Crossing the Digital Divide—Moving From Film to Filmless Radiology

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OUR APPROACH TO DESIGN and implementation of a filmless department was driven by our vision, but tempered by the reality of our environment. Our vision is that the perceived value of radiology as a specialty is moving beyond diagnosis toward information management. Currently, this is most often interactive consultation as to appropriateness of various imaging studies, but increasingly it takes the form of organizing and managing the distribution of images and reports. Our environment is that of a public hospital and geographically dispersed health care system with limited financial resources and even more limited personnel resources. The Diagnostic Imaging Department staff had no experience with information systems beyond the ability to recall signed reports and verify the date and time of completed examinations. Our Information Technology (IT) Department was seriously understaffed. Their responsibilities historically had been limited to Admission, Discharge, Transfer (ADT), Accounts Receivable (A/R), and payables information systems. There was no one with significant UNIX experience or much client-server architecture support experience.

Our strategy for a picture archival and communications system (PACS) was therefore one of a phased implementation (Table 1). The overriding design goal was to move as quickly toward filmlessness as budget and technology would allow, while maintaining functionality in the department that equaled or exceeded historical performance.

An additional benefit of a phased approach was the opportunity to educate our medical staff and department staff about the new digital environment. We accepted the fact that migration from an analog (traditional paper and film) environment to a digital environment would be psychologically challenging. It was important therefore to demonstrate meaningful advantage to the new systems to both the medical staff and administration.

A high profile user of diagnostic imaging services was selected for a pilot project. The criteria for selection included the following: (1) opportunity for demonstrable improvement in patient care (important for physicians and administration); (2) opportunity for improvement in patient satisfaction (important to administration); and (3) opportunity

for a positive impact on physician practices (important to user physicians).

A one-way point to point network was installed consisting of a laser film digitizer in the department sending soft-copy images to a high-volume outpatient clinic. A simplified patient examination database and limited image storage capacity introduced the concept of clinician access to images without involving the traditional film library/examination request routines or physically coming to the imaging department to review cases. Soft-copy techniques such as magnification, window and level selection, and image inversion were introduced to the clinic physicians. Initially, resistance to these procedures was high. We gained an understanding of the importance of thorough training of all staff using the minisystem by encountering a broad range of hardware and operator errors. Imaging department staff devoted significant hours to user training and system maintenance. This intense, personalized attention resulted in the referring physicians moving from resistance to tolerance and then enthusiastic support of the digital imaging concept within a 12-month period. Access to clinic patient examinations improved from an average of approximately 3 hours to less than 1 hour.

Because the majority of examinations in our institution still consist of conventional radiography or plain films, the conversion to computed radiography (CR) technology was essential to achieving the goal of eliminating reliance on film. A second demonstration project was undertaken with the objective of educating our technical staff and radiologists regarding the issues of CR. A secondary goal was demonstration to the administration of savings to be realized by a reduction in film usage. Because this project involved CR technology from more than one company, it also allowed us to

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Table 1. Timeline of PACS Development

1990	Research design issues for PACS
1994	Began pilot mini-PACS project
Jul 95	PACS site visits began
Aug 96	RIS selection
Dec 96	Preliminary Administration approval for PACS
Feb 97	Second pilot project—Computed radiography
Jul 97	Final Administration approval of PACS concept
Aug 97	PACS selection completed
Jan 98	PACS installation begun
Jun 98	PACS used in clinical role

evaluate those differing technologies, especially at the user interfaces: the plate readers for technologists and the viewing monitors for the radiologists. Perhaps more importantly, we were able to evaluate each vendor's service support systems and resources available to assist high-tech neophytes such as ourselves.

