activity of clinicians is patient management, while information seeking is a related, but external and sometimes unnecessary process. As illustrated in Figure 4, this model defines four states of information need (Gorman, 1995) and four strategies for responding to an information need should one become apparent.

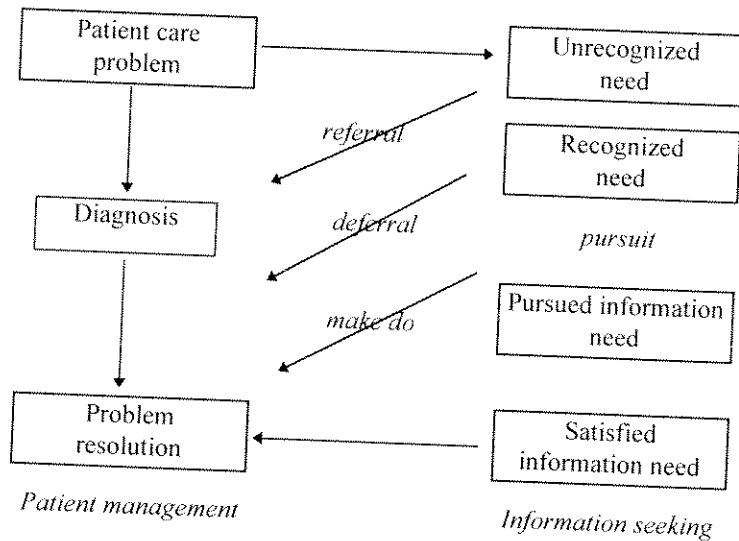


Figure 4: Information seeking in primary care

The clinician begins in a state of unrecognized information need. Every clinician is familiar with the challenge of staying abreast of an enormous, expanding, and evolving body of medical knowledge. Yet, until confronted with a specific patient problem, the clinician has no way to predict which of these unspecified information needs will occur next. Once confronted with a patient problem, if the clinician becomes aware that he or she does not possess information that is important to its solution, then a state of recognized information need has developed. This information need is often articulated as a clinical question (Covell *et al.*, 1985), or dilemma (Timpka & Arborelius, 1990).

In some cases, the clinician chooses to pursue the needed information, making the transition to the next state, pursued needs. This involves not only the decision of whether to pursue additional information, but also the choice of how to pursue it, that is, which knowledge resources to utilize (Haug, 1997, Curley *et al.*, 1990, Connelly *et al.*, 1990). If the information seeking activity is successful in finding an answer to the clinical problem, then a state of satisfied information need has been reached. Once again, from the point of view of patient care, success is defined here not in terms of the quantity, the quality, or the relevance of the information retrieved, but by the extent to which the information leads to resolution of the health care problem presented by the patient. On the one hand, a large amount of highly relevant information may not contain a conclusive answer. On the other hand, in some cases finding no information at all may be regarded by the clinician as a satisfactory answer (Gorman *et al.*, 1994).

Information seeking, however, is only with an information need once it has been recognized. Another strategy which clinicians commonly employ is *deferral*: when the patient's problem is not so serious nor treatment so urgent that immediate action is necessary, the best course may be 'watchful waiting.' As every clinician knows, eventually most disorders either declare themselves, making the diagnosis and appropriate management apparent, or improve on their own, making these questions moot.

Another frequent strategy for responding to a clinical dilemma is *referral*: sending the patient to a specialist who will assume the management of the patient obviates the primary care clinician's need to pursue information. Whether the specialist takes over the case completely or returns the patient to the referring clinician with recommendations for further management, the primary care clinician's need to pursue new information has been eliminated for all intents and purposes. Often the information that might have been sought will be apparent, if only implicitly, in the recommendations of the consultant.

The dominant strategy for dealing with an information need in the context of patient management is simply to act. In the majority of cases, clinicians apparently choose to tolerate their uncertainty, make do with the information at hand, and make the best judgement they can based on their knowledge of and experience with similar problems, as well as their knowledge of and experience with that individual patient.

Using this model as a framework, we have been examining the information seeking behaviour of PCCs. The goals of this work are to learn more about these states of information need and how to measure them, and to understand the factors that determine the actions taken by clinicians as they make the transition from one state to the next. The next section of this paper will summarise the findings of our studies in three main areas: information needs, information seeking, and information seeking outcome.

