Electronic Patient Record As A Basis Of Medical Information System

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Abstract: **Quality medical information systems realization is, nowadays, one of the most important areas in IT business. This paper presents some electronic patient record (EPR) design principles as well as important international standards. Also, paper includes one specific solution for realization of EPR considering human, technological and institutional factors both existing and yet undeveloped. In addition to offering a detailed implementation plan this paper recommends effective and comprehensive developing methodology.**

Keywords: **Electronic Patient Record, EPR, Medical Information System, Healthcare, Standard.**

I. INTRODUCTION

The leading idea of healthcare information systems (HCIS) realization is collecting and processing medical data in order to make them available for the best possible medical decision in urgent situation. Electronic patient record, as a main building block of medical IS, formats patient's and other data, and prepares them for processing and/or interchanging with other computer based systems.

The main improvement of medical service quality is done by creating "patient's electronic medical history". This set of data that can be easily accessed by the web or in the other way contains all relevant information about patient such are previous injuries, diseases, allergies, etc. In urgent situation, quick access to these data can be critical for medical staff to make right decision [1]. Reducing clinical costs, through avoiding non-necessary actions in the process of healthcare, is also important advantage done by medical information system (MIS). Managing medical resources in proper way, as well as reducing paper documents using, saves a huge percent of clinical material goods.

Availability of medical data makes educational and scientific work easier. All kinds of analysis can be done instantly, and data about "rare cases" cannot be loosed or forgotten. Researchers, students and other medical staff can access them to improve their work. In the same time, data access must be restrictable enough to avoid misusage.

Data, stored by EPR, can be used in any kind of medical institutions, both public and private, in order to improve healthcare in general. Except medical and healthcare institutions other users can be dental clinics, pharmacies, as well as related insurance and home health agencies. Analyzing key capabilities of different HCIS's it can be considered that the main uses of EPR based systems are:

- patient care delivery,
- patient care management,
- patient care process support,
- education and research,
- improving policy and regulations,
- public health improvement and
- Patient self-management.

EPR based systems process medical data which reliability, in some cases, could be life-important. Otherwise, there are a lot of potential users for MIS, from clinical staff to patients, students, researchers and the other interested persons. So, we can assume that developing of the medical information system is very important process for every society.

In its main part, this paper presents a solution for specific realization of EPR based MIS considering human, technological and institutional factors of public Serbian healthcare system. Also, both detailed MIS realization plan and an overview on existing standards and solutions are given by this paper.

II. EXISTING STANDARDS AND SOLUTIONS-OVERVIEW

EPR system implementation and its continuing development is a critical element of the establishment of an IT infrastructure for health care. In the process of electronic patient record developing there were some problems with poor domestic standards in the area of medical information systems. In that reason, following important international standards [2] [3] were considered during the process of EPR development:

- HL7, standard developed since year of 1987 by consortium of several companies mostly from United States,
- Guidance on the key care delivery-related capabilities of an electronic health record system, by Institute of Medicine (IOM) of National Academies of United States,
- eEurope 2005, an action plans presented by European Council in June 2002 for implementation various areas of informatical society including e-health.

After analysis of existing international standards, the next step was choosing appropriate strategy for development of EPR and MIS, according to potential users. To implement any

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strategy for development, one must first clearly define a functional model of key capabilities for an EPR system.

Generally, EPR systems can contain different sets of data, which can be organized on different ways. Some EPR systems include all kind of patient data, while others are limited to certain types of data, such as demographics, medications and ancillary results. Advanced EPR systems provide some simple types of decision support like preventive service reminders, alerts concerning possible drug interactions. But, for the most of contemporary EPR systems one can tell that they are medical institution-specific because they operate within a specific national health system in single or multi-hospital organization [4].

Weak point of number of MIS is the fact that they are not connected, and not provide stronger support for communication and interconnectivity across the healthcare providers in a community. The implemented functionalities of EPR systems also varies from one to the other solution, because some systems have been developed locally and others by commercial vendors. In summary, EPR systems are actively "under construction" and will remain so for next several years.

III. REQUESTED EPR FUNCTIONALITIES AND THEIR REALIZATION

The IOM Committee on Standards formulated following criteria in order to guide the process of identifying core functionalities of EPR [2] [3]:

- Improve patient safety.
- Support the delivery of effective patient care.
- Facilitate management of chronic conditions.
- Improve efficiency.

