An Overview of Data Analysis of EMR, Its Clinical Ontologies & Security in Database with respect to Today's Ehealth Apps

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Abstract:

The convergence of the information and communication technology (ICT) has produced many exciting possibilities for developing new services in medical field for the citizens. Electronic medical records (EMRs) are used in large healthcare centers to increase efficiency and accuracy of documentation. These databases may be utilized for clinical research or to describe clinical practices such as medication usage. The paper discusses an overview of the features and functions of major electronic health records (EHR) and reviews how they are being used in academic medical centers (AMC) AMCs were among the pioneers in developing automated EHRs, is the available ICT technology is suitably modified and used for experimentation, vocabularies and interfaces appropriate for clinical trial research.

***Keywords*— medical informatics, ehealth, e-records, health informatics, EMR, EPR**

I. INTRODUCTION

Today, the motto 'turning digital' is behind every successful management. EHR/EMR is the database of all patient records, which include both clinical and financial. This technology oriented process is best implemented when a system meets clinical, business, and administrative needs. The hospitals, nowadays, aim to adopt a paperless practice and a virtual assistant for keeping records. Writing prescription is again a time consuming task, therefore an ideal EMR should maintain formulary information by health plan, which provides drug-interaction, checking, allergy and patient education. Keeping a record for a billion people is a tedious work to maintain therefore a scalable process is required to streamline the process of maintaining information.

With healthcare in a state of crisis due to unsustainable cost increases, lack of patient focus, and low information transparency, a need exists for measuring healthcare performance. Electronic medical records (EMRs) are a gateway to improved healthcare where a potential exists for a more thorough assessment of facility health, depicting financial and quality improvements in the health system.

The advances in medical science and biomedical engineering on one side and Information and Communication Technology (ICT) on the other are offering wide opportunities for improved health care. [1]

Although technological advancements in science have greatly improved medical care in recent decades, improvements in the management of patient information have been languid. Many healthcare institutions continue to rely on paper-based medical records as the primary source of patient medical and demographic information. Medical care decisions are based on the information stored in these charts. An electronic medical record system was introduced as a way to facilitate a centralized patient information repository. Benefits realized by this system included improvements in patient care, clinical research, and patient service and satisfaction. The ultimate goal of this project was to provide a paperless patient medical record that linked research and clinical data.

Integrated Health Information Systems (HIS) seek to integrate the complete range of health departments' processes and functions in order to present a holistic view of the health care from a single information and IT architecture.

Processes in order to deliver high quality care while at the same time reducing costs. On the other words, health departments increasingly recognize the value of sharing information among all stakeholders. Integrated HIS packages have made a tremendous contribution to the world of health care

Indeed, the value that HIS packages can bring to health sectors is clear to many health organizations, and few will dispute its potential. However, there are also hazards associated with implementation of integrated HIS. Their failure is high and may cause negative effects on staff and patients [3, 5, and 6]. Many integrated software implementation failures have been due to the lack of focus on 'the soft issues', i.e. the business process and change management [6, 8].

EMRs store a wide range of information about patients including demographics; medical history: documentation of events, diagnosis, symptoms, treatment, outcomes, and test results – lab and imagining; associated documentation; and administrative information. In addition to this, EMR information when stored properly (on scalable database architecture) can become a powerful information source for care analytics and risk identification and other clinical information systems can then be bolted onto/integrated with it

II. REVIEW OF LITERATURE

A. Analysis

The sheer number of products in the market place has created a complex decision to be made. To invest in such a management system a buyer must answer few questions including:

- Which is the best EMR/EHR to be used?
- What is the cost of implementation of EHR/EMR?
- What is the benefit of implementing such integrated system in the organization?

