A Solution to the Distribution and Standardization of Multimedia Medical Data in E-Health

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Abstract

Electronic Patient Record (EPR) is an area of research in E-Health that is progressing rapidly due to its demand and rapid growth of Information Technology used in the Health Management Organizations (HMO). Benefits of having EPR are the timely access of critical data, inclusion of multimedia, and the ease of availability and distribution, those making it more presentable, distributable, efficient and cost-effective. A number of studies, ranging from global standardization of EPR to the building of the infrastructure to support it are being implemented. Along this trend, this paper discusses the problem in medical data standards and distribution. The proposed solution is an application that can adapt to the data used in the HMO that has the ability to automatically generate distributable EPR from any medical data.[1]

Keywords: Distribution; Electronic Patient Record (EPR); E-Health

1 Introduction

Electronic Health (E-Health) is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. The EPR has significant contributions to the development of the E-Health by being a medium to allow communication throughout the HMO including hospitals and the general practitioners (GP). The term EPR means the electronic collection of all diagnostic reports including multimedia such as Digital Image and COMmunication (DICOM), 3D image set, Voice recording as well as Health Level 7 (HL7) of an individual patient's entire medical history combined into a universal report in an electronic format (Sokolowski 1999). Through the use of EPR, HMOs objectives are to improve the overall quality of care by simplifying the availability, accessibility, and distribute-ability of the patient records, as well as management and presentation.

The value and importance of EPR have been repeatedly demonstrated around the world with many successful implementations (Jonher, Muller, and Reinshagen 2000) and in a recent survey (Brelstaff, Moehrs, Anedda, and Tuveri 2001) it clearly demonstrates the urgency and desire for the use of electronic form of medical records due to its benefits. The main drive behind the EPR is the lack of efficiencies the modern paper-based medical record have in terms of cost-effectiveness, distribution, reliability, data representation and content. EPR in its ultimate aim is to have a standard that are to be used in the entire HMO. Attempts at standardizing medical data has emerged and succeeded, such as the HL7 and DICOM, however there are many other alternatives and departmental specific data formats. This means that to exchange EPR successfully, all partners involved must comply with each other's standards, where the partners are hospital staff, GP, and the public. Also the adoption of Information Technology (IT) is not allowing for easy translation into the electronic reports with information systems within the HMO being distributed systems with the lack of integration for interoperability.

Current research in EPR concentrates on the new framework of medical data, developing a standardized definition for the syntax of communication between the trading partners, and the design of information systems architecture that can support such derived scheme. This paper will focus on the distribution of EPR, devising a solution that can handle all variety of medical data and create a Network distributable EPR (soft copy) or as a digital format into CD-ROM (hard copy). Presenting a system-independent application that has the ability to be used in any information system of the HMO and with the existing medical data means that there are no requirements of new system architecture and framework respectively. The EPR can be distributed via the Internet and the World Wide Web (WWW) but due to large quantity of information for networking and security reasons, hard copy as an option of distribution is available.

2 Methods

There are many medical data types used in the HMO, where each department and medical services has its own data set such as the Radiology department's reports, Nuclear Medicine department's Images, Customer reception department's billing (etc), and Patient history reports from local GP. A typical patient may require services from multiple departments in the hospital where each department produces it's own data sets during

his/her stay. This means there are many different data sets produced as well as a lot of requirements for distributions of these data. The distribution of the data are transferring of the data from departments to departments, to Local GP, to the outpatient, and for permanent storage.

The proposed method is a possible solution to the current difficulties in the distribution and the standardization of the medical data by generating a patient reports ready for distribution using any format of data that can be used in the HMO information system (Figure. 1). This solution is discussed in the following sections.

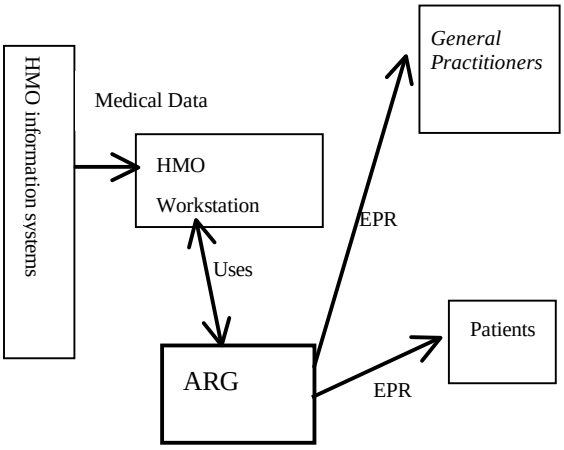

Figure 1: System architecture to the HMO in archive distribution and standardization.