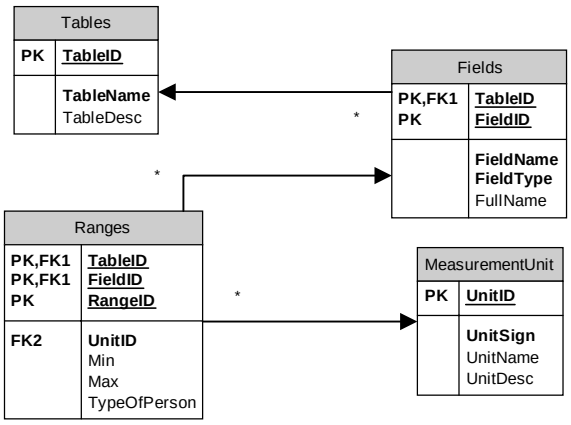

Figure 1. The structure of the healthcare related metadata

According analyzed standards, client medical institution needs and previously described guidance we consider developing EPR system that main schemas are given on figures 1, 2, 3 and 4. Figures related to data models are drawn in MS Visio as *database diagram*.

Metadata model is shown on figure 1. This part of EPR is important for more efficient creating database system for single healthcare facility. In the same time metadata model allows faster database recovery.

The most important data in system are healthcare related (both medical and non-medical data) that are grouped in adequate database (DB) tables, described in metadata model. Each of these tables corresponds to some medical analysis, treatment, diagnostic or similar. Every table consists of fields, and values of each filed are connected with specific ranges. Those ranges are values that are the most adequate for single group of patient. Every value can correspond to more ranges.

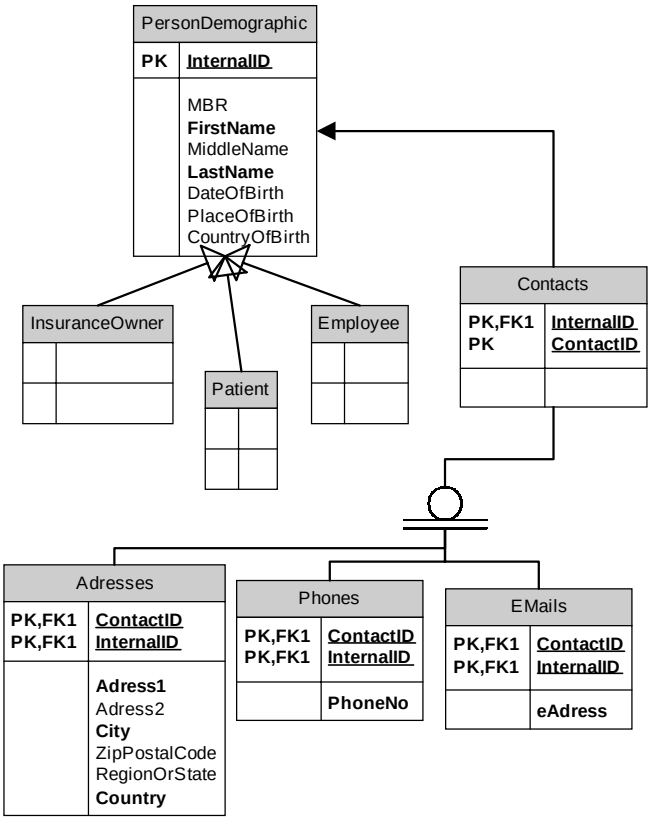

Figure 2. Demographic and other person related data model

The EPR system deals with data different types of persons. Three main classes of them are patients, employees (e.g. physicians) and insurance owner persons (e.g. parents). In the system, all of them are identified using internal ID that is consisted from 13 characters. First character describes type of person, next four are code of clinic and last 8 characters are unique number of patient in specific clinic. The other identification number in system is personal ID (in Serbia it is a 13-digit number which first 7 digits are derived from date of birth, next digit is region ID, and last 5 makes special code). The model of their demographic data and contacts is shown on figure 2.

The figure 3 represents relationships between patient demographic and insurance data as well as demographic data medical record. Internal ID, as primary key in table with demographic data and main key in system, is foreign key in every insurance related table. Patient medical record table has its own ID, and its foreign identification keys are patient ID as well as clinic identification code.

