ELECTRONIC HEALTH CARE SYSTEM

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Abstract - Health information technology provides the umbrella framework to describe the comprehensive management of health information across computerized systems and its secure exchange between consumers, providers, government and quality entities, and insurers. In this research work, an intelligent Electronic Health Record System(EHR) is defined to store different information of patient, doctors and disease in distributed dataset. The exploration of various challenges and various technological methods available to represent medical information and its distribution is discussed in this research paper so that it will help and provide a vision or guideline to other researchers working in this field.

Keywords - **PHR, Health Care Data Management Architecture, Standards in EHR System**

I INTRODUCTION

The health care system is defined under the comprehensive management of health information along with management of patients, doctors and the diagnosis information. This information can be utilized by different parties and stakeholders including the hospitals, health organizations, institutions, government agencies and NGO. The health information system is defined with specification quality metrics and health delivery system to achieve the efficiency and safety[1][2][3][7][8][9]. The health information is able to provide the solution under following aspects:

1. Provide the distribution management of health care data
2. Control the quality of data management
3. The intercommunication between the stakeholder is possible
4. The query system can be done
5. The updation to the personal information can be obtained
6. The authenticated access is provided

Medical Health Records

Medical health records are the primary requirement or the data in health care systems including hospitals, health centers or the related organizations. These organizations have to maintain the data of all the patients including the personal details, disease history and the treatment process. To computerize these records, there is the requirement of larger storage space and higher cost. The internal organization of the system maintains these health records in terms of (i) Personal Health Records (PHR) and (ii) is System intertwine. The personal health records are provided as the online data used by the patients, hospitals to retrieve the patient health history and to track his disease status. The information exchange by consent of patient or his family can be shared among other health agencies or the hospitals. The information communication between these hospitals, agencies or patients is done in a transparent manner. The patients are informed and engaged in each information exchange. The interwine information is the organization level information which is mostly accessed to the professions. This kind of information is used to improve the information strength and the capabilities of health care system. The involvement, interest, awareness to the patients and health agencies can be improved by using these information. In this chapter, the significance of health care system, record management and query based access to the health care system is explained[1][8][9][12][14][15][16].

The health records are today presented in electronic form which contains all the information generated by one or more encounters in the health treatment process. It includes the personal information, demographic information, initial disease, symptoms, progress notes, vital signs, medical history, earlier treatment details including doctors and hospital handled the case, laboratory data, number of test conducted along with date and the outcome, radiology reports and the immunizations. The current health status and the treatment going one which doctor reference is also maintained in these health record system. EMR(Electronic Medical Record) is the system that manage the clinical work flow and functionality and provide it in effective way. The system is also able to provide the selective information to each concerned person or organization. The data in EMR is maintained in multiple tables and managed at multiple locations. The information can be submitted and access to any locations with patient role specification. The communication system, information representation, document management, clinical decision systems and the generated notes can be shared through this EMR system[1][12][13][16]. The significance of EMR can be identified as it contains the sensitive and personal information of patients. There is the requirement to secure this information from illegal or unauthorized access. A secure system is required to manage this system in open environment so that the only the person or organization relevant information will be shared. To maintain this information, an individual organization is operated called Health Maintenance Organization (HMO).

Interoperability of Electronic Health Record(EHR) System

The medical professionals, health care organizations, physicians and the patients cannot be located at same place. Each one wants to access the information separately at different sites and different forms. The patient where provides the simplified information about the doctors, patient, disease or hospital. The doctor requires the technical information about the disease, symptoms and the treatment. The interoperability is the term that provides the distribution of common information in such versatile environment in different form. The requirement of each organization, institution and hospital are different regarding patient data.

