

Streamlining Importation of Outside Prior DICOM Studies into an Imaging System

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Abstract A patient has an imaging study performed at one facility and has the study exported to portable media. Later, the patient takes the media to a different institution. The study on that media may need to be imported into that new institution's imaging system. This would be done to avoid a repeat examination, or so that the study can be on file for reference purposes. Importing prior studies is best performed by creating a new order on the institution's imaging system and then associating the DICOM objects from the prior study with it. In this way the prior study is actually inserted into the imaging system's electronic health record (EHR) and is properly indexed so that it can be identified and later retrieved as needed. In the past at the Department

of Veterans Affairs (VA), importing prior DICOM studies into the VA systems had been a very slow labor-intensive process that took anywhere from 10 to 30 min to import a single study. We have developed a new DICOM Importer application that reduces the manual effort to import a prior study to *less than a minute*. We have redesigned and automated the process to make it much more efficient for the user. The Importer also handles contract examinations that are ordered by the VA and performed at outside imaging facilities, with similar time savings. This work is important because it addresses one of the major unsolved problems with import reconciliation workflow: how to efficiently handle the importing of prior studies.

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Background

Patients are generally mobile and can be treated in many different healthcare facilities, acquiring medical images at each. They could be referred to other facilities for special procedures, change physicians, be on vacation and get sick, change locations, etc. There is a need for clinicians to view these prior studies and store them at their local hospital.

Statement of Problem

The classic problem is how to deal with the prior study that was performed while the patient was being treated at

another facility. The patient brings the CD containing the prior study when the patient went to the local institution for treatment. The patient's clinician (provider) determined that the outside images/studies are clinically significant and need to be included in the patient's EHR as reference images. The solution involves importing an outside study that is unknown to the local system.

A related problem is how to import the contract study which is ordered in the local system and is performed at an outside contract facility. The DICOM objects are then returned to the local institution on portable media and need to be imported. This solution involves importing an outside study that is already known on the local system.

These solutions have applicability to some other use cases as well. The solution for importing a study that is unknown to the local system can also be used for handing the unscheduled imaging examination that is performed at the local institution. Similarly, the solution for importing a known study can be used to correct the locally acquired DICOM examination that has erroneous patient and/or study identification information so that it can be entered into the EHR.

Standards and Related Specifications

The DICOM Standard, Part 10 Media Storage and File Format for Data Interchange and the Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI) integration profile specify the format and content of portable media that is used to transfer medical images [1, 2].

Part 10 of the DICOM standard requires that there be a DICOMDIR DICOM directory file on the media which contains the hierarchical listing of all of the DICOM objects that are on the media. The DICOMDIR file contains the patient and study identifiers along with some additional information (study description, study date and time, series information, institution, modality, SOP Class, transfer syntax, etc., and the file paths of the DICOM objects). The IHE PDI builds on the DICOM standard and promotes implementation interoperability. While most new devices that create portable DICOM media support the DICOM Standard and follow IHE PDI, unfortunately, some legacy PACS still generate CDs and DVDs of DICOM objects in proprietary formats. (This puts the safety of the patient at risk because it is difficult to import DICOM objects from media that fail to conform to the DICOM Standard [3].)

The IHE Import Reconciliation Workflow (IRWF) integration profile specifies the industry-standard technique for importing DICOM objects [4]. IRWF deals with known outside studies and assumes that both the patient and the study are already registered on the local system. With the IRWF, patient and study identification information is

obtained from a designated study on the local system and is then used to replace the values of the corresponding data elements in the DICOM objects that are to be imported. To provide an audit trail, the original DICOM values and some credentials are saved elsewhere in the DICOM header. The outside study's DICOM objects, now updated with the local patient and study identification, are then imported and associated with the designated study on the local system.

When importing prior studies, because they are unknown to the local system, additional steps are required. An equivalent study must be created on the local system for every unordered outside study that is going to be imported.¹ The patient and study identification information for each newly created local study is then used with IRWF to update the outside study's DICOM objects. Importation then takes place and each outside study's DICOM objects are associated with its newly created study on the local system.

