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Cross-institutional document exchange system using clinical document architecture (CDA) with virtual printing method

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Abstract. Recently one patient received care from several hospitals at around the same time. When the patient visited a new hospital, the new hospital's physician tried to get patient information the previous hospital. Thus, patient information is frequently exchanged between them. Many types of healthcare facilities have implemented an electronic medical record system, but in Japan, healthcare information exchange is often done by paper. In other words, after a clinical doctor prints a referral document and sends it to another hospital's physician, another hospital's doctor receives it and scans to store the EMR in his own hospital's system. It is a wasteful way to exchange healthcare information about a patient. In order to solve this problem, we have developed a cross-institutional document exchange system using clinical document architecture (CDA) with a virtual printing method.

Keywords. virtual printing method, healthcare information exchange (HIE), electronic medical record (EMR), clinical document architecture (CDA)

Introduction

In Japan, there are many types of healthcare facilities. It is not uncommon that one patient is taken care of by several different healthcare facilities at around the same time. Thus, information about a patient is frequently exchanged between these facilities. Osaka University Hospital (2,524 outpatients visit per day, 929 inpatients stay in average) receives 19,854 and sends 11,472 referral forms per year.

These days many healthcare facilities introduce electronic medical record systems, even though the actual exchange of clinical information between them is undertaken by paper and a referral form input by a medical doctor is printed out. The patient then brings it and passes it to the staff of the current facility, and it is then scanned to store the EMR in the facilities. This process not only wastes employee resources but also gives away a chance for a doctor in an accepting hospital to read it in advance.

HL7's clinical document architecture (CDA) is a promising tool for exchanging any clinical document. To solve these problems we have developed a cross-institutional document exchange system using CDA and a virtual printing method.

1. Methods

1-1. Virtual printing method

Virtual printing is a kind of 'Printer Driver' application; thus, it is easy to install and has a high affinity to other existing systems. Our healthcare information exchange system, which uses the virtual printing method, is constructed of several components: a registration application, two cooperative applications (sending and receiving sides), a gateway server, a relay server, and a secure network. The registration application called "virtual printer," is installed into the registration terminal.

A doctor makes a document and runs the virtual printer through the same operation as he would if printing the document. At that time, the registration application contacts the gateway server and obtains information concerning such things as the document type and patient number. With this information, the virtual printer generates a PDF file (or Docuworks file which was originally developed by Fuji Xerox Co., Ltd.) and an XML file containing the meta-information of the document. Furthermore, our healthcare information exchange system meets the standard norm of the IHE (Integrating Healthcare Enterprise) as have other reports [2] [3] [4].

The relay server functions as the cross-reference manager for patient IDs containing PIX (Patient Identifier Cross-Referencing). The gateway server at each medical facility works as a substitute for the central patient information server prescribed in the PDQ (Patient Demographics Query). The XML file, which is added to the PDF file, conforms to the header of the HL7 CDA (Healthcare Level Seven Clinical Document Architecture) Release 2 (Figure 1).

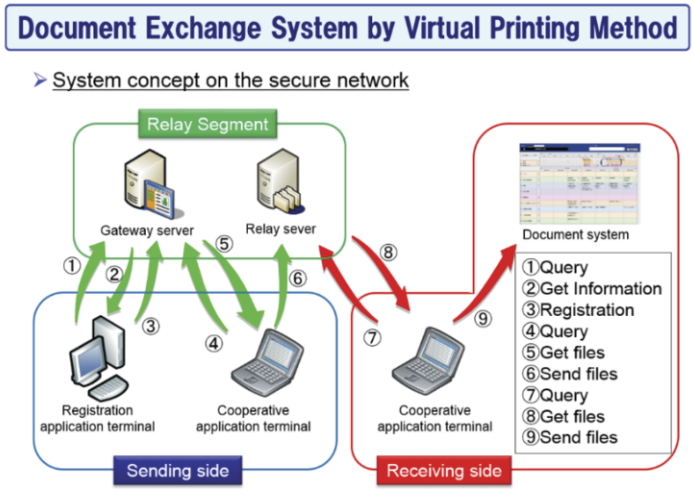

Figure 1. This is a schematic diagram of the document exchange system using the virtual printing method, which can be used for the exchange of documents between healthcare facilities. It contains four components: a registration application terminal, cooperative application terminal, gateway server, and relay server. These components' functions are shown in the figure above.

