SESSION VII

Is PACS a "WAMI" In Your Institution? It Should Be!

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HENNEPIN COUNTY Medical Center (HCMC) is a public teaching hospital in downtown Minneapolis staffed by approximately 360 physician and dentist members of Hennepin Faculty Associates who supervise the advanced medical training of approximately 220 resident physicians. Staff physicians are also members of the University of Minnesota Medical School faculty.

Hennepin County Medical Center occupies five city blocks near the Metrodome and also operates primary care clinics in south Minneapolis, in the southern suburb of Richfield, in north Minneapolis, and in the northern suburb of Brooklyn Center. The downtown location has 434 hospital beds (more than 100 intensive care), 16 operating rooms, four primary care clinics, and scores of specialty clinics and outpatient programs. In 1997, these clinics recorded more than 313,600 patient visits and counted more than 124,300 unduplicated patients.

Hennepin County Medical Center was named Minnesota's first Level 1 Trauma Center in 1989. Hennepin County Medical Center's Emergency Department is the most active in the state, experiencing approximately 85,000 patient visits and 48,000 ambulance runs annually.

PACS IMPLEMENTATION IS AS MUCH AN ART AS A SCIENCE

One visit to any of myriad conferences and exhibitions in the field of Medical Imaging, and one can't help but be overwhelmed by the variety of technology offered to this profession. Indeed it is a period of considerable technological innovation.

However, beyond the "techno-babble" highlighting the latest tech gadgetry lies the crux of the solution to translate these new technologies into effective tools in your health care enterprise. It is the "process" component of the now-familiar term, "processor," that dictates the degree of success of your automation initiative. Process, or workflow, automation is the critical success factor in separating the medicore system implementations from those receiving rave reviews.

A Picture Archiving and Communication System (PACS) initiative reflects this axiom probably more than any other technology-based project in your

enterprise. Since it utilizes the latest in computing platforms, it is natural to get caught up in the typical "processor battle-ground" ("this uses a sparc . . . , or a pentium . . ."). Our experience has shown, however, that a victory in this battle is very short-lived, with a newer, faster model just around the corner. What's more, the site with the fastest machine isn't necessarily the winner.

The winning solution is the one with the best "WAMI," ie, Workflow Automation for Medical Imaging.

A successful PACS installation is as much an art as it is a science. At Hennepin County Medical Center, the colloquial adage of "different strokes for different folks" was an informal guideline for our PACS implementation. This translated into maintaining a focus of flexibility while trying to standardize the new automated processes. The transition to a fully digital imaging environment was incremental at best. This promoted an iterative development of the new workflow procedures. The decision to commence the PACS initiative was not based on an in-depth business process analysis, but rather the result of a vision of how radiology would be accomplished in the future. It was not a question of "if," but rather one of, "when and how."

To manage the change process effectively, the Medical Imaging workflows at HCMC were categorized as being either intra-departmental (ie, within the core Medical Imaging department) or inter-departmental, (ie, Medical Imaging's interaction with other areas of the enterprise). In each case, the primary budgetary savings would potentially come from FTE reductions involved with the film-based processes. The biggest challenge to achieve these savings, has been to automate the handling of the non-image related components (eg, order requests,

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jackets, and so on) to keep pace with the new image distribution capabilities enabled by PACS.

INTRA-DEPARTMENT WAMI

Meeting the objective of total process improvement within Medical Imaging meant optimizing all the steps from order (or even pre-order) to final report. Process integration via leveraging information technology was the fundamental methodology.

An overview of the changes within the department observed during the PACS transition are:

- The distribution of studies became more specific and technologist-driven.
- The number and type of comparison studies used by the radiologist for reading became a critical image management and distribution issue.
- New roles within the technologist and film room staffs were necessary to oversee PACS-related procedures (at least until the full staff had made the transition to the new environment).
- The exchange of paper-based information (eg, order requests, technologist comments) would need to be expedited by the use of fax machines and/or be translated to an electronic messaging media.
- The strict demarcation of functions performed by the three primary job classifications was softened as overlaps of roles around the PACS environment evolved (see Fig 1).
- A computer support team was added to the Medical Imaging organization to handle the maintenance of the workstation user account and configuration parameters, and to respond to any system integration issue of the PACS with other Information Systems in the institution.

