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Integration of Health Information for Sharing Cda in Cloud System

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Abstract—Successful deployment of Electronic Health Record helps improve patient safety and quality of care, but it has the prerequisite of interoperability between Health Information Exchange at different hospitals. The Clinical Document Architecture (CDA) developed by HL7 is a core document standard to ensure such interoperability, and propagation of this document format is critical for interoperability. Unfortunately, hospitals are reluctant to adopt interoperable HIS due to its deployment cost except for in a handful countries. A problem arises even when more hospitals start using the CDA document format because the data scattered in different documents are hard to manage. In this paper, we describe our CDA document generation and integration Open API service based on cloud computing, through which hospitals are enabled to conveniently generate CDA documents without having to purchase proprietary software. Our CDA document integration system integrates multiple CDA documents per patient into a single CDA document and physicians and patients can browse the clinical data in chronological order. Our system of CDA document generation and integration is based on cloud computing and the service is offered in Open API. Developers using different platforms thus can use our system to enhance interoperability.

1 INTRODUCTION

ELECTRONIC Health Record (EHR) is longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or

health care provided to an individual and it can support of efficient processes for health care delivery [1]. In order to ensure successful an operation of EHR, a Health Information Exchange (HIE) system need to be implemented [2]. However, most of the HIS in service have different characteristics and are mutually incompatible [3], [4]. Hence, effective health information exchange needs to be standardized for interoperable health information exchange between hospitals. Especially, clinical document standardization lies at the core of guaranteeing interoperability. Health Level Seven has established CDA as a major standard for clinical documents [5]. CDA is a document markup standard that specifies the structure and semantics of 'clinical documents' for the purpose of exchange. The first version of CDA was developed in 2001 and Release 2 came out in 2005 [6]. Many projects adopting CDA have been successfully completed in many countries [7], [8], [9]. Active works are being done on improving semantic interoperability based on openEHR and CEN13606 [10], [11]. To establish confidence in HIE interoperability, more HIS's need to support CDA. However, the structure of CDA is very complex and the production of correct CDA document is hard to achieve without deep understanding of the CDA standard and sufficient experience with it. In addition, the HIS development platforms for hospitals vary so greatly that generation of CDA documents in each hospital invariably requires a separate CDA generation system. Also, hospitals are very reluctant to adopt a new system unless it is absolutely necessary for provision of care. As a result, the adoption rate of EHR is very low except for in a few handful countries such as New Zealand or Australia [12]. In the USA, the government implemented an incentive program called the Meaningful Use Program to promote EHR adoption among hospitals [13]. When a patient is diagnosed at a clinic, a CDA document recording the diagnosis is generated. The CDA document can be shared with other clinics if the patient agrees. The concept of family doctor does not exist in Korea, hence it is common for a patient to visit a number of different clinics. The exchange of CDA document is triggered in the following cases: when a physician needs to study a patient's medical history; when referral and reply letters are drafted for a patient cared by multiple clinics; when a patient is in emergency and the medical history needs to be reviewed. It takes increasing amount of time for the medical personnel as the amount of exchanged CDA

document increases because more documents means that data are distributed in different documents. This significantly delays the medical personnel in making decisions. Hence, when all of the CDA documents are integrated into a single document, the medical personnel is empowered to review the patient's clinical history conveniently in chronological order per clinical section and the follow-up care service can be delivered more effectively. Unfortunately for now, a solution that integrates multiple CDA documents into one does not exist yet to the best of our knowledge and there is a practical limitation for individual hospitals to develop and implement a CDA document integration technology. In this paper we present (1) a CDA document generation system that generates CDA documents on different developing platforms and (2) a CDA document integration system that integrates multiple CDA documents scattered in different hospitals for each patient. The benefits of adopting this system are as follows. First, the system is accessible through an Open API and developers can continue working on their developer platforms they specialize in such as Java, .NET, or C/Cþþ. Hospital systems can simply extend their existing system rather than completely replacing it with a new system. Second, it becomes unnecessary for hospitals to train their personnel to generate, integrate, and view standard-compliant CDA documents. The cloud CDA generation service produces documents in the CDA format approved by the National Institute of Standards and Technology (NIST) [14]. Third, if this service is provided for free at low price to hospitals, existing EHR are more likely to consider adoption of CDA in their practices.

2 MATERIALS AND METHODS

In this section, we present the necessary techniques in detail for the design, and explain the implementation of our CDA generation and integration system based on cloud computing.

