

An information retrieval service to support clinical decision-making at the point of care

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SUMMARY

The information retrieval systems currently available in general practice, such as Medline, and web search engines are passive and relatively difficult to access during consultations. Emergent technologies, including the National Electronic Library for Health, offer opportunities for more active decision support. We examine the extent to which information retrieval could support primary care consultations by examining the impact of the new technology at different stages of the consultation. We advocate a system whereby professional organisations concerned with quality of care, such as the Royal College of General Practitioners, might contribute to the process.

Keywords: decision-making; information retrieval; information technology.

Introduction

It is troubling to spend billions on health care research while neglecting the fact that most of the evidence generated from such studies goes to waste because we do not know how to overcome the problems of dissemination and application.¹

Retrieving and processing information in medicine are operations that we have tried to perform by thinking about them at the time of action... Enormous damage results from this misguided effort.²

IN current practice, the information that can be brought to bear on clinical decision-making at the point of care is doubly limited; first, because the clinician's education is limited, and, secondly, because the clinician's mental 'working space' is also limited. The problem is not unique to the late 1990s; over many decades it has gradually grown, just as the possibility of becoming a 'complete doctor' has diminished. What is unique to the late 1990s is a revolution in information technology. Thus a question arises as to whether information technology can be used to bring relevant information to the point of care, so as to support clinical decision-making. Studies of decision-making by clinicians under examination conditions, at least, suggest that information retrieval (IR) resources may improve the quality of decisions made.³

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We wish to examine the arguments in favour of a specific, practical recommendation: that the National Health Service (NHS) should work towards the development of a computerised reference information service capable of delivering medical knowledge to the point of care.⁴ The primary function of the service is not to generate information but to provide facilities for the distribution of reference information to computers at the point of care, so as to support clinical decision-making as it occurs. The service should provide the facilities outlined in Box 1.

Consultation tasks

During consultations there are seven tasks that are commonly completed jointly by the patient and general practitioner.⁵

Information is required to achieve each task with different demands upon the patient, the medical record, and wider (reference) sources during these different tasks. How can reference information best be brought to bear on the process of clinical decision-making during consultations? An analysis of the information needs for patients and doctors suggests the two models of clinical consultation presented in Model 1 and Model 2.

Model 1 assumes that clinicians will memorise some of the reference information with which they come into contact.⁶ During the consultation, through a process of recall, the clinician attempts to bring to bear that part of the information they have memorised that is relevant to the task at hand.⁷

What would happen if a 67-year-old diabetic man presented to his general practitioner with a two-day history of a painful right ear?

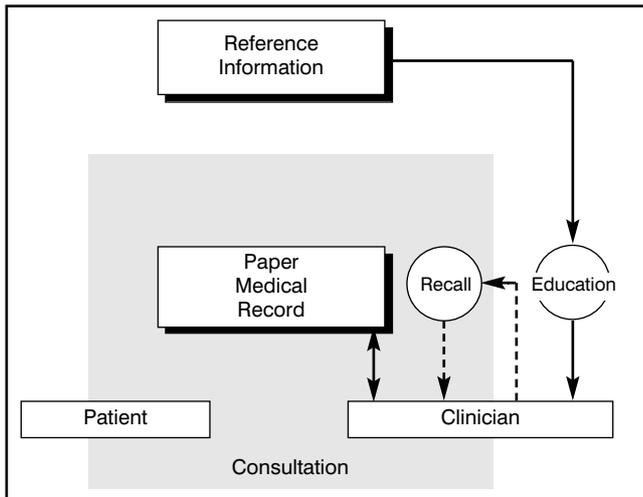
1. Define the reason for the patient's attendance

The doctor would take a history, including an exploration of the patient's ideas and concerns about his ear and what he expects the outcome of the consultation to be. The evidence that is important during this phase of the consultation is the patient's story and his behaviour in conjunction with this story.⁸ Model 1 should be satisfactory for this phase, although the patient may have unexpressed ideas⁹ owing to his failing to appreciate the significance of all his recent symptoms or because the doctor fails to elicit all of the information that may be offered by the patient.

