

Design and Implement Web Services for Sharing Standardized Medication Information between Enterprises

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Abstract—Duplicate medication between enterprises not only waste medical resources, but also endanger patient safety. Recently, Department of Health advocate about patient safety and the medication safety is also a part of patient safety. However, medication information may come from different medical institutes and use different terminologies. The majority of patients did not know the name of these drugs, and to other doctors, may also not understand medication information content. In order to avoid duplicate medication, drug allergy or other drug incidents, this study hope to implement web services for sharing medication information between enterprises base on IHE Cross-Enterprise Document Sharing (XDS) and RxNorm, making the medication information corresponds to the standardization. Through the consistency of the standards, the doctor could refer to a complete medication record of the patient in past when prescribe in order to avoid duplication or drug allergy. Patients in recent years for their own health management consciousness, this service also provide duplicate medication check automatically.

I. INTRODUCTION

After diagnosis, medication is one of the most common therapies of medical treatment process [1]. In 1995, the National Health Insurance (NHI) was launched in Taiwan. Some patients often go to different hospitals because their symptoms were not relieved in a short time and the low copayment subsidized by the NHI makes it more convenience to access the hospital [1]. As a consequence, the number of times in receiving similar or same medicine for a single patient has been increased more frequently.

However, under the NHI policy, duplicate medication has become a common phenomenon in Taiwan [1]. Recently, Taiwan Healthcare Reform Foundation (THRF) found that the practice of medicine registration and check in NHI IC card are not operative, and self-medication records management and the concept of general practitioner (GP) has not become widespread. These lead the amount of duplication medication in Hypertension, Diabetes, and Hyperlipidemia reach 2.7 billion NTD during 2006 to 2008 (clinics were not included) [2].

In 2008, the NHI statistics reported the average access to health care resources for each patient is about 15 times, which created a new high in the past nine years [3]. The opportunities for a patient taking varieties of drugs in a short time would also be increased simultaneously. Therefore, the events of duplicate medication, drug-drug interaction, and

drug allergy may be happened. These medication errors may expend much more medical costs because patient's medication information in different hospitals has not in circulation yet.

Although Electronic Health Records (EHR) and Personal Health Records (PHR) include medication information, the complexity of drug information and the continuous developments of new drugs make it difficult for most healthcare providers follow all of the medication and their related properties. Even if the hospitals agree to share information between each other, they may use different brands of drugs or they may create custom drug code to facilitate the operation, which also lead the physician to misunderstand the information.

Duplicate medication not only reflects the public does not understand what their own prescriptions, but also shows the use of the health care resources by medical institutions is not strictly examined. This pattern, deviated from the medical patient-centred care concept, not only makes it impossible to cure patients from their illnesses, but lets it become more dangerous to their health and safety [1].

The aim of this study is to develop a standardized medication repository based on Cross-Enterprise Document Sharing (XDS) architecture provided by Integrating the Healthcare Enterprise (IHE). The system utilizes RxNorm web service API [4] to convert medication list into standardized medication information and stores it as a CDA document with entry level in the standardized medication repository. When a patient visits cross-enterprise, the physician can query the patient's previous medication information to avoid duplicate medication. If the patient has questions about medication during this period, he or she can also access the system to obtain more detailed information and avoid the duplicate medication. Therefore, it effectively saves health care costs, and protects patient safety.

II. METHOD

A. Cross-Enterprise Documents Sharing

IHE was established by Radiological Society of North America (RSNA) and Healthcare Information and Management Systems Society (HIMSS) in 1998. IHE provides a framework for medical information interoperability [5]. XDS, one of the Integration Profile in the Information Technical Infrastructure domain, describes protocol about clinical document delivering and sharing between enterprises.

It recommends the use of the current information standards, such as Health Level 7 (HL7), ebXML, HTTP, SOAP and so on. IHE XDS Clinical Affinity Domain stands for healthcare enterprises agree to comply with the same policies and use a registry and repositories for sharing documents. The policies include document format, document metadata, patient identity etc.