VA's VistA Hospital Information System (HIS)

The Veterans Health Information Systems Technology and Architecture (VistA) is an enterprise-wide information system built around an electronic health record (EHR) that is used throughout the US Department of Veterans Affairs. The VA healthcare enterprise consists of 153 medical centers and 1,400 outpatient clinics that are used to treat a patient population of 5 million veterans. VistA Imaging, which integrates images into the VistA EHR, has about 2 billion images online. All of these images are available nationwide, where ever the patient is treated.

In VistA, the Computerized Patient Record System (CPRS)² is used to place orders for radiology procedures that will be processed on the Radiology Information System (RIS).³ The first step for processing a radiology procedure order is to register the request on the RIS. This action causes a radiology study to be created on the RIS for the request with an assigned study date, study time, and accession number. Then the radiology study is placed into the DICOM Modality Worklist database.

For a non-radiology clinical specialty study (e.g., cardiology, eye care, dentistry, endoscopy), there is no registration process, and the study is placed into the DICOM Modality Worklist database as soon as the order is placed.

Studies are removed from the DICOM Modality Worklist database when their examinations are completed.

¹ It may even be necessary to first register the patient on the local system.

² This corresponds to the Order Placer Actor in the IHE Scheduled Workflow Integration Profile.

³ This corresponds to the Department System Scheduler/Order Filler Actor in the IHE Scheduled Workflow Integration Profile.

Experience Importing Outside Prior Studies with a Commercial Product

Importing prior DICOM studies in the past at the VA had been a very slow labor-intensive process. The user would load the media into the drive and then wait for the commercial importer product to read all the DICOM files. The user would then have to work on one study at a time. First, the user would have to review the study on the commercial importer. The user would then have to go to the VA's VistA HIS and place an order for an equivalent radiology study. Then, the user would have to go back to the commercial importer and use DICOM Modality Worklist to retrieve the order, have the commercial importer update the DICOM images with the VA patient and order information, and have them sent to the VistA Imaging system. Finally, the user would have to go back to the VistA HIS to update the study status to indicate that it was completed. Processing a single study this way took anywhere from 10 to 30 min. And the user would have to repeat this effort for each study on the portable media that needed to be imported. This was a rather overwhelming task, given the volume of studies that need to be imported.

Methods

The VistA Imaging DICOM Importer is a new application developed by the VA as part of its VistA Imaging system. The Importer can process prior studies which are not known on the local system as well as outside contract studies whose orders are known. Figure 1 gives an architectural view of VistA Imaging and the Importer application on the VistA DICOM Gateway.

The workflow of the Importer was designed to operate like an online merchandise ordering application where the user adds items to a shopping cart and then proceeds to checkout. All of the interactive item selection is done first, and then followed by an automatic database update commit transaction. In an Importer session, all of the steps to align the outside studies with the VistA patients, radiology studies, and procedures are done first. When this is completed, the outside DICOM objects are automatically updated with the VistA information and then imported into the VistA Imaging database.

General Importer Operation

The user loads the media into the drive and enters the Importer application. The DICOMDIR file is read off the media and the user is quickly presented with a list of the studies on the media. Studies on the media which have already been imported are flagged and cannot be imported again. (Because of this check, none of these studies in

VistA are duplicated.) Outside studies that have been only partially imported are identified and can continue to be imported to the same VistA patient and study.⁴ Figure 2 shows an example of an Importer Study Selection List.

The user then can view individual studies, series, and images, and can select which studies are to be imported. For each outside study that is to be imported, the Importer application is used to identify the corresponding VistA patient and study and/or procedure. (The user interacts only with the Importer application.)

First the user identifies the VistA patient for each outside study that is to be imported. Then, for a prior study, the user selects the closest equivalent VistA radiology procedure and any appropriate modifiers. For an outside contract study, the user identifies the original study and/or procedure order.

