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The PROMPT Electronic Health Care Record

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Abstract: This paper accompanies the demonstration at MIE'96 of PromptPR, a PC-based, multimedia, object-oriented electronic patient record system. It was developed (as EdithPR) at the Institut Bergonié, Bordeaux within the EC Health Telematics DILEMMA project (1992-5). Although built initially for use in the field of hospital cancer care, its general design will enable it to be used by all health care professionals working in different clinical specialties, to support a full range of clinical activities from recording, managing and displaying data to prescribing and managing patient careplans. This paper provides an overview of PromptPR, its functionality and architecture, and summarises a number of the activities which have been planned to evaluate its clinical impact.

Keywords: electronic patient records, computer-based patient records, object-oriented patient data, knowledge-bases, AI in medicine.

1. Introduction

Limitations of paper-based patient records have been well-documented in the literature, and the need for electronic patient records (EPRs) for clinical practice and administration has been well established [1]. The EPR is now 'perhaps the most widely used and appreciated computer-based decision support application in healthcare' [2], and is seen as the most viable future method for collecting and supplying patient data. It is widely held that the introduction of computer-based medical records into clinical care will significantly improve quality and efficiency of care [3].

The main goals of PromptPR are to facilitate medical record keeping and review by health professionals working on the same or on different sites; to improve the management of patients by providing support for (a) the co-ordination of patient care across care sectors and (b) clinical decision making and care based on guidelines and protocols.

The Medical Record Institute, Newton, USA [4] defines a scale for the classification of electronic medical records or computer-based patient record systems. The scale ranges from a limited system used simply to complement a paper-based medical record (e.g. to store test results) at level 1, to a complete shared electronic healthcare record capable of storing all relevant health information, clinical data, therapeutic data as well as behavioural activities data (e.g. smoking) at level 5. The current implementation of PromptPR can be placed between level 3 (it has been integrated with an existing information system in a hospital in

S.W. France) and level 4 (it is planned to become a central component of a regional cancer care network in 1997).

2. PromptPR: functionality

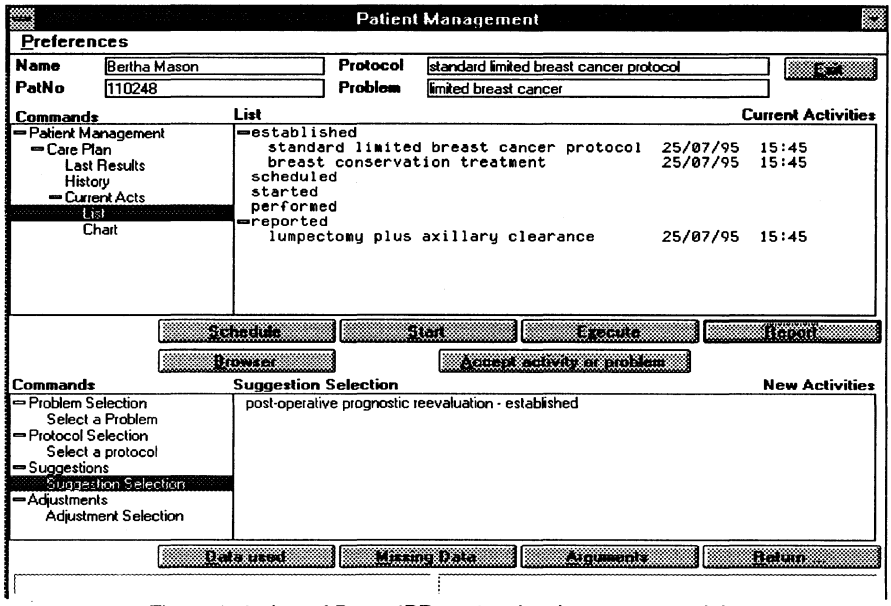

Figure 1: A view of PromptPR: protocol task manager module.
The two windows on the left provide the user with functions for information retrieval, data entry and care plan execution; the top right window summarises the current status of the therapy plan; the bottom right window provides 'aides mémoire' for recommended or required decisions and actions.

