Virtual Reality, Telemedicine, Distance Care and Education

Digital Imaging and Archiving in a Radiological Department: The 2nd Radiology Department’s Experience at the University of Athens

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Present problems with film-based procedures. Many aspects of the current organization and procedures in a radiology department are still based on film and paper documents for storage, display and communication. These methods are slow and less effective and they are incompatible with the methods used with the increasing number of digital modalities (CT, MR, DSI, Digital Radiology, etc.) which have been developed and tend to abolish conventional imaging techniques.

Film storage and retrieval in a conventional radiology department present many problems. The more serious of these problems are: slow access; loss of images due to misfiling or unrecorded loans; difficulty in finding a specific image at a needed time; no possibility of interacting with the recorded information; requirement for a large amount of space; and the need for a great deal of physical effort in order to create and maintain an image database. These are some of the reasons that created the need for the Picture Archiving and Communication Systems (PACS) some years ago.

Digital image management. The introduction of the first digital imaging systems has led to the concept of a totally digital imaging department — the “filmless” department. This concept has now been grasped by clinicians, researchers and manufacturers. Developments in key technologies, such as semiconductors, data processing equipment and communications, show impressive progress. Now technology is offering new means with which to organize the imaging department. These new means are not only compatible with the new digital imaging modalities, but promise great improvements.

Some years ago, the main problem of archiving digital images from any modality of a radiology department in a common database was the incompatibility of digital image formats between different modalities and manufacturers. This problem was recently solved when manufacturers adopted a common protocol to manage medical images, named Digital Imaging and Communication in Medicine (DICOM). The DICOM standard is a set of rules that allow medical images to be exchanged between instruments, computers, and hospitals. It establishes a common language, guaranteeing that a medical image produced on one vendor’s machine will be displayable on the workstation from another vendor.

The Picture Archiving and Communication System (PACS) in Evgenidion University Hospital of Athens. In order to find a solution to all the above stated difficulties in storing and managing conventional medical images printed on film, a PACS system has been developed in the 2nd Radiology Department of the University of Athens in Evgenidion University Hospital.

The main problem was that most of the medical equipment of the department did not dispose the DICOM standard. The digital modalities of the department are: a Philips Tomoscan LX/C CT system, a Philips Diagnost ARC digital subtraction angiography system, a Philips Diagnost 96 digital radiology system, and a Philips Gyroscan ACS NT 1.5T MR system. From all these modalities, only the MR adopts the DICOM standard.
To overcome this problem, the video output from each non-DICOM modality was used. The video signals are sent to a laser film imager (Agfa LR3300) passing through a special purpose computer (Agfa MG) which manages the printing procedure. With the use of an analog-to-digital converter placed into the MG, the signals are digitized and sent simultaneously to the laser imager and to the PACS server. At the same time, with the use of specially designed software which performs an optical character recognition (OCR) procedure, all the identity data of the patient that were written on the image are stored in another file. There are thus two files at the end of the procedure, one including the identity data of the patient and another including the image in a digital format. This transformation results in a patient file containing both the patient data and the examinations performed on the patient (usually, there is more than one examination of a patient from either the same modality or from different modalities). In this way, all patient data are stored in a DICOM format. When selecting a patient, all examinations are displayed and when any one of them is selected, all the images can be viewed for diagnosis, processing, printing on film, or any other purpose.

The PACS server consists of an Oracle database server together with limited image storage facilities. This server is connected with a jukebox that can house 52 optical disks (OD) of 2.3 GB capacity each for image storage, and each of them has a unique label that tells the system which images are included on the disk. When all 52 ODs are full of data, the

Table 1. Advantages of the Picture Archiving and Communications system (PACS).

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<thead>
<tr>
<th>Archiving Films</th>
<th>Using PACS</th>
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<td>Much physical effort needed to maintain the archive</td>
<td>No physical effort needed to maintain the archive</td>
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<tr>
<td>Loss of images due to many reasons</td>
<td>No loss of images at this time</td>
</tr>
<tr>
<td>Need to print twice every image (one for patient use and one for the archive)</td>
<td>Need to print every image only once (for patient use)</td>
</tr>
<tr>
<td>10–30 minutes average image retrieval time</td>
<td>3 minutes average image retrieval time</td>
</tr>
<tr>
<td>Very difficult to produce slides for educational purposes</td>
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To use PACS

- No physical effort needed to maintain the archive
- No loss of images at this time
- Need to print every image only once (for patient use)
- 3 minutes average image retrieval time
- Not difficult to produce slides for educational purposes

To use hardcopy non DICOM modalities

- Much physical effort needed to maintain the archive
- Loss of images due to many reasons
- Need to print twice every image (one for patient use and one for the archive)
- 10–30 minutes average image retrieval time
- Very difficult to produce slides for educational purposes

Figure 1. The picture archiving and communication system in the 2nd Radiology Department of the University of Athens: The scheduled situation.
system requires the replacement of the disks. If someone requires images stored in a replaced disk, the system asks for the specific disk to be placed into the jukebox.

A number of workstations (up to 50) can be connected on the server. Therefore, patient files can be distributed in any workplace in the department. The workstation is a common personal computer executing special software developed by Agfa Medical Company named IMPAX, which allows the user to find and display any image of any patient stored. The software has all the common capabilities of a database, such as finding a patient by name, examination date, type of examination, etc. It also provides the possibility to extract images outside the system in common image formats (.tiff, .bmp or DICOM), print images on film, perform common image processing, etc.

This system has been operating since January 2000, and the examinations of all patients are stored. The use of the system has resulted in the easy location of any patient. The average time for displaying a specific image of a certain patient is 3 minutes, as compared to 10–30 minutes when conventional films were stored in a room. Other advantages of this system are shown in Table 1.

Future targets. The next step of the system expansion is to install workstations in all departments of the hospital, allowing clinicians to have easy and prompt access to their patients’ images. The final scheduled step of the expansion is to install a web server, which will allow clinicians to retrieve images while away from the hospital (e.g., at their office or home). The scheduled situation is shown schematically in Figure 1. Security aspects are now under consideration.

Conclusion. The operation of the PACS system solved many problems that had arisen with the use of conventional films for archiving patients. The time required to find important images has been shortened dramatically, no images are missing, and the production of educational materials is very easy — a very important feature considering the duties of a University Department.

REFERENCES