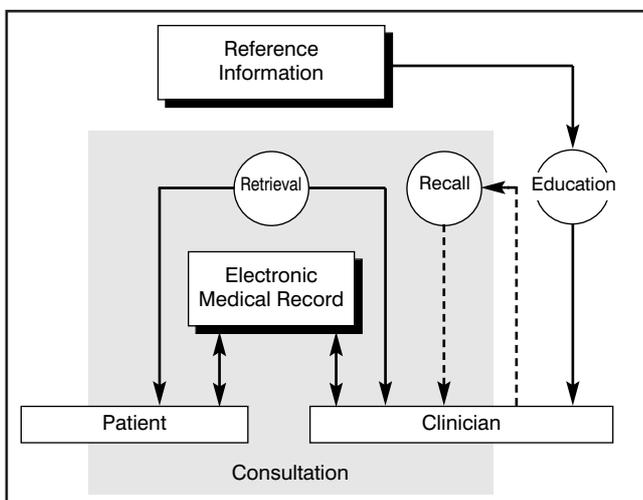
The second phase of problem definition involves detailed consideration of the medical history and physical examination. This is the phase where the doctor must integrate all the evidence to reach a diagnosis before moving to a review of other problems and risk factors. Model 1 begins to break down in many situations. The range of potential history and examination items is enormous, but the doctor's understanding of which ones will give the most information is limited. Some limitations to the success of this phase will relate to examination skills, but knowing what to ask about the ear and how to examine it effectively are knowledge items. If a presumptive diagnosis of, say, *otitis externa* is made, the primary care physician must decide whether to manage the problem himself or refer. This decision will depend upon the level of information available. A textbook with a chapter on *otitis externa* would be useful. If this information were not available, a search process might include the shelves, drawers, and cupboards in the room, and/or a trip along the corridor to the

- Access through a single gateway to a large, distributed collection of digital multimedia documents.
- A set of tools for the identification, indexing, and mark-up of existing documents by cooperating groups of clinicians, to facilitate their assimilation at the point of care.
- A set of editing tools, such that documents having local relevance can be constructed by local non-programmers.
- Multiple information retrieval strategies, so that these can be combined to the best effect in particular circumstances.
- Operation either independently or in association with an electronic medical record system. It is essential that there is provision for automatic exchange of information with computerised medical record systems.

Box 1. Facilities necessary for a computerised reference information service.



Model 1.



Model 2.

practice library to find the practice resource.¹⁰ Values for the positive and negative predictive value of history items, examination findings, or test results based upon the probabilities in that patient are similarly difficult to find.¹¹ A practice intranet may nowadays have information on CD readily available.¹²

2. Consider other problems

The patient may have known diabetic eye disease or be screened

for risk factors. In the first case, the relevant guideline may be available or it may be difficult to locate with all the other guidelines that have flooded into general practice recently.¹³

3. Choose, with the patient, an appropriate action for each problem

The third task involves choosing an appropriate action for the problem(s). Here the doctor must consider the evidence relating to the specific clinical problem (in this case an acute right ear) with that relating to the individual patient. The doctor must consider the patient's multiple pathology and polypharmacy and, most importantly, the acceptability of any new treatment to the patient himself. The doctor may remember reading a good article about topical steroids, which have minimal systemic absorption, 'a few months ago', but be unable to recall whether it was in the *British Journal of General Practice*, the *BMJ*, or *Family Practice*; or perhaps it was a reprint given out at a meeting he had attended? In any case, the paper is likely to be at home in a filing cabinet or lying in an unsorted bundle in the practice library.

4. Achieve a shared understanding of the problems with the patient

The fourth task involves the doctor ensuring that both he and the patient understand each other and share an acceptance of the chosen further action or treatment. This requires the doctor to move closer to the patient's 'unscientific' approach in order to achieve compliance. If the patient knows little about the potential diagnosis and therapeutic options, the doctor will have to spend some time dealing with these issues to ensure patient comprehension and concordance with management decisions taken.¹⁴

5. Involve the patient in management and encourage him/her to accept appropriate responsibility

Many excellent sources of patient information are now available but, like books, papers, and guidelines, there are too many topics to keep all the material in a paper version within easy reach.

6. Use time and resources appropriately

In order to be maximally effective, the conflicting demands of patient utility, cost effectiveness, and clinical effectiveness must all be recognised.¹⁵ Data are required from reference sources for these last two factors, which is simply unavailable in Model 1.

7. Establish or maintain a relationship with the patient that helps achieve the other tasks

The final task is that of establishing and maintaining the doctor-patient relationship. If this task is well achieved, the relationship has tremendous therapeutic power.¹⁶

Information retrieval at the point of care

In the previous section we argued that Model 1 does not provide adequate support for the information processing tasks involved in clinical consultation. Indeed, there have been a number of studies which show that doctors report information needs in most consultations,¹⁷⁻²⁰ that unperceived information needs can be demonstrated,²¹⁻²³ and that some types of information interventions are effective in changing clinical decisions.²⁴⁻²⁹ (The study of Vissers²⁸ addresses the impact of routine use of reference information by clinical users at the time of clinical decision-making. Even their most conservative estimate of 19% for the number of cases in which routine information retrieval influences patient management represents an enormous opportunity for improving

clinical decision-making.)