To enhance intra-department communication on the project, two multi-disciplinary committees were formed. One, a Technical Advisory Committee (TAC), and two, an Image Management System (IMS) Oversight Committee. The TAC is comprised of representatives from the various technolo-

Fig 1. Triangle diagram of overlapping job functions.

gist staffs with a liaison from department administration. The Oversight Committee is a multidisciplinary team with representation from the radiologists, the technologists, operations administrator, purchasing administrator, the computer support team, and the PACS vendor. Regularly scheduled issues meetings chaired by the Oversight Committee with expanded representation from all Medical Imaging functions reviewed project and delivery time lines and critical implementation issues.

New Roles Within The Medical Imaging Department

Two new departmental roles defined to facilitate the PACS implementation were the Image Control Technologist (ICT) and the Image Control Clerk (ICC). Each of these roles was considered to be a temporary job assignment bestowed upon specific individuals in the technologist and file room staffs respectively. The personality traits sought after for these individuals were: an overall affinity towards information technology; an ability to learn quickly; and an even-tempered personality able to "roll with the punches" as the digital process evolved. In addition, to enable these individuals to enact change within their respective areas, they had to be well-respected by their colleagues and be considered effective liaisons to management.

One of the final tasks in their roles as ICT/ICC, was the education of their colleagues to eventually bring about a metamorphosis of the staff to a department of ICT's and ICC's. This functional transition might be comparable to the recent transition in most industries from the traditional secretary (with excellent typewriter skills) to the administrative assistants skilled in word processing and desktop publishing prevalent today.

Until such time as the pre-fetch and auto-routing of historical studies could be realized through technology, the technologist was identified as the most capable person to direct the "study assembly" activity. With film-based reading, the distribution of comparison studies was done "in bulk" with little regard to exactly what each radiologist used to complete his/her reading tasks. With PACS, an efficient assembly of an effective "study package" for reading is vital to the success of the project and is essential for optimal network and workstation utilization.

During the finalization of the "study package,"

the individual reading styles of the radiologists gained visibility and became the subject of considerable discourse. Feedback from other institutions was even solicited to help provide an objective benchmark for the process. The Hennepin County Medical Center result: each new study would be "packaged" with the most recent previous study of the same anatomical region and/or modality. Comparison "packages" for ICU (Intensive Care Unit) patients and multiple trauma cases would require special considerations if deemed appropriate by the technologist. Any additional comparison studies required would be the responsibility of the radiologist to query electronically or request from the file room.

Improving the Full Process

In general, improving the communication of the non-image components (eg, order requests, previous reports, and so on) was considerably more challenging than moving the images through the network. A full integration to the Radiology Information System (RIS), currently works-in-progress, will enhance some of this information exchange. However, it will need a transition phase as well until the PACS and RIS study demographics are fully synchronized. During this transition, special work-arounds will continue to be deployed for handling differences in key criteria such as study date and time, patient names, and accession numbers. These work-arounds typically consist of custom reports or system queries to facilitate efficient cross-referencing of information. It is anticipated that this transition phase is likely to be accompanied by the introduction of one or another "temporary support roles" in the department.

Despite some of the manual bridging of informational components in the total process improvement, the overall decrease in turnaround time for the Medical Imaging Department resulting from the PACS implementation has been substantial. It's downward trend (depicted in Figs 2 and 3) is expected to continue as a tighter system integration is achieved.