2.1 Adaptive Report Generator (ARG)

ARG is an application that can be used with computer workstation of the HMO that generates an EPR with any number of the medical data formats provided. The process of report generation includes data parsing and report presentational transformation. The functions of the processes and the design and implementation details are described in the following sections.

2.2 Medical Multimedia Data Parsing

There are many varieties of data included in the EPR that needs to be organized and structured for presentational and distributable purposes. The input data to the ARG will be first identified for its data format and then parsed into an XML document to express medical data to a structured and manipulative format that is both human readable and optimized for machine interpretation. XML, developed by the World Wide Web Consortium is a powerful hierarchical data model that allows documents to be self-describing, manipulative and provides the rules for integrity (WWW Consortium).

The parsing is done towards all medical data that has textual information such as DICOM and HL7 messages, ASCII text messages, and markup language such as HTML. HL7 and DICOM has grammar definition file that consists of structural representation of the data but for other types, similar grammar file is required. Once it is parsed, the data is then inserted into a formatted structure that holds header information (extracted from the parsed input) and original unparsed data. For medical data without any textual information such as GIF images, 3-D volume representation etc, the header will be applied only containing information that can be extracted such as the data type, date of creation, patient name etc. The ARG can be customized to allow inclusion of data sets that are not supported. These customized formats uses similar header as non-textual data formats. (Table. 1).

```
<DATA>
  <URI>file:/D:/Thesis/vip/app1/io/rpa2.hl7</URI>
  <FILE_TYPE>2</FILE_TYPE>
  <FILE_NAME>rpa2.hl7</FILE_NAME>
  <REPORT_INCLUDE>true</REPORT_INCLUDE>
  <DATA_COMMENTS />
- <hl7>
  + <MSH>
  - <PID>
      <PID_field3 title="MRN_Total">0242915</PID_field3>
      <PID_field5 title="Patient_Surname">Ward</PID_field5>
      <PID_field5_2 title="Patient_First_Name">Neville Duncan</PID_field5_2>
      <PID_field7 title="Patient_DOB">19321115</PID_field7>
      <PID_FIELD8 title="Patient_Sex">M</PID_FIELD8>
      <PID_field11 title="Address">4/21-23 Canara Avenue</PID_field11>
      <PID_field11_2 title="Suburb">Phillip Bay</PID_field11_2>
      <PID_field11_3 title="State">NSW</PID_field11_3>
      <PID_field11_4 title="suburb_ID">9444</PID_field11_4>
    </PID>
  + <PV1>
  + <ORC>
  + <OBR>
  - <OBX>
      <OBX_field5 title="Conclusions">There is a single focus of markedly
        increased FDG uptake adjacent to involving the R hilum - there is no
        evidence for mediast</OBX_field5>
    </OBX>
  + <MSA>
  + <QRD>
  </hl7>
</DATA>
```

Figure 2: The XML document from the parsed input of the HL7 document.

Any data that is not in digital format such as old records and GP's letter wanting to be included in the EPR, the data must be made into digital format either by scanning of the data or by converting them into textual format using a word processor. This is a problem that all studies in the EPR are facing and without a suitable solution (Hasman, Tange, Visser 1998). Figure 2 displays the header content for a typical report. The EPR created by the ARG is not intended to have every records of the patient (full EPR) but the records that are to be distributed between intended audiences.

Once all the data is collected, they are then merged together to form a single XML document. In this stage, the user may customize the presentational format of the data.

2.3 Presentation Transformation

This is the process of formatting the XML document into presentable report format. There is default formats available including: to outpatients; referring GP; and all the different departments/services of the HMO where each type of audience requires certain information and has different interpretation as well as criteria. For example presentational format to the outpatient will omit all technical information about the procedures involved in the operation and after treatment whereas these are crucial information to the GP and hence included for the GP distribution. Another format is the storage, compressing all the data together for optimal space efficiency. This presentational transformation is achieved using XML Style-sheet Language for Transformation

(XSLT), allowing transformation to other formats, such as HTML and the Portable Data Format (PDF).

The final product will be a distributable package containing a single HTML patient medical report and related medical data. The report contains the extracted information from the specified data and all the links to all the referenced data. The information towards the report is mainly extracted from the HL7 message, a standard format for clinical diagnostic report. The distribution of the EPR can be either in Electronic format using networks of the hospital or in cases where it needs to be physically distributed such as to the referring physicians, in CD-ROMS. The affordability of CD's and with its wide acceptance, it is an ideal option. Another alternative is the traditional printed material.