## STUDIES OF INFORMATION SEEKING BY PRIMARY CARE CLINICIANS

### Methodological approach

To investigate information seeking by PCCs, we have used paired semi-structured interviews to observe clinicians in the course of primary care. The method is modified from that employed by Covell, *et al.* (1985) in their provocative and widely cited study. This approach has limitations, including the possibility of overestimating (Barrie & Ward, 1997) or underestimating information needs (Forsythe, *et al.*, 1992), but it has the advantages of being familiar, reproducible, practice based, and potentially useful for future evaluations of information systems. Subjects are selected from a pool of volunteers solicited through mail invitations sent to a random sample of active, non-academic, Oregon PCCs. In the Office Interview, trained interviewers visit the clinicians during one half-day of typical practice, asking the clinician after each patient has been seen whether any questions have arisen about that patient, and recording any questions the clinician articulates. Interviewers also record any observed information seeking activity, such as telephone calls to a consultant or use of textbooks or other information sources. After the office interview, subjects read their clinical questions to verify that they have been recorded correctly, and complete a structured interview regarding their information seeking behaviours. A Telephone Follow-up interview takes place two to ten days later. The interviewer contacts each clinician by telephone and asks, for each of that clinician's questions, whether or not he or she has had a chance to pursue that question and if so, the information resource chosen, whether an answer was found, and whether the answer had an impact on the patient.

### Information Needs

**How much information need? The frequency of clinical questions.** Using the methods described above to measure recognized information need, clinicians in our studies have asked approximately six to eight questions for every ten patients they see (Gorman *et al.*, 1994, Gorman *et al.*, 1997b). This compares reasonably well with findings of other studies when differences in definitions and methods are taken into account. Not surprisingly, the prompt used by the interviewer to inquire about clinical questions can significantly affect the measurement obtained (Gorman *et al.*, 1997a). What other factors determine the frequency with which clinical questions arise? Clinician age? Gender? Specialty? Participation in teaching or research? Proximity of colleagues? Because

univariate analysis may give misleading results due to interactions and correlation among these variables, we are using multivariate methods to analyze our data to try to answer these issues. Results of this analysis will be published when they are complete.

More difficult is the question of what factors contribute to the transition from unrecognized to recognized information needs. Unrecognized needs can only be assessed indirectly, such as by assessing knowledge or clinical practices. Directly assessing knowledge assumes that the knowledge tested is the knowledge that will be needed, while assessing clinical practices assumes that deficient practices imply deficient knowledge and vice versa. Neither of these is likely to be a safe assumption, and measurement of unrecognized need remains problematic. An interesting possibility is the suggestion of Covell *et al.* that clinicians might ask more questions if they had greater expectation of finding answers (Covell *et al.*, 1985).

**What kind of information need? The types of clinical questions.** No standard taxonomy of clinicians' information needs has been defined to date. In most studies, clinical questions have been classified by the investigators according to the organ system or domain involved or according to the investigator's judgments of the expected source of an answer. We asked PCCs to classify their own questions in three dimensions: 1) the type of information needed: patient data, population statistics, medical knowledge, logistic information, or peer practices; 2) the type of medical knowledge needed, using the categories from common medical textbooks such as etiology, pathophysiology, clinical manifestations, diagnosis, treatment, and prognosis; and 3) the type of response required, using categories modified from Bloom's taxonomy of educational objectives: description, explanation, application, analysis, synthesis, or judgment (Bloom *et al.*, 1964). The most common type of information needed was general medical knowledge, such as might be found in textbooks or journals, followed by information about peer practices. The most common textbook category of information needed was treatment information, followed by information about pathophysiology and clinical manifestations. The most common type of response needed by PCCs was simple descriptive information, followed by judgment and application. While the overall pattern was quite similar for different types of clinicians, we found significant differences in the information needs of nurse practitioners and physician assistants compared to physicians, including a greater need for logistic information and information about peer practices ('standard of care' issues), a broader range of medical knowledge needs including more need for pathophysiology and clinical manifestations of disease, and a more frequent need for higher levels of response, such as application, analysis, synthesis, and judgment (Gorman *et al.*, 1997b).

### Information Seeking

**How much information seeking? The frequency of pursuit.** The information seeking observed in the Oregon studies has also been reasonably concordant with other reports, depending on the definition (which needs are included in the denominator) and the time to and method of follow up. Using a narrower definition of information need, confined mainly to medical knowledge, only about a third of clinical questions were pursued (Gorman & Helfand, 1995). Using a broader definition that includes the need for other types of information such as peer practices or logistic information, the amount of information need increases from about six to about eight questions per ten patients, and the rate of information seeking increases to nearly half (Gorman *et al.*, 1997b).