Once all of the studies that are to be imported have been selected, the user initiates the actual import process. From then on, all the rest of the steps are automatic. The VistA radiology procedures for the prior studies are automatically ordered. The orders are assigned a study date and time and accession number and become radiology studies. The selected studies are read off the media, import reconciliation is performed, and the updated DICOM objects are imported. Finally, the status of the radiology study is updated.

This workflow succeeds in reducing the average user time to import a study to less than a minute, making the application very practical.

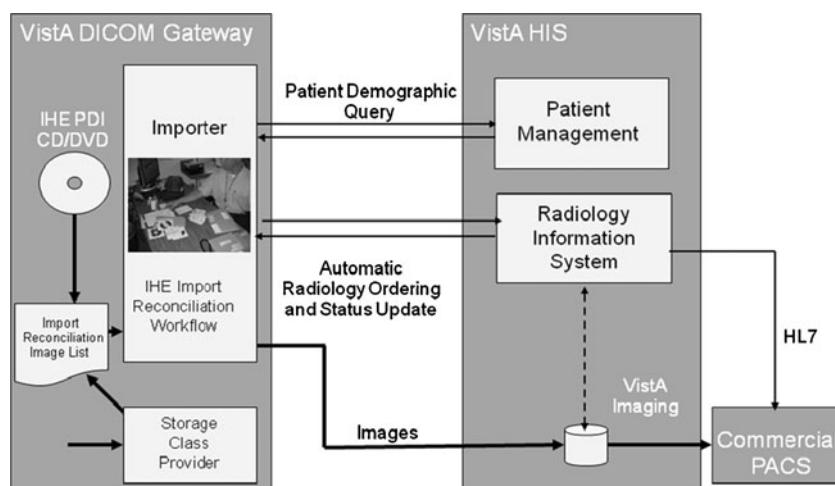
Importing Prior Studies (Unknown Patient ID and Studies) — Details

When the user selects a prior study to import, the user first identifies the patient using the Importer to access the VistA HIS database.⁵ Once the patient is identified, the user selects the VistA radiology procedure that most closely matches the examination that was performed at the other facility. The user may also specify an optional procedure modifier. The patient, procedure, and modifier information for the study is retained by the Importer. Figure 3 illustrates these steps.

When the user has finished selecting all the studies that are to be imported, the user starts the automatic importation process. For each study that is to be imported, the corresponding VistA radiology procedure with modifier is automatically ordered on the VistA HIS. After the order has been placed, a new VistA study is automatically registered

⁴ The outside study may span multiple pieces of media. Importing the study from the first piece of media defines the mapping of the outside study to the one on the local system. Importing additional DICOM objects for the study from subsequent pieces of media can make use of this mapping.

⁵ It is always assumed that the patient is registered on the VistA HIS.

Fig. 1 VistA Imaging DICOM Importer

in the radiology system. The date and time of the original examination is used as the date and time of the new VistA study so that the imported study is in the correct chronological sequence with the rest of the patient's radiology studies.

The VistA patient and study identification information from the new study is used by the Importer to perform import reconciliation and update the headers of the outside

study's DICOM objects. The images are then sent to the VistA Imaging system and are associated with the new VistA study. Afterwards, the status of the study on VistA is updated to indicate that it has been completed.

Figure 4 shows the radiology order that was automatically generated for the prior study selected in Fig. 3. Note that the original study date and time (April 17, 2006 at 01:00 A.M.) are retained for the automatically generated study.

