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Synopsis

Computer-based Patient Records

Implemented, successful Computer-based Patient Records (CPRs) are still very rare, especially outside the area of primary care, despite years of hard work. The main reason is most certainly the lack of user involvement in the development phase and the resulting low acceptance by user groups of clinical physicians, nurses and paramedics. The other reasons constitute matter for discussion, but the issues of controlled vocabularies and the lack of well-structured terminology systems are of major consequence.

It is generally accepted that all patients should have CPRs, and that co-ordinated information for shared patient care should be collected at all points of care along the care chain comprising primary care, hospital clinics and labs, rehabilitation wards, and home care. The information should be able to trigger knowledge and guidelines in the same way that physicians make decisions, by using all available data about the patient simultaneously.

Moreover, both patient information and medical knowledge will increasingly come to be delivered electronically via the Web and related technologies. It will be filtered and relevant to particular patient situations, meaning that indexing and access to knowledge resources require co-ordination with patient care systems [2]. Several studies have also shown that paper records cannot adequately support the task of providing patient care in an efficient manner [6].

The seven papers that have been selected and included in the *Computer-based Patient Records* section are indirectly or directly related to the heading of this section. They can be roughly grouped into three subsections: 1. Terminology issues, 2. Methodology, 3. Implementations and usage.

1. Terminology issues

In their article, de Keizer and Abu-Hanna describe [1] the application of conceptual/descriptive and formal representations to handle and better understand terminological systems. Their representation formalism is also designed to support communication between, for example, domain experts and engineers working with the terminological system.

The authors maintain that a terminological system should enable the use of attributes to define or further specify concepts. Relationships between concepts should be explicitly represented by a label designating the meaning of the relationship, along with constraints to restrict the interpretation of the relationship. Other criteria are domain completeness, the ability to handle synonyms and multi-lingual terms, multiple classifications (Is_a, Is_part_of relations), and cross-mapping e. g. between ICD and other (local) systems.

They report their experiences by using the representation formalisms for comparing the structure of five well-known terminological systems with given criteria, namely ICD, NHS Clinical Terms (Read code), SNOMED, UMLS, and GALEN [8] .

The authors found that the NHS Clinical Terms, SNOMED and the UMLS seemed to do better on most criteria, but composition rules and formal definitions were missing or premature. GALEN and SNOMED RT [9] aim to address this deficiency, but they are not yet in routine use.

They conclude that a precise understanding of the structure of a terminological system is essential in order to assess and compare existing terminological systems, to recognize patterns in various systems, and to build new terminological systems.

The second article in this group, by Alan Rector [2] , is a thorough analysis of the requirements and obstacles involved in building terminology systems. The underlying presumption is that a terminology system is essential for building CPRs.

Alan Rector initiated and successfully led the European Community project GALEN [8] , which is an ambitious and promising work aimed at producing a formal semantic description for the entire medical domain. One of the ambitions and conclusions reached in this project was that great effort should be directed toward syntax and grammatical rules to guarantee sensibly composed concepts and, in a broader sense, to be able to "communicate meaning".

Rector looks to the past to analyze why it has been so difficult, despite all the hard work, to arrive at a re-useable terminological system that can satisfy developers of CPRs and their users. His paper highlights the reasons why it is difficult to develop such terminologies. He argues that they all stem from underestimating the great changes entailed in using terminology in software for 'patient centered' systems rather than for the traditional functions of statistical and financial reporting.

Rector initially notes that the complexity of building medical terminologies for CPRs, rather than satisfying the need for papers records, is enormous and exceeds what can be managed manually with the rigor required by software. Presentation and retrieval for clinical tasks must include validation of their use when they are implemented in software. He then elucidates ten reasons why clinical terminology for software is difficult, including the complexity of clinical pragmatics, the separation of language and concept, achieving an appropriate level of clinical consensus, and co-ordination with conventional coding in existing medical records and messaging.

Rector discusses these issues and their ramifications. He defines, clarifies, and formulates criteria for clinical terminology, thereby also pointing toward solutions for how to deal with different issues and with what priority. A clinical terminology should be understandable to human health care professionals in their own language, be usable and intuitive, and fit into the daily routine of health care professionals. At the same time, it should behave in a way that is rigorously predictable to software engineers and CPR developers.

Rector concludes that a medical terminology system must simultaneously solve problems in at least three primary disciplines: clinical linguistics, clinical pragmatics, and formal concept representation. He also discusses what the priorities should be. Should we simplify the problem to achieve the highest priorities? Should we apply more effort, combine efforts, and/or create or search for better management tools? Rector responds that simply applying more effort does not work. One approach, used by GALEN [8]and the SNOMED-RT project [9], is to obtain better tools.

A successful outcome of this would be, that clinical terminologies in software are not only used but also reused.

The third article in this subsection, by Gu et. al. [3], reports on a representation of the UMLS - The Unified Medical Language System - as an Object-Oriented Database (OODB). The purpose of this is to support the user's comprehension and navigation. The UMLS combines many well-established, authoritative medical informatics terminologies in a knowledge representation system, and is a very valuable resource for the health care community and industry. However, the UMLS is very large and complex and poses serious comprehension problems for users and maintenance personnel.

An Object-Oriented Database representation was designed and used to represent the two major components of the UMLS—the Metathesaurus and the Semantic Network—as a unified system.