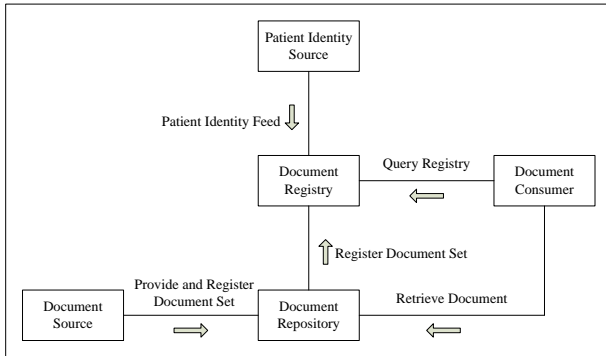


Figure 1. IHE XDS Technical Framework

There are five actors and five transactions in IHE XDS Technical Framework (Figure 1). Patient Identity Source provides each patient a unique identification. Document Source represents a document provider, which sends a clinical document and metadata to Document Repository. Document Repository registers the metadata to the Document Registry. Document Consumer queries the clinical document from Document Registry.

B. Clinical Document Architecture

Clinical Document Architecture (CDA) is a document format defined by HL7. The HL7 CDA is a document markup standard that specifies the structure and semantics of a clinical document for the purpose of exchange [6]. CDA documents are encoded in Extensible Markup Language (XML) [7]. A CDA document can include text, images, sounds, and other multimedia content [6]. CDA header sets the context for the document as a whole to enable clinical document exchange across the institutions [6]. CDA header includes the document type, effective time, patient demographic, the information about author, and so on. There are one or more sections in CDA body which describes clinical reports. Each section includes a narrative block, entry, and external references. The descriptive section uses “<text>” tags for easily reading and the entry level includes machine-readable codes.

C. RxNorm

RxNorm is a standardized nomenclature for clinical drugs developed by the National Library of Medicine (NLM) [8, 9]. RxNorm is based on a model developed at the NLM in consultation with HL7 vocabulary technical committee Veterans Administration (VA). In RxNorm nomenclature, clinical drug’s name is a semantic normal form (SNF) [8], including active ingredients, strength, and dose form. RxNorm organizes data by concepts. A concept is a collection of names identical in meaning at a specified level of abstraction and is assigned with an RxNorm concept unique identifier (RXCUI)

[8]. Using concepts, RxNorm can recognize strings of characters from disparate sources to the same material.

III. SYSTEM IMPLEMENTATION

The system architecture was designed based on the IHE XDS Technical Framework and implemented by Java language (Figure 2). We implemented Document Repository and Document Registry using an open source project, freebXML Registry [10], as the central registry and the standardized medication repository. The Hospital Information System (HIS) plays a role as the Document Source to submit a clinical document and the register document metadata to the repository and the registry, respectively. Physicians and patients like the Document Consumer query the standardized medication information. The architecture of the system includes three major processes:

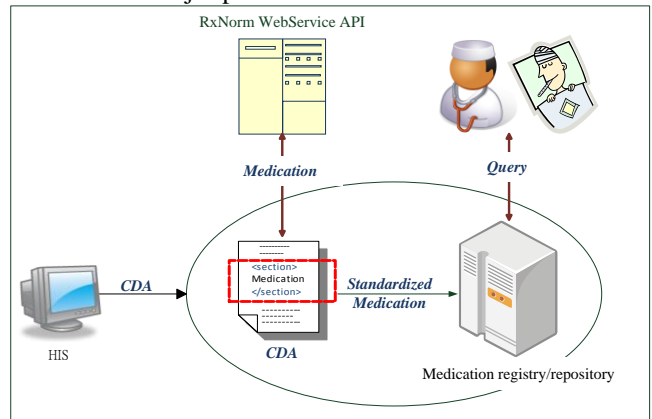


Figure 2. System design

A. Standardize Medication

The CDA document is first validated by the system and the medication section with the drug’s brand name, dose form, and strength is parsed and extracted. The system then calls the RxNorm web service API and transfers the drug information for standardization. The resulting standardized medication includes drug’s brand name, ingredient, dose form, strength and RXCUI.

B. Share Standardized Medication Information

The standardized medication data together with patient’s demographic and allergies information are saved into a new CDA document in a central medication repository. This information can be accessed from the Document Registry by physicians and patients to retrieve the complete standardized medication within certain duration.

