AN EHR DOCUMENT MODEL OF CHRONIC PATIENTS

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Abstract

This paper presents a new approach for developing and improving medical and pharmaceutical services focused on XML solution as a common exchange language between specialists in collaborative framework. Our target was to establish several hierarchical features according with SIUI national e-health system and international medical standards.

Keywords: medical registrations, EHR standards, hierarchical decomposition, XML

Introduction

Workflow management systems (WfMS) can be used for modeling and control specific health activities, based on several existing international medical standards and core features of WfMS. It allows organizations to define and control the various activities associated with a business process, offering the opportunity to measure and analyze the execution of the process in order to continuous improvements. Many workflow systems integrate with other systems used by the organization: document management systems, databases, e-mail, office automation products, GIS, production applications, etc. This integration solution provides structure to a process which involves several independent systems and a method for documents management from several sources [1], [2].

Medical registrations are longitudinal electronic registrations of information about a patients' health, generated by one or more meetings between the patient and their doctors from any medical assistance point [7]. It also have the ability to support many other direct or indirect related activities in health care business, for example, the proof based decision support, quality management support and results report support.

We mention several standards regarding electronic healthcare record (EHR) and EHR architecture: Standards on Electronic Health Record Content and Structure, made by

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ASTM Committee E31.19, CEN 13606 - The European electronic healthcare record interoperability standard (2004), HL7 v3 (2003) and HL7 CDA, Standards on Electronic Health Record Content and Structure [3]. CEN 13606 concern on EHR reference model, archetype interchange specification, reference archetypes and term lists, security functions, exchange models to support communication. As a messaging standard to support communications between hospital and physician record systems and between EMR systems and practice management systems, HL7 v3 is linked with HL7 Clinical Document Architecture (CDA). HL7 CDA is an XML-based generic model for the representation and transfer of clinical documents and CDA 2.0 became an ANSI standard in May 2005, usefully in electronic health records projects [4].

According to ISO_18308, Clinical and technical requirements for an Electronic Health Record Reference Architecture, we have a concrete definition of such system "that supports using, sharing, and exchanging electronic health records across different health sectors, different countries, and different models of healthcare delivery" [3],[4],[5].

After an introduction, Section 1 is focused on EHR architecture, with main features and requirements of available technology, according with international standards and recommendations. Section 3 presents EHR document model, linked with SIUI e-health national system. We concern on different features of workflow modeling and implementation, from XML-document representations to for providing different views for users (doctors or patients), based on hierarchical decomposition. Section 4 summarizes the results and future work.

1. EHR Architecture

We focused on main recommendations about electronic medical records (EMR), electronic health records (EHR), personal health records (PHR), and patient accessible health record (PAEHR) and basic requirements for an Electronic Health Record Reference Architecture (EHRRA) for developing a WfMS prototype for medical application domain [4].

For providing a greater safety, quality and efficiency in health care delivery, an EHR System must have 8 core care delivery functions: *(1)Health information and data, (2)Result management, (3) Order management, (4) Decision support, (5) Electronic communication and connectivity , (6) Patient support, (7) Administrative processes, (8) Reporting*, according with Tang et all [6]. *Health information and data* gives access to key information (patients' diagnoses, allergies, lab test results, and medications) and improve caregivers' ability to make clinical decisions. *Result management* is the ability for all providers participating in the care of a patient in multiple settings to access all test results for increasing patient safety and the effectiveness. *Order management* is the feature to enter and store orders for prescriptions, tests, and other services for reduce duplication, and improve the execution speed of which orders.

Decision support assume reminders, prompts, and alerts, computerized decision-support systems and other preventive practices, identify possible drug interactions, and facilitate

diagnoses and treatments. *Electronic communication and connectivity* offer an efficient, secure, and accessible communication between providers and patients for optimizing diagnoses and treatments, and reduce fault or malicious events.

