Optimizing Radiology in the New Picture Archiving and Communication System Environment

Jay F. Cook, Mark Hansen, and James Breitweser

Picture archiving and communications systems (PACS) have inescapably altered the face of radiology. Images are available to radiologists and clinicians alike, nearly instantaneously. For patient care management, service has improved, but without inclusion of input from radiologists. Effecting timely report availability requires reorganization of radiology. In a hospital-wide PACS environment, we undertook to render a preliminary report on all nonprocedural computed radiography examinations within 30 minutes in a teaching environment. Two periods of time in the same month were analyzed, one before reorganization and one after. Of 686 reports, 117 were examined with a statistical significance of $\alpha = .05$ (95% confidence) and a power of 90%. Average times for examination acquisition to preliminary report availability on the PACS decreased from 5 hours to 31 minutes. Standard deviation in report generation times decreased from 8 hours to 30 minutes. This preliminary study suggests that business process reengineering can effect improvement in information flow within a teaching facility resulting in radiologists rejoining the patient care management team. Successes, pitfalls, and future requirements are discussed.

KEY WORDS: picture archiving and communications system (PACS), radiology reports, diagnostic radiology, department management.

HOSPITAL-WIDE picture archiving and communications systems (PACS) have been in use since the installation of the first medical diagnostic imaging system (MDIS) at Madigan Army Medical Center in 1992. Since this event, there has been considerable growth in this technology. With PACS came a new era of immediate availability of roentgenographic images throughout the hospital. Image loss rates fell to less than 1%, and clinical acceptance of the system has been nearly instantaneous. Tripler Army Medical Center (TAMC), a 387-bed facility performing 115,000 examinations annually, installed an MDIS PACS in June 1996.

The literature contains numerous articles and editorials elaborating on the benefits of efficiency and productivity, as well as savings and/or costs created. Additionally, numerous reports have reviewed the problem of report generation and result dissemination. None have actually described the process of departing from the old concept of batch mode reading at the alternator. Thus far, installation of PACS results in replacing the view box with a computer monitor. The past delays in presentation of routine films to the radiologist because they are in a clinic or being compiled in the file room are no longer. The immediate availability of images allows for immediate interpretation. However, in a teaching facility with the primary objective of patient care and the secondary mission of graduate medical education, there is a precarious balance between fostering a resident teaching environment versus timely availability of interpretations to meet the clinical user's needs.

To favorably influence the outcome of both sides of the equation, we engaged in business process reengineering (BPR) to reorganize the manner in which nonprocedural computed radiographic examinations are treated.

MATERIALS AND METHODS

Our radiology reporting system includes a remote telephone access system (RTAS) to dictations performed within the previous 3 to 5 days, a radiology information system (RIS) incorporated into MDIS, and a hospital information system (HIS) provided by the Composite Healthcare Computer System (CHCS). Radiology residents and staff verbally place a time and date stamp on the report at the time of dictation. This date/time stamp is then transcribed onto the report by the transcription service.

Two 5-day blocks of time during the same calendar month were chosen retrospectively; one before the organizational shift and a second following the reorganization of the department. Finalized reports from CHCS were reviewed to extract examination completion to dictation time. This represented the time interval from beginning the acquisition of images to the time of dictation and the placement of a preliminary report into the RIS folder of MDIS. From a total population of 411 reports reviewed in the first group and 275 in the second, 62 and 55 reports were used respectively for data analysis. These 117 reports represented those in the reviewed population containing a time stamp dictated by the radiologist. The use of the time to completion of the preliminary report as opposed to the verified report was arbitrarily chosen as a result of three factors. The preliminary RIS report is available concurrently with the images and therefore more likely to be reviewed by the clinician as opposed

From the Department of Radiology, Tripler Army Medical Center, Honolulu, HI.

Address reprint requests to LTC Jay F. Cook, Department of Radiology, Tripler Army Medical Center, 1 Jarrett White Rd, Honolulu, HI 96859-5000.

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to use of RTAS. Holman et al[1] demonstrated a small potential risk of increased risk to patients based on unedited transcribed preliminary reports. However, this was based on the incorporation of transcription or dictation errors. The preliminary report entered on MDIS is entered by the report creator(s), not by transcription services. Standard reports entered into the RIS, selected from a menu within the RIS, were not included in the data, as a date/time stamp is not generated.

A *t*-test was applied with an $\alpha = .05$ (95% confidence) and a power of 90%. This included 62 reports from the first block and 55 from the second block of time.

RESULTS

The performance times for the previous departmental reading organization and the result of BPR are listed in Table 1. Average time of examination acquisition to dictation was reduced by 968%. Standard deviation for reporting was reduced by 1,600%. Availability of reports on either the RTAS or the RIS within 30 minutes showed an improvement of 360% and at 60 minutes of 340%, respectively. The exclusion of standardized reports did not affect the results. This method of report generation, with exception that they are not available on the RTAS, follows the same pathways as those included in the study and were present during both time periods selected.

