Evaluation of the Use of CD-ROM Upload into the PACS or Institutional Web Server

P. M. A. van Ooijen, R. Roosjen, M. J. de Blecourt, R. van Dam, A. Broekema, and M. Oudkerk

Purpose: Patient data are increasingly distributed between hospitals using CD-ROMs instead of actual films. This introduces problems because different viewers from different vendors are provided, and sometimes viewers are unusable because local software installation is not allowed. In 2004, we started to facilitate the incorporation of CD-ROM data into the normal workflow of the hospital by using commercially available software to perform patient reconciliation based on the DICOM (digital imaging and communication in medicine) modality worklist. The purpose of the current study is to evaluate this new procedure. *Methods and Materials*: A questionnaire was sent to all users to evaluate the satisfaction with the current facility and to evaluate possible improvements. Several quality parameters on speed and satisfaction were rated on a 5-point scale (1 = bad to 5 = excellent). *Results*: Replies from 17 different respondents were evaluated, accounting for an average of 76 CD-ROMs per week. Mean (median) results showed a score of 3.6 (4) for handling time, 3.4 (4) for archival of second opinion data, 3.8 (median 4) for archival of external data onto the web server, and 4.5 (median 5) for the overall performance of the current procedure. *Conclusion*: Although some improvements can be made, storage of the study data from CDs from outpatients into PACS (picture archiving and communication system) and web server already provides for an existing need. Using this service, physicians can access the data with ease and familiarity. User satisfaction with the provided solution is high.

KEY WORDS: PACS, clinical workflow, computers in medicine, Integrating Healthcare Enterprise (IHE), medical informatics applications, radiology workflow, radiology information systems (RIS)

INTRODUCTION

With the advance of digitalization in radiology departments, the interchange of data between institutions is shifting toward shipment of CD-ROMs instead of the actual films. Although this is a positive change in terms of costs, it also has its disadvantages. One of the main problems is how to integrate these CD-ROMs into the normal workflow. Although most CD-ROMs are equipped with a dedicated viewer, these viewers are different per vendor and thus, users have to learn to operate many different software packages. Some of the software packages also require installation on the local work station, which is not always possible for security reasons. To solve these problems, we included the study data from the CD-ROMs into the normal hospital workflow.[1,2] To achieve this, all DICOM (digital imaging and communication in medicine) files from the CD-ROM are read, the DICOM header is changed (reconciliated) to comply with the patient ID and accession number used in our institution, and the data are either stored into the PACS (picture archiving and communication system) or the web server. Only second opinion cases are stored into the PACS; all

other data are stored on the web server and will be removed after 2 years.

After this methodology has been used for 1 year in our department, a questionnaire was distributed among the users for evaluation of the procedure.

MATERIALS AND METHODS

To store DICOM data into the PACS, a commercially available software tool is used (DICOM Open LiteBox; ETIAM, Rennes, France). This software supports the two DICOM functionalities required: DICOM Modality Work List (DMWL) query and DICOM Storage. DMWL is used to facilitate patient reconciliation, which replaces the patient ID and name by valid ones. The whole procedure comprises six steps[1,2] (Fig 1) as follows:

(1) Patient is entered, if needed, into the hospital information system (HIS) to obtain a locally valid patient number.
(2) The patient is planned into the radiological information system (RIS) to obtain a valid accession number.
(3) The CD-ROM is loaded into the drive and the DICOM Open LiteBox software is started.
(4) The CD-ROM is selected in the DICOM Open LiteBox software.
(5) Reconciliation is defined for required fields (patient name, patient number, accession number) by using the DMWL entry that is automatically generated after step (1).
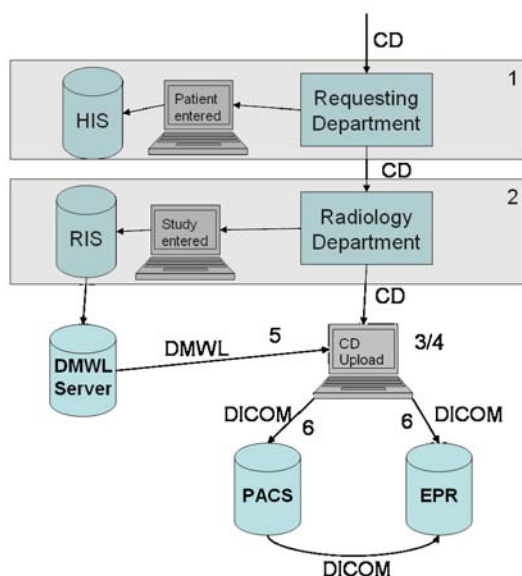