Patient support is formed by several tools for patient's access to health records, interactive patient education and help. *Administrative processes* are based on specific tools, scheduling systems, managing users for improve efficiency and provide service to patients. For electronic data storage *Reporting* function follows uniform data standards for health care organizations, and private reporting requirements, including PAEHR [5], [6].

By the other side, we discuss about some typical features associated with Workflow Management Systems, which we used in development phases of our prototype. *Process Definition Tool* is a complex software solution for defining and modeling the business process, *Rules* are created to determine how the activities progress across the workflow, *Simulation, Prototyping* and *Piloting,* is used for monitoring and managing solution, *Task Initiation & Control* involving the appropriate human and IT resources for each activity of the process.

Rules Based Decision Making was created for each step to determine how workflow-related data is to be processed, routed, tracked, and controlled between patient, dentist, doctor specialist or surgeon. *Document Routing* was managing by Document Management System (DocMan) according to standards and legislations. For *View* and *Manipulate Data* we have XML technology and application's module which can be invoked to allow users (patients and doctors) to create, update, and view data and EHR documents [7].

Worklists contains doctors' current tasks (appointments, control date, goal date, priority, etc). *Task Automation* is invoked at patient management, to send an email for daily programming patients, or to fix or change the appointment, according to dentist schedule and patient preferences. *Event Notification* and *Distribution (Routing) Lists* for Messages/Mail link doctors to patients, but we can manage a chat or other communication features [1].

Process Monitoring is based on RBAC (Role Based Access Control). We have identified three users' categories: patient, dentist or ophthalmologist and doctor (surgeon or doctor specialist). Every category has own access to EHR documents, based on tree hierarchy and rights. Beside it, everybody has full *access to information* via World Wide Web, based on interfacing modules, in order to provide workflow information to remote patients, suppliers, collaborators [1], [2].

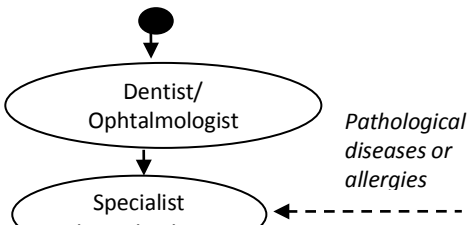

Figure.1. Workflow model for healthcare service

Every part of application can give information about each step can be logged (*Tracking and Logging of Activities*) and *Administration and Security* module offers several functions to identify the actors and their respective privileges associated with them, as well as to administer routines associated with any application (e.g., back-ups, archiving, errors) [2].

Electronic medical records (EMR) or electronic health records (EHR) give physicians and other medical professionals a computerized system for managing patient files and information, by providing real-time data access and evaluation to healthcare professionals.

Several software companies offer solutions for EHR software started to simple, low-cost technologies and strategic outsourcing, which are helped solo physician practice efficiently, even without any staff. This solution involve also some guideline practice improvement in medical relationship with patients: (1) offer online appointment booking, (2) delegate history-taking to patients, (3) using free tools to measure the results, (4) using e-mail to convey laboratory and X-ray results to patients, (5) using answering machine in patients' dialogue, (6) electronic billing for patients' medical services, (7) hire a poster medical bill [6],[7].

For an effective electronic medical records software system we point some basic features: look up of patient data by clinical staff, accurate claims processing by insurance

companies, automated checks for drug and allergy interactions, management of clinical notes, prescriptions management, patient scheduling, management of laboratories data.

2. EHR Document Model

2.1. SIUI Features

In crisis context and in a small practice environment, physicians, dentists, and medical practices are challenged to provide the highest quality care and manage a profitable business with proper and suitable tools. Budget is restricted and insurance instruments do not offer all facilities for support the patient treatment. Software business models developed around several licensing are too expensive and offers several facilities at highest costs, or simple balance and several commercial functions that small practice physicians or dentists can not afford to manage it.

