Design of Radiology Referral System

Su-Yeon Cho[a], Gi-Beom Kwon[a], Jong-Min Lee[b], Il-Kon Kim[a], Yun-Sik Kwak[c], Hune Cho[c]

[a]*Department of Computer Science, Kyungpook National University, Korea*
[b]*Diagnostic Radiology, School of Medicine, Kyungpook National University, Korea*
[c]*Department of Medical Informatics, Kyungpook National University School of Medicine, Korea*

Abstract

When a patient visits a primary care hospital, the doctor refers the patient to a third care hospital if needed. After the patient discharges the third care hospital, the summary of discharge information is sent to the primary care hospital. This is the very process of the Referral System. The Referral System is helpful for faster recovery of the patient and high quality medical services by sharing the patient information. The department of Radiology uses the HL7(Health Level 7) messages to send and receive medical data. And uses the same form for reservation and the summary of discharge. But the most important data of Radiology are images. Such images are taken, stored and transferred by DICOM(Digital Imaging and Communications in Medicine)standard. The summary of discharge made by the department of radiology should include medical images. When a patient can't take images in the third care hospital, the patient is referred to a primary care hospital that has image acquisition equipments. This is the Reverse Referral. We designed Radiology Referral System considering such features.

Keywords：
Referral System, DICOM, HL7, Medical Information Exchange, Medical Image Communication, Radiology Referral System

1. Introduction

When a patient visits a primary care hospital, he may have several tests. And if other tests or intensive care are required, the doctor of the primary care hospital referring this patient to the third care hospital. In this case, nowadays, nothing shared between hospitals. In the third care hospital, patient has to talk again about his symptoms and has to get tests from the first step. It increases physical and mental stress and financial burden. And from the wide point of view of health care policy, these processes are wasteful. A Doctor who in primary care hospital refer treatment for patient to third care hospital with patient's treatment history and treat recommend. Then patient visit third care hospital, he is overhauled by doctor. When patient discharge from third care hospital, the attending physician refer the summary of discharge to primary care hospital[1]. That is the referral system.

HL7 is international standard for Medical information exchange and sharing treatment information. We use XML message for presenting medical information which is saved database in the form of HL7 message because of using platform and application independent message communication.

The import feature of Radiology is it treat medical image which is saved and transmitted by the standard for medical image. DICOM is the standard of constructing and communicating medical image[2].

When we design Radiology Referral System, we have to consider the policy for save and transfer the Medical Digital Image information. Many patients wait for take pictures, patients have to wait for a long time. But if rapid diagnose are needed, the third care hospital refers patients to the primary care hospital that has equipments. That is so called Reverse Referral.

We suggest efficient referral system and Reverse Referral System for useful to Department of Diagnostic Radiology.

2. Backgrounds

Medical Information Exchange follows HL7 standard. HL7 is the standard that plays a role of communication protocol for Medical Information. HL7 supports communication between departments in a hospital as well as hospitals[3]. And supports all kind of medical works such as patient management, Laboratories, Pharmacies, Financial Managements. If use HL7 standard, sharing and exchange of medical information between radiology and other departments that using independent systems. But it is hard to read HL7 messages because it was developed for medical systems not for human reading. To make messages readable, change HL7 messages as XML documents. To HL7 version 2.5, messages are based strings. HL7 version 3.0 now developed is XML based. But version 2.5 has tree structure that can easily change as XML.

Digital images are coded by DICOM and these images can be transmitted to other systems in the department of radiology[4]. DICOM files are displayed in specific viewers. Radiology Referral system can send and collect patient information as well as images. And offer DICOM viewer.