Fig 1. Schematic overview of the steps in the upload of DICOM data from CD onto PACS and/or EPR.

(6) Relevant data are selected and transferred. Reconciliation is performed on-the-fly during the transfer to PACS or institutional web server.

The first step is performed by the administration of the requesting department. If this is not done before the request is sent to the radiology department, the request will not be processed and the CD will be returned.

The second step is performed by the radiology patient administration, which receives the request form, or by the dedicated PACS employees. To enter the studies into the RIS, two new radiological examinations are defined: EXTERNAL DATA and SECOND OPINION.

The other steps are performed by dedicated PACS employees. Currently, 2 fte are assigned to PACS-related tasks: besides the upload of CDs, this also includes, e.g., the helpdesk for PACS-related issues, quality control, and CD publication.

All data are read from the CD-ROM, and patient ID and accession number are replaced on-the-fly during transfer to either the PACS or the web server by using DMWL.

Data marked as EXTERNAL DATA are only stored into the institutional web server to provide access to the data through the electronic patient record, which is accessible everywhere in the hospital. These data are only stored for the life cycle of the data on the web server, currently 2 years, and are hereafter deleted. No report is added to this data and they are only used for referral. An example is the use of data acquired elsewhere during a surgical procedure.

The SECOND OPINION data are permanently stored into the PACS and, from there, automatically forwarded to the web server. For these studies, a radiological report is required.

The process described above was monitored for a year (July 2004–July 2005) at the radiology department. The number of images and series stored at the PACS both for EXTERNAL DATA and SECOND OPINION were determined by using queries on the PACS. Based on the results of these queries, the amount of storage required was calculated by using an average size per image. The average image size was determined for each modality.

After 1 year, a questionnaire was distributed to all departments that had been using this facility, to evaluate whether the procedure was satisfying.

The questionnaire contained the following questions:

1. At which department are you employed?
2. Who is handling the CDs within your department?
3. How many CDs do you send on average per week?
4. How do you grade the time between submitting the CD and availability of the data for viewing?
5. How do you grade the possibility to request to upload to both PACS and web server compared to viewing the CD-R on your own PC and storing it locally?
6. How do you grade the possibility to request to upload to the web server only compared to viewing the CD-R on your own PC?
7. How do you grade the procedure compared to viewing the CDs on your own PC using the viewer included on the CD?
8. Do you have any remarks or suggestions?

Questions 4 to 6 were to be graded on a 5-point scale (1 = bad, 2 = not so good, 3 = reasonable, 4 = good, 5 = excellent), and median and mean values were calculated.

The questionnaires were distributed by e-mail to the different departments, so an exact number of the number of questionnaires issued is not known.

RESULTS

From the time we started archiving outpatient data, a total of 185,880 images in 8,440 series have been stored into the PACS (status on July 18, 2005).

The data stored originate from multiple modalities. Most data intended for second opinion originate from computed tomography (CT) and magnetic resonance (MR) (Fig 2). Besides these two, ultrasound (US) and computed radiography (CR) are also very common modalities. Other modalities found on the CD-Rs, included in the REST group, are secondary capture (SC), external camera photography (XC), nuclear medicine (NM), x-ray angiography (XA), positron emission tomography (PT), structured reports (SR), radiographic imaging

(RG), digital radiography (DX), mammography (MG), other (OT), and radiofluoroscopy (RF).