2.1 The CDA Document

The HL7 Clinical Document Architecture Release 2 (CDA R2) was approved by American Nation Standards Institute in May 2005. It is an XML-based document markup standard that specifies the structure and semantics of clinical documents, and its primary purpose is facilitating clinical document exchanges between heterogeneous software systems.

A CDA document is divided into its header and body. The header has a clearly defined

structure and it includes information about the patient, hospital, physician, etc. The body is more flexible than the header and contains various clinical data. Each piece of clinical data is allocated a section and given a code as defined in the Logical Observation Identifiers Names and Codes (LOINC) [15]. Different subcategories are inserted in a CDA document depending on the purpose of the document, and we chose the Continuity of Care Document (CCD) [16] because it contains the health summary data for the patient and it is also widely used for interoperability. Notable data included in CCD .For the integrated CDA document, we chose the Korean Standard for CDA Referral and Reply Letters (Preliminary Version) format as the number of clinical documents generated when patients are referred and replies made, is large .It has the identical structure as the CCD and the types of data contained in the body are listed in Table 2.

2.2 Cloud Computing

Cloud computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services The user pays fee depending on the amount of resources allocated, such as network, server, storage, applications and services. Currently, three major types of cloud computing service exist

III CDA Genration

Interoperability between hospitals not only helps improve patient safety and quality of care but also reduce time and resources spent on data format conversion. Interoperability is treated more important as the number of hospitals participating in HIE increases. If one hospital does not support interoperability, the other hospitals are required to convert the data format of their clinical information to exchange data for HIE. When the number of hospitals that do not support interoperability, complexity for HIE inevitably increases in proportion. Unfortunately, hospitals are reluctant to adopt EHR systems that support interoperability, because changing an existing system adds cost for software and maintenance The advantages of an API service as ours are at the amount of resources that hospitals need to allocate for interoperability is minimal [26]. Therefore, offering a system that supports interoperability with cloud computing is a good alternative for hospitals that have not yet adopted EHR because of cost issues. The CDA document format a clinical information standard designed to guarantee

interoperability between hospitals, a large number of HIE projects that use the CDA document format have been undertaken in many countries. HIE projects and whether they generate CDA documents or integrate multiple CDA documents. Our cloud computing based CDA generation and integration

system has a few pronounced advantages over other existing projects. First, hospitals do not have to purchase propriety software to generate and integrate CDA documents and bear the cost as before. Second, our The Use Case Scenario and Patient Data Used for Integration Patient Characteristics service is readily applicable to various developer platforms because an Open API is to drive our CDA document generation and integration system. Regardless of the type of the platform, CDA documents can be easily generated to support interoperability. Third, CDA document generation and integration system based on cloud server is more useful over existing services for CDA document if the variety of CDA document increases. As of December 2013, there are 54 different types of CDA documents recognized by US NIST, and the number continues to grow year by year . Among 54 CDA Document Templates, the approach suggested in this paper is being tested for CCD part of CCDA and Korean Standard for CDA Referral and Reply. Ordinarily, when a new type of CDA document format is established, hospitals have to upgrade or purchase proprietary software to accommodate files in that new format. With our API

however, there is no need to change the software on the client-end; only the software at the server-end needs to be modified to adopt the new CDA document format. With the cloud-based architecture proposed in this paper, it becomes convenient to generate documents that comply with new document standards. Thus, the cloud server can readily provide documents that comply with CDA Release 3 if only the server adopts its model, data type, and implementation guidelines. As the number of HIE based on CDA documents increases, interoperability is achieved, but it also brings a problem where managing various CDA documents per patient becomes inconvenient as the clinical information for each patient is scattered in different documents. The CDA document integration service from our cloud server adequately addresses this issue by integrating multiple CDA documents that have been generated for individual patients. The clinical data for the patient in question is provided to his/her doctor in chronological order per section so that it

helps physicians to practice evidence-based medicine.

In the field of document-based health information exchange, the IHE XDS profile is predominant and our cloud computing system can be readily linked with the IHE XDS profile.

IV CONCLUSION

The service model that serves periodic PHR which is made by a medical specialist based on web service Only CDA generation function, but not CDA Integration CDA integration and generation system based on cloud computing in our paper The system that provide CDA generation and integration function independent from any specific platforms Yes converted to the string array type. This is suspected to have been caused by the IDE software of C#, which automatically makes this type conversion. Hence, the returned data needs to be as generic as possible to be applicable to as many platforms as possible.

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