3. Radiology Referral System

A patient who has received treatments in a primary care hospital is referred to a third care hospital when additional tests or intensive cares are needed. In most cases, after the patient discharge the third care hospital, the summary of discharge is not shared. The doctor who cared the patient in the primary care hospital doesn't know anything about treatments in the third care hospital. When the patient visits the primary care hospital after discharge, the doctor may ask to patient about diagnoses and treatments. But most patients are non-specialist. The patient may know his diagnose. And if the patient tells about treatments, drugs and others, there can be many errors and omissions (Figure 1).
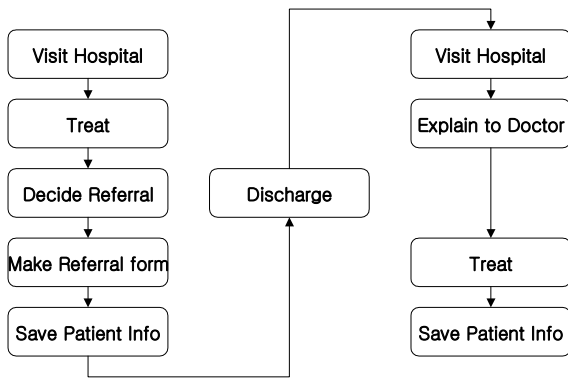
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Figure 1 Treatment process without the summary of discharge

Figure 2 Treatment process with the summary of discharge

This is one example including referral between primary care hospital and third care hospital.

Patient: an infant / 5months

Diagnosis: bronchiolitis

Reasons for referral:

Implemented medication and inhalation at the same time

but symptom aggravation, recommended an admission.

Treatments in third care hospital:

After nebulization, fluid therapy, oxygen inhalation,

Checked with x-ray and

auscultation.

Not complete improvement but relatively improvement and

was discharged

In this case, periodical care is required after discharge. But due to the patient is too young to visit crowded third care hospital, his parents return to the primary care hospital. The doctor in the primary care hospital doesn't know about prescribed medicines, treatments, x-ray images and etc. But if he knows these things, it will helpful to further care for patient. The Referral System transmits the summary of discharge to the referring hospital (in this case, the primary care hospital) when a patient discharges the referred hospital (the third care hospital) (Figure 2).
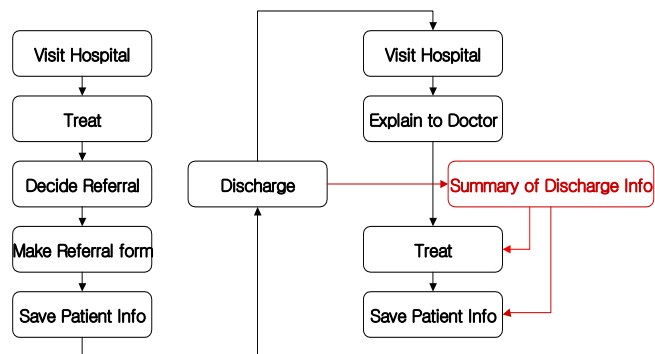
With Referring System, information about medicines, diagnosis, test result and treatments are sending to the referring hospital. The doctor of the referring hospital can know patient's reaction on medicines, progress of disease, and latest state of the patient. When the patient visits referring hospital, the doctor can observe current state compare to the summary of discharge. The information are using for prescriptions, diagnosis and treatments. The Referral System supports periodical treatment and high quality medical services.

3.1. Referral System

The basic process of the referral system is like this.
The referring hospital refers patient by HL7 messages or other refer format. The referred hospital registers, diagnoses, treatments patient with exist HIS. All results are stored DB(DataBase) of HIS. When the summary of discharge is needed, the referring hospital requests information to the referred hospital. If there is system that can process HL7 messages in referring hospital, request includes data such as IP address, port number or other information to get data through networks. The referral system in the referred hospital makes the summary of discharge with patient information, technical information, laboratory test data, images from HIS. Data communication between HIS and the referral system uses HL7 messages. The referring hospital has system that can process HL7 message and notice information for networking, the referral system send HL7 messages to referring hospital. If there is no such system, the summary of discharge is served by web as XML (Figure 3).
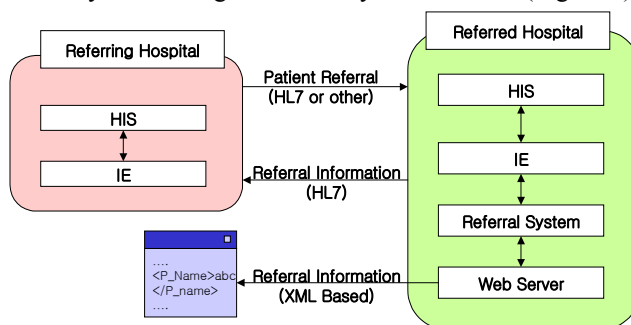

Figure 3 Message Exchange between Hospitals: Case of Using Referral System

The referred hospital's process is below.