The same holds true for external data: most images stored originate from CT and MR although, when looking at the series, CR also is a major contributor (Fig 3).

Approximately 80% of the images and 74% of the series is stored for second opinion; the remaining images and series are stored for reference to external material. This results in a required storage space of 83 GB for the second opinion (PACS and web server storage) and 27 GB for the external data (web server only storage) for the first year.

Seventeen questionnaires, originating from 10 different departments, were returned to our department. Altogether, these departments provide an average of 76 CDs per week. The mean (median) scores were 3.6 (4) for handling time, 3.4 (4) for archival of 2nd opinion data, 3.8 (4) for archival of external data onto the web server (EPR), and 4.5
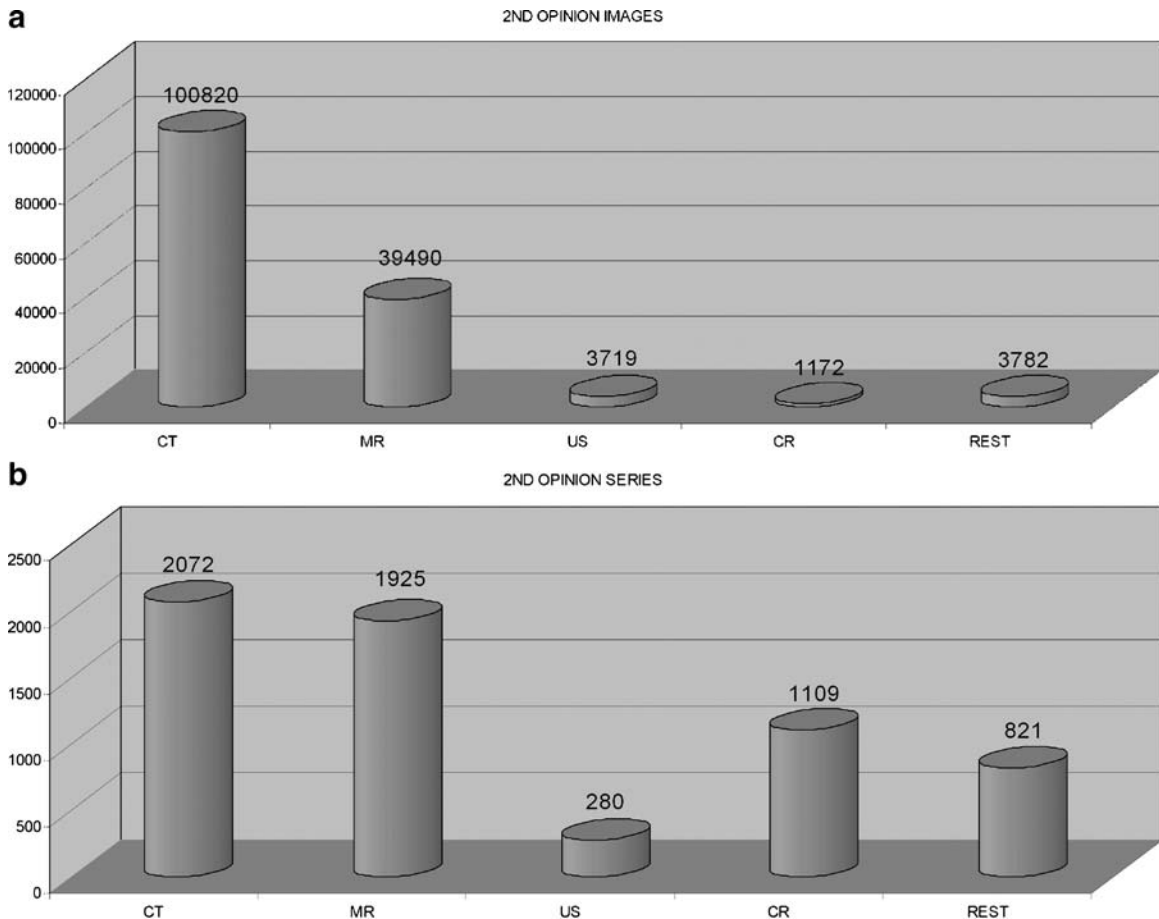

