Use of a Low-Cost, PC-Based Image Review Workstation at a Radiology Department

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Despite the increasing use of diagnostic workstations, film reading is still commonplace in most radiology departments all over the world. The purpose of this work is to assess the adoption of image review workstations in a radiology department where the usual primary diagnosis is film-based and cannot be replaced with diagnostic workstations. At our institution, a tertiary care center specialized in diagnostic imaging, a pair of PC-based review workstations running a Digital Imaging and Communications in Medicine (DICOM)-conformant public domain software for image display and analysis were installed in two reading rooms. Studies are automatically routed after acquisition from the picture archiving and communication system (PACS) server to the workstations and remain available for visualization for approximately 15 to 20 days. Data from two radiologists and two technologists collected over a 3-month period were analyzed, including purpose of use, time savings as compared to traditional manual methods, and overall user satisfaction. The results from the analysis presented in this work indicate a high degree of approval from the users, who report significant timesavings in numerous circumstances, in particular when it comes to discussing findings with referring physicians whenever films are not available. It also enriches communication between radiologists, facilitating peer review on the telephone when one of them has questions at the outcome of any given study. One of the main advantages associated with the system is the possibility of using it as a powerful tool for teaching and research. In conclusion, even when primary diagnosis is performed on film, the availability of a PACS for review can be helpful to enhance communication with referring physicians, as well as technologists and radiologists' efficiency. Our experience shows that it is possible to implement such a system using low-cost or freely available components without compromising ease of use while keeping costs down, which is a major concern in developing countries.

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THE IMPLEMENTATION and adoption of picture archiving and communication systems (PACS) in radiology departments has been largely aimed at replacing traditional film-based reading by a fully digital scheme utilizing diagnostic work-

stations. The advantages supporting such a major upgrade include greater efficiency and productivity associated with such systems, better response to referring physicians, and the reduction or elimination of costs related with films, to name a few.¹ However, there are often a number of factors that hamper the migration toward a fully filmless environment.

Our institution is an academic, tertiary-care center in which diagnostic imaging represents the main specialty. Outpatients are referred from a variety of public and private centers, some of them far away and without the necessary infrastructure for reading or manipulating digital images. For that reason, it is not as yet possible to stop producing and handling films, which are required by referring physicians along with the corresponding report.

As a result, although we do not attempt to introduce diagnostic workstations as a substitute for films at the radiology department, the purpose of this work is instead to evaluate the use of review stations installed in the reading rooms of that department. We also assess their impact on the daily activities of radiologists and technologists and the quality of service provided to referring physicians, who customarily communicate with the radiologists to discuss study findings.

METHODS

The PACS currently functioning at our institution² was mainly developed in-house using public domain software and integrates five diagnostic modalities (positron emission tomography [PET], computed tomography [CT], magnetic resonance [MR], ultrasound [US], and nuclear medicine), a Radiotherapy Treatment Planning workstation, a three-dimensional workstation, and several computers in a local area network for image storage, database management, and image review, processing, and analysis. It also includes a web-based application that allows remote users to query the archive for studies from any workstation and view the corresponding images and reports.

The review stations installed at the reading rooms are personal computers based on conventional hardware (600 -MHz Intel (Santa Clara, CA) Pentium III, 10 -GB hard drive, 128 MB RAM, 17-inch color monitor) running a publicly available application for viewing and manipulating medical images (eFilm Workstation, eFilm Medical Inc, Toronto, Canada).

CT and MR studies are automatically routed to both review stations immediately after acquisition from the PACS server and stored for approximately 15 to 20 days. Such studies can also be retrieved from the network on-demand in case they had been deleted from local disk, although retrieval time can be as large as 1 hour, since studies are archived on tapes.

In this work, two radiologists were requested to fill in a data

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collection form whenever they used the review stations indicating log-on date, purpose of use (clinical care, teaching—residents or medical students—or documenting a case of interest on personal folders), reason of use (referring physician consultation, personal motivation or peer-consultation with another radiologist), and visualization level (basic or advanced). Concurrently, two technologists filled in a separate form whenever they were asked to manually locate and retrieve radiographic films because the corresponding studies would not be available at the workstation, indicating the total time spent in fulfilling such request. The objective was to quantify technologists' time savings due to workstation availability.

RESULTS

Two hundred sixty-nine studies (CT and MR) were accessed from both review stations, representing almost 9% of the total number of studies generated within the department during the same period of time. That can be considered a conservative figure since the radiologists did not always recall to document workstation usage and did so according to workload. An important fraction (56%) of operation was to deepen on clinical findings using advance image visualization tools (zoom, measurements, three-dimensional navigation, etc), as well as simple window level and width adjustments (87% of the studies required advanced visualization tools). Teaching and research account for the rest of workstation usage (44%).

Seventy-one percent of times the person originating the review was the radiologist himself/herself. Only 2% of workstation usage was devoted to peer consulting between radiologists, and consultations by referring clinicians seeking additional information (either in person or by phone) accounted for the remaining 27%. All of these situations resulted in significant clinician, radiologist, and technologist time savings, as well as better patient care, since there was no need to manually search and retrieve films and consequently no reason for obviating the reviewing step.

Only on five occasions were technologists requested to manually search and retrieve films that were not available at the review stations, spending on average 15 minutes per study. Their productivity has improved because they had to perform the tasks by hand before PACS installation. Tables 1

Table 1. Percentage of Studies Accessed at the Review Stations According to Purpose of Use

Documenting a Case of Interest	Clinical Care	Teaching
18.22%	56.13%	25.65%

Table 2. Percentage of Studies Accessed at the Workstations According to Reason of Use

Referring Clinician Consultation	Peer Consultation	Personal Motivation
26.39%	2.23%	71.38%

and 2 provide further details regarding purpose of use and person making the request, respectively.

CONCLUSIONS

The availability of image review stations at a radiology department, where primary diagnosis is still performed on conventional means, proved to be extremely convenient for radiologists. It also contributes to provide a better service for referring clinicians since communication between both parties is improved. Although more information is needed to confirm, our survey suggests that the availability of both review stations has fostered consultation between clinicians and radiologists.

Technologists' productivity is enhanced since manual search and retrieval of films becomes unnecessary, except for only some situations.

Radiologists have a powerful tool for teaching and research, as well as for routine clinical care. It has been shown that there are many situations that require further analysis and image manipulation in order to clarify diagnosis and the availability of review stations saves time and contributes to better patient care.

Another associated advantage of installing review stations at the radiology department is users recognition of computer-based medical image viewing and analysis. This factor can be taken into account when designing the strategy to move on to a completely filmless environment.

Radiologists demonstrate a remarkably positive acceptance of image review stations. Our experience demonstrates that it is possible to implement a satisfactory solution using low-cost hardware and publicly available software without compromising user acceptance while keeping costs down, an issue that should not be overlooked in developing countries.

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