C3: Java-based Medical Record System for Cardiology

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Abstract. This paper describes a system for electronic medical record (EMR) we have developed for use in our health care institution, mainly dealing with diagnosis and treatment of cardiovascular pathologies. This activity is part of the project SPERIGEST, supported by Health Ministry of Italy, for the management of health care delivery, as concerns both clinical and administrative aspects. A networked computer-based information system was realized to integrate the different heterogeneous sources of patient information. Both clinical and administrative patient relevant data are provided from the various systems and stored into a central database. The EMR system was designed using World Wide Web (WWW) technology (Java, HTML). The system is currently under clinical evaluation.

1. Introduction

The information system, developed at our institute, is aimed at the integration of different architectures (both existing and new installations), applications and health care services. It integrates clinical, administration and management systems [1,2]. Administration is enabled to derive healthcare costs directly from data provided by clinical system. The outstanding feature of this system is the full data access allowing design of a comprehensive patient record and playback consultation for both patient care and clinical research. The core is the clinical information system (SIC-C), which integrates the different sources of information related to the single patient. Diagnostic units (e.g. Clinical Chemistry, ECG labs, Imaging labs) and cardiosurgery units have been integrated in the SIC-C. These units (called Functional Islands), which autonomously provide to local data processing and archiving, take care of storing structured patient reports into the database of SIC-C (ARCA) (Figure 1). Excerpts of signals and significant images are possibly added to these reports for better documentation of test findings or procedural results. Even though many patient data are provided in electronic form and stored automatically into the database, there still remains the need for health care personnel to enter manually much information (e.g., medical history, physical examination, reports of external tests). A viewer/editor of EMR was developed addressing friendliness and communication capability.

2. The Electronic Medical Record

All data of interest for medical record are stored in ARCA, the clinical repository of SIC-C (DB2 database) (Figure 1), either collected automatically from the functional islands or manually entered by health care personnel. Patient data are structured according to the
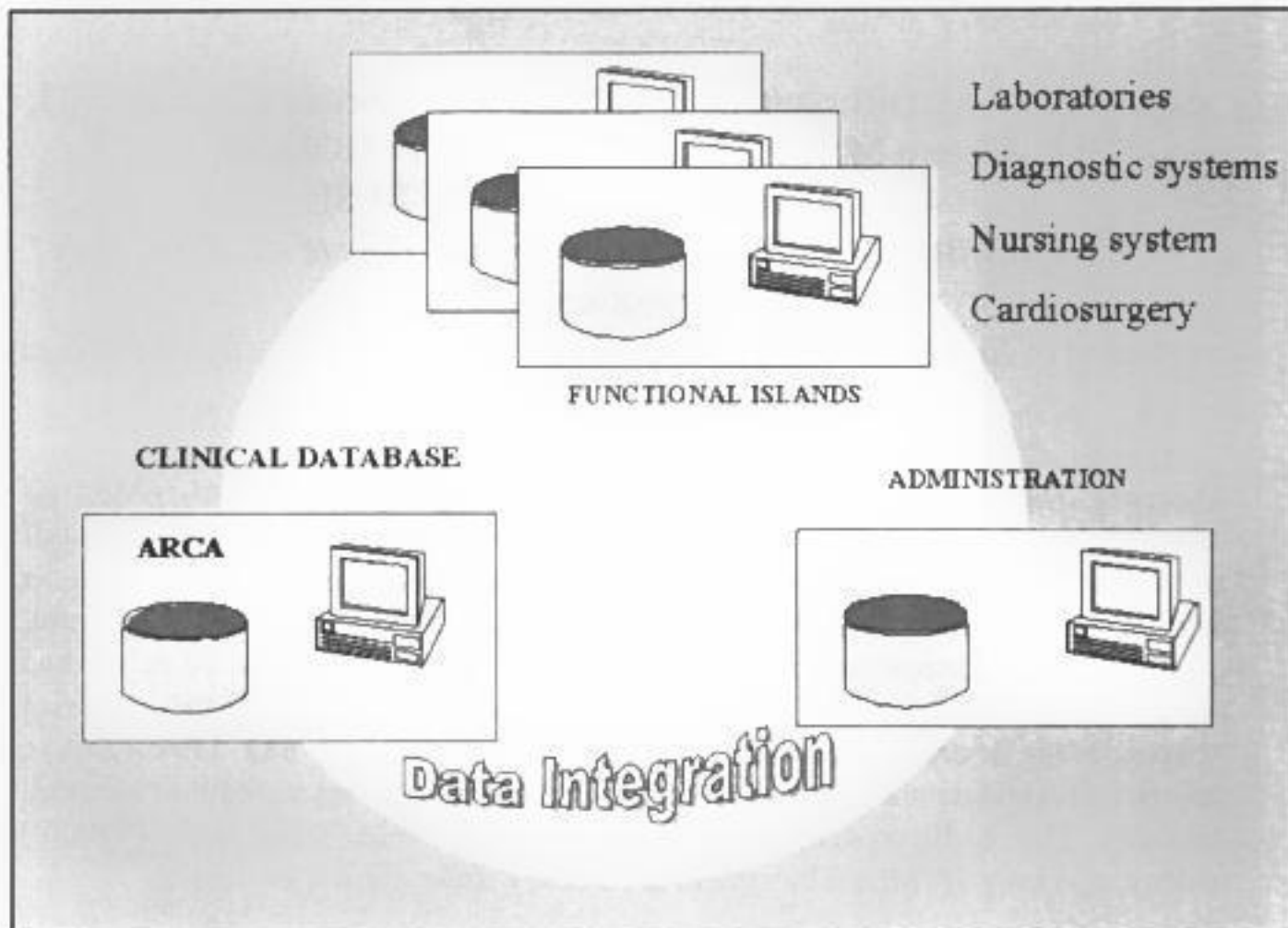