The health care sector uses such informatics and decision making to provide the appropriate data. The effective sharing of different kind of data requires the different level of interoperability between different entities and environment. The quality of storage and distribution provides the easy communication between these different organizations and the effective decision can be taken. The interoperability itself is a cost and time consuming process but on adoption of this method, the overall cost of information management, distribution and sharing is reduced. It increases the productivity of physicians and the health organizations. This kind of system benefits each kind of contextual information sharing across the platforms and individuals. The patient central query mapping and the information availability is provided to boost the usage of Electronic Health care records.

II CHALLENGES IN EHR MANAGEMENT

The electronic health record system is very beneficial to maintain the patient records in collective form and able provide the instant information. Various protocols and frameworks are available to manage and distribute this health information among different organizations. This open environment based sensitive information distribution suffers from various challenges[1]. These challenges are further divided in three main categories called Global Challenges, Individual Challenges[5], Organizational Challenges. These challenges associated to eh work are listed hereunder:

2.1   Global Challenges

These challenges are the architecture specific, data representation specific and data access specific. The technical challenges that can affect the adoption of the EHR to any environment is discussed in this subsection. The security and the capacity driven observations are also provided in this subsection. These challenges are independent to the individual or the application domain in which EHR will be applied.

2.1.1 Large Volume and Different Data Forms

The health care system has to manage the large amount of data collected for all the global patients. The thousands of patients, doctors, hospitals and organization information is maintained. Along with this, the disease, symptoms, medicines and solutions are recorded. Each of the patient is managed under the personal details, test reports, patient health history etc. This data also includes different data forms including the textual information, image data in the form of X-Ray and CT scan images, ECG or EEG signal reports etc. This kind of hybrid data management collected from different sources is required to manage in single dataset. The larger volume and type specification cost higher to manage this data. The information sharing of this large amount data also need better communication speed and higher bandwidth. The instant availability of this in bulk is always challenge for current system as well as for the data management and distribution server.

2.1.2 Interoperability

The Electronic Health records are accessed by different kind of users globally with different requirements, constraints and considerations. These users include the organizations, institutions and the patients which are geographically present at different position. The information requirement of each user is different. The interoperability is required to understand the requirement of each user and provide them the requirement information in some user specific way. The language and region specific information transition is required. The interoperability also required to share the information among different users in different forms.

2.1.3 Sensitivity

The medical information is personal to a patient which includes the highly sensitive information. This information can be relative to the person fertility, abortions, mental problems, sexual behaviors or the psychiatric treatment etc. The disclose of such information can cause social embarrassment or prejudice. Sometimes it can cause the financial repercussions or the business loss. The availability of the heath records in open environment always suffers from such information leaks.

2.1.4 Security

The health care records are available globally but it contains various aspects of patient information including personal information. Because of this, to access this information the different level of security is required. The first level security is to authenticate only the individuals to the health care domain including the doctors, hospitals and health organization. The second level of security is in terms of selective information sharing. It means the personal information such as address, name, phone no etc can be accessed by the patients only. To achieve the higher security level, it is required to track the users who accessed the information of patient, so that the tracking of users can be done if some information leak situation occurs.

2.2   Individual Level Challenges

The individual challenges are specific to the user characteristics, knowledge and behavior. The knowledge, efforts and expectations of person are observed and listed in this subsection.

2.2.1 Individual Characteristics

There is lot of variations in users of EHR system in terms of their knowledge, education, work behavior and experience. An individual can be a unemployed patient or can be a skilled doctor or some technical expert. The knowledge and experience specific features are the key challenge to the adoption of EHR System.

2.2.2 Effort Requirement

To utilize the system, some technical knowledge and efforts are required by each user. The interface specific, software system specific and technical knowledge specific learning is required.

2.2.3 Job Performance

The system performance can be evaluated in terms of productivity, time and workload. The EHR system having the higher impact on the productivity of health professions. The system is quite useful to accept the online queries because of which

the outcome efficiency can be improved but it will also increase the load on system. The professional users can get more enhancements to the performance in case of short term difficulties.

2.2.4   External Control

The global distribution of services and information sharing suffers from various security threats. These threats are imposed to the inflexible mode data entry and decision making. The sharing requirement and control suffers from data loss in case of application consideration. The profession specific knowledge and expertise sharing also affected by this external control.

