Incorporating Out-Patient Data From CD-R Into the Local PACS Using DICOM Worklist Features

P. M. A. van Ooijen,¹ J. Guignot,² G. Mevel,² and M. Oudkerk¹

With the introduction of digital imaging in radiology, CD-Rs are increasingly used to distribute patient materials. This study investigates the application of a new software package and work protocol to integrate out-hospital data into the local PACS (picture archive and communication system) archive, which is hampered by differences in patient numbers. A one-month trial was started to import CD-Rs from two departments (radiotherapy and radiology). Seventy CD-Rs were collected from 20 different hospitals holding data of eight different modality types and published by eight different software packages from different vendors. All CD-Rs were successfully transferred into the PACS. The new software and work protocol provide an easy way of introducing the out-hospital data into the PACS. CD-Rs can be destroyed after transfer to PACS, eliminating physical storage. Furthermore, all data can now be viewed and reported using the default viewers of the hospital and no additional training of staff is required.

KEY WORDS: PACS, out-patient data, IHE

INTRODUCTION

In the Netherlands, an increasing number of hospitals is operating filmless. This does not only affect the internal workflow, but also the external workflow. In increasing amounts, data will be transferred between hospitals on CD-R. This data can concern patients that transfer from one hospital to another or patients that require a second opinion. However, because every hospital in the Netherlands uses its own patient ID conventions, the interchange of data is difficult.¹

Fortunately, the DICOM standard defines a standardized approach to exchange DICOM data on a storage medium. In the DICOM standard, medium normalization is dedicated only to data

exchange, not to inner storage format. DICOM Part 10 deals with media storage and file format for media interchange.² This document covers DICOM models for media storage which define access to storage media independently from specific physical media storage formats and file structures. One of the tools used to standardize the storage is the use of a DICOMDIR for each file set. This file includes a description of the DICOM Media Storage Directory, which contains general information of the complete file-set. A DICOMDIR file, which may be seen as a table of content of one medium, should be present at the root level of that medium to comply to PS 3.10 of the DICOM standard. Besides the DICOMDIR, other media formats and restrictions are defined in DICOM Part 12³—for example, the usage of different media (e.g., CD-R, MOD, and DVD-RAM) and the requirement of storing only one fileset per medium.³ Since synchronous and online negotiation is not possible between the media provider and the media user on image format and encoding, and on media structure, DICOM defines in its Part 11⁴ some guidelines, called Application Profiles, which may help to anticipate compatibility issues

¹From the Department of Radiology, Groningen University Hospital, Groningen, The Netherlands.

²From the ETIAM, Rennes, France.

Correspondence to: P. M. A. van Ooijen, Department of Radiology, Groningen University Hospital, PO Box 30001, 9700 RB Groningen, The Netherlands; tel: 431-503612286; e-mail: P.M.A.Van.ooyen@rad.umcg.nl

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Fig 1. Four screenshots of the software. First the CD is read (A). Next, the copy command is given and a selection can be made to copy either one series, or the full content of the CD and the destination to which to copy can be selected (B). When copy to PACS is selected with reconciliation of the fields that have to be replaced, the copy can be selected (C). Finally, the DMWL is queried based on the accession number and the local examination is selected (D). After acknowledgement of the examination, the data is copied with reconciliation of the selected DICOM header information.

between different equipment. For example, a file-set reader that complies to the STD-GEN-CD profile (all types of images, only uncompressed) should be able to read data from any CD containing information compatible with this profile.

The application of the DICOM standards can be evaluated within the IHE (Integrating the Healthcare Enterprise) initiative. This initiative focuses on real use-cases to define rules to improve operability between functional actors for a set of use-

Fig 1. Continued.

cases. These use-cases are always based on standards such as DICOM and HL-7 and often lead to the definition of restrictions to DICOM and HL-7 services. In the IHE/PDI 2004 experimental test of portable media use at the RSNA of 2004, the following restrictions or suggestions were given:

- Only use STD-GEN-CD profile for this experiment,

- A strict convention for naming of CD files and subdirectories
- Restricted rules for CD labeling,
- No windows autorun on the CD.

Media creators could also insert web content, but only when they conformed to strict rules.

