Building the Computer-Based Patient Record

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Have you ever tried to find something in a patient record? Have you struggled to read someone's illegible handwriting, spent precious time tracking down the one copy in the entire hospital of a patient's chart, or navigated through hundreds of pages looking for the answer to a simple question? These common experiences illustrate some of the problems with today's paper-based patient records.

Computerization of the patient record offers solutions to these problems, along with the opportunity to expand the patient record to perform important new functions.[1] Computer-based patient records can coordinate patient information with medical knowledge to support clinical decision making, for example to alert clinicians to adverse drug reactions.[2] Also, computer-based records can make patient information available for broader decisions about health policy and hospital management.

Much important work has already been done to develop computer-based patient records[1,3]; however, many research challenges remain before we can produce systems that are complete, flexible, and practical.[4] We must develop models of the medical record, models of medical information (including controlled vocabularies to express medical concepts), protocols for data interchange, and user interfaces for presenting and acquiring information.

Models of Medical Records.—It is important to consider at the outset of a discussion of the patient record what the patient record actually is. Is it a diary of observations, a database of facts, or a record of conversations between health care providers? More than an idle theoretical concern, the high-level conceptual model of the record determines what patient information should sensibly be recorded in it. For example, it would not make sense to put two conflicting diagnoses of a patient's illness in a record intended to state *what is true* about that patient; however, such conflicting observations would make sense in a record that describes *what was said* about the patient.[5,6]

Models of Medical Information.—Medical information is complex and heterogeneous. A typical patient's record might be expected to contain everything from her home telephone number to an image of her last mammogram, from physician orders requesting diagnostic tests and procedures to a chronicle of the management of her diabetes and hypertension. The challenge is to represent this wealth of information in a structured way so that both human and computer users can make sense of it.

For some types of patient data the representation is fairly straightforward—a phone number is a phone number, and there are standard ways of encoding images as collections of bytes. But simple data types and coding schemes are not expressive enough to capture many clinical concepts. The natural language of our written and spoken notes provides great expressiveness, but also allows ambiguity, inconsistency, and imprecision; a more structured representation language is required.

A richly structured representation language for medical concepts needs several components. Foremost among these is a *controlled vocabulary* of terms, so that words can be used consistently to identify specific concepts: a serum sodium measurement should be called the same thing regardless of which clinical laboratory reports it. A representation scheme should also specify how its terms are organized and how they can reasonably be combined with one another. These components allow the expression of complex ideas, yet restrict what can be said to sensible and precise medical concepts.[7]

Protocols for Data Interchange.—Models of the medical record and of medical information describe *what* the patient record can contain. In our diverse computing environments, it is also necessary to specify *how* patient data can be communicated between different computers. Low-level protocols for data communication can be defined independently of the data that are communicated. For example, the Health Level Seven data-exchange protocol makes no assumptions about the contents of the messages that are transferred or the terms used to encode those contents.[8]

User Interfaces.—Just as it is important that computers be able to exchange medical data with one another, it is critical that they be able to present medical information to human users in ways that are understandable and helpful. Anyone who has seen the overwhelming display of data from devices in an intensive care unit, or struggled to use an arcane computer operating system, knows the importance of good interface design. Two examples of information design for medicine are graphic metaphors to display respiratory ICU data, and graphic summaries of patient status to overlay the patient chart.[9,10]

In conclusion, medical informatics researchers continue to study the nature of medical records, medical information, data interchange, and user interfaces to provide sound foundations for building powerful computer-based patient record systems.

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