Import Unordered Studies from CDs and DVDs from DoD facilities

#	Patient ID	Patient Name	Birth	Sex	Accession Number	Date	Description	Images
1)	000-00-0001	OUTSIDE-1, PATIENT-1	02/01/2002	M		02/20/05		DX=1
2)	000-00-0001	OUTSIDE-1, PATIENT-1	02/01/2002	M		01/04/05		IO=1
3)	000-00-0001	OUTSIDE-1, PATIENT-1	02/01/2002	M		07/03/05		IO=1
4)	000-00-0001	OUTSIDE-1, PATIENT-1	02/01/2002	M		03/17/05		PX=1
5)	000-00-0001	OUTSIDE-1, PATIENT-1	02/01/2002	M		06/22/06		XC=1
6)	000-00-0002	OUTSIDE-2, PATIENT-2	01/01/1900	F	000000037	07/05/05	Bite Wing X-Ray	IO=2 PX=1
7)	000-00-0003	OUTSIDE-3, PATIENT-3	12/24/1948	M		03/06/05		IO=3 XC=2
8)	000-00-0003	OUTSIDE-3, PATIENT-3	12/24/1948	M		06/20/06		IO=4 XC=3
9)	000-00-0003	OUTSIDE-3, PATIENT-3	12/24/1948	M		04/17/06		IO=3 PX=1 XC=3
10)	000-00-0004	OUTSIDE-4, PATIENT-4	08/04/2006	O		08/04/06		DX=1 IO=2 PX=1
11)	000-00-0005	OUTSIDE-5, PATIENT-5	05/13/2005	M	1	05/13/05	OCD Digital X-ray	DX=1
12)	000-00-0006	OUTSIDE-6, PATIENT-6	05/13/2005	M	1	05/13/05	Sigma Digital X-ray	IO=1
13)	000-00-0006	OUTSIDE-6, PATIENT-6	05/13/2005	M	1	05/13/05	Sigma Digital X-ray	IO=1
14)	000-00-0007	OUTSIDE-7, PATIENT-7	12/05/2000	M	1	05/13/05	OPD Digital X-ray	PX=1
15)	000-00-0007	OUTSIDE-7, PATIENT-7	12/05/2000	M	1	05/13/05	OPD Digital X-ray	PX=1
16)	000-00-0008	OUTSIDE-8, PATIENT-8	01/01/2006	F	007	06/07/06	Sample for ADA 2006	DX=1
17)	000-00-0008	OUTSIDE-8, PATIENT-8	01/01/2006	F	007	06/07/06	Sample for ADA 2006	IO=1
18)	000-00-0008	OUTSIDE-8, PATIENT-8	01/01/2006	F	007	06/07/06	Sample for ADA 2006	PX=1
19)	000-00-0008	OUTSIDE-8, PATIENT-8	01/01/1926	F	007	07/20/06	Sample for ADA 2006	OT=1
20)	000-00-0008	OUTSIDE-8, PATIENT-8	01/01/2006	F	007	07/20/06	Sample for ADA 2006	XC=1
21)	000-00-0009	OUTSIDE-9, PATIENT-9	11/02/1955	F	20	01/17/05	Cosmetic series vid	XC=3
22)	000-00-0009	OUTSIDE-9, PATIENT-9	11/02/1955	F	35	03/28/05	2 PA	IO=2
23)	000-00-0009	OUTSIDE-9, PATIENT-9	11/02/1955	F	36	03/28/05	PA	IO=1
24)	000-00-0009	OUTSIDE-9, PATIENT-9	11/02/1955	F	18	01/17/05	Panoramic	PX=1
25)	000-00-0010	OUTSIDE-10, PATIENT-10	02/14/1972	M	1432	04/15/05	ProMax Ceph	DX=1
26)	000-00-0010	OUTSIDE-10, PATIENT-10	02/14/1972	M	1	04/15/05	Planmeca images	IO=2 PX=1
27)	000-00-0011	OUTSIDE-11, PATIENT-11	08/07/1970	M		08/08/06		IO=1
28)	000-00-0011	OUTSIDE-11, PATIENT-11	08/07/1970	M		08/08/06		IO=1
29)	000-00-0011	OUTSIDE-11, PATIENT-11	08/07/1970	M		08/08/06		IO=1
30)	000-00-0011	OUTSIDE-11, PATIENT-11	08/07/1970	M		08/08/06		IO=1
31)	000-00-0012	OUTSIDE-12, PATIENT-12	01/01/2000	M		03/17/06	FULL MOUTH SERIES (IO=1
32)	000-00-0012	OUTSIDE-12, PATIENT-12	01/01/2000	M		03/03/06	FULL MOUTH SERIES (IO=1
33)	000-00-0012	OUTSIDE-12, PATIENT-12	01/01/2000	M		03/29/06	FULL MOUTH SERIES (IO=1
34)	000-00-0012	OUTSIDE-12, PATIENT-12	01/01/2000	M		06/14/06	PANO 1x2	PX=1
35)	000-00-0013	OUTSIDE-13, PATIENT-13	03/11/2005	O		08/04/06	ADA DICOM CD	DX=1 IO=1 PX=2
36)	000-00-0014	OUTSIDE-14, PATIENT-14		O		12/16/05		IO=2
37)	000-00-0015	OUTSIDE-15, PATIENT-15	11/23/1963	O		10/20/05	Study 10/20/2005	DX=1
38)	000-00-0015	OUTSIDE-15, PATIENT-15	11/23/1963	O		07/06/06	Study 7/6/2006	ES=1
39)	000-00-0015	OUTSIDE-15, PATIENT-15	11/23/1963	O		05/26/06	Study 5/26/2006	IO=1
40)	000-00-0015	OUTSIDE-15, PATIENT-15	11/23/1963	O		10/05/05	Study 10/5/2005	PX=1