**What factors determine information seeking?** To investigate this question we have used a model that relates information seeking to four classes of factors: clinician factors, such as curiosity, demographic background, etc.; practice setting factors such as practice location, the number of patients seen, and the availability of knowledge resources; patient factors such as severity of illness, and question factors, such as the complexity of the question, the organ system or domain of the question, etc. These can be operationalized in a logistic regression model that predicts the probability that a question will be pursued as a function of these four classes of factors. In a study of primary care physicians, we found that of twelve candidate question attributes, only three were associated with pursuit of information: 1) the belief that an answer to the question exists; 2) the urgency of the patient's problem; and 3) the specificity or uniqueness of the question (the more generalizable the question, the less likely it was to be pursued). Other factors, such as the physician's knowledge of the problem, liability concerns, and the expected difficulty of finding an answer, were not significant in the model (Gorman & Helfand, 1995). Importantly, in the final multiple logistic regression model, physician and practice setting variables were much stronger predictors of information seeking than were the features of the questions themselves, accounting for 27% of the total information seeking variation. We are currently analyzing data from a subsequent study of PCCs to learn, if we can, which of these factors is most important.

**What information sources are used?** Our data are concordant with those previously reported in health care (Haug, 1997, Connelly *et al.*, 1990) and other domains, with PCCs demonstrating a strong preference for human sources of information and for sources that are highly accessible and familiar, such as textbooks that are immediately on hand in the office (Gorman *et al.*, 1994). On the other hand, a comparison of rural and non-rural PCCs suggests that accessibility alone does not fully explain knowledge resource use: while rural clinicians had less access to certain resources than non-rural clinicians, their overall patterns of information seeking were quite similar. Non-rural clinicians

had greater access to human sources of information, digital sources, and library-based resources, but both groups used human sources and local print resources heavily, and neither group made much use of library or digital resources (Gorman & Yao, 1998).

### Information Outcome

**How successful is information seeking by primary care clinicians?** When measured as the proportion of pursued questions to which the clinicians report finding an answer, the overall success rate has been quite high, averaging 77% in our most recent study of PCCs (Gorman *et al.*, 1997b) and about 80% in a previous study of physicians alone (Gorman & Helfand, 1995).

**What is the value of information seeking?** Huth's Economic Approach This brings up the important question of what constitutes success or value in information seeking. Huth proposed an economic or cost-benefit approach to evaluating information systems, where the value of pursuing information is determined by the relative utility of the information retrieved compared to the relative cost, in time, effort, and resource use, of obtaining it (Huth, 1985). If clinicians' information seeking follows a rational choice model, such an approach should allow for investigation of the determinants of information seeking. This approach has already been used to examine knowledge resource preferences (Curley *et al.*, 1990) and the determinants of information seeking (Gorman & Helfand, 1995).

Seen from the perspective of the clinician, the usefulness of information retrieved is likely to be related to factors such as a) relevance of the information content to the question; b) applicability of the information to the clinical context; c) coherence, or the extent to which the information conforms to the clinicians existing knowledge; d) familiarity of the source of the information based on prior experience with that resource or its similarity to other preferred sources; e) authority, or the relative status of the author or publication relative to the clinician's specialty; f) the quality of the information, in terms of the level of scientific evidence upon which it is based; and g) redundancy, or the extent to which the information confirms what has been received through other channels.

### CONCLUSION AND FUTURE DIRECTIONS FOR RESEARCH

There are interesting parallels between some of the computer tools that have been created to assist in the clinical process and the evolution of our models of the process. In particular, computer tools for gathering a defined patient database are reminiscent of the early medical student's exhaustive History and Physical: long on data but short on organization or understanding. As comprehensive records, they may be very successful, but they are too

cumbersome for clinicians to actually read them (Sackett *et al.*, 1991). Similarly, the performance of computerized diagnostic decision support tools is also reminiscent of the beginning medical student's differential diagnoses. Like the novice, computerized tools usually include the correct diagnosis, but fail to list it within the top ten possibilities. They suggest additional diagnoses that warrant consideration, but equally often suggest irrelevant possibilities and fail to include important alternatives (Berner *et al.*, 1994, Bacchus *et al.*, 1994). Given the vastly superior memory and computational capacity of computers, the difficulty of developing effective tools to aid clinicians in these tasks attests to the complexity of the information processing involved.

Studies such as those briefly summarized here demonstrate the importance of obtaining empirical data to verify and validate conceptual models of information seeking. This is especially important if these models are to form the basis for the design of information systems meant to be useful to clinicians. As a result of such studies, information needs of primary care clinicians can be seen to involve integration of more diverse types of information than might have been predicted. Primary care clinicians appear to seek information according to a rational choice model, but the determinants of their information seeking choices do not always follow expected patterns. Further investigations can improve our understanding of these behaviours and assist in the design and evaluation of new information systems for clinicians. In future studies we intend to focus on measures of the complexity of the clinical questions as a determinant of information seeking activity, on measurement of the reduction in uncertainty achieved when information is received and the quality of evidence of the information as determinants of the value of information seeking, and on observation of the discourse of clinicians as a means of capturing the types of information that are incorporated into their patient care decisions.

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