Figure 1 Integration of patient information (SIC-C)

specific aspects of information (i.e. demographic data, medical history, laboratory tests, diagnostic tests) and are associated with the single patient.

WWW technology was applied to develop the EMR system in such a way that any authorized user can access patient data from every workstation within the Intranet hospital infrastructure or outside through Internet, using proper confidentiality and security safeguards [3]. A Java application was developed, accessing ARCA by JDBC standard and allowing patient data entry and consultation through graphical user interface (windows style). HTML documents, produced on the WWW server of the clinical database, were used to represent multimedia patient reports by the use of standard browsers. Use of Java allowed to execute this EMR application, originally developed for MS-Windows platform, on other common platforms (e.g. IBM-OS2, Apple Mac-OS) [4].

The time interval since admission to discharge represents a single "session" of the patient diagnostic-therapeutic process. A new session is opened each time the patient is again admitted (Figure 2). A medical record describes, session by session, patient events as a function of time (e.g. patient history, hospital admission, visit, diagnostic test, surgical operation).

The EMR application is started by a password-based login procedure which allows the identification of the user and the authorization to access patient information. The single patient is selected from the list of the patients currently admitted in the care department under the care of administration, with the exception of emergency situations or network faults when patients need to be admitted directly through EMR session using provisional identifiers. Data concerning medical history or physical examination of patients, who previously accessed to the health care institution, can be retrieved from the database and used in the current patient session after proper editing or updating.
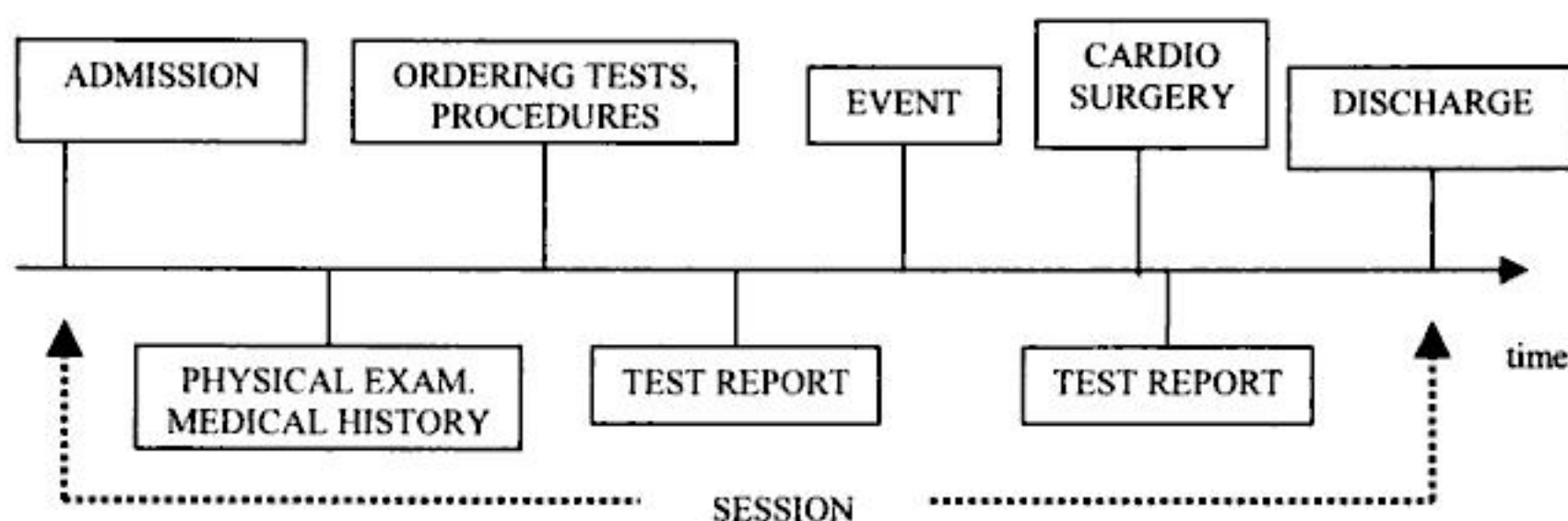
Figure 2 Typical operations of the in-patient "session"

