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Synopsis

Computer-Based Patient Records

Introduction

Computer-based Patient Records (CPR) still represent a wager for today's computer science. In fact, CPR has to face a vast quantity of difficulties, each of them being sufficient to define huge problems:

- a variety of histories of individual patients, with inherent difficulties to "encode" them into predefined schemes;
- a variety of document types within paper medical records (texts, numbers, structured or unstructured, images, notes, handwritten or typed, graphics), and even in verbal form (exchanged by telephone or around shift reports) never transcribed in paper form;
- a variety of vocabularies used, mostly based on local use and habits, and rarely explicitly defined;
- a variety of "vocabulary-cultures", each user having a particular experience with a term (e.g. "malaria" is associated with a rare or frequent concept depending on the geographical location of the physician - "pleural puncture" may be conceptually associated with a harmful or a benign procedure depending on physician experience and on technical environment);
- a variety of vocabulary needs ("anterior myocardial infarction" may be too specific for a dermatologist but much too coarse for a cardiology specialist);
- a variety of actors (physicians, nurses, other care providers, patients, radiology or laboratory machines, insurance companies, etc.),
- a variety of objectives for the medical record (memory of the patient's state and medical actions, report of communication between physician and specialists, summary made for transfer of responsibility for a patient (shift or discharge or transfer), medico-legal objective, cost - control studies, etc);
- a variety of temporal structures (interval as in hospital stay or successive punctual consultation as in outpatient with inherent difficulty to clearly define beginnings and ends); and
- difficulty in describing the output of the health care or the patient outcome, which can be described using negative items (disease, illness or impairment of a vital or physiological function, handicaps) or through positive items (quantity or quality of life, ability to work or to perform activities of daily living), all being deeply related to time, absolute or relative.

There is a clear need to build a consensus, a general representation model of both patient record representation and underlying medical knowledge. The papers by Moorman, Campbell and Powsner illustrate this need [1,2,3]. Henry [4] has the same approach, but focused on the nursing aspect of CPR. Frisse [5] gives a most interesting and quite different approach to the medical record and proposes a CPR essentially based on exchange and communication (including the notion of emergency). Tierney [6] focuses on physicians' opinions while directly working with computers in their daily practice, underlining time of data-entry as a key factor, especially for senior physicians. Ornstein [7] and Ridsdale [8] studied patients' views on these computers, showing that there is a generally positive attitude, with some reservations about security and confidentiality. Kluge [9] evokes ethical aspects of CPR.

Data entry

Moorman [1] focused on data entry. Given the fact that only structured data can ultimately be treated by computers, two main methods may be distinguished, as noted in Moorman's paper. The first method is the extraction of structured data from free text with natural-language-processing (NLP) techniques, and the second is direct entry of data in a structured format, structured data entry (SDE). This paper promotes SDE by identifying "Descriptional Knowledge" (DK) as a means for improving acceptability of the system by physicians. Acceptability will be enhanced if physicians do not lose valuable time by entering unnecessary information, and when trivial matters can be deduced by the system itself. Such "intelligent" structured data entry can only be achieved when based

on knowledge about the scope and meaning of the information that is to be captured. For example, one physician may describe a cardiac murmur by its loudness, location of maximal loudness, and the phase of the heart-cycle in which it occurred. Descriptive knowledge should enable the identification of terms that physicians are likely to use in the description of a given term.

DK is represented by Sowa's conceptual graphs with entities and relations. Concepts and relations form a semantic network. In terms of patient data representation, a concept is considered as unambiguous when it explicitly shows which of the possible paths applies; the whole path of selected findings will represent a finding. For example, "physical examination - examination heart - auscultation heart - murmur - loudness - grade II". The full context is thus included in the patient data representation. Normal findings are distinguished from absent data. The system presently functions as a stand-alone prototype. An evaluation using the endoscopy DK is the next step scheduled.

Representation of Patient Data

Campbell [2] states, like Moorman, that the collection of clinical data is expensive and time-consuming. Any analysis requiring new data elements consumes significant resources to develop a sampling plan for the data, to develop data-collection instruments, to train data abstracters, to collect the data, and to analyze the data. Today, there is no existing standard capable of representing the detailed clinical data contained within histories and physical examinations, progress notes and discharge summaries. The paper describes a model for how these clinical data (including their temporal dimensions) might be represented. The approach is to add a logical foundation to existing medical terminologies. Campbell starts from Aristotle, with his theory of categories, who developed a method for defining new types within the type hierarchy by genus (the category of classification for a term) and differentia (the elements, features, or factors that distinguish one term from another). Sowa's conceptual graphs are also used to represent Logical Foundation (LF) with concept and relation nodes.