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If a patient is referred, this patient is registered HIS of referred hospital and cured. Every steps and data are stored in HIS. When the patient discharges, this event is noticed related systems including referral system in this hospital by HL7 discharge message. After get discharge message, the referral system makes the summary of discharge. The MDM (Medical Data Management) module collects data, such as patient information, test data and others communicating with HIS by HL7 messages. The DBM (DataBase Management) module reorganizes such data to the form of the summary of discharge and stores to the referral DB. The Referral DB uses XDB (XML DataBase). The XDB is DBMS that can extract, store and manage medical data as XML documents [5].

After all process, the Referral Reply module makes HL7 message and transmit to the referring hospital. Data in the referral DB are also displayed in the web browser as XML form[6] (Figure 4).
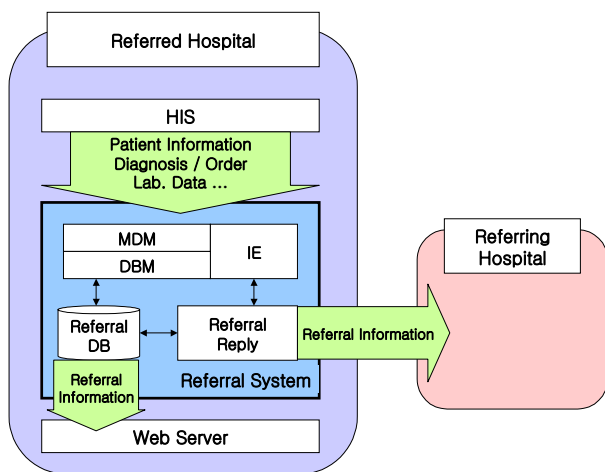

Figure 4 Architecture of Referral System

3.2 Radiology Referral System

Common radiology information appeared the summary of discharge is shown below. There is test name and diagnosis but no images. Radiology Referral System includes basic radiology data and medical images (Figure 5).

Figure 5 Radiology Test Information

And there happened Reverse-Referral that the third care

hospital refers image acquisition to the primary care hospital. When there are too many patients waiting for take pictures, patients have to wait for a long time. But if rapid diagnose are needed the third care hospital refers patients to the primary care hospital that has equipments. This is the Reverse Referral and can happen usually nowadays (Figure 6).
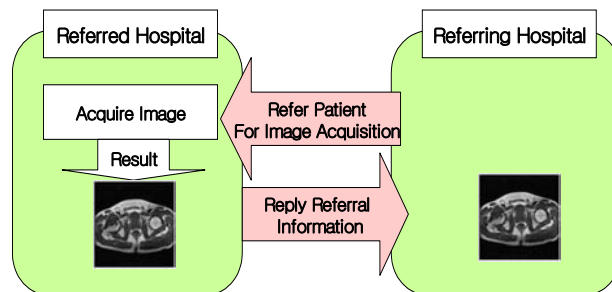

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igure 6 Process of Reverse Referral

Other data included in the summary of discharge are text based that can seen without specific viewer. But radiology images coded by DICOM need specific viewer (Figure 7).
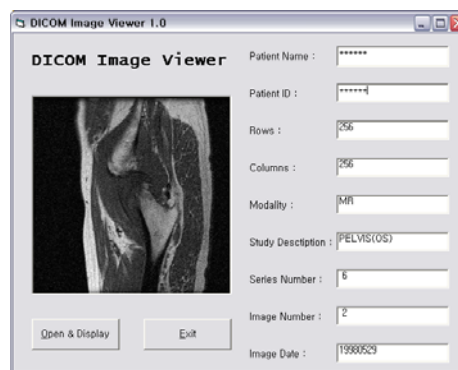