III HEALTH CARE DATA MANAGEMENT ARCHITECTURE

EHR system defines standard using different protocols such as HL7, open EHR etc to provide adaptive health care information processing and adaptation. The semantic map between the data and its logical representation in the hybrid environment is required. The ontology specific constraints are also defined to apply this environment including the reusability, query processing and the interoperability. The mapping from low to high form of data is provided in the figure. The virtual representation of data and supportive mapping through data pattern is provided by this semantic model[15][16]. The layered description of this architecture with relative components and the behavior are listed below-
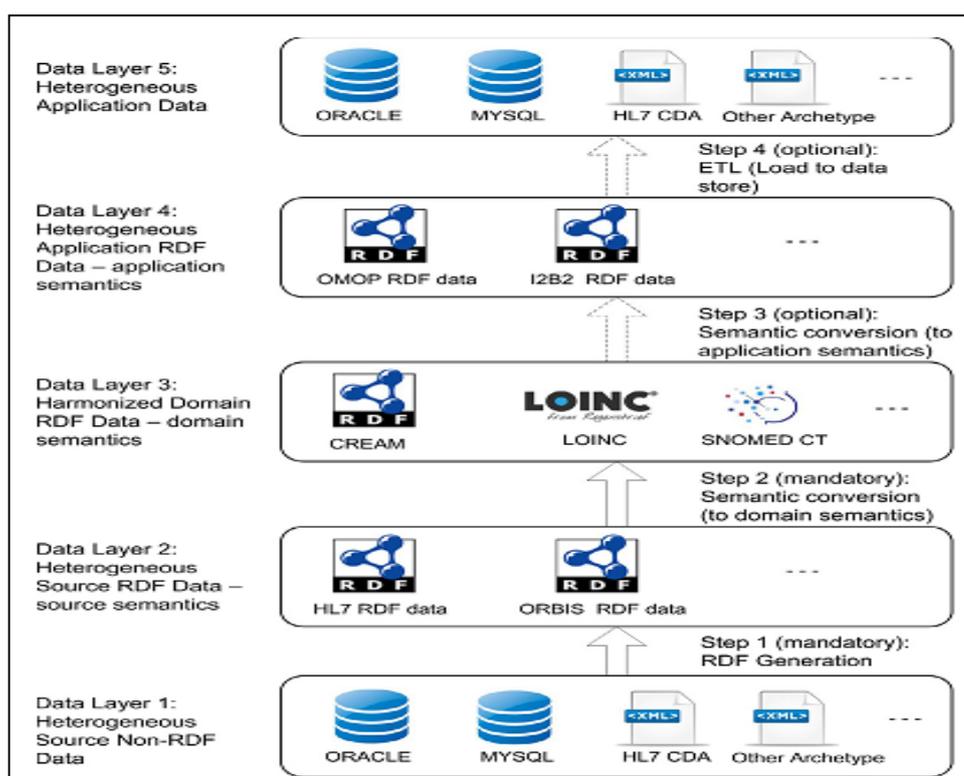

Figure 1: Healthcare Data Management architecture

1. **Data Layer 1**

In this layer, the EHR data is represented in different non-RDF formats. The data is represented as the core data repositories such as the relational database system or the XML data form. The patient data is stored in the form of tables or XML files. The data warehouse is defined to maintain the patient data, hospital data, disease data, treatment data and doctors data. The data in this layer is present in raw form. The data can be in different forms by using different database system including my sql, oracle etc. The detail or the partial information can be stored in this dataset. This raw data is selected as the abstracted which requires the preprocessing to select the appropriate and normalized data form. After collecting data in this raw form, the first processing behavior is to convert this data to RDF form using native representation. The RDF transition map the data architecture of layer 1 to layer 2 as shown in the figure 1.