Data type	**Definition**	**Integration**
DICOM	Widely accepted medical imaging and communication standard.	DICOM has a detailed header that contains the information about the patient, image examination and diagnosis. This information will be extracted for the report.
HL7	Standard used in medical field for mostly textual information.	Messaging standard for information exchange between disparate clinical, administrative and financial computer systems for the healthcare industry. All the information in the HL7 message are used for the report
Other image formats (gif/jpeg) *	Common image formats	Image type, color, dimension, resolution and any related comments (either in a related document or directly inserted)
Other textual formats (txt/html/ word/rtf) *#	Common formats for textual representations	File type, word count, date produced etc. Potential to extract much more data but must be accompanied by a grammar standard
Voice Recording (wav/midi) *	Voice data formats	File type, recording length, bit-rate, date, size and additional comment from the user.
Cine Sequence (Mpeg) *	Movie stream data format	Frames, encoding algorithm and all of the 'Other images' information.
Custom data format. *	User defined file format.	Includes type, date, size and additional comments by the user.

** Must accompany with information on Patient identity number (PID) and Department where the data is from*

 # There must be a grammar standard used in the textual data so that information can be extracted in the parsing process.

Table 1: Integration of the data type in to the report.

3 Results

The proposed ARG can be used on the workstations of the HMO that contains or has the access to medical data. Medical data are loaded into the ARG, which is parsed and merged into a single integrated report. The ability to allow selection of information to be included in the report as well as inclusion of multimedia and additional comments are supported (Figure. 3). Depending on the type of audience the report is intended, there are presentational templates available with the report being generated containing the information that are appropriate and necessary (Figure. 4). The report produced is the summary of the entire content of the EPR. The report displays the patient detail, examination report, patient history, multimedia data (images, voice cine) and the links to retrieve the data.

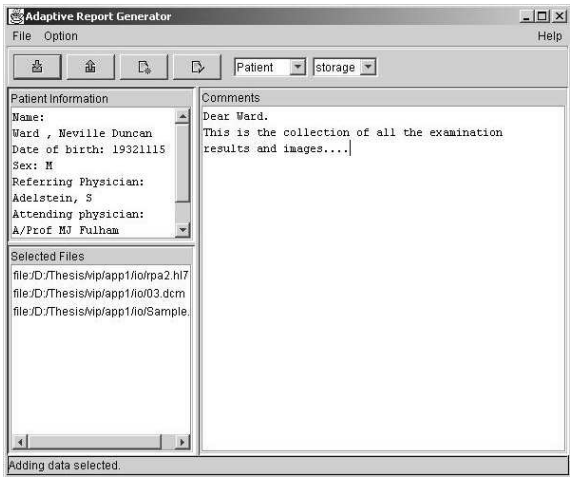

Figure 3. ARG interface.

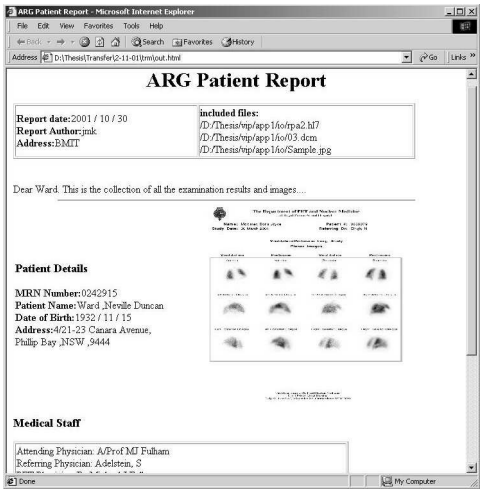

Figure 4. Automatically generated patient report.

4 Conclusion and Future work

The design of an application that automatically generates electronic patient record from the usage of any form of medical data has been presented in this paper. The use of ARG can resolve the difficulties in the distribution and standardization of the medical data by being adaptive to its environment in terms of data types used and its intended audience. The benefits that this system brings to the HMO are the efficient distribution and the standardization requirements of the medical data within the HMO. Evaluation with large variety of medical data as well as functionality and usability has been conducted with positive results.

The use of the ARG thus far has shown the need to be integrated with the information systems of the HMO to utilize the advantages of data accessibility and sharing. In the future, the ability for the ARG to communicate and access the information systems within the HMO will be evaluated. Another interest rises in the adoption of data mining techniques, which can be used in enhancing the report presentation by providing historical, statistical and related data that can assist in decision making.

5 Acknowledgement

This research is supported by ARC, UGC and CMSP Grants.

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