Transmural Exchange of Cardiology Related Information Between Two Academic Centers and Referring Hospitals Using XDS(-I)

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Abstract

More than 50% of the patient population undergoing a therapeutic invasive procedure in an Academic center has undergone diagnostic based procedures in a referring hospital. Until recently the medical documents were on paper and CD and sent by mail, fax or taxi.

In this paper we describe two different IHE-XDS(-I) solutions based on a network that facilitates the transmural exchange of documents as well as images. XDS is based on medical, industrial and internet standards.

Using XDS cardiologists from different centers share rather than exchange information regarding a patient, before as well as after a therapeutic invasive procedure.

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1. Introduction

A substantial part of the workload of our departments deals with invasive procedures like Percutaneous Coronary Intervention (PCI) performed by cardiologists and coronary artery bypass grafting (CABG) performed by cardiac surgeons. Xray recordings of the coronary arteries, atria, ventricles and valves as well as ultrasound recordings are used to support the diagnoses and to display the results of therapeutic interventions.

Until about 1995 the Xray recordings were made on 35mm films and the ultrasound recordings on video. The information on these media could only be displayed on special workstations. Later the images became digital and were burned in DICOM-format on CD's. Additional information like clinical findings were filled in on an application form.

Figure 1 represents the origin of the circa 3000 PCI procedures performed in 2009 in the department of cardiology of the University Medical Center in Groningen. About 60% of the PCI-patients were referred by 8 hospitals in the Groningen region (figure 2). The medical information concerning these procedures was send by mail, fax, cabs and even by ambulances. This way of transporting information involves many administrative procedures, is relatively slow and sensitive to errors.

In this study we investigated the possibilities of incorporating electronic connections in the transmural exchange of medical information in order to minimise delays and errors and therefore improving medical care.

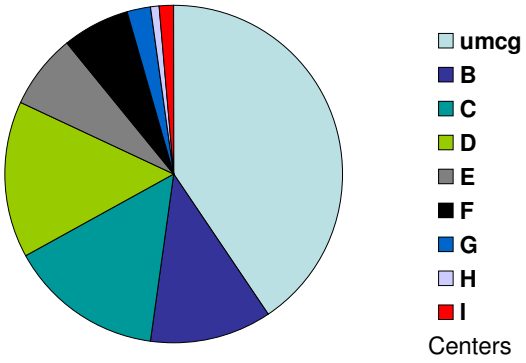

Figure 1. Origin of 3000 PCI procedures in 2009

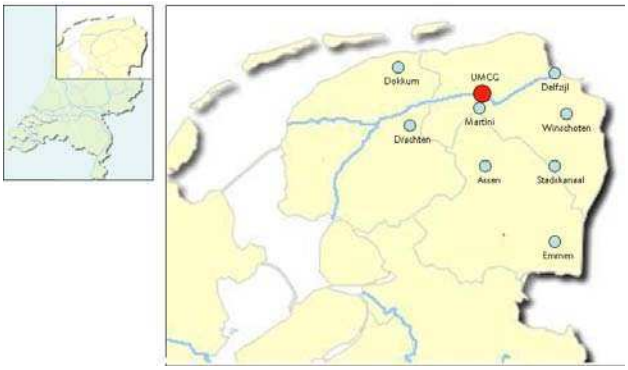

Figure 2. Groningen region in The Netherlands

2. Methods

Electronic data exchange should fulfil the following criteria: it has to be based on standards, be vendor neutral and widely supported by institutions and industry. Because more or less the same problems exist in other

areas like oncology, it should be applicable in those other medical disciplines as well.

These requirements agree well with the objectives of the Integrating the Healthcare Enterprises organisation (IHE) [1] being to stimulate the integration of the information systems that support modern healthcare institutions. The approach employed in the IHE is not to define new integration standards, but rather to support the use of standards like HL7, DICOM and IETF as appropriate in their respective domains. The IHE Technical Frameworks for the various domains (Cardiology, Radiology, Oncology, etc.) define specific implementations of the established standards to achieve integration goals that promote appropriate sharing of medical information to support optimal patient care. The IHE technical frameworks identify a subset of the functional components of the healthcare enterprise, called IHE actors, and specify their interactions in terms of coordinated, standards-based transactions. A functional unit of transactions that highlight their capacity to address specific clinical needs is called an Integration Profile.