Protection of records from destruction is an important task as they provide us evidence of legal status, ownership, accounts received and the particulars of obligations required by the government agencies or private organizations. These records can be either electronic or in print forms and are critical because they contain information required to continue functioning during disasters or to re-establish operations after a calamity has ended. There are lots of troubles with reference to electronic health records from which some are discuss below:

1. The first known medical record was developed by Hippocrates, in the fifth century B.C. He prescribed two goals:
    - Medical record should accurately reflect the course of disease.
    - A medical record should indicate the probable cause of disease [4].
2. CORBA is the "Common Object Request Broker Architecture" of the object management group to standardized interoperability among heterogeneous hardware and software systems [9]. CORBA allows applications to communicate with one another no matter where they are located or who designed them.

    However, in the current state of standardization it is not clear what exactly CORBA will contribute to the challenge of integrating information in health care information system.
3. The Palo Alto Medical Foundation (PAMF), located in the San Francisco Bay Area, is a 500-physician multi-specialty group practice with over 1.5 million outpatient visits per year. They announced the general release of PAMFOnline to their patients in January, 2002. One of their biggest initial challenges was to efficiently process the enrollment requests. Because their application gives patients access to information from their medical record, they considered each application to enroll in PAMFOnline as a request for release of medical information. Accordingly, they required authentication of the signature on each user agreement, either in person or by comparing the submitted signature with the registration signature on file. After the signature was authenticated, a 25-character access code was mailed to the patient at the address on file. Because of the delay between applying for an access code and its receipt, not all patients who received their codes logged in immediately to establish their private ID and password. For security reasons, access codes expire after 30 days. Consequently, for patients who tried to log in after their access codes expired, they had to re-issue another access code. As they improved their turnaround time and provided email reminders to log in, they decreased the problem of expired codes [11].
4. There are companies such as IBM, Intel, Microsoft, and Accenture that lack established clinical record product lines and are investing in the development of EHR-related technology. But the health care industry is not necessarily the same as other industries. The rate of change for some ancillaries is much greater than others, and monolithic vendors may not be able to update the ancillary systems fast enough to suit the provider community's needs. In an AMC environment, this may lead to development of a federated architecture instead. This type of architecture would use standard messaging and vocabularies to integrate several systems into a unified view [10].

B. Synthesis

Now, here we go through the problems which we have discussed above, and discuss some solutions which we have obtained while analysing the difficulties:

- Electronic health records systems can provide functionality, such as interactive alerts to clinicians, interactive flow sheets, and tailored order sets, all of which can not be done with paper-based systems. The first EHRs began to appear in the 1960s. "By 1965, Summerfield and Empey reported that at least 73 hospitals and clinical information projects and 28 projects for storage and retrieval of medical documents and other clinically-relevant information were underway [12].
- Digitizing medical records, for instance, improving medical treatment of patients and the computerized evaluation of patient data to support research in medicine. Electronic medical records are not merely automated form of today's paper-based medical records, but encompass the entire scope of health information in all medical form. The electronic medical records may include medical history, current medications, laboratory test results, etc.

- One of the concerns that arises when releasing more detailed information from the EMR to the patient is that it may lead to more questions and, potentially, more concern or anxiety [14]. This is particularly true of unfamiliar terms and phrases contained in test results. In order to address this proactively, Sentius (Palo Alto, CA), apply their dynamic hyperlink technology, RichLink, to content presented within PAMFOnline. RichLink works by dynamically processing HTML documents to create a hyperlink for each word or phrase it recognizes from its Meta-Dictionary. In the Meta-Dictionary, we have created mappings between words, phrases, and synonyms to physician-endorsed content. It is well known that, although patients and consumers are searching the Internet for health information, they prefer to receive information from their physicians, especially if it is tailored to their particular situation [13].
- The health level 7 (HL7) protocol has been designed to standardize the data transfer within hospitals. It is based on level seven of the ISO/OSI protocol hierarchy. HL7 covers various aspects of data exchange in hospital information system, e.g. admission, discharge and transfer of patients, as well as the exchange of the analysis and treatment data. The HL7 standard represents hospital related transactions as standardized messages. HL7 is a de-factor standard for data exchange between commercial system for hospitals.
- HL7 defines messages as strings to be exchanged by subsystems. The messages themselves contain standardized information, but do not invoke specific methods at the destination. HL7 can be used to transfer electronic medical records across subsystems in hospital and, therefore, implicitly defines a data model for electronic medical records.
- The HL7 special interest Group for Object Broking Technologies is mapping the fourth coming HL7 version 2.3 onto the IDL of CORBA and version of HL7 will be based on an object oriented model of the underlying data so we can expect the combination of CORBA and HL7 in the future.
- It has been suggested to use object-oriented techniques for modeling health care information system. They use the UML for modeling, which offers a rich set of notations that are in the process for standardization by the Object Management Group (OMG). To support extensions and the modificati0ons to the class diagrams, a new tool has been developed which allow translating changed models from the ROSE internal repository into a schema for the object oriented database which automatically generates a simple application to be used for experimentally evaluating the changes made to the model. This tool supports early prototyping of extensions and modifications. Prototyping is an important concern in participatory development to involve the users of health care information system.