Please enter the next study to import, enter "C" to continue, or press <Enter> for more studies:

Fig. 2 Importer Study Selection List (data from the American Dental Association 2006 DICOM CD [5])

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Please enter the next study to import, enter "C" to continue, or press <Enter> for more studies: 9

Patient Name: OUTSIDE-3,PATIENT-3      Patient ID: 000-00-0003      Birth Date: Dec 24, 1948      Sex: M
Accession #:      Study Date: 04/17/06      Study Time: 01:00:00 am
Study Instance UID: 2.16.840.1.114059.1.19481224.20060417

Is this the correct study/view images? [enter Y, N, V]: v

Series 1 contains      3 XC files
Series 2 contains      3 IO files
Series 3 contains      1 PX file

There are 3 Series in this Study. Enter a series number:

Is this the correct study/view images? [enter Y, N, V]: y

Enter VA Patient: P1001

      Patient ID      VA Patient Name      Birth      Sex
-----
      000-00-1001      PATIENT,ONEZEROZEROONE      04/03/1945      M

Is this the correct patient? No // y

Enter Procedure: teeth part
TEETH PARTIAL EXAM ----- 70310

Is this the right procedure? Yes // Yes

Select Procedure Modifier(s): RIGHT
Select Procedure Modifier(s):

      Imported File      Vista
      -----
Patient Name:      OUTSIDE-3,PATIENT-3      PATIENT,ONEZEROZEROONE
Patient ID:      000-00-0003      000-00-1001
Date of Birth:      12/24/1948      04/03/1945
Patient Sex:      M      M
Accession Number:      (automatically generated)
Study Date:      04/17/06      (will be set to same date)
Procedure:      TEETH PARTIAL VIEW
      RIGHT