A defined Integration Profile called XDS (Cross Enterprise Document sharing) generally addresses the issue of transmural and intramural publishing, registering and retrieving medical records. It provides for on standards based specifications for the management of these shared documents. XDS is content agnostic and therefore suitable for all kinds of medical records.

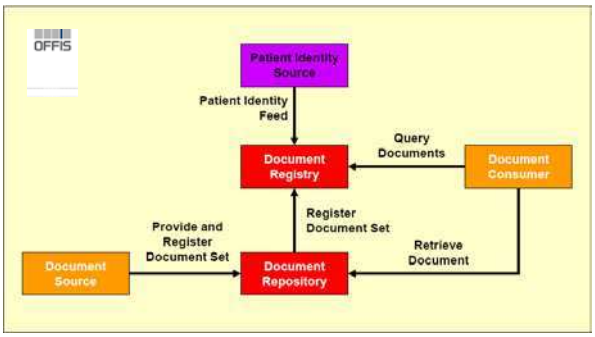

Figure 3. See text.

Figure 3 represents the basic XDS architecture composed on actors and transactions. The actors in this scheme are the Patient Identity Source, the Document Source, the Registry, the Repository and the Consumer. The transactions are the processes that take place between the different actors like providing and registering a Document Set by the Document Source to the Repository. The documents are stored in the Repository and the meta-data of such a document in the Registry. When a Document Consumer queries the Registry for a document, it receives these meta-data and subsequently retrieves the requested document from the Repository.

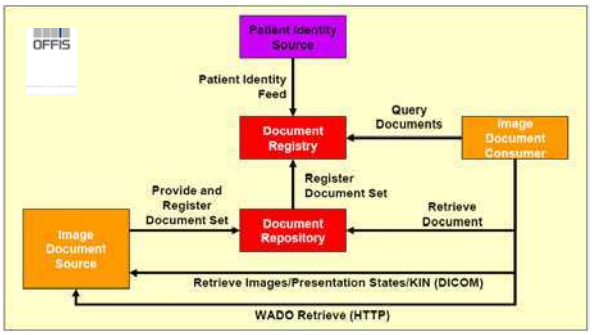

Figure 4. See text.

A specific XDS profile labelled XDS-I (Cross Enterprise Document sharing for Images) has been defined for images in order to avoid duplicate storage of large volume images. As is graphically shown in figure 4 the Repository only stores a Key Object Selection document (KOS-document) with references to the image stored in the Document Source, in this case a PACS. So in XDS-I the meta-data stored in the Registry do not refer to the actual image but to a related KOS-document which in its term contains the address of the actual image in the source PACS. The image(s) can then be retrieved from the Image Document Source through a DICOM query / retrieve protocol or its web-based successor WADO.

Table 1 displays a list of Integration Profiles additionally used to manage the system adequately.

Table 1. Other Integration Profiles

PIX	Patient Identifier Cross-referencing
CT	Consistent Time
PDQ	Patients Demographic Query
ATNA	Audit Trail and Node Authentication
PAM	Patient Administration Management
BPPC	Basic Patient Privacy Consent
XUA	Cross Enterprise User Assertion

3. Implementation

Two alternatives to implement XDS-I for transmission of cardiac related information between hospitals within the region were explored:

1. Develop the infrastructure ourselves, based on chunks of public available code [2]
2. Purchase a complete system [3]

We decided for the second alternative because the public available code was not yet suited for XDS-I. The selected company did already implement its system in another Dutch region with acceptable functionality. Next to offering the standard XDS-I software the vendor also offers a component that serves as a broker for transforming DICOM and HL7messages into XDS-format. With this component non-XDS compliant systems

can be incorporated in the XDS-infrastructure. Table 2 holds an overview of the existing equipment in the participating clinics.

Table2. Installations at the participating centers.

PACS	HIS	Cath-lab
Carestream	Chipsoft EZIS	Philips
General Electric	i-Soft HIS	Siemens
Own development		

The implementation consists out of 2 phases. The first phase concerns 3 referring clinics and our clinic, in the second phase all other referring clinics are included. The first now finished phase was divided into 4 stages from only transmitting images from the referring hospitals to the central clinic to finally sending all information back and throe.