Through the main page of the single patient all the system functions are accessed: data entry, view, editing and consultation (Figure 3). Data entry is made mainly in structured form. Anamnesis is inserted through four sections: physiological, metabolism and hypertension, familiar, pathological. For each pathology or procedure the corresponding ICD9-CM code is stored. Similarly physical examination concerns: general, nervous, cardiovascular, respiratory, abdomen, cutaneous, muscular, urinary. During structured data entry of both anamnesis and physical examination text summaries are automatically generated from structured data and their editing is allowed. These summaries are included in printouts of both medical record and discharge letter.

Most of diagnostic tests are executed in the Functional Islands, which are integrated in the SIC. So, reports are transferred into the database automatically, as soon as they are ready, in two forms: structured records of heterogeneous data (text, signals, images), describing test details, and short text summaries. On the other hand, a number of tests is also executed by external or not yet integrated laboratories and only summary reports can be manually entered. Anyway, in case of breakdown of the SIC system reports need to be inserted manually. Thus, manual data entry of reports has been provided through the EMR interface. Standard classification codes (ICD-9-CM) were associated with pathologies and procedures throughout the EMR in such a way that cost analysis by administration is made possible. Any information acquired on patient during the session is stored into the database and listed in the main page (Figure 3). Pointing and clicking on the list the synthetic view is first obtained (i.e. text summary of the test report); next, the analytic view can be required. The latter is obtained starting the WEB browser for representation of HTML document including, possibly, signals or images.

Information on patient conditions and test scheduling, therapy and diet plans are provided automatically by the Nursing system to the ARCA database. A time-oriented color graphical interface is provided to summarize chronologically (weekly or daily) the patient care events and conditions. Biohumoral parameters (i.e. temperature, weight, blood pressure, pulse rate, liquid balance), provided from Nursing system, are plotted. Patient events (e.g. pain episodes, symptoms), visits, diagnostic and laboratory tests are represented on the time diagram by specific symbols. Pointing and clicking synthetic and analytic views are obtained. Therapy and nutrition plans are also reported.

External data repositories as well as guidelines or knowledge resources can be consulted from EMR main page by the use of standard browsers and navigation through Internet allows to search information of interest from any WWW site.