C. Check Duplicate Medication

Because the standardized medication is stored as a CDA document with an entry level, the RXCUI or ingredient is extracted and used for checking the duplicate medication.

IV. RESULTS

The HIS produces a clinical document in a CDA format for each patient per visit. If the CDA document includes the medication list, the healthcare provider submits the CDA

document to the standardized medication repository. Before storing the CDA document to the standardized medication repository, the system standardizes the medication list and combines the results with patient's allergy information in a new CDA entry level as shown in figure 3.

```

80 <entry>
81   <substanceAdministration moodCode="EVN">
82     <templateId root="2.16.840.1.113883.10.201.24"/>
83     <effectiveTime xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:type="TVL_TS">
84       <low value="20091223"/>
85       <high value="20091231"/>
86     </effectiveTime>
87     <effectiveTime xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:type="PVL_TS" instructionSpecified="true">
88       <period value="12" unit="h"/>
89     </effectiveTime>
90     <doseQuantity value="1"/>
91     <conformer>
92       <manufacturedProduct>
93         <templateId root="2.16.840.1.113883.10.201.53"/>
94         <manufacturedMaterial>
95           <code displayName="Famotidine 10 MG Oral Tablet" codeSystemName="PatNorm" codeSystem="
96             2.16.840.1.113883.6.88" code="199047"/>
97           <originalText>famotidine</originalText>
98           </code>
99         </manufacturedMaterial>
100       </manufacturedProduct>
101     </conformer>
102     <entryRelationship typeCode="SUBJ" instructional="true">
103       <act moodCode="INT" classCode="ACT">
104         <templateId root="2.16.840.1.113883.10.201.49"/>
105         <text>
106           <reference value="#patient_instruction:1261579350"/>
107         </text>
108       </act>
109     </entryRelationship>
110   </substanceAdministration>
111 </entry>

```

Figure 3. Medication information in CDA entry level

When this patient visits to different hospitals in a short time, the physician can access the new created CDA document with 'patient id' to retrieve the patient's current medication and allergy information by defining a certain time period (Figure 4).

The screenshot shows a web browser window with the title "Standardize Medication Records" and "© Mackay Memorial Hospital". Patient information is displayed: Patient ID: A123456789, Patient Name: 陳○○, Birthday: 1980.09.21, Gender: 男. Two tables of medication records are shown for dates 2006/5/12 and 2007/10/12.

Name of Medication	Start Date	Stop Date	Amount Each Time	Frequency	Instruction
Aluminum Hydroxide 45 MG/ML / Magnesium Hydroxide 40 MG/ML Oral Suspension [Antacid Suspension]	2006/5/12	2006/5/14	1 teaspoon	Once a Day	In the Morning
Zantac 2.5 MG/ML Oral Solution	2006/5/12	2006/5/14	1 units	Once a Day	
Aspirazine 400 MG/ML Oral Suspension	2006/5/12	2006/5/14	3 ml	3 Times a Day	On Empty Stomach

Name of Medication	Start Date	Stop Date	Amount Each Time	Frequency	Instruction
Aluminum Hydroxide 45 MG/ML / Magnesium Hydroxide 30 MG/ML Oral Suspension [Antacid Suspension]	2007/10/12	2007/11/1	1 teaspoon	Once a Day	In the Morning
Zantac 2.5 MG/ML Oral Solution	2006/10/12	2007/11/1	1 units	3 Times a Day	On Empty Stomach

Figure 4. Standardized Medication Records

If patients want to know the medication information after their visits, they can also access to the web interface to obtain the complete personal medication information and review the drug information they have. The system also provides a "check duplicate medication" button to checking the duplicate medication.

V. DISCUSSION AND CONCLUSION

Maintaining the integrity of personal medication information is an important thing as increasing number of patients concern about their health information in the recent years. This study not only provides a platform for patients to manage their personal medication list but also shares medication cross-enterprises. As a consequence, reducing duplicate medication, protecting patient safety and saving medical costs become more efficient.

Because there are still some arguments on the issues related to the internal operational procedures in the hospital, this system does not integrate the computerized physician order entry (CPOE) system at the moment. Nevertheless, based on the system architecture, our system can be easily incorporated with other systems in the hospitals to alert duplicate medication immediately with agreement in the future.

VI. REFERENCES

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