Figure 7 Example of viewing Medical Image

Images used by radiology referral system are copied from PACS(Picture Archiving and Communication System) to Referral DB when the summary of discharge is organized when referring hospital or the patient requests. In the summary of discharge, there are just the locations of images in referral DB not original files. Because if referring doctor want to know diagnosis only, send all image data is unnecessary. When the doctor wants to see images, image data are sent. If there is specific DICOM viewer in referring hospital system, the doctor can see images. If not, download image viewer control from web service[7]. This viewer search images using location information in the summary of discharge, and download image. The Location information is also collected from HL7 message (Figure 8).
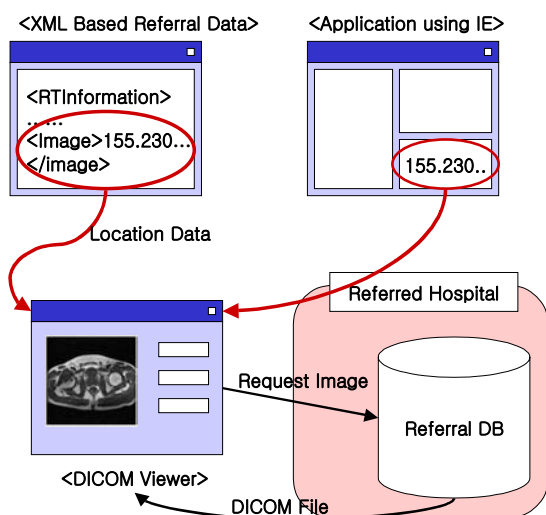
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Figure 8 Management and Communication of Medical Image in Referral System

4. Discussions and Conclusions

The agreement of patient for personal information is required when using referral system. If the summary of discharge is shared without agreement, there can be legal problems. The agreement of patient is essential problem.

We designed referral system and radiology referral system satisfying HL7 version 2.4 and DICOM version 3.0.

To make paperless hospitals, many groups and people are trying. Medical standards are developed and systems using such standards are also developed. We trust that the Referral system we suggest can be a step for paperless hospitals for the future.

5. Future Works

CDA(Clinical Document Architecture) is now developed[8]. With CDA, referral system can send the summary of discharge itself not each part of data. To support CDA, the DBM module should be redesigned.

Reliable policy for security through web is also required.

Radiology referral information includes images. Other data of the summary of discharge can be represented as XML and HL7. But images should be coded by DICOM standard. In most hospitals, DICOM and HL7 have own domain. But nowa days integration of two domains are necessary. To make a new standard including such two standard may be so hard[9]. The framework that supports each standard together are needed. And this is the IHE (Integrating the Healthcare Enterprise).

We will use several integration profiles of IHE Technical Framework. And will define actor and transaction for radiology process and patient care process to upgrade radiology referral system that can use HL7 and DICOM data[10].

Acknowledgement

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Address for Correspondence
Gi Beom Kwon, Ph.D candidate
kgb@knu.ac.kr
Su Yeon Cho, M.S candidate
csy9850@cs.knu.ac.kr
Il Kon Kim, Ph.D
ikkim@knu.ac.kr
Phone: +82-53-950-6376
FAX   : +82-53-950-6369
Department of Computer Science Kyungpook National University
1370 Sankyuk-dong Buk-gu, Daegu Korea, 702-701.

Jong Min Lee, Ph.D
jonglee@knu.ac.kr
Phone: +82-53-420-5472
Diagnostic Radiology, school of medicine, Kyungpook National University Hospital
50, Samduck-dong Jung-gu, Daegu, Korea

Yun Sik Kwak, Ph.D
yskwak@knu.ac.kr
Hune Cho, Ph.D
hunecho@knu.ac.kr
Phone: +82-53-420-6051, +82-53-420-6050
Department of Medical Informatics, School of medicine, Kyungpook National University Hospital
50, Samduck-dong Jung-gu, Daege, Korea

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