INTER-DEPARTMENT WAMI

Continuing the project's "flexibility" emphasis in its interaction with other departments, Medical Imaging's workflow analysis and resulting process improvement targets for its partners in the health care enterprise were tailored to each specific depart-

Fig 2. Average turnaround time prior to PACS initiative. Turnaround time defined as end procedure time to final report.

ment as the digital imaging system was introduced. In all cases, a PACS preview process was conducted with all effected personnel within those departments. This preview consisted of both formal and informal training programs on the use of the workstations and an open invitation to assist in that

department's workflow re-engineering to leverage the new PACS environment effectively. If possible, a lead PACS "champion" was identified in the department to serve as a liaison to Medical Imaging on PACS issues.

In general, a peer-to-peer training process was

Fig 3. Percent of studies with turnaround time less than 24 hours. Turnaround time defined as end procedure time to final result.

orchestrated. The clinicians were receptive to interacting with the radiologists on the new technology, the nursing support staff with the technologists, etc. As such, it was critical to have all personnel of the Medical Imaging Department exhibit a positive attitude regarding the PACS transition. Technological innovation is always an easy target for criticism so managing expectations and attitudes is as important to success as the technology itself. Open dialogue regarding problem areas and a respect for existing processes in other departments was the underpinning of the change initiative. As a result, true long-term inter-departmental partnerships were formed to jointly manage the transition process.

Some of the partners participating in the PACS project and the resulting process improvements in their departments are outlined below.

Medical Imaging in the ED and ICU's

Following some initial presentations and workstation training by Medical Imaging, the Emergency Department (ED) and Intensive Care Unit (ICU) clinicians were extremely receptive to adapting their workflow to digital imaging. One reason for this rapid acceptance, was due to the decision to physically locate part of the PACS equipment in the ED itself. Two Siemens Computed Radiology (CR) Systems, a Dejarnette digitizer (primary used for digitizing Stabilization (STAB) room films) and a Quality Control (Q/C) workstation were installed early in the PACS program. An ICT (Image Control Tech) was stationed in the ED to ensure a smooth system transition and efficient digital image capture procedures.

Studies concluded in the ED were routed immediately to a clinician viewing workstation installed in the clinician "pit" area following the ICT's quality control tasks and CR post-processing. Simultaneously, these studies were "packaged" with appropriate comparison studies and routed to the radiologists for interpretation. Clinician consultation was an immediate benefit, especially in high trauma cases. Similarly, studies captured portably on ICU patients were dual-routed to both ICU stations to achieve maximum consultation benefit and study availability for the ICU clinicians. Problems identified in a pre-PACS analysis (see Table 1) were either greatly reduced or eliminated in a short time frame after PACS implementation.

Film was initially generated as a backup media by the ICT and distributed to the file room for

Table 1. Problems Greatly Reduced or Eliminated With the Introduction of PACS

Overall repeat exam rate reduced from:
• 35% to 4.8%
Lost film rate reduced for:
• Emergency Department 3.5% to 0%
• ICU's 8% to 0%
• Pediatrics 3% to 0%

inclusion in the patient's jacket. Stabilization (STAB) room studies have continued to be laser printed until renovations in the ED are completed in the Fall of 1998. At that time, digital imaging monitors will largely replace the omnipresent view-boxes in this final bastion of film-based imaging in the Emergency Department. This portion of the plan, however, is being re-visited. A better solution may be a "throw away" film-generation in the STAB room as well as the operating room.

As the digital imaging workflow achieved stabilization in the ED, the role of the ED-located technologist began to be fully assimilated into the patient care workflow of that department. A terminal from the Emergency Department's own scheduling and patient management system was installed near the Q/C workstation. The ED technologist learned to update the scheduling matrix of this system and began to improve his or her own workflow by pro-actively retrieving patients from the ED patient areas based on an "electronic order" signal only. For now, the paper catches up. In the future, it won't be generated at all.

Medical Imaging in the On-Site Out-Patient Clinics

Prior to PACS, more than 500 jackets were requested, pulled and distributed to these in-house clinics *every day*. The percentage of jacket utilization, however, was estimated at only around 30%-50%. Since the turnaround time for retrieving and "running" the jacket to the clinic on-demand would not be timely enough for real-time patient care workflow, the clinic chose to error on the side of having too much rather than too little.

