Design and Implement a Generator with Clinical Document Architecture standard

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***Abstract*—Electronic Health Record (EHR) allows the health records to be easily integrated, shared and exchanged between health institutions. However, the system heterogeneity and the lack of standards present the current challenges which hinder efficient exchange of medical information between institutions. Health Level 7 (HL7) Clinical Document Architecture (CDA) is a renowned exchange standard. Presently, there are many studies regarding CDA to resolve the problem discussed above. This paper implements a tool to simplify the CDA generation and provide a friendly user interface. It is divided into three main parts: Template Designer, Mapping engine and CDA Generator. The CDA tool helps users to create and edit the template (e.g. discharge summary) through an efficient user interface. In addition, it maps the CDA elements to the field of the legacy information table. Ultimately, the CDA generator generates the CDA documents and saved as XML files. The application of CDA as a promising standard in the hospital environment ensures the efficient exchange of health records.**

Keywords-CDA, HL7, EHR

I. INTRODUCTION

The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting [1]. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports. Recently, EHR has become more and more popular in the health institutions; it saves manpower, it improves the lack of storage space of paper-based records, and the most important thing is it made the medical record more easily to be exchanged between institutions [2]. To date, lots of studies have focused on how to exchange EHR between medical institutions. Although the EHR seems to bring more efficiency for exchanging information between various actors in the healthcare domain, the heterogeneity between different systems and the lack of unified standard are still the most challenging problems currently.

Health Level 7 (HL7) Clinical Document Architecture (CDA) is a well-known exchange standard that defines the conceptual classes. CDA is an XML markup standard that specifies the structure and semantics of "clinical documents" for purpose of exchange [3][4]. CDA became an ANSI-approved HL7 standard in May 2005. It derived from the HL7 Reference Information Model (RIM) and used HL7 v3 data types.

Since CDA has been widely used in exchanging medical information in the international community, more and more countries implemented it as a standard of exchange. Presently, major implementations are PICNIC (European Union), SCIPHOX (Standardization of Communication between Information Systems in Physician Offices and Hospitals using XML, Germany), Aluetietojärjestelmä (Finland), Mayo Clinic (USA) and so on. SCIPHOX is the Germany project [5][6][7] and it specifies the use of the CDA as a generalized international standard in the national context of discharge and referral letters.

Apart from those mentioned previously, there are also lots of studies used CDA to improve the exchange between different health institutions. In 2002, Grace and Michael used CDA for exchanging discharge summary and developed web-based platform to display the discharge summary [8]. In 2004, Marcel created CDA conversion engine to generate CDA document, and used CDA-based data for exchanging information between mobile devices and Health information systems (HIS) [9]. In 2006, Jing-Jia Lin proposed a study on web services based CDA for medical information exchange system [10]. In 2007, Ji Hyun proposed using CDA entry for semantic interoperability [11]. These studies all demonstrate an important role of CDA in medical information exchange. Nevertheless, the CDA documents used in these studies were either generated manually or created by other software (Figure 1). If the data is too large, the manual generation is inefficient.

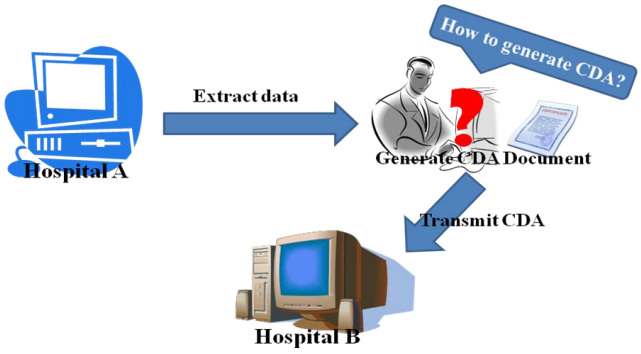

Figure 1. Document exchange procedure

In this study we followed the CDA standard to develop a CDA tool with friendly user interface. The CDA tool provided a platform for users to create and edit the template by themselves and generate the CDA document. We

anticipate that using the CDA tool developed in this study would greatly simplify the current CDA generation process, which also promotes CDA to be a promising standard in the hospital environment, so the health records between different institutes could be exchanged without difficulty.

II. METHOD

The CDA tool was implemented on Apache Wicket Framework Version 1.4.5 (component-based web framework) and Apache Tomcat (web server) using the JAVA programming language JDK 1.6. The CDA tool architecture is shown in Figure 2. Firstly, user uses Template Designer to design a new template or edit an existing template (e.g. discharge summary, progress note). In this step, a CDA template is generated and saved in XML files. Secondly, the records in the HIS database are mapped to the corresponding CDA items in the template by the mapping engine. Finally, the CDA generator generates a valid CDA document and saves it to the repository.