1-2. Encryption and transfer method

Then, our system compresses some files into the ZIP format and encrypts them by AES protocol. Finally, an 'enc' file is sent to a gateway server by Simple Object Access Protocol (SOAP). The Gateway server has IIS and Apache Tomcat services. The IIS service contacts the 'Oracle database' and obtains user and patient information, then sends it to each application terminal. The Apache Tomcat service has the ability to send and receive a compressed file containing both a PDF and an XML file by SOAP.

When the gateway server receives the file, the cooperative application from the sending side confirms and obtains it. At that time, it can add other files, which it sends to the relay server. The cooperative application of the receiving side regularly watches the folder concerned. When a relay server receives the file, a cooperative application obtains the files. The application can add other files in the same way as the sending side and after that, send files to a document system from the hospital's information system.

1-3. Network security

Additionally, the network system is adequately controlled by a firewall system and rooting machine. When the network transaction is constructed, an IPsec or SSL-VPN protocol is selected. Furthermore, we use a special protection system on the relay segment that serves as an antivirus, an IPS (Intrusion Prevention System), an IDS (Intrusion Detection System), a firewall, a Web application protection and as a monitor of security logs.

2. Results

This system has been implemented smoothly and effectively in one clinic and two hospitals from 2009 and over fifty pieces of referral information have been exchanged every month until now. This system has continued to run stably.

By using this system, documents generated both on paper and from applications can be electronically transferred to other hospitals via a secure network. Thus, one can browse both documents on the hospital's own information system. Furthermore, the system can adequately fix a patient's identification number at each institution.

With this method, we have been able to exchange medical information and image diagnostic reports. Furthermore, using this method, one can integrate and view all documents by a single viewer [5].

3. Discussion

The virtual printer system can convert a document into an electronic file such as a PDF, so by using the virtual printer method medical doctor can directly make an electronic document file. We have modified the virtual printer system to have a function to add XML files including meta-information of the relevant document. In addition, in the case of digitizing a paper document with a scanner, the virtual printing system can also add meta-information to it (Figure 2).

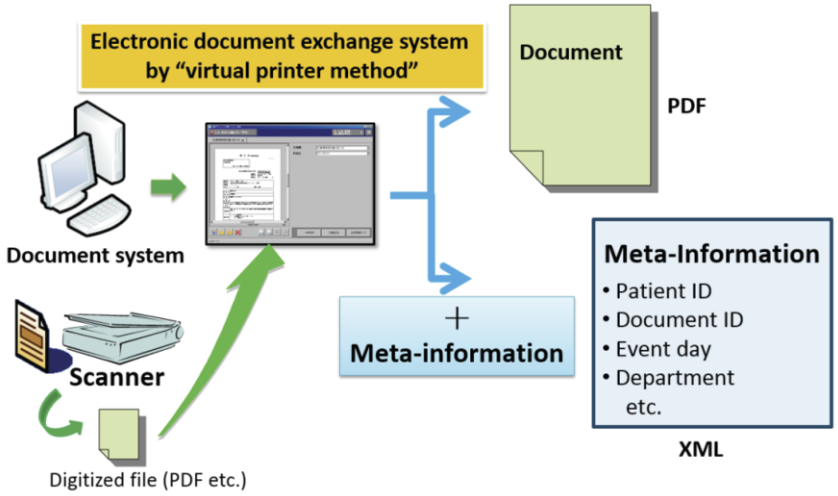

Figure 2. The virtual printer system can convert a document into a PDF file. This system is available for both PC and with a scanner. The electronic document exchange system can add meta-information files such as XML files including information from the document.

By using this electronic document exchange system doctors can send the electronic document directly to the recipient-side hospital, and furthermore the doctor can digitize a paper document, add information to it and send it electronically through the same pathway. In addition, if the doctor on the sending-side hospital prints out the document on paper and sends it to the recipient-side hospital, the recipient side staff can convert it to the electronic file in the same way. Therefore, by using this concept, doctors can integrate and refer to all documents by a single viewer.

