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# Synopsis

# *Computer-based Patient Records*

## Introduction

Medical records continue to be at the centre of developments in Medical Informatics. Standards bodies struggle with definitions and interchange standards; controlled vocabularies and terminologies continue to be sources of both controversy and research issues; how best for clinicians to interact with medical record systems remains a central issue; commercial vendors are increasingly offering "clinical workstations", but few yet support anything like the richness of a complete medical record.

Underlying all this activity are two questions:

1. To what extent it is practical -or even possible- to capture, represent and present electronically the information now contained in manual records;
2. What is the value -in improved health care or cost savings- of so doing and what are the potential disadvantages and hazards.

If we focus more narrowly on the technical problems, we might analyse the issues to be faced into a six-stage sequence:

1. Capturing the information;
2. Representing the information;
3. Sharing the information;
4. Presenting the information;
5. Evaluating the process of managing information;
6. Evaluating the outcome on patient care.

To this linear progression through stages we must add four additional issues which are nearly orthogonal to it:

1. Fitting into the social and organizational context of care;
2. Being sensitive to patients' reactions and concerns;
3. Exploiting the possibilities of the technology and coping with its limitations;
4. Integrating into the broader technological framework of health care information systems and standards.

Any given study -any given research program- can deal with only a limited number of these issues. Studies of medical records *per se* tend to concentrate on the core issues of capturing and representing information and evaluating the quality of the information and the acceptability of the process.

## Structured Data Entry and the Computer in the Examination Room

The papers by Moorman [1], Hammer [2], Kalra [3], and Solomon [4] all deal with data capture and its evaluation. Between the four studies, six major criteria were used for evaluation: completeness, accuracy/consensus, availability, speed, user acceptability, and patient acceptability.

Solomon's paper is unique in discussing the issues of patient acceptability which is still a worry to many doctors. Despite the study's admitted limitations, it is gratifying to find further data suggesting that patients are not disturbed by the use of computers during the consultation. Solomon considers a number of different areas in which use of a computer might be expected to disrupt the physician-patient interaction and finds no support for any of them.

The other three papers deal with structured data-entry systems for direct use by clinicians. (Studies of the use of natural language for data capture, e.g., [5, 6], are not included in this section.) Moorman's study is an evaluation of a system whose technical description was published last year [7]. The other two papers combine technical description and evaluation. Each is of a slightly different task - Kalra's paper formally concerns an "integrated assessment system" rather than "medical records" - illustrating the difficulties of drawing the boundaries between which studies constitute "Medical Records" and which decision support or some other topic.

Hammer's and Kalra's studies concentrate on speed, acceptability and completeness, while Moorman's concentrates more on coverage. Interestingly, speed of use is now so widely accepted as a key aspect of user acceptability that it is often reported separately from other factors. Both Hammer and Kalra found the systems faster than the alternatives and well accepted. Hammer, in particular, emphasises the potential incidental benefits of the system: improved access to the literature and to definitions for coding using DSM-IV. It is also worth pointing out

that the decision-support systems cited were passive rather than active; the ability to access definitions and summaries of past experience rather than to obtain direct advice.

Kalra's study is also noteworthy for its use of a portable pen-based system. Many of us have long thought that pen-based computing would have important consequences for clinical use. Even without touch screens, the easy availability of portable computers has changed the practical considerations for introducing electronic patient records to situations where physicians are mobile and go to patients rather than remaining in a consulting room where patients come to them. However, touch-screen hardware has often proved disappointing. It is to be hoped that the absence of any discussion of hardware issues in Kalra's paper means that the hardware is finally proving satisfactory.

## Studies of the Coverage of Compositional Representations

Both Kalra's and Hammer's studies were performed in the context of a well-defined target for data collection, the international classification of psychiatric disorders DSM -IV for Kalra, and a series of measures of impairment and morbidity for stroke for Hammer. Both might be regarded as special situations in which the line between "medical record" in the usual sense and "diagnostic" or "psychometric" instrument is blurred.

Moorman's paper, by contrast, is an attempt to study more usual routine medical records, albeit in the restricted context of reporting the results of endoscopic studies. It concentrates on completeness and coverage, and takes as its starting point the natural-language reports written independently of the computer. Furthermore, it deals with a compositional formalism rather than the atomic coding schemes used in the other studies in this group and, hence, it has greater ambitions in what it seeks to represent. In this respect the Moorman study is closer to our own study using the GALEN and PEN&PAD formalisms [8] (see below).

Several points from Moorman's study are worth noting. Unsurprisingly, there is greater consensus among the physicians when reporting using the structured reports than when reporting using free text, as indicated by the greater number of endoscopists describing each feature in the structured reports. This is useful confirmation of our intuition that, given a fixed structure which constrains and cues the physician, physicians record information more consistently than when writing in free text guided only by a largely unwritten framework. Note also that in the free-text reports, "unclear" feature descriptions accounted for nearly 10% of the total. Our own experience suggests this is relatively low and may reflect the fact that endoscopy is already a highly constrained domain. Overall, the evidence is accumulating that structured data entry improves consistency and consensus in data capturing, although worries remain about its expressiveness. Worries also remain that phycians may be forced to distort information by entering it in inappropriate categories.