Features of the EPR include:

- Intelligent data retrieval, presentation display, browsing. Patient data entry either as free text or supported by structured forms. The forms use a common terminology to ensure compatibility with other integrated modules such as the decision support system.
- Functions to record the changing characteristics over time of patient data (e.g. the size of a tumour); the dynamic lifecycle of clinical processes (pathology, signs or symptoms); and the state of health care activities (guidelines, nursing care acts).
- Functions to support service order entry and workflow management; ordering tests and therapeutic procedures. The 'administrative data' necessary to organise health care teams are compliant with those specified by the CEN TC251 Activity Health Care Common Component [5].
- Support for protocol-directed care (figure 1) including advice on diagnosis, therapy selection and planning, prescribing, provision of prompts relating to medical acts to be carried out (alerts and reminders) e.g. data to be collected, adjustments to be made to dosages of prescribed medicines.
- Dynamically configurable views of individual patient care plans. The patient care plan can be configured to provide different views to meet the individual needs of different health professionals. The following have been implemented: time-oriented views (i.e. covering a

specific time period), problem-oriented views (e.g. all drugs, tests ordered, therapeutics actions, complications etc. linked with a specific patient problem) and task-oriented views (types of acts, such as nursing protocols, drug administration, or stages of acts such as 'scheduled', 'delayed', 'in progress').

3. Architecture

CEN TC251 WG1 provides a prestandard architecture for healthcare information systems (including a definition of standard health care component modules with a high level data model and services to be provided). The logical data model for clinical acts managed by PromptPR conforms to the UK NHS Common Basic Specification (CBS) [6] and ESPRIT-RICHE [7] models.

The structure of PromptPR conforms closely with recommendations published by CEN TC251 WG1 on EPR architectures [5]. Indeed, CEN TC251 itself follows the CBS model in part. If we compare PromptPR with the CEN TC251 prestandard, PromptPR has the equivalent of an independent Healthcare Common Component for the clinical concepts stored as a knowledge base, and unites the HCC-Health Datum (for clinical data management) and the HCC-Activity module (for patient care activities). By following CEN TC251 and the CBS models, we have been able to enhance and gradually improve PromptPR without compromising the functionality of existing clinical systems which have been integrated with it.

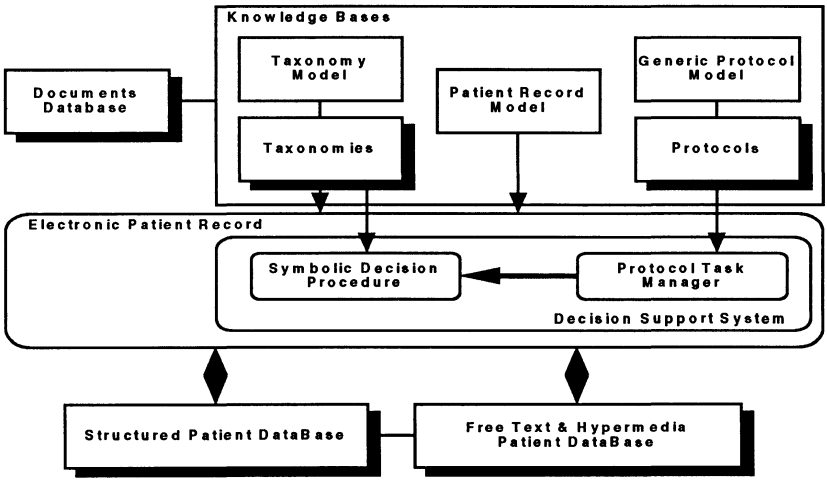

Figure 2 : Conceptual model of PromptPR

The structure of PromptPR is made up of three main layers (figure 2): i) medical domain models and knowledge, ii) the patient record application (including the decision support system) and iii) patient data. This modular approach allows the medical knowledge, expressed as declarative knowledge bases, to be kept completely separate from the patient data and the procedural routines which use that knowledge, with consequent advantages for maintenance and reuse.