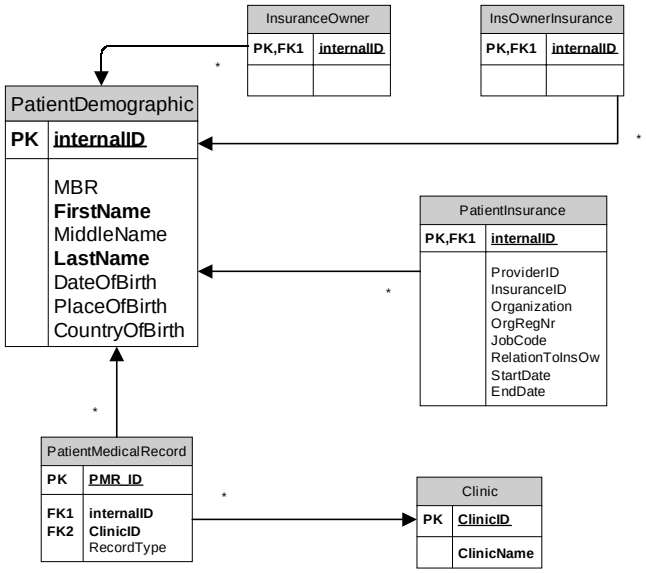

Figure 3. Relations between different types of patient related data

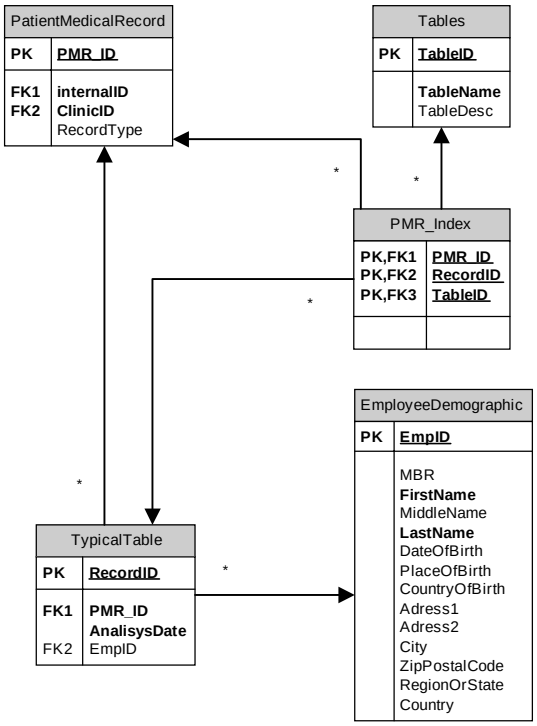

Figure 4. Patient medical record and related tables

Patient medical record and related tables that make base of EPR are shown on figure 4. Medical data, in this system are stored in typical tables, which are created on the base of metadata model. Except the fields described in metadata model, those tables have also the following fields: RecordID, PMR_ID (medical record ID), date of analysis and identification of responsible member of staff. There is a table named PMR_index, too. This table represents a list of pointers to every analysis that is made as a part o single medical record. The existence of this table helps in faster searching for specific data. Table EPR_index consists of RecordID and table ID for each of mentioned analyses.

Patient identification methods include patient's name, partial name, social security number, date of birth, MBR and internalID. Once the patient is selected, updates or edits can be made to the demographic recall file from any user with adequate privilege.

IV. MEDICAL INFORMATION SYSTEM IMPLEMENTATION PLAN

Provider of medical information system's applicative software should realize versions for different types of operation systems. In our realization, we develop software versions for Windows and Linux using Borland CLX technology. The main advantage of this technology is that one CLX project can be compiled under different Borland development tools – Delphi and Kylix. The result of CLX project compiling under Delphi environment is Windows, and under Kylix Linux application. The functionallities of the resulted applications are completly equivalent [5].

The hart of the system is database and it should be the most stabil part of the system. The database is realized according to previously described electronic patient record model. In a perspective DBMS will be exposed to large quantity of different data, as well as different attacks through the web. From these reasons we propose databases infrastructure as it is shown on figure 5. During software testing Interbase 6 was used as the main DBMS, but for system exploatation some more robust DBMS, such are Oracle or Intersystems Cache, should be installed.