Campbell then describes "canonical graphs" able to be treated by operations such as "copy", "restrict", "simplify" and "join". After giving an example of a radiology report described in LF and canonical graphs, the paper shows an example of "Canonical-Graph Derivation", where a combination of operations is applied to finally give an impressive synthetic and relevant graph of the report. Time is also represented by interval-based information, allowing the representation of intervals and uncertain dates. Campbell proposes a model to enhance SNOMED by conceptual graphs, to provide a syntax to combine the terms into a statement, in order to explicitly add relations; for example to "pleural effusion", a functional relation with "effusion - accumulation of fluid" and a topographic relation with "pleura - respiratory system".

Powsner's approach [3] is to design a graphical summary of patient status, showing at one glance on one page the whole patient's disease history, focusing on recent events. Stating that patient records are bulky, difficult to file, hard to retrieve and often illegible, Powsner fears that the acronym for the medical record might well be WORN (write once read never). He proposes a very elegant graphical representation of each type of data within the same format, including lab results, medication and even clinical findings and psychiatric status. In a similar format normal, abnormal and extremely abnormal data are represented throughout many years with a focus on the most recent days. Text is then added providing the most recent progress notes signed by the author's initials and professional degree. Even images may join this one-page summary. One of the intentions is to clearly assess relations between findings and treatments, allowing for the consideration of alternative diagnostic and management strategies.

Henry et al. [4] raises the question "can SNOMED III represent nursing concepts in the patient record?". Henry's paper begins with an overview of six nursing classifications (including NANDA, North American Nursing Diagnosis Association Taxonomy) and 6 general classification schemes. Current emphasis on outcome classification is then discussed which includes notions on quality of life and patient satisfaction, beyond traditional outcome measures such as mortality, length of stay, costs, hospital readmission and "what went wrong" (e.g. nosocomial infection and patient falls). Eight studies are then reviewed that evaluated the adequacy of standardized classification schemes to represent clinical data. This review concludes that while specific vocabulary served the purpose for which it was designed, no single vocabulary or unifying scheme was adequate to represent the broad array of clinical data in the patient record.

A study of 485 consultations for 201 patients hospitalized for Pneumocystis carinii pneumonia is then described. Patient problems were obtained from two verbal sources (nurse short interview and intershift report) and two written sources (nursing care plan and progress notes flowsheet). Of the overall 4,262 problems recorded, 56% were related to the main pulmonary problem, and the

remaining 44% fell into AIDS-related problems, problems related to psychosocial concerns and problems related to lack of knowledge. NANDA diagnoses were used more frequently in the written data sources; in the verbal sources of data, the type of term used most frequently was sign/symptoms. To test the feasibility of using SNOMED to represent data, a subset of the 25 most frequent nursing terms representing 53% of the written problems has been extracted. Overall, 69% of these terms were matched by using one or more SNOMED III codes. In conclusion, Henry states that SNOMED III with the inclusion of NANDA diagnoses has the potential to represent more nursing concepts than the NANDA terms alone, and the nursing profession must also test the feasibility of using other existing vocabularies to represent nursing concepts.

Frisse [5] first says that "the frantic pace of change in health care has created a growing tension between the need for far more sophisticated patient-record systems and the necessity for greater deliberation and reflection on just how these systems should be created". He describes two historical processes of the medical record. The first one created, approximately a decade ago, a need to unite the clinical information obtained from the hospital record with the financial consequences of the care provided. The second one created longitudinal records of the care of ambulatory patients, leading to a single, lifetime medical record for each patient that then serves as an archival record of all care provided to an individual and of the financial impact of this care. He then discusses the five forms of the patient record: (i) the record as a set of personal notebooks of those providing care, resembling a diary or monologue more than a communication vehicle, (ii) medical records as a database, defined as a collection of discrete, ordered, typed elements stored in a uniform way and retrieved using a formal query language, (iii) the problem-based patient record, based on the work of Weed, (iv) the patient record as an artefact of conversation, based on the fact that in health care as in other rapidly changing sectors, the need for recognizing and modeling the concerted actions of a widely diverse group of individuals sharing little common knowledge becomes all the more acute, (v) and a decision-based patient record, a hypothetical construction based on previous models. Frisse ends his paper with, "The challenges of the era require all parties involved in the clinical record to move rapidly, but not so rapidly that they forget that the health care of each of us will, over time, be entrusted to what we have created."