Following the installation of some PACS viewing stations in selected clinics, the medical imaging-related processes improved substantially. One outcome of a PACS-equipped partner is that the lead time required for the clinic to inform (or retrieve) the studies it required was shortened. As this time is reduced, the specificity of the request becomes better because the patient schedule at the clinic is

more exact. The higher the specificity of the request, the higher the integrity of the data provided. This results not only in a more focused workflow within the clinic, but also a better utilization of medical imaging resources, both human and electronic.

Initially, the ready availability of a digital archive was easy to abuse. Response times for historical studies were typically in the 1-3 minute range. However, if left unabated, a thoughtless clinician or staff member could easily push this time range to 10-15 times that. Some follow-up training with the clinic staff was provided to increase their awareness of the enterprise nature of this critical resource. To further mitigate this type of event, transaction requests resulting in excessive archive retrievals were quickly documented and the individual involved was re-educated on the impact of their actions. An expedient response to this event clearly demonstrated to the clinic personnel that this resource was being monitored closely. A repeat problem rarely occurred.

FTE savings in Medical Imaging due to the PACS initiative have been estimated in the \$60,000 range per annum. This is partially attributable to the elimination of "runners" distributing the jackets. By the end of 1998, when the full complement of clinics are serviced via PACS, this savings amount should triple.

FTE savings in the clinics have been negligible to date due to the replacement of previous jacket-handling tasks with the absorption of some PACS workstation maintenance tasks. Overall, however, the workflow has become more streamlined in that it is more easily managed in the clinic via a computer worklist than the unwieldy stack of patient jackets previously received from Medical Imaging.

Medical Imaging In Offsite Clinics

Although the primary purpose in expanding the PACS network to the offsite clinics elimination of courier runs between facilities in the amount of \$15,000 per annum.

A film digitizer and PACS viewing workstation was installed at each remote clinic. A frame-relay T1 communication link was installed to each site due to the relatively low break-even point of the wide area communication options offered by the local carrier. In addition, the T1 link could be

shared with other computer applications running at these clinics if the medical imaging volumes were low enough.

The presence of a digitizer on the clinic premises which could process and route the studies to both the local PACS workstation and the main facility radiologist station expediently did not, however, alter the standard patient care practice by the clinician of using the film for the preliminary diagnosis. At the clinic level, even a delay of 5 minutes in the patient care process was unwarranted. Basically, if the film was produced at the clinic, the film will continue to be used by the clinician for the current study. Workflow improvement was achieved by the access to the historical patient studies now readily available at any of the clinics no matter where within the enterprise the patient was seen initially. In addition, in the event of a suspicious pathology, the clinician could initiate an immediate consultation with the radiologist at the main facility. This "one visit" outcome resulted in both cost savings to the institution as well as time and cost savings to the patient.

CONCLUSIONS

The success of the PACS installation at Hennepin County Medical Center can be attributed primarily to two project mandates:

1. The objective was to provide the best imaging service possible to the patient i.e. total process improvement for patient care delivery, not just image management.
2. The clinicians, their departments and the vendor(s) are key partners in the realization of this objective.

Some of the tactical steps for Medical Imaging to operationalize these mandates were:

- Be pro-active in documenting the workflow of the partner departments in order to demonstrate your understanding of their processes, to highlight critical exceptions and to demonstrate areas where the PACS technology could be leveraged.
- Quantify financial benefits, but don't over-prioritize them in the finalization of the solution. Typically the time-frames for the realization of these economic returns are over-zealous and do not adequately reflect fundamental adversions to change.

- Identify an “inside champion” in the department or clinic to serve as a project liaison.
- Write contracts with vendors with an emphasis on flexibility with regard to both actual devices deployed and delivery time frames.
- Keep the Medical Imaging Department organi-

zation fluid and don’t hesitate to define new job functions and/or sub-departments to address transitional requirements.

Per our estimates, workflow automation is about 40% technology and 60% people and procedures. Make sure your project team is focused accordingly.