DISCUSSION

Installation of MDIS at Tripler had an immediate beneficial effect secondary to the near instantaneous availability of images and electronic archiving. Emergency Medical Services Quality Improvement monitors showed a decreased incidence, from 11.7% to 5.3%, in patient extended stays of 3 or more hours. This decrease was noted after institution of PACS and an automated laboratory system. Pre-MDIS image availability ranged from 82% to 86%. Post-MDIS availability rose to greater than 99%. Report availability on RTAS or the RIS for all CR examinations decreased from an average of 10 hours pre-MDIS to 5 hours post-MDIS. As expected, the interval for the generation of statim (STAT) radiology consultations was not affected.

The immediate availability of diagnostic images in an electronic environment poses a new challenge to radiology. Treatment planning and decisions are now being made more than ever without the input of the radiologist. Reports have surfaced in specialty journals other than radiology questioning the value of radiologists' interpretations in trauma and outpatient settings.[2,3] Input from radiologists decreased from 92% to 26% after the institution of PACS in the Medical Intensive Care Unit of a Pennsylvania hospital.[4] We have observed a similar decrease at TAMC. While not reported in the literature, the authors perceive this trend in decreased consultation may soon extend to all of radiology including the outpatient arena. Result communication at even 5 hours is well beyond the expected elapsed time between a patient-provider encounter and initiation of the treatment process by the healthcare provider. For radiologists to be relevant requires the initiation of timely service, without sacrificing quality, for our referral base.

In a teaching environment, resident education is nearly as important as patient care. To facilitate the learning process teaching institutions incorporate the 'batch mode' reading process. This is usually performed at established times periodically during the day. Continuous coverage for 'wet' readings is performed by a dedicated staff and resident. At a facility using either RTAS or HIS or both, the rate limiting step to improving the timeliness of report availability lies in the time period between the completion of the roentgenographic examination and the presentation of the examination to the radiologist.

To effect this BPR effort, the departmental operations were reviewed. From this review it was concluded that approximately 160 examinations were performed daily during normal business hours. After-hours coverage was provided by a resident physically present. Of the 160 examinations, the majority were pertinent to the chest, bone, and pediatric services. An objective of 30 minutes from examination availability to report availability was set. To meet this goal, the next step was to devise a

Table 1. Report Availability

Time Block	Reports in Survey	Average Time*	STD Deviation	Sample Size†	% Reports Available 30 min	% Reports Available 60 min
Dec 2-6	62	5:00	8:04	62.5	18	26
Dec 23-27	55	0:31	0:30	0.2	65	89

Time format is hours:minutes.

*Average procedure stop to dictation time.

†For a 2-hour precision & 95% confidence.

radiology reading operation that met four criteria. First, the primary objective of report availability must be met. Second, radiology subspecialty service time must be available for review of in-patient images and consultation rounds with clinicians. Third, resident teaching must occur. Finally, a system of peer review should be included.

The initial operation was developed principally to ensure that the first criteria was met. One staff and one resident would read all films from two folder lists in MDIS, 'Unread STAT' and 'All Unread Exams,' the latter further refined by placing a filter in MDIS to register only CR. If a back-log occurred, a back-up resident and staff were designated to provide coverage as needed. The majority of the staffing for this reading service came from the three services primarily affected. Additional time was made available for AM review of in-patient images and clinical consultation for the chest and pediatric services.

The results indicate that the objective of producing a report and the first two criteria were met. Meeting the latter two criteria will require further refinement of the concept. The daily scheduling adjustments proved difficult. Procedures requiring staff supervision retained priority affecting the overall responsiveness of the reading operation. Culturally, it was evident that workload redistribution among the residents was not well-received. Previously busy service volumes were shifted to less occupied services. Senior residents assumed more of the workload than their less experienced juniors. Due to the complex scheduling, teaching time between staff and residents subjectively decreased. A peer review system at the subspecialty service level required creation of additional folders in MDIS, currently under development.

Reevaluation of the process is ongoing. The latter two criteria are considered integral to success of the teaching mission and insurance of quality of service to the clinicians. Initial review of the process demonstrates no treatment misadventures resulting from this image interpretation paradigm. Clinician satisfaction surveys will be devised to ensure that quality does not suffer in the pursuit of timeliness and also to assess the value of improved report generation to patient care.

The change in radiology registered here represents the beginning of an expanded global network in which consultations are provided regardless of the location of the radiologist or the point of image acquisition. To be relevant to the clinical care management team, we must provide rapid report generation without sacrificing interpretative quality. The electronic environment affords us this opportunity.

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