2. **Data Layer 2**

In this layer, the heterogeneous data collected from various source is represented in normalized RDF format. The ontology specific and protocol specific transformation is done in this stage such as HL7 RDF data form. The source ontology based ontology is defined to perform this one to one mapping. The database schema and the policy specific mapping is applied in this stage. The features of this Relation DB to RDF transition are

- The mapping of relation DB table to RDF class.
- The columns of the table are mapped to RDF property.
- The data types of these columns are mapped to XSD type of class. The range specific constraints are also applied.

The semantic conversion to heterogeneous data form is also applied for the normalization of data respective to domain specification transition. The transition is also done respective to the involved parties.

3. Data Layer 3

In this layer, the accepted normalized RDF data is transformed to the domain semantic specific harmonized dataset. The domain specific and the platform specific constraints are applied on it for the semantic mapping. The maximum interoperability is applied for generating the mapped result. The expression codes are defined to perform the semantic mapping and local coding to achieve the standard coding map. The semantic mapping is also achieved in this stage. The standard patterns or codes are applied for this semantic mapping. The creation of this mapping is done over the reused projects. The local codes are mapped to the standard one so that the possible code specific mapping to the existing constraint is defined.

The semantic interoperability based aggregative mapping is applied to achieve the semantic feature domain map. Data layer specific harmonized semantic map is defined for relevant domain mapping. The domain specific mapping with application semantic map is applied. The clinical research based semantic conversions can be performed in this stage.

4. Data Layer 4

The RDF data representation with heterogeneous application semantic map and the application ontology specific mapping is applied. The heterogeneity is the main concern to the clinical system. The application ontology specific data modeling to the database structure can be applied. The recommendation to the source ontology is also defined in this stage. The capability of this model is to process the RDF data of layer 3 or layer 4. The lightweight mapping and job specific mapping relative to the target data repository is done in this stage. The transformation process is applied through application level semantics.

5. Data Layer 5

The clinical data of the repository is ready to use after mapping to the application data. The representational data form is provided in this form. The versatility is also achieved at this stage. The user type specific data form transition and the region specific language conversion is also performed in this stage. The application level data processing and the mapping of the patient data to the required form is done in this stage. The ample of the patient data and the database specification with direct mapping is defined with better representation. This stage or data form is actually processed for the query. The expressiveness of this data form is better with more semantic and logical mapping. The transition of data of this layer is directly done to the actual stored data. The complex rules are applied for improvement of data retrieval from the system.

IV POPULAR STANDARDS IN HEALTHCARE SYSTEMS

There are number of protocols or standards that provide the management of healthcare records in a distributed environment. The protocol or the standards are not only used to store the health records electronically. The protocols are able to handle the complexities of health care system including the multi value attributes, format independent data storage etc. Some of the popular protocols or standards are listed below:

4.1 Health Level 7 : *HL7 v2.x,v3.0*
It is used for Data Exchange Messaging.
It is a messaging standard for clinical exchange of clinical data.

4.2 Digital Imaging and Communications in Medicine (*DICOM)*
It is used for Radiology Messaging.
It is a common language structure for sharing Radiology images.

4.3 Institute of Electrical and Electronics Engineers (*IEEE)*
It is used for Medical Device Messaging.
 It is a common messaging structure used for sharing medical device communications.

4.4 National Council for Prescription Drug Programs *(NCPDP)*
It involves Prescribing Messaging. It is a standard used for exchanging prescription0related information. It allows to facilitate online prescription also.

V CONCLUSION

The electronic health record system is very beneficial and crucial to maintain the patient records in collective form that is capable of providing instant information. Various types of protocols and frameworks are also available to manage and distribute the health information among different organizations and stakeholders. In today's advanced and hyperconnected world, electronic healthcare system will provide a framework to develop a system which helps the patients, doctors, health organizations etc. to connect with the world by using different models and by developing a framework using NLP ,java and other languages or by making desktop applications ,cloud computing etc in the medical or clinical area.

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