By the other side, even physicians dentists or ophthalmologist live in global space, and offer to patients, who can be assigned to special customers, common facilities: internet access to medical records and several services, on-line appointments, common advices, health history and treatment schedule, also [8].

SIUI - a recommendation of CNAS is a unique, integrated, computer system. SIUI is essential for developing and improving medical and pharmaceutical services and it is a solution for improving the unique, national insurance fund management and for offering improved medical services for insures. SIUI is important for achieving health virtualization, for standardizing the national and zonal reporting and medical data management system. It can be easily aligned to the international standards so it could exchange information with other foreign authorities as well [10], [11], [12]. DOCS MF was designed to be used in family medical cabinets, to improve the consultation process, introducing patients' information in databases, completing the predefined documents and for managing and reporting information to CNAS, SIUI and ASP (Public Health Administration) as well.

2.2. Modeling workflow based on RBAC

In dental or ophthalmologic medical health domain we can model as a process the patient-doctor interaction based on several observations. Every patient starts with an appointment for consulting a family doctor or a dentist/ophthalmologist, than he/she is directed to a specialist for investigations, if he/she has some pathological diseases or allergies. Otherwise the medical act are consuming between patient and dentist/ophthalmologist, with several usual controls and treatments. If dentist/ophthalmologist discover some complications, patient are directed to the hospital, and after consultation and registration at the hospital, will be a schedule for passes through all stages of preparation, stays in the hospital until the operation is performed. Then he/she will be treated by aftercare specialists and dentist/ophthalmologist aftercare (Fig. 1). During this process, several actors are involved and various documents have to be exchanged, some of them are delivered by the patient, as paper sheet, others are sent by mail or fax.

For implementing this model we have identified several actors involved and them role in interaction with EHR document or PHR document:

- dentist or ophthalmologist, which are able to identify and design the EHR template of personal health record, can require from specialist medications and restrictions for chronically disease; he/she collaborate also with surgeon or other specialist in medical act;
- specialist, which offer details about treatment and diseases both to dentist and family doctor;
- surgeon, which collaborate with dentist and or other specialist in medical act;
- patient, as a "customer" and an active actor, which can manage own EHR and can view the treatment evolutions, results, and schedule during the treatment.

If we analyze diabetes we must link the patient investigations with several others diseases like: ocular affections, diabetes foot also. Specialists can easy exchange analysis, results, and medication list, using our hierarchical model as an exchange solution. Our solution can integrate collaborative effort in a common workplace and increase team efficiency in diagnose and treatment.

First we built our model focusing on decomposition of PHR and EHR records, using modular solution, storing all data in XML files. Thus, our first proposal had to be simple to use and allow family doctors to focus their efforts on the content rather than on the technology used to create it. Our current model allows a great flexibility in handling document and family doctor interaction and offers several extra features by comparison with SIUI. This model offers opportunity to develop a suitable specialist application, which can be connected easier with SIUI [12].

We use XML solution for HER and PHR as mix collaboration between patient, doctor, specialist and dentist or ophthalmologist. In this manner it can make an easy delimitation between disease stages: acute, sub-acute, chronic, and prophylactic. For chronic patients collaboration between specialists is essential and the treatment can be improved.

2.3. Hierarchical decomposition and XML approach

This project proposes an active role of the patient, the possibility to fill and manipulate can e-file list information in this registry. If he/she is interested to manage own personal information, with personal observations, DocMed offers opportunity to change/add/remove information under the assumption that the data entered by that date will be marked as not coming of specialized personnel, and be treated as having a possible degree of error through ignorance or intentional [13],[14].