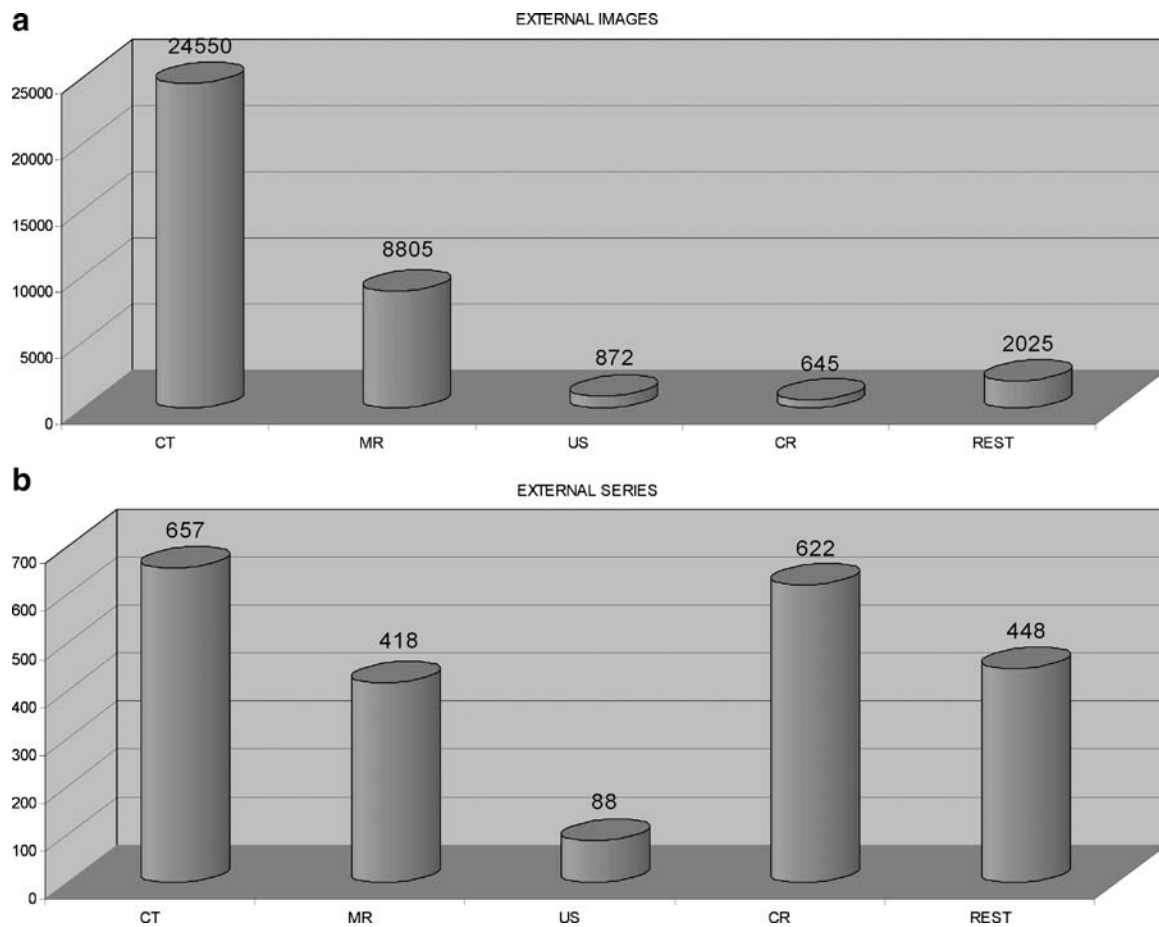Fig 2. Overview of the number of images (a) and series (b) stored into the PACS for second opinion.

