

Picture Archive and Communication Systems Implementation in a Community Medicine Practice

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In order to gain experience with vendor-supplied picture archive and communication system (PACS) products, a Vantage PACS from Lockheed-Martin was installed in a Mayo community medicine practice in Rochester. This practice produces about 45,000 radiology examinations annually. The PACS includes central long- and short-term storage devices, 10 image display workstations, and a dedicated high-speed image distribution network. Digital images are produced using two Fuji computed radiography readers. Custom worklists were created to facilitate efficient system usage. Currently, all radiographic examinations for this practice are acquired digitally, and interpreted and distributed using the PACS. Remote softcopy interpretation via PACS has decreased the turnaround time for both routine and urgent examinations, and has allowed subspecialty interpretation or consultation for pediatric examinations. These results have significantly improved the radiology component of this community medicine practice.

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NEAR THE BEGINNING of 1995, the Department of Diagnostic Radiology at Mayo Clinic in Rochester embarked on a program to evaluate picture archive and communication systems (PACS) from three different equipment vendors in three different areas on our campus. These pilot projects emphasized the use of computed radiography (CR) and the delivery of images and diagnostic reports to the clinicians served by each radiology practice. The Lockheed-Martin Vantage PACS (Lockheed-Martin Medical Imaging Systems, Hoffman Estates, IL) was selected for installation in the Baldwin building, which houses the Community Medicine practice. That project began in July 1995 and has evolved over the last 2.5 years. The Baldwin PACS-based practice will be described in detail.

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The Baldwin radiology practice produces approximately 45,000 examinations per year. These examinations are ordered by physicians in 10 clinical departments (including an Urgent Care Center) residing on six floors in the Baldwin building. Regular clinic hours are 8 am to 5 pm, Monday through Friday. The Urgent Care Center is open until 9 pm on weekdays, as well as from 9 am to 4 pm on Saturday and Sunday.

The Baldwin radiology practice is supported by one radiologist, one transcriptionist, and 4.5 full-time-equivalent radiographic technologists. Image acquisition occurs in three general radiographic rooms and one dedicated chest imaging room. Reports are directly transcribed by the transcriptionist as they are dictated by the radiologist.

We thought that the introduction of PACS into the Baldwin building could enhance the practice in several ways. The examination turnaround time (measured from the time the examination was started in radiology to the time the images and report were sent back to the ordering physician) for Urgent Care orders averaged 58 minutes during clinic hours, but was 128 minutes after-hours. After-hours, the films were sent via pneumatic tube to Methodist Hospital, where they were interpreted by a second-year resident, and then tubed back to Baldwin. Turnaround time could be considerably longer than the average. We expected that a PACS would allow remote, after-hours interpretation from St. Marys Hospital (~1 mile distant) by a more experienced resident, resulting in quicker turnaround of higher-quality interpretations. Also, the Urgent Care physicians thought that if they could view the images in certain cases before radiology interpretation, some patient management decisions (eg, whether or not to refer a fracture to the emergency room) could be made more rapidly. Finally, when reading pediatric cases, the general radiologists who rotated through the Baldwin practice often desired a consultation with a pediatric radiologist. PACS was expected to facilitate preinterpretation image viewing for Urgent Care and consultation with pediatric radiologists by allowing remote softcopy image display.

Methods—PAC System Configuration

A radiology information system (RIS) terminal was installed at the Baldwin Radiology desk for entry of exam orders. Acquisition of digital projection x-ray images is provided by FCR 9000 and FCR 9501ES computed radiography (CR) readers (Fuji Medical Systems USA, Inc, Stamford, CT). All radiology images for the Baldwin practice are currently acquired digitally using these two devices.

Image display for the QC technologist is supplied by one single-monitor 1K display workstation. Radiologist primary interpretation is performed using a four-monitor 2K display workstation in the Baldwin reading room, and two two-monitor 2K display workstations located in the pediatric reading room in the Mayo Clinic building and the general Radiology reading room at St. Marys Hospital. RIS terminals are present next to each primary interpretation workstation for direct report transcription. Image display for clinicians in the Baldwin clinical departments is provided by six two-monitor 1K display workstations.

Short-term image storage is provided by a single image server configured with 256 GB of storage based on redundant arrays of inexpensive disks (RAID). The PACS database also resides on the server. Long-term archiving occurs on a 0.5 TB optical disk jukebox. The server and archive are sited in a centralized data center in the Harwick building.

When the PACS was first installed in July 1995, the RIS incorporated in the Vantage PACS (PARIS) was used. In January of 1997, the Mayo Radiology Information Management System (RIMS; developed in-house at Mayo Clinic in Rochester) was interfaced with the Vantage PACS, and the use of the PARIS system has been discontinued. The RIMS database server is also located in the Harwick data center.

An especially important aspect of PACS software configuration involved the definition of folders and worklists for the different system functions and users. Folders and worklists are essentially shortcuts that allow rapid access to predefined searches of the entire PACS database of examinations. The worklists organize the examinations according to each of the specific tasks involved in the creation, distribution, and display of radiology examinations, and allow the PACS to be fully and tightly integrated with the Baldwin Radiology

practice workflow. Worklists were defined for image acquisition and exam QC. Three separate radiologist interpretation (ie, "unread") worklists were configured, one for all Baldwin practice examinations, one showing only those examinations ordered by Urgent Care (for remote after-hours reading), and one showing only pediatric examinations (for remote consultation or interpretation by a pediatric radiologist). Worklists were also defined for each Baldwin clinical department.

RESULTS

All radiographic examinations in Baldwin are currently acquired digitally, and interpreted and distributed to the clinicians using the PACS. There has been a very high level of acceptance of PACS and CR by radiologists, technologists, and clinical physicians. The turnaround time for Urgent Care examinations ordered after-hours has been reduced from a pre-PACS time of 128 minutes to 32 minutes via remote softcopy interpretation and transcription from St. Marys Hospital. (Examination turnaround during regular clinic hours has been reduced from 58 minutes before PACS, to 42 minutes using PACS.) Further, within 12 minutes of image acquisition, the images have been QCed (ie, verified by a radiology QC technologist as being technically adequate and ready for interpretation), and are made accessible to the Urgent Care physicians for viewing. Finally, using the PACS primary interpretation workstations at St. Marys Hospital and in the Mayo Clinic building, pediatric examinations are routinely reviewed or interpreted by a pediatric radiologist.

CONCLUSIONS

PACS has significantly improved the Baldwin Radiology practice by decreasing the image-availability and examination turnaround times, and improving the quality of the Radiology interpretations (through remote exam interpretation by pediatric subspecialists, and senior residents after-hours). Two key reasons for the success of this project are: (1) tight coupling of an RIS with the PACS to provide all of the text-based information necessary for both image interpretation in radiology and clinical access to complete examination results, and (2) the worklist and folder functionality, which facilitated radiology workflow management and clinical access to imaging examinations.