Model 2 portrays a situation in which, in addition to the processes of Model 1, reference information is retrieved and used at the point of care.

1. *Define the reason for the patient's attendance*

A recent review of diagnostic strategies in primary care ear symptoms³⁰ may be helpful if the diagnosis is uncertain.³¹

2. *Consider other problems*

As the patient is diabetic, you may wish to ensure compliance with current guidelines for prevention of retinopathy.³²

3. *Choose, with the patient, an appropriate action for each problem*

Shared visual aids may help patients understand information about therapy being discussed. The electronic British National Formulary (BNF) or the e-journal *Best Evidence* (ACP journal club) on CD-ROM are examples of this type of information.

4. *Achieve a shared understanding of the problems with the patient*

Several websites exist that provide patient information at the appropriate level; e.g. the patient education leaflet³³ is very helpful.

5. *Involve the patient in management and encourage him/her to accept appropriate responsibility*

Some of this depends upon interpersonal communication and the information used in earlier phases of the consultation, but reference material may be useful in this case; for example, if the patient is at high risk of a cerebrovascular accident, the issue of reversibility may be shared by joint review of the New Zealand Guidelines.³³

6. *Use time and resources appropriately*

Efficiency may be improved by better information if it can be integrated into practice workflow patterns.

7. *Establish or maintain a relationship with the patient that helps achieve the other tasks*

Information retrieval may assist in both these tasks, but more research is required on the integration of these resources into existing consultation styles.

The problems of information retrieval

Technology for the storage and immediate transfer of large documents over electronic and optical fibre networks is already available. Such 'documents' may include pictures, sound, video, or executable computer programs. There is a large and rapidly expanding volume of medically-related information in digital format, such as textbooks, journal articles, clinical guidelines, image libraries, and patient education material.

However, there are three further problems to the implementation of Model 2; namely, those of finding documents, assimilating the information in the documents, and cost.

Finding the material

Suppose a doctor has, in the consulting room, a desktop computer with a CD reader, an electronic textbook of medicine on CD, a database of clinical trials on CD, the BNF on CD, a subset of MEDLINE on CD, and access to the World Wide Web; each of

which can be searched by submitting queries to programs running on the computer. Even though huge volumes of information are at hand, it is very difficult to find the items most useful for any given consultation for the following reasons:

- Each CD must be loaded in turn and requires a different search program using different query syntax, which the doctor must have learned previously.
- Valuable time is spent composing and typing a query for each system.
- Indexing vocabularies are designed by and for librarians, and are inconsistent³⁴ and non-intuitive for clinicians.
- The search programs and their displays are designed principally for research or educational purposes, not for use at the point of care. Clinicians need more focused information.
- There is no provision for system initiative; that is, the doctors can only find what they choose to look for. There may be a highly relevant document in the clinical trials CD but, if the doctor believes that finding a relevant trial is unlikely, that CD will not be searched.
- Although many clinical situations occur frequently, it is very difficult to reuse or share retrieval success.
- Managing and updating the information resources is an extra responsibility for the doctor.

A number of studies have measured the usage of information provision similar to that described.^{35,36} Two notable findings are that the observed frequency of access is low, typically a few times a month per clinician, and that there is a 'novelty' effect, such that frequency of access diminishes over time. Hersh³⁶ concludes that 'Current IR systems have had a modest impact in clinical settings, and they are used in meeting only a tiny fraction of clinicians' information needs'.

Traditional medical IR systems rely on the user to construct a query expression, against which the system evaluates each of a collection of documents,^{37,38} but there are many other approaches to IR; for example:

- Human annotation — in which links between relevant documents and each of a selected set of common queries are manually assigned.³⁹
- Case-based reasoning — a generic approach to problem solving developed by researchers in the field of Artificial Intelligence.⁴⁰ Problems are solved by adapting the solutions to similar, previously solved problems. In the domain of clinical IR, this would involve storing and using feedback on the relevance of documents to previous queries similar to the current query. (Case-based reasoning for IR has been used with some success in the domain of law.⁴¹)
- Automatic query construction — in which information from an electronic medical record is used to construct the query, partially or fully automatically. Approaches include interactive user selection of terms, automatic recognition of MeSH index terms in the text of medical records, and developing generic queries that can be started up with terms from the record.⁴²
- Search by navigation — rather than construct a query, it is possible to search for information by traversing a network of links between information items. Fixed links may be organised either in a hierarchical menu structure or more generally as hypertext; both very familiar to users of the World Wide Web. Links may be also be created dynamically as the user's information need evolves.⁴³ Finally, links may be implied by visual metaphors.^{44,45}

There are technical and organisational reasons why none of these approaches used individually are likely to solve the prob-

lem of IR at the point of care. However, we suggest that a combination of strategies might provide a workable solution.