The early years of the migration toward digital imaging and PACS have correctly emphasized hardware. Network configurations and speeds, monitor resolution and luminance, storage devices, and all the software associated with these elements have been studied and debated. However, it was our concern that the acceptance of PACS would ultimately succeed or fail on the human issues. For this reason, approximately 1 year before the anticipated implementation of the PACS and radiology information system (RIS), we began a detailed analysis of our present state. Monthly meetings with all section supervisors were held in which a designated supervisor would describe in as much detail as possible the procedures and processes performed in their area. Following this presentation, the group was encouraged to question the assumptions underlying those procedures and search for efficiencies that could be realized with PACS and RIS. All activity, beginning with the examination ordering process and ending with long-term film storage and retrieval, was deconstructed and analyzed. There were many areas solely within a section's ability to improve efficiency. However, the emphasis in these meetings was directed at the interfaces between the various sections. For example, the effect scheduling clerk's actions had on technologist's workflow, the effect examination completion procedures had on radiologist access to studies waiting to be reviewed, and the radiologists' habits that affected transcription were discussed in a nonthreatening manner. In an effort to reenforce the nonthreatening nature of this process, meetings were held off

campus, in a "happy hour" setting that was also conducive to the free exchange of ideas.

A secondary objective of this process was to break down barriers to intradepartment cooperation that had developed over the years and to build and strengthen esprit de corps as a department dedicated to serving the larger enterprise. In retrospect, this latter objective probably was most important. During the stressful weeks of the RIS and PACS installation, the cooperative spirit of department personnel was essential to our success.

Also critical to the successful operation of the department was the advice and assistance of our RIS and PACS partners. Contingency planning and development of fail-over policy has proved crucial. The department was designed to be functional using film, although at a significant cost in throughput. Disruptions of interfaces between the hospital information system (HIS), RIS, and PACS were anticipated. Redundancy was designed in such a way that each modality could still be used in patient care independently of a functioning network. The PACS design anticipated the occurrence of erroneous patient or examination data. A repository for corrupt images or image data was constructed in such a way as to allow physician access to those images even before the examination data were corrected, thus not impeding patient care.

Beginning approximately 4 weeks before actual first use, department technologists were given 8 hours of group orientation and instruction on the use of the RIS and 8 hours of instruction on the use of the PACS. There were 5 days of applications support, with approximately four support staff assisting 30 technologists. Nurses from each of the inpatient units, operating room, emergency department, and other key areas were also instructed in the basic purpose and functionality of PACS. It was thought that the nursing staff would act as a teaching resource for new house staff and the infrequently visiting attending medical staff. Each shift had at least one person identified as a super-user—a person with an aptitude for computer systems or with previous computer experience. These super-users were given additional instruction in the RIS and PACS functionality and tasked with being assistant trainers and troubleshooters. In practice, the house staff opted for a trial and error approach or turned to the Imaging Department for advice. Most of the nursing staff therefore had little

interaction with the PACS and quickly lost their skills.

The medical staff was invited to sign up for instruction in the PACS. Meetings were scheduled over a period of 1 week, after or before normal working hours for the physician's convenience. The groups were limited to six in size to allow as much hands-on practice as possible. Any physician unable to attend a scheduled meeting was contacted and a one-on-one teaching session arranged. Approximately 40% of the active medical staff received training in this way. Because the majority of doctors failed to receive formal instruction in the PACS, there has been a continued demand for assistance and, in some cases, a perception that PACS has a more limited functionality than is the case. We have attempted to respond to the need for additional training by continuing individual instruction as requested, and by having the system administrator available by wireless phone and widely disseminating her phone number. After the first 5

months, there has been a steady decrease in the calls for help, now averaging four per day.

For 8 months, the radiologists, attending medical staff, and house staff of Riverside County Regional Medical Center have used a PACS system for all diagnostic imaging with the exception of mammography. The process of redefining the tasks and responsibilities of the technical and clerical staff was a collaborative one. Moving from a traditional film-based environment without any meaningful RIS support to a virtually filmless department dedicated to complex information management requires detailed analysis of one's present state, as well as careful planning for the future state. The process of educating the department personnel in new procedures used in a PACS environment is a time-consuming one. The process begins with the commitment of the radiologists to a digital world, and then effectively sharing that vision with the medical staff, information systems staff, and administration.