Now, hereafter we are going to discuss, that what we are doing regarding the problems, when the article progresses and our research aims for that.

III. NEED FOR RESEARCH

There are many models and methods in the MIS field that can be applied to healthcare information systems. These include Nolan's stages of growth, Rockart's CSFs, Porter and Millar's value chain concept, the Capability Maturity Model of the SEI and numerous others. The application of many of these classic models will help us understand better the complexities of healthcare information systems and the organizations that use them. Expertise and lessons learnt in client server computing, artificial intelligence and expert systems, and decision supports systems can be applied to analogous situations in healthcare. This would help in the smoother transition to sophisticated information technology. Other research areas include studying the impact of information technology on the patient/provider relationship, the effect of IT on learning in health care organizations, developing cost-effective models and methods for implementing telemedicine and applied medical informatics projects.

The basic problem faced by many medical records vendor is of data extraction. This made the classic idea of research needs as to extract data in uniform ways and to store it on multi platforms in a distributed database environment is a great challenge.

IV. EXTRACTION OF ELECTRONIC HEALTH RECORD DATA

To manage the public interests in health services, local and national health authorities need updated and precise information on use of medical resources, medication, epidemics, etc. Today, this information is at the best incomplete and outdated. For medical doctors and health personnel in general, access to updated and complete patient records is vital for an optimal patient diagnosing and treatment. Today, vital patient data at the GPs offices is unavailable for hospital doctors and medical specialists, or to medical emergency units. Through the extraction of patient data from EHRs, the DEPR project will provide a powerful tool both for local and national authorities and for GPs and hospital doctors and health personnel.

In India we have one EPR for home-based caring services, two EPR system providers for GPs and three EPRs for hospitals.

No standard data format exists, which means that all EPRs have their own data formats.

This calls for a system that can manage different data formats.

As a result of lack of standards and systems for secure integration of patient data, statistical data have been registered manually.

For some of the EPR systems, statistical modules exist. However, they do no support electronic interpretation and grouping, and they are not widely distributed. In addition, the implementation of regional and national computer networks for health institutions enables integration of EPR data.

Due to the need for openness as regards EPR database formats and patient data, we will construct our own experimental EPR database modules and use unauthentic patient data.

The scope of the DEPR project requires a broad range of competence within medical systems, security, distributed systems, computer networks and software agents.

V. OBJECTIVES

With the existence of n-no of technologies to formulate the EMR & varied methods for calculating the Patient Epidemic Index the need for formulating a systematic semantic approach for resonance of EMR has to be derived in context with Clinical Ontologies. To bridge this gap the project **DEPR (Distributed Electronic Patient Record)** is suggested & the research will be carried out to formulate the methods & simulate the results.