The authors provide examples of how the intersection classes, which are defined as model concepts of multiple semantic types, help expose omissions of concepts, highlight errors in semantic classification types, and uncover ambiguities in the concepts of the UMLS. The resulting UMLS OODB schema has more depth and is more refined than the Semantic Network, since intersection classes are introduced. The Metathesaurus is classified into more mutually exclusive, uniform sets of concepts.

The authors conclude that the UMLS OODB schema they have developed supports the user's comprehension and navigation of the Metathesaurus. It also helps expose and resolve modeling problems in the UMLS.

2. Methodology

Although the papers mentioned so far also deal with technical issues, the fourth paper in this section is more clear-cut and concerns methodology for the development of CPRs.

Yamazaki and Satomura [4] have developed a Template Definition Language (TDL) to share knowledge about how to construct a Computer-based Patient Record template. A TDL is based on the extensible mark-up language (XML), and has been designed to be independent of CPR platforms or databases. The work was conducted by evaluating the descriptions of various currently available CPR templates and by comparing some computer-based clinical guidelines.

The authors favor capturing data in coded form, rather than as narrative text, to reach the desired beneficial effects of CPRs. They claim that structured data entry (SDE) is a more promising approach than natural language. The advantage of SDE over natural language is, the data capturing process can be influenced by implemented knowledge. Physicians can be stimulated to produce more complete records through online reminders and alerts.

They argue further that data entry with such templates best suited for restricted, well-defined medical sub domains with predictable patient-independent information patterns needs. When the required data are less predictable and more varied, these templates tend to make data entry cumbersome.

The authors focus on dynamic templates that can be changed according to the physician's action or patient data. As a means for implementing dynamic templates, they discuss the use of the Arden Syntax knowledge representation [10].

3. Implementations and Usage

As Medical Informatics is an applied discipline, proof of success should be demonstrated and validated in reported implementations and usage. In this subsection, three papers with quite different applications and aspects are included, all of which report positive results of using computer-based technology.

Vlug et al. [5] report on a study in which data requirements were assessed for post marketing drug surveillance studies in Computer-based Patient Records of Dutch general practitioners (GPs). Such studies encompass a variety of topics including the side effects of drugs, beneficial effects of drugs, and the prescription behavior of physicians.

It was found that additional software was required to collect data that is not recorded in routine practice. Therefore, they set up an organization to monitor the use of data and performed validation studies to test its quality.

To avoid having to obtain informed consent from each enrolled patient, the authors developed a semi-anonymous system where both patients and GPs were anonymous to the researchers. Under specific circumstances, the researcher can indirectly contact (through a trusted third party) the physician who made the data available. Only the GP is able to decode the identity of his own patients.

Validation studies showed, that with additional software to collect data not normally recorded in routine practice, data from electronic patient records of general practitioners could be used for post marketing drug surveillance.

In the second paper in this group, by Tang et al [6], the objective was to investigate whether using a Computer-based Patient Record (CPR) affects the completeness of documentation and appropriateness of documented clinical decisions.

A blind expert panel of four experienced internists evaluated 50 progress notes for patients with chronic diseases and whose physicians used either a CPR or a traditional paper record. The measurements used were completeness of the problem and the medication lists in the progress notes, allergies noted in the entire record, consideration of relevant patient factors in the progress note's diagnostic and treatment plans, and appropriateness of documented clinical decisions. The findings of the study were: The expert reviewers rated the problem lists and medication lists in the CPR progress notes as more complete than those in the paper record. The allergy lists in both records were similar. Compared with providers who used traditional paper records, providers using a CPR documented consideration of more relevant patient factors when making their decisions and seemed to document more appropriate clinical decisions.

This study shows that the CPR improves the completeness of patient documentation and that documented decisions are more appropriate when evaluated by an expert panel on the basis of information contained in the record. The authors maintain that an improvement in documentation is an improvement in clinical practice.

The last paper in this section, by Weatherburn and Bryan [7], concerns a dedicated picture archiving and communication system (PACS) which, in addition to imaging data, also includes patient data. A study was conducted to determine whether the doses for the radiographic examination of the lateral lumbar spine changed as a result of the introduction of a hospital-wide PACS. Doses were measured by thermo-luminescent dosimeters (TLD) and dose–area product (DAP) meter readings. Radiographic technique, exposure factors and patient characteristics were noted, effective doses were calculated, and a comparison was made of all variables. When summed doses for all images, including rejects, required to demonstrate the lateral lumbar spine for each patient were compared, PACS was found to be associated with a significantly lower surface entry dose than conventional film.

As a whole, the seven papers included in this section demonstrate important aspects of developing, implementing, using, validating and measuring effects of Computer-based Patient Records (CPRs). They reflect the present status, trends and opinions in the area.

Availability and use of controlled vocabularies is certainly one of the main prerequisites. Reading and reflecting on Rector's excellent and comprehensive paper will be of great help in this respect.

The final proof of whether a developed CPR or information system is valuable and successful is, of course, if it is being used, and, especially, if a positive effect on patient care can be demonstrated. The paper by Tang et al is therefore of great importance in showing that computer-based patient information may provide a basis for better patient related decisions. Also, the responsible physician should feel more comfortable with clinical decisions knowing that these decisions are well-grounded and documented.

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