The other side of the issue is to determine what information is lost in structured data entry; what information could not be recorded. Moorman's paper gives some indications. Most information was recorded successfully. Of the rest, roughly half required only simple additions to the underlying model.

The fact that only minor additions were needed to accommodate new information leaves open the question which a brief study cannot answer, namely how would the rate at which simple additions were required decrease over a long period of use? Would the rate of new additions ever fall near zero? Experience in the natural language community suggests that the requirement for new lexical items declines rapidly initially and then remains relatively constant. Whether or not this is true for structured representations such as Moorman's or GALEN's remains to be seen.

Moorman raised two quite different considerations. Firstly, there is the issue of what should be considered "inherent" in a concept, e.g., since erosions are, by definition, superficial is the phrase "superficial erosion" therefore redundant? (This issue is also a central focus of GALEN's concerns with normalisation of concept representations and bridging levels of granularity [9].) These issues require the ability to manipulate the logical structure of definitions and descriptions. The second issue is that of alternative coordinate systems and units as illustrated by the request of some endoscopists to use "hours" on a clock face rather than the anatomical descriptors "left", "right", "front", and "back". Such problems require not just the ability to cope with descriptions but also the ability to perform various calculations and transformations.

Our own study[1] [8] was part of a workshop exercise organised by the CANON group [10] which gave rise to a number of other studies and commentaries [11-14], some of which appeared in last year's Yearbook. It dates from an early stage in the development of GALEN. Like Moorman's study it concentrates on coverage of a compositional formalism by comparison with naturally occurring free-text records. By contrast to Moorman's study, it attempted to construct the complete theoretical representation rather than constraining itself to what could be entered by a particular structured data-entry system.

In so doing, it raises two groups of

further issues. Firstly, there are issues of the expressiveness of the formalism itself. These include the representation of negative findings such as "absence" or "without", the handling of temporal relations and references to previous (or subsequent) events within the record, the representation of uncertainty, and how (or whether) to distinguish between observed manifestation and the inferred condition of the patient, e.g., between the "opacity" on a radiographic film and the "atelectasis" in the patient's lungs. Approaches to each of these issues is presented, but none can be considered definitive.

Furthermore, each issue dealt with adds to the complexity of the representation. Often the additions add global complexity even though they arise relatively rarely. For example, to deal with the possibility of negative findings using the form "absence *which* isStateOf...", an extra level must be included in all findings which is usually the seemingly redundant wrapping "presence *which* isStateOf... " (Note that while an implementation might choose only to store the "absences" and assume the "presences", the formal mechanism must have both if it is to be consistent and avoid anomalies such as retrieving an "absent ulcer" as a kind of "ulcer disease".

The second set of issues are those of implementation and appropriateness. Despite the emergence of object-oriented data-bases, most medical records continue to be implemented on relational databases which require predefined fixed structures. Descriptive formalisms such as Moorman's or GALEN's fit such systems poorly. Either they must be constrained to limit the depth and length of expressions, or special mechanisms must be developed. The emerging CEN standards on medical records represent one attempt to provide a modest restriction while allowing expressivity which is believed adequate for most purposes; GEHR [15] represents another related such effort. GALEN's approach of a terminology server [16] represents an alternative approach of encapsulating descriptive complexity so as to hide it from relational systems.

The broader issue of how much complexity it is worth implementing can only be answered over more time with experience than is covered in these papers. Those of us advocating more complex systems must show that we can produce applications with them which would not have been possible without.

## Presenting Information

The final paper in this Section, by Goldschmidt [17], reports a novel means of presenting the information in medical records, specifically the laboratory findings and functional test results. Goldschmidt's technique attempts to present information in a way which makes effective use of clinicians' visual pattern recognition. The information is presented in a circular array in which different patterns of anomalies give rise to strikingly different shapes. Like the first of the Moorman papers last year, it presents the technique but does not provide an evaluation of its practical use. Of particular interest in this case will be information on the training and experience required to learn to recognise the patterns generated. We await such further evaluations with interest.

In the mean time, the most important aspect of the paper may be that it breaks new ground with a radically different means of presenting information, which could only be possible with computers. To date, most presentations are extensions of how we present information in manual records. There is no reason to believe that these techniques, despite their familiarity, will be the most effective possible. The use of computers presents opportunities for radical new presentations using shape, colour, three dimensions both in abstract forms such as presented here and in more representational pictorial, diagrammatic or iconic forms. Some will turn out to be "just pretty pictures". Others may give physicians a much more powerful way of apprehending patient information quickly.

## Conclusion

Data capture, representation and presentation are each moving forward. It is becoming clear that physicians will use structured data entry if it can be made convenient, quick and available, at least in certain situations. It also seems likely that if physicians do use more structured methods, they will record data more consistently and with less ambiguity than otherwise. The price is that some things may not be able to be said or may require supplementary free text or dictation.

What is also clear is that complete representation of the clinical notes with their full complexity of time, uncertainty, evidence, causality, etc., is a difficult task which will take time and tax the capabilities of existing data-management systems. A balance of immediate application, long-term development, and careful construction of migration pathways from existing to new systems will be required before the potential of electronic health care records is achieved.

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**Acknowledgement:** [1] I am grateful to be asked to summarise this year's papers, but reticent about the fact that one of our own studies is included. Readers should be aware that I can claim greater knowledge but must admit to less objectivity with respect to that work than would an independent reviewer.

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