The proposed research DEPR project aims at integrating electronic health record (EHR) data through the national computer network for health institutions. The DEPR project will be organized into two phases. In the first phase, the main focus will be on accumulation of statistical data from EHRs. The main objective in this phase is to study how diseases spread both in geographical and chronological order. This objective requires an infrastructure that enables this kind of data extraction from geographically disperse and heterogeneous EHRs.

The second phase will concentrate on EHR data extraction. This requires access to EHRs and transference and integration of confidential patient records. Ethical problems arising from issues related to privacy will also be considered. The second phase in the DEPR project calls for an infrastructure that handles identification, transference and integration of confidential patient data.

The DEPR will be formulated on the basis of HIPAA norms & it will have the message portability. This will be used as per the Indian norms as well as normal US norms. The project will have full capabilities of HL7.

The extraction of EHR data demands confidentiality, authentication and authorization. In phase one, all data will be anonymous – no names or patients' identification data will be transferred. This phase will focus on collecting activity data and epidemiological data and other medical data for statistical purposes.

In the second phase, the extraction of patient's data (for each particular patient), which means that confidential patient data will be transferred through the network. The patient data for one particular patient may be available from several geographical distributed EHRs. The extraction process of patient data will be independent of how many GPs the patient has consulted or in which area of the country his/her medication data is located. To gain necessary openness as regards both EHR database formats and patient data, we will construct experimental EHR-like database models and use unauthentic patient data.
The overall goal of the DEPR project is to improve the quality (i.e., accuracy) of patient data available for Hospitals as well as general practitioners (GP), and make statistical health data for local and national health authorities available.

We will construct a prototype system for extraction of patient data. The system will be based on EHR database formats. We expect that only minor modifications will be necessary to test DEPR with existing EHR systems.

A. General Objectives

The overall focus in the DEPR project is the integration of electronic health record (EHR) data. The general objectives of the DEPR project are to:

- Establish a multidisciplinary research effort within extraction of patient data from heterogonous EHRs.
- Gain new knowledge within secure distributed systems and software agents.
- This will partly be realized through the construction of a prototype system for EHR data integration that supports health care personnel (efficiency), ensure patients' privacy (security) and makes medical information available (connectivity).

B. Project Objectives

The DEPR project objectives include:

- Create an intelligent system for EHR search that handles interpretation of patient records.
- Devise a secure architecture for the extraction of EHR patient data.
- Ethical problems will also be taken into consideration.

C. Technical Objectives

We have restricted the application domain of the DEPR project to security and software agents. We will consider the following technical objectives:

- Modeling of system requirements for EHR data extraction, especially security and agent-based information retrieval.
- Construction of prototype system for EHR data extraction.
- The T1 models and their realization T2 will be made such that they can be adapted to specific domains, modes and configurations of our prototype system.
  The modeling of system requirements (T1) of EHR data extraction includes:
- Security will play an important role in the design of a system for medical use. Integrated security modules (e.g., based on smart card technology) can provide the basis for a secure EHR data extraction.

VI. SYSTEM ARCHITECTURE

The DEPR project will extract data from different electronic patient records. The system architecture will be based on user model based agent system technology. The basic idea behind user model based software agents is to construct the agent from a task specification and a user model. Such an integration of adaptive user interface and software agent technology represents the core module of a user model based software agent. In this way, a software agent can be constructed by transferring only the task specification and the user model to remote hosts. This approach requires that the body part, which includes most of the agent code, is present on the remote hosts.

The agent-based system architecture will be evaluated with other models and approaches, including middleware and distributed databases.

A major problem with EPR data integration is privacy and security. Distributed systems that handle confidential information give rise to a new set of challenges. In particular, authentication and authorization are more difficult than in other settings. E.g., while medical doctors must be given access to the entire patient's medical data, other groups as nursing assistants are not granted the same access rights.

This calls for a careful study of the relationship between authentication and authorization. Furthermore, confidentiality is closely linked to authentication. In a system for EPR data integration, no medical data should be transferred before the receiver is authenticated and a secure channel has been established.