Consider the following scenario. Suppose that the Royal College of General Practitioners manages an information 'mapping' initiative in which 500 volunteers each devotes 30 minutes per month to the creation and maintenance of an information 'map' for one of a set of clinical problems chosen by general practitioners. The volunteers do not generate information but, rather, identify and arrange items of information so that they can be presented in a rapidly browsable manner to colleagues whenever the problem situation arises. Hypercholesterolaemia is entered into the problem list of the computerised medical record system, either manually or automatically, when the laboratory result is acquired. Without any further effort on the part of the clinician, the information 'map' for hypercholesterolaemia is retrieved and passed to a browsing module. The 'map' contains two short textbook passages with added hypertext links, a clinical guideline, relevant drug dosage details, and the abstracts of three scientific articles, all arranged in a manner designed for rapid navigation. The abstracts are passed to a search by a query (automatic) module, which searches MEDLINE for articles that appear to be similar to those already known to be relevant to this condition and published since the 'map' was last modified. If the clinician indicates that one of these newly found articles is relevant, this feedback is stored for future use and also an email message can be sent automatically to the 'map' maintainer. The key point is the clinician's control of the use of information. Reference information is offered by IR; only those clinicians who need that information need use it. Typically, in a period of about 20 seconds, the clinician might scan seven or eight titles, and (i) recognise that they are already familiar with the content of two or three documents; (ii) decide that two or three documents are not appropriate for this particular case; (iii) mark one document to be read at the end of the day; (iv) print one document to give to the patient; (v) decide to spend a further 30 seconds reading part of one of the documents (perhaps the bullet points of a clinical guideline).

If no suitable 'map' exists, previous encounters by other clinicians with this condition are reviewed, so that any feedback on documents noted as relevant can be exploited.

Note that, in this scenario, apart from browsing the retrieved information and giving occasional feedback, IR requires no effort or skill on the part of the clinician. (Entering the problem in the computerised medical record, if done manually, would be necessary whether or not it is used to initiate IR.)

The problem of assimilation

Most currently available documents are designed for research or educational use, not for use at the point of care. For example, although excellent clinical guidelines can be accessed via the World Wide Web from SIGN,⁴⁶ each one may be 40 or more pages long. Even the summaries may be too long to read during a five- to 10-minute GP consultation. However, the effort required to adapt documents for use at the point of care might not be great. For example, many journal articles, particularly those in secondary journals aimed at evidence-based medicine, are presented with short structured abstracts. Though the full text of clinical guidelines may be many pages, these documents are inherently structured. It would not be difficult for the authors to produce a hypertext version suitable for rapid browsing on a computer monitor.⁴⁷ Indeed, if clinical guidelines were written using XML, summaries and hypertext versions could be generated automatically. (EXtensible Mark-up Language is a new, industry standard format for describing the logical structure of

documents.⁴⁸ We predict that it will have a major impact on medical information processing, being used both for patient records and for reference material.)

Another assimilation problem is the validity and reliability of the sources found. Work is under way to create a practical, valid, and reliable method of rating.⁴⁹

The problem of cost

In the current financial circumstances of the NHS, the affordability of IR at the point of care must be questioned.

In practice, the costs incurred might be surprisingly low, because much of the expenditure on infrastructure will be justified by other functionality. That is, point of care computer devices, electronic medical record systems, high bandwidth networks, and powerful data servers will be seen as essential to the basic data processing requirements of health care and will be installed for that reason, irrespective of their capacity to support clinical decision-making with reference information. Work towards the provision of Internet access for all Scottish general practitioners is already complete.⁵⁰ Therefore, the additional cost that would be incurred in the implementation of IR facilities is limited to that involved in licensing and adapting appropriate documents, and developing suitable retrieval software.

Once implemented, IR at the point of care might reduce NHS costs through avoidance of inappropriate investigations or treatments, rationalisation of prescribing, and optimisation of resource usage.

Conclusion

Information retrieval is a general approach to providing an appropriate form of decision support for clinicians. While with other approaches there is a danger that the patient and GP may be relegated to a somewhat passive role in decision-making, IR educates and empowers both patient and doctor. Some of the attractions of IR are that there is no requirement for teams of engineers, expensive dedicated hardware, or a constant availability of human consultants. IR also offers great flexibility in the nature of information that can be presented and in the updating of that information. To ensure quality, professional bodies with an interest or responsibility in high standards of care could contribute to the key task of assessing evidence.

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