3. Discussion

The information infrastructure, developed in SPERIGEST project, allowed the integration of the different sources of patient information in the department of Cardiology. Collection of all patient relevant data in the database was crucial to set up the EMR, aimed at supporting healthcare personnel in patient care, but also allowing playback data consultation for clinical research. Use of Java through the Intranet, protected by a firewall system, allowed secure access to patient medical record from almost any workstation equipped with standard browser. Remote EMR consultation through Internet will need to apply special techniques for protecting security and confidentiality. Particular attention was
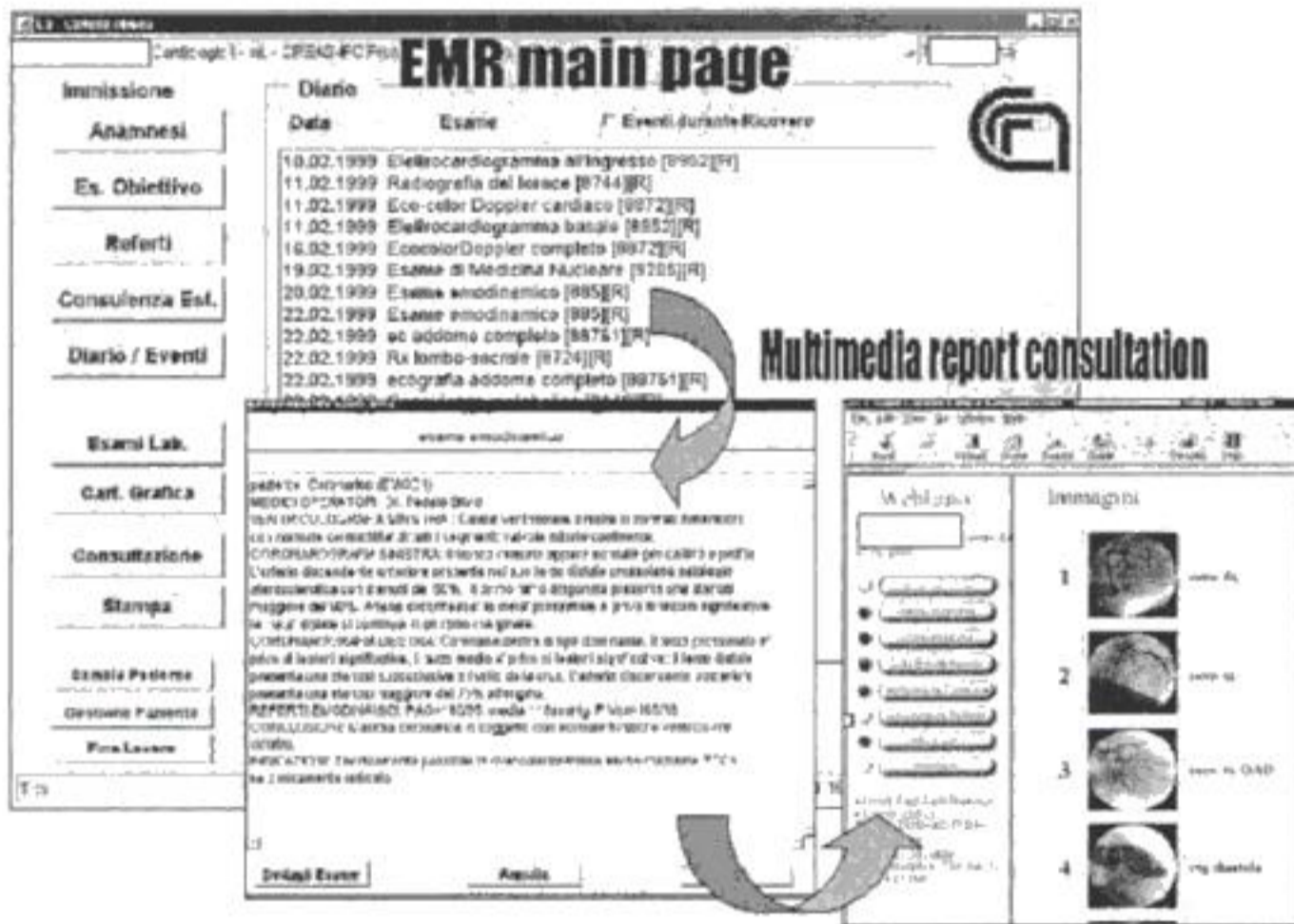

Figure 3 Screen capture showing the main patient page (data entry and consultation functions on the left). The user has selected a report to view (from the report titles list): first text summary report is represented and secondly analytic multimedia report (by WWW browser).

dedicated to the design of the user interface through interaction of health care personnel. The developed model of EMR is currently under clinical evaluation in the Cardiology department.

References

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