Figure three shows the overall concept of an electronic document exchange system. In this figure, I will introduce two components, one is a "registration application", the other is a "cooperation application". These have the following important roles:

First, doctors make a document by a specified document system, then convert it into a PDF and an XML file by the "registration application", and sends files to a clinic co-worker. The clinic co-worker confirms them by the "cooperation application" and sends it two ways; one way is to the document server and the other is to the relay server. The function of the relay server is similar to that of the post office. It can save temporally the encrypted files, has a list of connecting facilities and has a "send and receive list" within its database.

The next step is, the clinic co-worker in the recipient-side hospital confirms the files in the relay server, gets and sends them to the document server. Following that process, the reverse is also possible through exactly the same process, as in this figure:

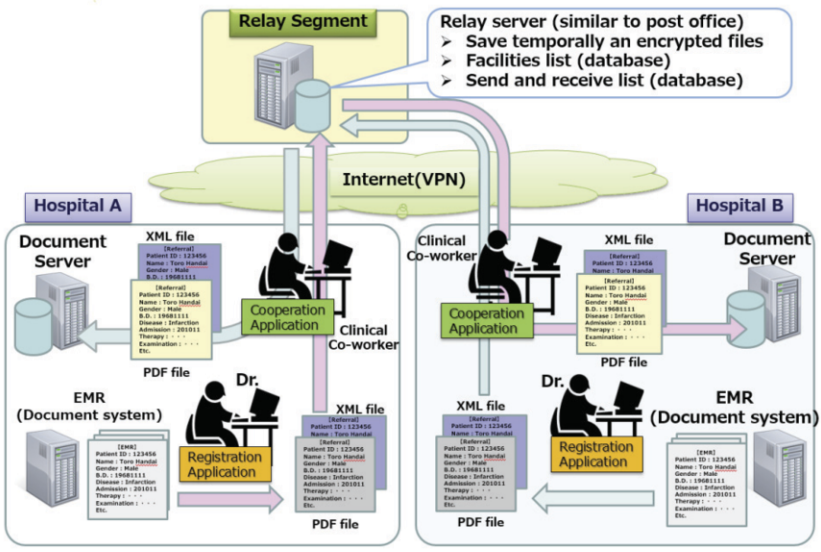

Figure 3. Over all concept of cross-institutional document exchange system.

We have built an electronic cross-institutional exchange system by a virtual printing method. It was relatively easy to install the virtual printer driver. Thanks to the electronic exchange of documents, we can now avoid the unnecessary printing of documents, making of envelopes, sending, scanning and so forth.

Generally, existing document systems doesn't have the function to send documents electronically to the other facilities, but using this virtual printer method our system can send a file electronically. After having developed our system, it is thought that document paper will still not disappear for a while. But by using our system doctors can convert them to electronic files and refer to all documents in exactly the same view. By using this cross-institutional document exchange system, doctors now have the possibility to read referral documents in advance.

References

[1] Takeda H, Matsumura Y, Kuwata S, Nakano H, Sakamoto N, Yamamoto R. (2000) Architecture for networked electronic patient record systems.Int J Med Inform. Nov; 60(2):161-7.

[2] Schabetsberger T, Wozak F, Katt B, Mair R, Hirsch B, Hörbst A. (2010) Implementation of a secure and interoperable generic e-Health infrastructure for shared electronic health records based on IHE integration profiles. Stud Health Technol Inform. 160(Pt 2):889-93.

[3] Dogac A, Laleci GB, Aden T, Eichelberg M. (2007) Enhancing IHE XDS for federated clinical affinity domain support. IEEE Trans Inf Technol Biomed. Mar; 11(2):213-21.

[4] Duftschmid G, Rinner C, Kohler M, Huebner-Bloder G, Saboor S, Ammenwerth E. (2013) The EHR-ARCHE project: satisfying clinical information needs in a Shared Electronic Health Record system based on IHEXDS and Archetypes. Int J Med Inform. Dec; 82(12):1195-207.

[5] Matsumura Y, Kurabayashi N, Iwasaki T, Sugaya S, Ueda K, Mineno T, Takeda H. (2010) A scheme for assuring lifelong readability in computer based medical records. Stud Health Technol Inform. 160(Pt 1):91-5.