Physicians and the CPR

Tierney [6] studied opinions of physicians while using workstations for writing inpatient orders. He first states that "patients whose physicians used the workstations had hospital bills that were almost $900 (13%) lower and were discharged almost a day earlier than patients whose physicians wrote orders in paper charts". The study was performed on the inpatient medicine service of Wishard Memorial Hospital, where a comprehensive CPR has been in use for more than 20 years, and where the display of patient-specific information to physicians has shown increased preventive care and reduced outpatient costs. During 16 months, 275 medical students and housestaff participated in the study (106 junior medical students, 28 senior medical students, 36 interns and 32 residents). Opinions were generally positive. Those of junior students were the most positive with opinions declining progressively for senior students, interns and residents. This trend was independent of computer literacy. Students appreciate the information provided by the workstations and were the least critical of the amount of learning time required. The majority of both groups agreed that using the workstations made their work more accurate and more interesting. The discussion reports that as the student and housestaff move through the socialization process, they become more set in their ways and more constrained by time, making them less open to innovative approaches to health care delivery. Time constraints thus appear to be a major factor.

Patients and the CPR

Two papers speak about the patient's view, how the patient is personally affected by computer-based patient records. Both papers express the same generally positive view, i.e. patients in general have a positive attitude toward CPR. Ornstein [7] describes a small survey of 16 patients seen at the family medicine department at the Medical University of South Carolina.

Quoted advantages are easy access to information, which appears to be a major element; saving time for the physician, the patient and the staff; use of state-of-the-art technology; durability of electronic records, better organization of the record, decreased paperwork and storage space.

Security and confidentiality appear to constitute the major disadvantages of CPR to patients. One patient complained that another patient with a similar name had been inadvertently filed in her record; another noted that her physician became frustrated when the system malfunctioned: "... and the computer completely dumped the physician out of the system and he had to start all over and he was aggravated". Several patients mentioned that they did not want their records widely ac-

cessible. But most patients had confidence that mechanisms were in place to protect the confidentiality of their records. Most important, CPR does not seem to change the relationship with their physician. "It was just a tool used just like his tongue depressor or to look in my ear".

Interesting also are patients' ideas for enhancements to the CPR, including diagnostic decision support aids; prompts to follow up abnormal findings; and the ability to provide dietary and other health education advice, thus saving the physician's time.

Ridsdale [8] studied 30 patients in the context of a suburban practice South of London. Overall quoted advantages are the same as in Ornstein's paper. Disadvantages are described in more detail. Fear of loss of confidentiality was mentioned as the main disadvantage. Two thirds of the patients thought medical records were vulnerable to gossip, blackmail, insurance companies and future employers, especially for cases of mental illness or HIV infection. Some patients believed that if a lack of confidentiality occurred this could result in a breakdown in the doctor-patient relationship.

CPR does not seem to change the relationship with their physician. Most patients considered there to be no difference between the doctor typing during the consultation or writing up notes in their presence, as long as verbal skills and eye contact were maintained.

In summary, computers were viewed by most patients as an efficient tool providing quick access to medical histories and savings in the doctor's time. The doctors use of a computer was equated with progress and modern methods of treating illness and disease.

Ethics

Kluge [9] enlightens another aspect of CPR, namely ethics. He states that the medical record is going to completely change its status: "the electronic patient record is increasingly coming to assume a functional reality of its own that is independent of the patient", speaking of "reification" of the record. He raises the principle of Equality and Justice, saying that "all patient records must be treated the same way"; and in some cases, "patient records may be treated differentially if such special treatment is necessary in the treatment of equity". He also stresses problems of confidentiality, security and integrity of data: "when linkages [between patient data] are made, patients' identifiers should be removed as much as possible". He insists that "a balance must be struck between what society can do and what it should do".

Conclusion

CPR is confronted with numerous difficulties, as seen in the introduction and throughout these different papers. One may enlarge the debate about explicit goals and intentions, following Frisse on the "necessity for greater deliberation and reflection on just how these systems should be created". What do we expect from CPR? Is it to bring together the initial state of the patient and the result of the care procedures, as stressed by Powsner? Is it to provide a measure of the outcome, as emphasized by Henry? What do we expect from the Health Care System? Is it to provide the best quality of care on a basis of "Equity and Justice", as underlined by Kluge? To supply an answer, even partial, to these questions would indicate a direction for research on classification schemes, medi knowledge bases and other patient representation subsequently providin a validation tool able to measure if rea improvements are made.

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