Is this the correct patient/study/procedure from Vista? N // y

```

Select Study

Identify Patient

Choose Equivalent
Procedure & Modifier

Verify Selections

Fig. 3 Selecting a prior study, identifying the patient and choosing the equivalent procedure and modifier

Importing Contract Studies (Known Patient ID and Studies) — Details

A contract study is initially ordered on VistA and then performed at an outside imaging facility.

The difference between importing these contract studies and the unknown prior studies is that the original patient and order information is already known on VistA. The patient and study information is retrieved from VistA instead of being created anew, and the outside studies are associated with these original studies on VistA.

When the user selects a study to import, the VistA patient and study information needs to be obtained. The way to get this information for a regularly performed procedure is to use the DICOM Modality Worklist service. The VA workflow for outside contract service requests is different than that for regular procedures, however. The outside studies are not performed by the radiology department and are usually not registered. Without registration, the study is not in the DICOM

Modality Worklist database, and hence precludes the use of a DICOM Modality Worklist query.

We developed an alternative method to get this information for outside contracted studies by retrieving a patient's pending radiology procedure orders directly from the RIS database. With this capability, the user first selects the patient, then reviews a list of pending and active orders, and then selects the original radiology order. The necessary patient and study information is then obtained from the original radiology order. This direct lookup capability is simple and fast, and is used instead of DICOM Modality Worklist.⁶

VA radiologists read some contract studies, but not all. Many contract service requests include outside diagnostic reporting and will not be read by a VA radiologist. The patient and order information and

⁶ The DICOM Modality Worklist query is used for the clinical specialties where orders are directly put into the Modality Worklist database.

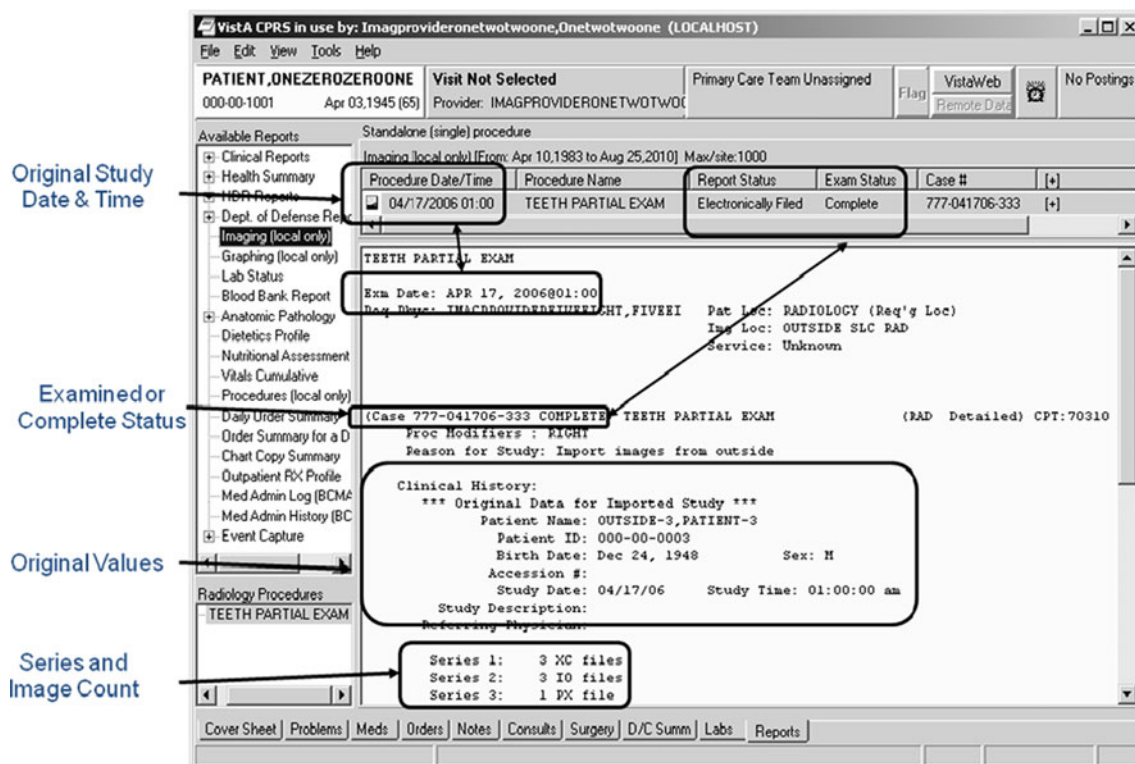


Fig. 4 Automatically generated radiology order

whether or not a VA radiologist will read the study are saved for later use.

When the user has finished selecting all the studies that are to be imported, the user starts the automatic importation process. For each study that is to be imported, the original VistA radiology order is automatically registered in the radiology system using the date and time of the outside examination as the date and time of the new VistA study. In this way, it is in the correct chronological sequence with the rest of the patient's radiology studies. The VistA patient and study identification information from the VistA study is then used by the Importer to perform import reconciliation and update the headers of the outside study's DICOM objects. The images are then imported and associated with the VistA study.

Afterwards, the status of the study on VistA is updated. If a VA radiologist is going to read the study, its status is set to indicate that the examination has been completed, but that there is no report. The study is then placed on the VA radiologist's read list. Alternatively, if the study has already been read, the status of the study is set to indicate that the entire study has been completed.

Import Reconciliation — Details

Import reconciliation is a standardized process defined by the IHE IRWF by which outside DICOM objects have their patient and study information replaced with local system

information in order to enable successful importation. Here are the import reconciliation steps used by the VistA Imaging Importer:

- Replace the following data elements in the header of each imported DICOM object with values from VistA:
 - (0008,0050) Accession Number
 - (0010,0010) Patient Name
 - (0010,0020) Patient ID
 - (0010,0021) Issuer of Patient ID (always set to "USVHA")
 - (0010,0030) Date of Birth
 - (0010,0040) Sex
 - (0010,1000) Other Patient IDs (set to the VA Integration Control Number)
- Save the original values for these data elements in the Original Attributes Sequence (0040,0555).
- Record the Importer User name in the Operator's Name (0008,1070) DICOM element in the Contributing Equipment Sequence (0018,A001).