Fig 3. Overview of the number of images (a) and series (b) stored into the PACS as external data.

(5) for the overall performance of the procedure (Fig 4). The percentage of no response on the different questions were 6%, 24%, 24%, and 24% for handling time, archival second opinion, archival external data, and satisfaction compared to reading CDs, respectively. The main reason for nonresponse to one of the two archival options was that the department does not use that particular option. Four respondents did not fill out the overall satisfaction question.
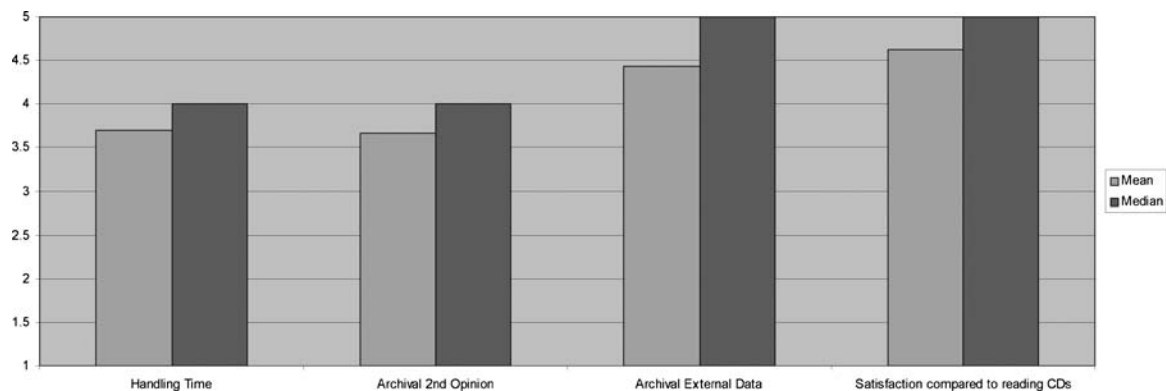

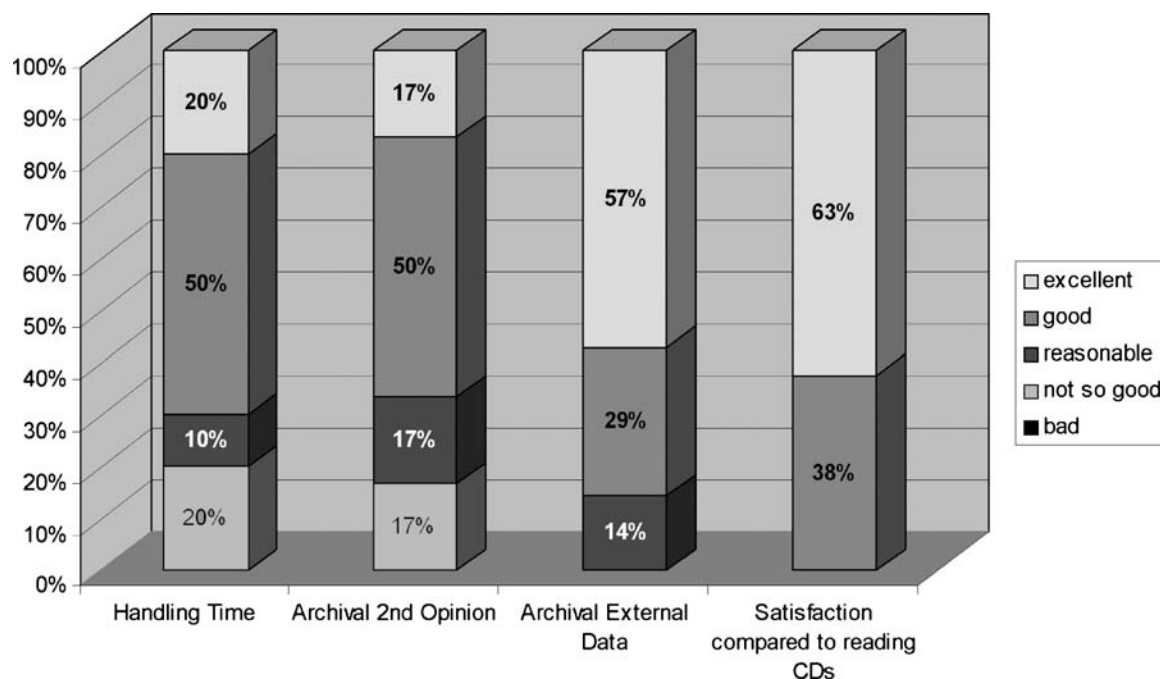Fig 4. Mean and median scores for the different questions.