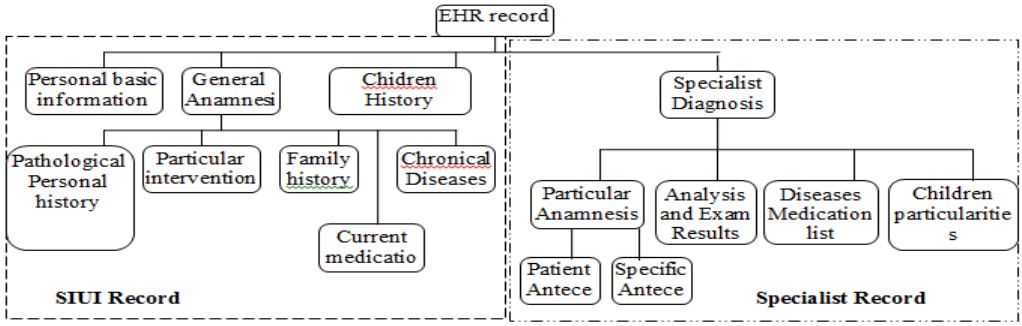

Figure.2. EHR hierarchical decomposition

The proposed system will use Internet technology; will be accessible to patient itself from any location which is available for an internet connection that can be accessed by any authorized medical system membership.

According to described standards we implement a DMS which uses two kinds of records: PHR and EHR, both structured in XML formalization approach, in order to obtain several links with laboratory, dentist or ophthalmologist, surgeon and patient.

We propose a hierarchical decomposition and split the structure of EHR health record in two parts: *SIUI Record*, according to national DOC structure and *Specialist Record*. *SIUI Record* was decomposed in: *Personal basic information*, *General Anamnesis*, and *Children history*. Personal basic information consists in: birth date, name, age, sex, address, Profession /Job, Birthday Prescriber, personal doctor (name, unique national code and email) and family history. This last field contains details about both parents and it is required only for children (Figure. 2).

General Anamnesis was decomposed in: *Pathological personal history*, *Particular intervention*, *Family history*, *Chronically Diseases*, and *Current medication list.* If patient has one or more of listed *pathological disease* (diabetes, anemia, heart disease, rheumatism, CA, aso) *current medication list* contain most than one medicine. Also, if the patient has *allergies*, he/she will point which one and will fill *current medication list.* Workflow will check *Pathological disease* and *Allergies*, and follow special branch for treatment.

Every section has divided according to EHR hierarchical decomposition and based on workflow and RBAC we establish role and rights permission for every actor involved (Table 1). Our XML schema Template offer solution for changing information between different applications: SIUI, CAS and specialist application using XML technology for representing data and documents. In this way we obtain a high portability of documents because XML data are represented platform and technology independent and offer a facile communication between applications. We adopt a collaborative solution for communication according to medical act, which involve several specialists, analysis, and collaborative diagnostic [15].

By defining vocabularies for describing data according to the activity domain, every specialist can develop own node, according to proper features about investigations: analysis, parameters, observation, in order to facilitate the exchange of documents between specialists as partners from the same area. In this manner we can easier exchange information from several specialists and offer a well documented diagnosis and treatment.

As a sample we offer a model for children node (Figure 3 a), developed as a sub-node of dentist, and two schema for *Patient Antecedents*, according to dentist requirements (Figure 3 b) and ophthalmologist requirements (Figure 3 b). Because every specialist can develop own nodes schema, they can update data in this nodes. Major advantage consists in the global schema view, which can able to offer medication restrictions or linked information from different medical specialization. As a results, medication list will be obtain as a join between specialists' recommendations, taking into account all features of every diseases.

XML Schema Template	Role	Access
<Patient Template> /* Schema for patients*/ <CabinetInfo> …. </CabinetInfo> <PatientInfo> <Children>/*only for children*/ …. </Children> <FamilyHistory> <Mother>…</Mother> <Father>….</Father> </FamilyHistory> <MedicalInfo> <PresentDoctor>…</PresentDoctor> <SentBy>….<SentBy> <Observations>…<Observations> <PatientAntecedents>…. </PatientAntecedents> </MedicalInfo> </PatientInfo>	SIUI System, Specialist	Read only for Patient, update for family doctor
<*DeseasDetails*> <AnalyzesInfo> <Analyzes1> <CommentAnalyzes></CommentAnalyzes> <DecisionDeseas ></DecisionDeseas> </Analyzes1> <Analyzes2> <CommentAnalyzes></CommentAnalyzes> <DecisionAnalyzes></DecisionAnalyzes> </Analyzes2> </AnalyzesInfo>	Laboratory, Specialist	Read only for Patient and specialist, update for Laboratory doctor
<*SpecialistDecision*> <Recommendations ></Recommendations >	Specialist	update for specialist, read only for family