Results

The VistA Imaging DICOM Importer application was tested at a number of different VA sites. Three test sites are

importing a thousand outside studies a week, both priors and contract studies. The application is now being used nationally and has become very popular because it saves the users so much time. This is a good indication of success, because not only does it work well and is easy to use, but the redesign and automation of the import process makes it much faster than the previous methods. In a short time, the users become familiar with the application, and it is easy for them to quickly do the manual work to import a study.

Discussion

The goal of the VistA Imaging DICOM Importer application was to reduce the manual effort and wait time to import DICOM studies to the absolute minimum. This was accomplished by minimizing the amount of time the user has to wait for the CD/DVD to be read, and by completely reorganizing the workflow. All of the manual study selection steps are performed first. The import reconciliation processing is completely automated.

If the methods developed for the Importer for handling unknown prior outside studies are to become universally supported, four new capabilities would have to be added to the IHE Radiology Technical Framework:

- (1) Remote Order Entry — the Importer sends a transaction to the Order Placer actor to create an order for a procedure.
- (2) Remote Study Creator — the Importer sends a transaction to the Department System Scheduler/Order Filler actor to create a study for the ordered procedure with a designated date and time. The accession number and other data items assigned by the Department System Scheduler/Order Filler would have to be returned to the Importer.
- (3) Report Generation — the Importer can generate a “canned” radiology report.
- (4) Remote Study Status Update — the Importer sends a transaction to the Department System Scheduler/Order Filler actor to update the status of the study. A study might have an examination status and a report status that would need to be updated independently.

We learned several things in field testing this application. First, there are many “DICOM” CDs and DVDs that either do not follow the DICOM Standard and IHE PDI, or have faulty implementations. The VistA Imaging DICOM Importer application does not handle non-standard DICOM media. A few of the commercial DICOM Importer software products do handle some of the common anomalies in DICOM media. Some VA sites

are using commercial DICOM Importer software to read the exception media, and send their DICOM objects to the VistA Imaging DICOM Importer for the actual importation.

Second, the workflow for contract studies is different from regular radiology orders because the contract studies are not registered. Since the registration event is necessary for entering the study into the DICOM Modality Worklist database, this basically ruled-out the use of DICOM Modality Worklist queries for the majority of the studies. We found it necessary to retrieve the order information directly from the VistA RIS database.

Third, some examinations performed at a contract facility do not correspond to the actual studies on VistA. For example, the VistA RIS provides the capability to order a bilateral examination that becomes two studies, a left one and a right one, when the examination is registered. If the outside examination is performed as two studies, a left one and a right one, it is easy to import them to the two corresponding studies on VistA. However, if the outside examination is performed as a single study containing both left and right images, it is very hard to split it apart, import it, and match it to the two corresponding VistA studies. When requesting contract studies, it is important to specify how the studies are to be performed.

Fourth, diagnostic reports from contract facilities need to be able to be imported as easily as the images. The VA pays outside imaging contractors to perform the examinations and the reads. The images of these studies are sent back to the VA on DICOM media. Reports are currently faxed back. The VA would like the transfer of the reports to be automated too. VA is considering contractually requiring that the outside imaging facilities produce DICOM IHE PDI compliant media, and that they place the reports on the media in DICOM format as well.