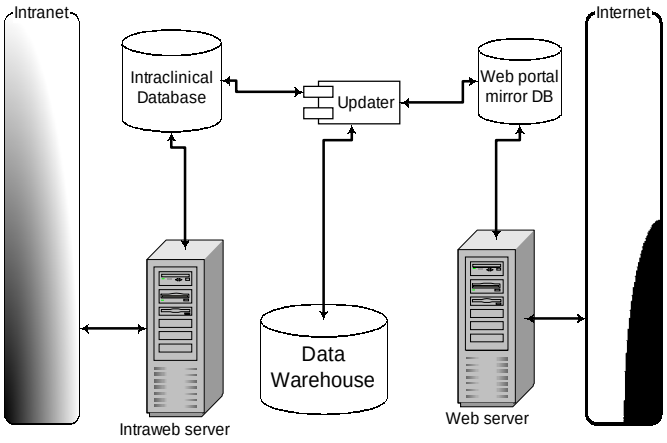

Figure 5. Database system structure

Our realization considers medical information systems that are consisted of many different parts, called modules, with a number of different roles. Each module can be treated as independent software component, but common objects for all of them are networks that bind them together physically, databases that concentrate data and security modules that control data access. These common objects make central part of system, called the core [6].

This kind of system organization allows its modular implementation, and brings more results in shorter time. General strategy for development of such system is implementation one by one part. The main part of the system, the core, should be realized and tested before implementation

of any other module. The core must be very stabile and secure system because all the other components use network infrastructure, databases, database management applications and security modules for their work. It should allow proper environment for the rest of the system. The rest of the MIS is a set of applications that provide access to database system, such are:

- **Security module** consists of two parts: main security module, directly connected to databases, and additional extranet security module. The purposes of extranet security module are guarding system from unauthorized access and keeping patients' privacy. Also, the main job of this module is creating user accounts and profiles and defining access privileges.
- **Medical documentation management module (MDMM)** is a part of system implemented as intraweb application that allows clinical staff more effective work with medical documents.
- **Electro medical instrumentation data collecting module (EIDCM)** is Intranet application for transferring data from medical instruments to database.
- **Material resources management module (MRM)** is intranet application for clinic material goods management. The job of this module is to avoid "disappearing" of medicaments and other material resources.
- **Medical insurance module (MIM)** is extranet application that allows flowing of data between clinic and institutions such are government's Health department and different social insurance funds.
- **Research and education improvement module (RIM)** is a part of system implemented as extranet/internet application that is consisted from more elements, such are telemedicine and different applications for extracting data from databases, suitable for researchers, students and other interested persons.
- **Internet module** is one of the most important elements in the system. Mainly part of this module is web-portal that allows to registered users viewing some data they are interested in. Also it provides different forums and discussion groups.
- **WAP module** is extension internet module**.** In some critical cases, it allows communication with members of medical staff that can help by advice or similar way.

The price of realization of such web-oriented MIS is more than reasonable corresponding to improvements that bring in whole healthcare systems. Investments in network equipment, hardware and software are equal to costs for paper documents and "loosed" medical material during 12 to 18 months.

V. CONCLUSION

Medical information systems simplify almost every process in complex healthcare system. Their targets are all activities connected with healthcare. From the process of patient scheduling, over medical documentation management and telemedicine to using stored data for scientific work, these systems help reducing errors and misunderstandings.

The importance of such complex and voluminous informatical product can be viewed through support of the government. The results, presented by this paper, were made under project of MIS developing for Clinical center in Niš. This project is supported by Serbian ministry of Sciences and Ecology. Realized EPR should become a model for realization of similar systems that would be realized for other Serbian public health facilities.

Summarizing main electronic patient record's characteristics it can be considered that EPR:

- is electronic and replaces existing paper records,
- supports all patient care processes,
- is patient – centric model of public health organization,
- is generated by health care providers as a business record,
- Can be longitudinal across providers, care settings and time.

One characteristic that become more actual today is ability of sharing data between medical institutions. But, in wide number of countries there are no relevant paper-based model of patient record. The new standards, which can be brought with development of EPR and MIS, can improve whole health – related public sector.

The quality EPR is main factor in integration of different medical information systems. This fact, together with development of medical expert systems and improving of medical instrumentation, can help further advance in healthcare, and generally in medicine.

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