Although many of the media (CD-R discs) delivered to our hospital have their own viewers

installed, this is not optimal, especially in view of the fact that every hospital has its own vendor promoting his own viewer with a variety of different user interfaces and capabilities. Furthermore, some of the software packages need to be installed onto the hard drive of the computer, which is not always allowed on general workstations. In order to include all these CD-Rs in the normal radiology workflow, the data have to be available in the picture archive and communication system (PACS). However, they should not be transferred into the PACS without adaptation to the institution's standards.

Within the Netherlands, as in most countries, every hospital uses its own patient identification number; no nation wide number is available. Therefore, the risk exists that when patient data are transferred into the PACS without adapting the patient number, they might overwrite an existing patient and/or be lost. Furthermore, all interaction between components such as PACS, RIS, HIS, Speech recognition is based on the accession number of a study. These accession numbers are also hospital-specific. For this reason, the patient has to be known in our hospital and our identification information has to be entered into the data retrieved from the CD-R. To achieve this, a new work process had to be designed and software had to be sought for.

METHODS

As a first step in the adaptation of the work process, a request form was designed for the requesting physician. On this form, patient information has to be added including a new, locally generated, patient identification number. Besides this, the physician can describe the reason for which the CD-R has to be read into the PACS. Priority handling and whether or not to destroy the CD-R can also be marked. The filled out form is then shipped to the radiology department together with the CD-R, where a new (virtual) radiological procedure is planned in the RIS. This new procedure is then automatically placed into the DICOM modality worklist. When reading a CD, the data on this CD can be linked to the data in the DICOM modality worklist for the conciliation as required by the IHE initiative and described in the proposed Portable Data for Imaging (PDI) profile.⁵ Possible procedure descriptions for CD-Rs are: "EXTERNAL IMAGES" or "SECOND OPINION." By defining these two specific procedures, data from CD-R can be easily distinguished from locally acquired data since these descriptions also show up on the PACS.

To transfer the data to the PACS and to perform the reconciliation, a software package named Open LiteBox (ETIAM,

Rennes, France) was evaluated. It reads DICOM data from the CD-R and has the ability to transfer this data to the PACS. Before this transfer is carried out, patient identification information can be changed (Fig 1). This change of identification information is not manual, but a DICOM Modality Work List (DMWL) server can be queried to find the appropriate entry. Hereafter, a selection can be made to perform Patient Information Reconciliation, in which certain fields of the data on the CD-R are replaced by the information retrieved using the DMWL service. The reconciliation is performed "on the fly" during DICOM transfer to the PACS, i.e., the original data are left unchanged.

A Beta version of this software was installed at the radiology department and the request form was evaluated. In the first weeks, CD-Rs provided by our radiologists were read and archived into the PACS. A one-month pilot (August 2004) was started after this first test in cooperation with the Radiation Therapy department, during which the work procedure for the CD-Rs was deployed and the request form was used. After evaluation of the pilot, the procedure was made available throughout the hospital.

During the test period, information was recorded for each CD-R about the origin of the CD-R, the used software viewer on the CD-R including the version number, the vendor of this software, and the modality type of the data. Furthermore, unsuccessful reading and/or storage was recorded.

RESULTS

In total, 77 CD-Rs were stored into the PACS over a period of four weeks. The CD-Rs came from 20 different hospitals, six of which (30%) accounted for 66% of the CD-Rs (Fig 2).

Of the available CD-Rs, 76 were loaded with an embedded viewer software package that either ran from CD-R or was installed on the local machine. Eight different viewer software packages were present on the CD-Rs and 11 different software versions. Approximately half (48%) of the CD-Rs were published using Kodak (26%) and Merge (22%) software packages. Other frequently found packages were Agfa (18%) and AccuImage (17%) (Fig 3).

Data from eight different modalities were included in this test (Fig 4) and 36/77 CD-Rs contained data from more than one modality (47%). The maximum number of different modalities on one CD-R was four.

Out of the 77 CD-Rs, 72 (94%) were loaded from the CD-R without any problems. Two CD-Rs only loaded part of the images because of an incomplete DICOMDIR file, the other three CD-Rs that failed initially did not contain a DICOM-

Fig 2. Number of CDs sent by each hospital included in our study.