The report would be included on the portable media as two DICOM objects with the same Study Instance UID as the study’s images. One version of the report would be in DICOM Encapsulated PDF format so that the report can be viewed in the same format as it was generated. The other version of the report would contain discrete data elements for VistA and be in either DICOM Structured Report format (Basic Text SR) or in DICOM Encapsulated CDA format (i.e., HL7 Version 3.0 CDA XML).

Comparison with Commercially Available Products

The capabilities of the VistA Imaging DICOM Importer were compared with two commercially available products: the Medavis DICOM Importer Pro V3.1.0.12 [6] and Sorna Reviewer V1.9.5.0 [7].

The commercial products were designed to work with any combination of HIS, RIS, and PACS. They had well developed graphical user interfaces (GUI) and were able to import a set of DICOM files without a DICOMDIR file being present, or when it contained errors. The commercial products use HL7 Patient Data Query, DICOM Query to obtain patient information from the HIS, RIS, and PACS, and DICOM Modality Worklist to obtain patient and study information from the PACS. In addition, the Medavis DICOM Importer could communicate directly with the Medavis RIS. Both commercial products support Storage, Storage Commitment, and Modality Performed Procedure Step as service class users.

The VistA Imaging DICOM Importer supports DICOM Modality Worklist as service class user, and can communicate directly with the VistA HIS, RIS, and Imaging system. A second version of the VistA Imaging DICOM Importer is under development to provide a GUI capability and the ability to import DICOM files in the absence of a DICOMDIR file.

Three very important capabilities of the VistA Imaging DICOM Importer are not supported by either commercial product:

- (1) Search PACS for existing Study Instance UIDs (and SOP Instance UIDs) when staging the media.
- (2) Automatically place and fill radiology orders for prior studies and associate them with imported studies.
- (3) Retrieve previously placed contract orders, fill them, and associate them with imported studies.

The first capability, the UID PACS search, is very useful to identify studies that have already been either partially or completely imported. It could be supported by commercial products using a DICOM Query, but is not yet today. The other two capabilities dealing with radiology orders for prior and contracted studies are much harder to support by commercial products, as they are very specific to the RIS.

Conclusion

The VistA Imaging DICOM Importer application has been a tremendous time saver. It has made importing of outside prior studies feasible, whereas before it was prohibitive.

Outside prior studies can now be imported, stored, and retrieved when needed. In some instances, this may mean that a patient is spared a repeat study. In other cases, this may mean that images captured from an earlier time will be available to help with later diagnosis and treatment.

We have shown that it is possible to construct a manually efficient application to import outside prior studies. However, a fair amount of work is needed before this capability can be provided outside of the VA. The IHE committee needs to consider supporting this capability and will probably need to add several new transactions to the IHE Technical Framework. HIS, RIS, PACS, and Importer vendors will need to implement them and test them for interoperability. Customers will need to purchase these products. But that is all in the future. We have shown a method that is very doable, and for the VA, may be the best way to solve the problem of how to import outside prior studies.

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References

1. NEMA: Digital Imaging and Communications in Medicine. Rosslyn, VA 22209, 2009. <http://dicom.nema.org>
2. IHE Portable Data for Imaging Integration Profile, IHE Technical Framework, vol. I, Rev. 8.0, 2007-08-30
3. <http://www.dclunie.com/blog/blog/2008/08/is-winter-of-discontent-with-cds.html>
4. IHE Import Reconciliation Workflow, IHE Technical Framework, vol. I, Rev. 8.0, 2007-08-30
5. American Dental Association DICOM demonstration CD, 2006
6. Medizinische Informationssysteme GmbH, Bannwaldallee 60, 76185 Karlsruhe, Germany www.medavis.com
7. Sorna Corporation, 2020 Silver Bell Road, Suite 17 Eagan, MN 55122 USA 651.406.9900 www.sorna.com