XML Schema Template	Role	Access
</SpecialistDecision> *</DeseasDetails >*		doctor and patient
<TreatmentFile> <Date> <Year></Year> <Month></Month> <Day></Day> </Date> <Diagnosis></Diagnosis> <Treatment></Treatment> <Cost></Cost> <Payed><Payed> *</TreatmentFile>* </PatientTemplate>	Specialist, SIUI	update for specialist and for family doctor, read only for patient

Table 1. XML Schema Template

a) Children node

```
<Children>
        <Weight></Weight>
        <Height></Height>
        <TeethInjuries></TeethInjuries>
        <FacialInjuries></FacialInjuries>
        <DeviatedSseptum></DeviatedSeptum>
        <FingerSucked>
                <Finger></Finger>
                <Age></Age>
        </FingerSucked>
        <SpeechProblems></SpeechProblems>
</Children>
```

b) Dental antecedent's node

```
<PatientAntecedents>/* Schema for dental patients*/
    <Pathological>
        <Adenoidectomy>
          <Age></Age>
        </Adenoidectomy>
        <Tonsillitis>
          <Age></Age>
        </Tonsillitis>
        <Diabetes></Diabetes>
        <Anemia></Anemia>
        <Cardio></Cardio>
        <Rheumatism></Rheumatism>
        <BoneDiseases></BoneDiseases>
        <TBC></TBC>
        <Epilepsy></Epilepsy>
        <Renal></Renal>
        <Hepatitis></Hepatitis>
        <Endocrine></Endocrine>
        <Nerve></Nerve>
```

```
        <Fainting></Fainting>
    </Pathological>
        <OtherDiseases></OtherDiseases>
        <Medication></Medication>
        <Alergy></Alergy>
</PatientAntecedents>
```

c) Ophthalmology antecedent's node

```
<PatientAntecedents>
/* Schema for ophthalmology patients*/
<HeredoCollateral></HeredoCollateral>
<Pathological>
      <ChronicDisease></ChronicDisease>
      <Medication></Medication>
      <Analysis></Analysis>
 </Pathological>
 <OcularDisease>
            <Childhood></Childhood>
            <Squint></Squint>
            <Trauma></Trauma>
            <Inflammation></Inflammation>
            <PreviousConsultation>
          …
          </PreviousCon sultation>
            <Symptoms>
           ….
          </Symptoms>
  </OcularDisease>
</PatientAntecedents>
```

4. Conclusions

After analyzing the medical software used and recommended in Romania, we fill consistent upgrades can be made so that it would be really useful. In this paper we described several improvements we consider mandatory to create software that enables collaboration in this field and permits its users to better do their jobs.

We propose a document management system model that breaks time and space barriers and provide doctors the independence they need to avoid paper work and obtain greater efficiency in medical act. Started with XML schema template we show several nodes in hierarchical decomposition, using specialist's role and EHR features, pointed for symptoms, analysis, collaborative diagnosis, and medication.

Our model should be regarded not as a replacement for SIUI but as a model that could correct some of the errors that we encountered while analyzing SIUS. Our aim in this research was to find means to improve the medical services' qualities, increase doctors' productivity, and decrease the administrative cost.

Acknowledgment

This work was supported by Romanian National Authority for Scientific Research under the grant no. PN2 IDEI /2009 PROCORD.

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