DIR file at all. The solution to be able to load the CD-Rs with a faulty or missing DICOMDIR was to copy the data to the local hard drive and to load them subsequently into the software. Copied DICOM data could then be read and reconciled on the fly during the DICOM storage process. The missing DICOMDIR only occurred with old version software that did not comply with PS 3.10 of the DICOM standard,² which was still used by some institutions. However, newer versions from the same software vendor included a correct DICOMDIR file.

DISCUSSION

In our study, a procedure and software setup was defined for the storage of out-patient data from CD-Rs into the radiology PACS. The used procedure enables the easy integration of outpatient materials into the normal workflow of the hospital. Introduction of this procedure eliminated much stress and work for the physicians in our institution, because all the required data now can be accessed through the same, familiar, user interface.

Fig 3. Number of CDs containing software of a certain vendor.

Fig 4. For each modality found, the number of CDs containing that modality is given.

It can be discussed whether the effort should be taken to include all external CD-Rs into the PACS. To construct a threshold, we require that a local patient ID is available for each CD-R. Furthermore, most CD-Rs will be included as second opinion and thus a report will be dictated for which the corresponding fee is charged. The inclusion of images into the PACS was triggered by several questions that arose during the transition to filmless of our hospital:

1. Viewing of CD-Rs of other hospitals demands using different viewing software packages from different vendors. However, one single viewer is used throughout the hospital integrated into the electronic patient record for viewing data in the PACS. Question: Can we view the CD-Rs using the same viewer?
2. The operating theatre receives patients with CD-Rs. However, viewing a CD-R in the operating theatre is cumbersome. Large screens are available (Fig 5) for using the EPD and default viewer. Question: Can we view the CD-Rs using the same screen and viewer?
3. Data for second opinions are often received on CD-R. Dictation requires a lot of manual tasks that are not required in the standard PACS environment. Question: Can we get the CD-Rs into our standard PACS environment?

The answer to all three questions posed above was that the CD-R data should be included into the PACS and that they should be available

throughout the hospital using a local patient identification number. A disadvantage of this decision is the large amount of data, not acquired primarily within the hospital, has to be stored in the PACS.

To prohibit inclusion of unnecessary images into the PACS, the physician has to fill out a request form on which he stresses the reason to include the patient into the PACS; the patient has to be identifiable within our hospital and the physician has to pay a fee for the services provided by the radiology department. Furthermore, the majority of the requests will be processed as second opinions, meaning that a radiologist's report is required and the corresponding fees are applied.

Fig 5. Large screens (white arrowhead) mounted on the wall of the operating theatre next to the light box.

Future steps are to provide the clinicians with a simple tool to upload the content of a CD-R to a server at the radiology department to diminish the distribution of CD-Rs throughout the hospital and to reduce the time required to store it in the PACS.

Evaluation with the participating departments showed that the procedure available works well for both the providers of the CD-Rs and the radiological personnel that had to process the CD-Rs. During evaluation meetings, two possible points of improvement were discussed.

First, the inclusion of the data on a CD-R is now performed on one single date; the physicians would like to have each study on its own specific date. Second, the request form is currently in paper, but it would be preferable to have this in a web form.

Both issues have been investigated. The first point is not changed because the information is available in the actual images. The second issue will be solved in the near future by using the intranet of the hospital.

CONCLUSION

The IHE initiative⁶ defined a Portable Data for Imaging (PDI) profile that addresses the standardization needed for portable data exchange. This PDI profile defines that “the portable media Importer imports and reconciles the DICOM portion of the media content into the local information system.”⁵ The software package evaluated complies with this PDI profile. It also defines Patient Information Reconciliation rules and limits. Our experience shows that outpatient PACS data on CD-R can easily be incorporated into the

hospital PACS. To achieve this, the patient has to be known within the hospital and a new examination has to be defined. Reconciliation is performed according to the IHE specifications automatically by using the DMWL service.

The new feature allows for easy access of the data on CD-R with a familiar user interface by all physicians in the hospital and it allows for easy second opinion reporting following standard working procedures by our radiologists.

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