The construction of the knowledge bases making up layer 1 of the EPR is constrained by well-defined knowledge models based on UMLS (Unified Medical Language System) [8] and the Common Basic Specification (CBS) [6]. Standard nomenclatures provide a unified

vocabulary for supporting the organisation of large modular, shareable, adaptable and maintainable medical knowledge bases, critical to improved communication and the quality of data collected by clinicians. The knowledge base models define the top level classes and their possible links in the taxonomy, the protocol knowledge bases and the patient data.

The EPR software application, constituting the second layer, provides such basic functionality as patient data capture and retrieval [9, 10], as well as decision support functions [11]. PromptPR integrates a protocol task manager dedicated to assist health professionals following a patient care protocol. This module uses a symbolic decision procedure developed by Huang et al [11] for decision making (covering including and excluding criteria, protocol adjustments, monitoring, detecting side effects, evaluating toxicity etcetera).

There are two types of patient data making up the third layer of PromptPR: unstructured (free text) and structured. Structured patient data can be used to provide decision support to health professionals in clinical tasks, and can include references to remote reports, hypermedia documents, images and URL addresses. This functionality allows PromptPR to act as a central store for all the information produced on individual patients entered into systems by health professionals at different hospital or primary care sites.

3.1. Technical approach: declarative and object-oriented techniques

The structure of all PromptPR patient data follows an object-oriented approach: it is based on the COSMOS/CBS entity-relationship model of the clinical care process. Medical knowledge bases are structured according to a class and sub-class hierarchy where relationships, attributes and their respective values may be inherited (multiple inheritance is supported for multi-axial taxonomies). The model constraining this structure is stored in a separate knowledge base. Each entity (e.g. tumour) relevant for a user to describe a patient's health can be described as a " class " in the medical domain knowledge base and is instantiated in the patient record as an " object " (e.g. the specific tumour of the patient X, located at Y, with a maximum diameter of Z mm...) with several states (current or past, present or absent). The initial entity details can be described (size, date of appearance), and changes in the characteristics of the entity or modifications in the state over time can be recorded.

A declarative approach has been adopted to represent medical concepts and their relationships. This complements the implementation of object-oriented patient data, and has also been crucial for such activities as the integration of the EPR with a hospital information system and a decision support system during the Dilemma project [12]. Data and knowledge entered via one module of the integrated system are available to, and can be utilised by, each of the others. Thus, for example, laboratory data entered via the hospital information system can be viewed by a doctor on the EPR, and can trigger the decision support system. The declarative and object oriented approach for representing patient data is used to manage changes of patient data over time, and facilitates integration with decision support in the form of complex processes like clinical protocols.

The declarative approach initially used for building the decision support system [11] has been used to implement clinical functions (data entry and browsing etc.) in the EPR. Main user screens have been implemented using Prolog-like tuples. This declarative approach also facilitates reconfiguration of screens to meet the specific needs of individual health professionals. In addition, patient data can be related by formal links, compliant with the patient record model knowledge base, so users can browse the data or obtain customised summaries of patient data. The dynamically generated patient data summaries or views which are provided are listed in section 2 above.

4. Evaluation Plans

PromptPR has been designed to form a central part of an integrated clinical workstation [13]. Within the PROMPT project, it will be integrated with 'CrossWay', a hospital information system, developed by ICSF SA, Bordeaux; in primary care it will also be integrated with information systems in France. PromptPR will be evaluated in a number of EC 4th Framework Health Telematics ACTION cluster projects, in particular CONQUEST (dealing with imaging in radiology), EUROPATH (dealing with imaging in pathology) and MACRO (dealing with remote data entry in clinical trials). The largest scale evaluation of PromptPR will take place in Aquitaine, South West France in 1997. Here, PromptPR will form a central part of a pilot regional health information network for cancer: the Aquitaine Health Information System (AQHIN). This network will be intended to decentralise, expand and improve the co-ordination and quality of continuing cancer care provided at regional and local levels. Within the network, PromptPR will be integrated with an EDIFACT compliant telecommunication module to enable Hospital and Primary care healthcare professionals to exchange data. The impact of PromptPR on the quality, co-ordination and cost of decentralised healthcare will be evaluated.

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