Fig 5. Distribution of the answers over the different categories without the nonrespondents.

After elimination of the nonrespondents, the percentage per rating category was determined (Fig 5). Most ratings were good to excellent with 38% good and 54% excellent for the overall satisfaction with the new method compared to using CDs. Only handling time and the archival of second opinion were rated as "not so good" by 13% and 15%, respectively. The bad rating was given by 6% for handling time, 8% for archival of second opinion data, and 8% for archival of external data. None of the respondents rated the overall satisfaction as bad.

DISCUSSION

The use of CD-ROMs for the distribution of image data is widely accepted. However, every hospital, which receives patient information from multiple centers, will experience problems with the different viewers used. In a previous publication,[1] the current solution was described. However, an evaluation of the use of this new solution was not yet available. In this study, we performed this evaluation to determine the viability of this method in our institution. Results show that user satisfaction is very high, although some improvements can be made.

The question arises whether the external data should be stored into the PACS, because we are not obliged to store these data. However, for integration into the normal workflow, it is a requirement to provide the data to the physicians in an easy manner. This very question led us to decide to only store data that have a radiological report attached to it (second opinion) into the PACS. Other data—which are only for review and therefore not likely to be used later—are automatically deleted approximately 2 years after the storage on the institutional web server.

Although the overall satisfaction is shown to be high when compared to the situation where CDs had to be read, results for the different procedures show that the current set-up has some limitations.

First, the complete process is rather time-consuming and requires a lot of traffic of CDs around the hospital. A CD is received from another hospital by one of the departments in our institution, then sent to the radiology department with a request to read the data into the PACS or web server, whereupon the content is uploaded, and finally the CD is returned to the requesting department if indicated on the form.

Second, reports and information other than DICOM images are not yet included into the process. Some vendors already include radiological reports on their CDs in text files in different formats. These files are not yet supported by our procedure. Ideally, the files should be read and stored into the radiological information system by using an HL-7 message.

Third, because of staff shortage all data on the CDs are stored entirely into the PACS under one accession number. This can cause difficulties in finding the right study of the right date because the complete history of a patient acquired in another hospital that is available on the CD will be stored under a single accession number. More ideal, but even more time-consuming than the current procedure, would be a process that stores all studies from the CD with different accession numbers.

Current research is focused on the automation of some of the steps in the process to eliminate some of the problems that arise.

CONCLUSION

Although some improvements can be made, the storage of study data from CDs from outpatients into the PACS and the web server already provides for an existing need. Using this service, physicians can access the data with ease and familiarity; user satisfaction with the provided solution is high.

REFERENCES

1. van Ooijen PM, Guignot J, Mevel G, Oudkerk M: Incorporating out-patient data from CD-R into the local PACS using DICOM worklist features. J Digit Imaging 18(3):196–202, 2005

2. van Ooijen PMA, ten Bhomer PJM, Blecourt MJ, Roosjen R, van Dam R, Oudkerk M: DICOM storage into PACS of out-hospital CD-ROMs—a half year experience report. In: Lemmura K, Inamura K, Doi K, Vannier MW, Farman AG Eds. International Congress Series 1281 (2005) Elsevier, Amsterdam, 2005, pp 883–887