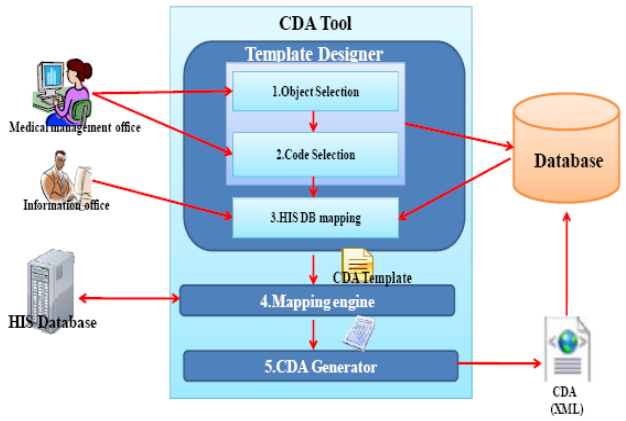

Figure 2. System architecutre

The CDA tool includes three main parts:

1) Template Designer: it provides a friendly user interface to let user easily create required template. It displays the tree format of the CDA schema (see Figure 3) and Field Module. If the user is not familiar with the CDA schema, Field Module is used to create the template instead. Field Module, like Patient Module, includes all related item of a patient (e.g. patient name, patient telephone). Template Designer has three functions:

a) Objection Selection: it shows the CDA schema and the commonly used fields (e.g. patient name, provider name). The user can select the suitable elements according to different forms (e.g. discharge summary, progress note).

b) Code Selection: our system used LOINC as the code standard. Each CDA section needs to be mapped to the related code (e.g. the Diagnosis section's code is 29548-5).

c) HIS DB Mapping: it mpas the CDA element to the fields in the legacy information table.

We suggest Ojection Selection and Code Selection to be edited by medical information management office and HIS DB Mapping to be edited by information office. In addation, Template Designer also provides the functions to save the template information as XML files, so that next user can reuse and modify the exsiting template.

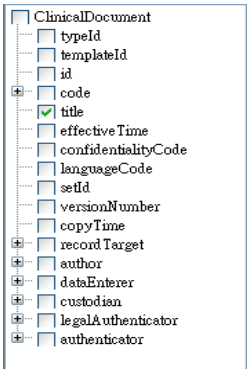

Figure 3. Tree format

2) Mapping engine: it processes the mapping between HIS items and CDA items. It adaptes the mapping engine from Muller *et al.* [3], where each CDA item is mapped to the HIS item (e.g. CDA item birthday is patient_birthday in HIS) and the data is extracted from HIS for CDA generation (Figure 4).

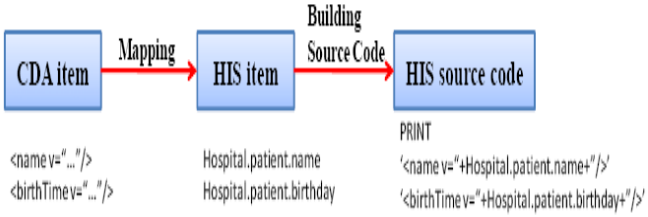

Figure 4. CDA/HIS mapping engine

3) CDA Generator: it generates the resulting CDA document and save it as XML files.

III. RESULTS

The CDA tool developed in this study provides the capasity to directly connect to HIS and extract the data needed. It also provides a user-friendly interface to let user easily create a CDA document. When using the CDA tool at the first time, the Template Designer is used to help to generate the desired CDA template where all the necessary fields from the clinical forms (e.g. discharge summary) are included upon selection (Figure 5). The left panel shows the CDA schema and the right panel shows the Field Module. After the template is created, the information from the legacy database is extracted and mapped to the related fields by the mapping engine. Once the mapping process is finished, a CDA document is generated by the CDA generator and saved as an XML file (Figure 6).

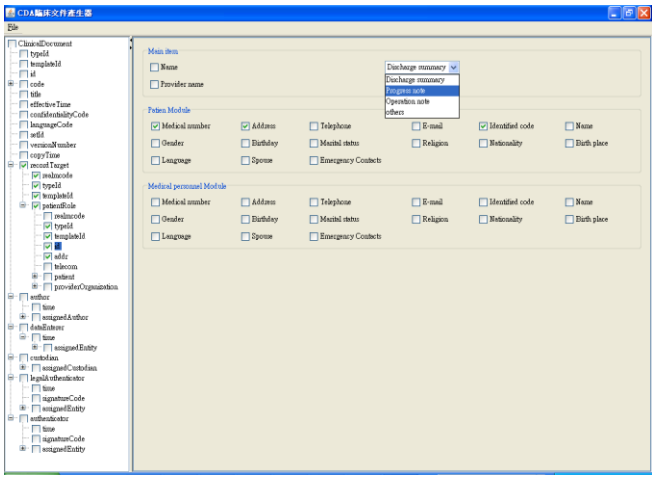

Figure 5. Initial screen of Template Designer.

Figure 6. An example of the CDA document.

IV. CONCLUSION AND DISCUSSION

To date, CDA is still a great solution for exchanging data between different health institutes. The CDA documents include not only text, but also images, sounds, and other multimedia contents. It significantly improves the problem of semantic interoperability. However, manual CDA document generation requires additional manpower and is a time-consuming process.

Our CDA tool provides a friendly interface and many useful functions to help a user to generate the CDA document more easily and efficiently, such as providing the means to save the template information as XML files, so that users can reuse or modify the exsiting template. It greatly simplifies the current procedures on the CDA document generation, thus reduces the processing time and saves manpower. Nevertheless, the CDA tool implemented in this study will be continuously developed by adding more useful functions, such as alerting user with a misuse of elements, attributes, and values, in the future.

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