VII. CONTRIBUTION

Our approach comprises theory, modeling and design. We will conduct more theoretical studies within the area security and privacy; model the medical situation and design (construct) a prototype of a working system for EHR data extraction.

Extended laboratory tests and experiments will be done in all phases of the project.

VIII. CONCLUSION

The application of information technology to patient records offers the promise of new knowledge that can be obtained only by integrating and analyzing data extracted from hundreds if not thousands of patient records, including clinical information, medical images, environmental profiles, and genetic analyses, combined with new findings from molecular and genomics research. As institutions struggle with the adoption and implementation of EMR systems, it is crucial that they consider the needs and seek the advice of the research community.

Importantly, improvements made in EMR systems in response to research needs will ultimately serve clinical care needs as well. For example, in trying to achieve consistency and standardization, patient record systems will not only become more useful for research but will also contribute to improved quality of patient care. Likewise, the development of customized algorithms and pattern recognition systems will aid researchers while simultaneously providing physicians with smart clinical decision support tools.

With the proposed system the search & indexing of EMR on any platform will be made with an ease & the software medical service providers will be hugely benefited.

REFERENCES

[1] Telemedicine Concepts, Modalities and Implementation: Onkar S Kemkar, Publication: i4 Journal Volume 5 Issue 1/2 ISSN # 0975-2757:2011

[2] Johnson K.F., "Integrated Systems Brings Hospital Data Together", Health Progress, October 1987

[3] Anderson, J."Increasing the Acceptance of Clinical Information Systems", MD Computing, Jan-Feb, 1999, pp. 62-65.

[4] Linda J. Greene, R.N, Geralyn A. Saunders, R.N., M.S.N., Janice Wilson, R.N. M.S., "Clinical Documentation Panel: HIMSS Nursing Informatics," HIMSS 2005.

[5] Beynon-Davies, P., Lloyd- Williams, M. When health information systems fail", Topic in Health Information Management, Vol. 20, No 1, 1999, pp 66- 79.

[6] Kim, K.K, & Michelman, J.E. "An Examination of Factors for the Strategic Use of Information Systems in the Healthcare Industry", MIS Quarterly June, 1990.

[7] Kelly, S.; Holland, C. and Light, B. "Enterprise Resource planning: A Business Approach To Systems Development", In: Proceedings of AMCIS, Milwaukee, WI, USA, 13-15 August 1999.

[8] K. Dhinesh Kumar, H. Roth, L. Karunamoorthy, "Critical Success Factor for the Implementation of Integrated Automation Solutions with PC Based Control, in: Proceeding of the 10th Mediterranean Conference on Control and Automation MED 2002, Lisbon, Portugal, July 9-12, 2002.

[9] T.J. Mowbray and R. Zahavi., The Essential CORBA: Systems Integration Using Distributed Objects., Wiley, 1995.

[10] "Electronic Health Record Overview", National Institutes of Health National Centre for research resources, The MITRE Corporation, April 2006.

[11] PAMFOnline: Integrating EHealth with an Electronic Medical Record System Paul C. Tang, MD, William Black, MD, PhD, Jenny Buchanan, Charles Y. Young, PhD, David Hooper, MD, Steven R. Lane, MD, Barbara Love, Charlotte Mitchell, RN, Nancy Smith, and Jenifer R. Turnbull, AMIA Annu Symp Proc. 2003; 2003: 644–648.

[12] International Clinical Documentation Model, see Asp, Lone & Petersen, Jan, A Conceptual Model for Documentation of Clinical Information in the EHR, National Board of Health, Denmark, 2003

[13] Jones R, Pearson J, McGregor S, Cawsey AJ, Barrett A, Craig N, et al. Randomised trial of personalised computer based information for cancer patients. BMJ. vol. 319, no. 7219, pp 1241–1247, 1999.

Ross SE, Lin CT. The effects of promoting patient access to medical records: a review. J Am Med Inform Assoc. 2003;10(2):129–138.