For security reasons the hardware is placed in a demilitarized zone.

3.1. Unique Patient Identification

Each Dutch citizen has a unique medical ID number. From June 1 2009 this number has to be used by law for all cross enterprise communication. Naturally we adopted this number as unique patient ID in this project. NICTIZ, a Dutch organization to coordinate ICT in healthcare published a draft proposal [4] by the end of October 2009 about how to handle this ID number in DICOM objects. Unlike in HL7 this is not at all clear in DICOM. Companies are waiting for the definite guieline before they update their products. In order to avoid delays we acquired an extra PIX module in the broker to be able to receive this ID number by means of an extra HL7 connection with the hospital information system.

3.2. Informed consent

As a patient can potentially be referred to different clinics for a therapeutic treatment, only the clinics having a treatment relationship with this patient are allowed to view the published information. The basic patient privacy consent profile was employed to manage this issue. Each patient entry in the registry is accompanied by an informed consent form on which the sending party has indicated by means of checkboxes which receiving hospital is allowed to view the data (figure 5).

At the consumer side the available information of a particular patient is displayed in a so called document list. Figure 6 is an example of a document list where the available information exists out of a report and catheterization laboratory images. When the consumer accepts the patient for further treatment, the images can be downloaded into the consumer side PACS after adding the consumer side's patient ID.

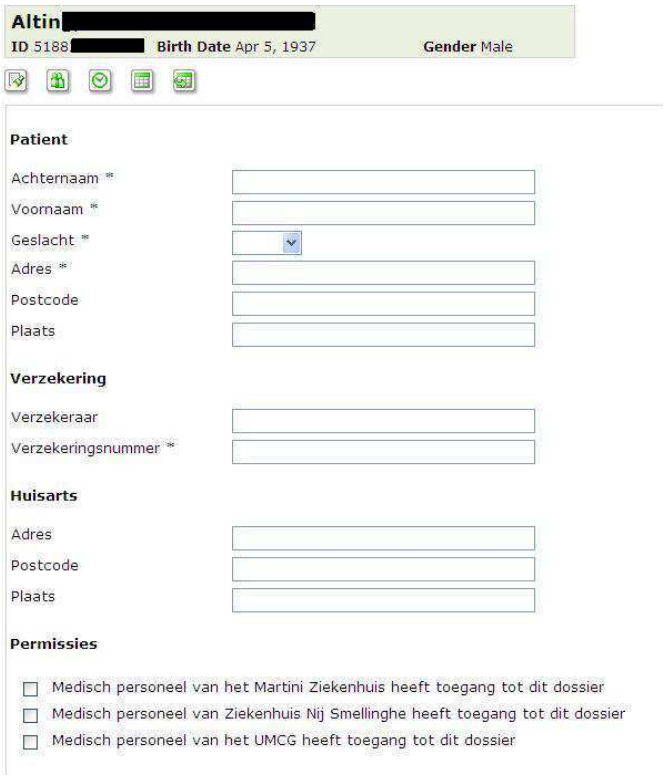

Figure 5. Patient informed consent form (in Dutch).

3.3. Data flow intervention center

We have tried to incorporated the transmural dataflow through XDS in an identical way compared to the local procedures. Information from other clinics is merged with the local workflow data of our catheterization laboratory The generation of a DICOM worklist for our catheterization laboratory equipment is generated from the combined external and internal planning system data. At the end of a procedure the result images and reports are published to the Repository and Registry. The referring hospital can view and download the information and add it to the patient files.

4. Discussion

At this moment he first 3 hospitals are at the moment using XDS(-I) for transmural exchange of cardiology related information. Administrative procedures are fine tuned and accepted by the administrative staff. Especially the steering mechanism if the informed consent form is appreciated after some adaptations. In the referring hospitals each catheterized patient is registered in the XDS system. The informed consent form regulates which other clinic is allowed to have access. This means that all processes but one are automated. The informed consent

form is the only steering mechanism through its checkboxes.

Figure 6. Document list at consumer side

A first evaluation revealed that although it functions adequately in a small setting, once the infrastructure will be expanded to more invasive centers and other domains, the solution is too rude and needs to be adjusted.

The quality of the data has been improved and the delay between the application of the patient and the treatment shows a significant decrease of 1 – 2 days!

Acknowledgements

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