## Developing Policies and Procedures for a Picture Archiving and Communication System

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Policies and procedures (P&P) constitute the mechanism for planning, standardizing, and documenting the provision of clinical services. Upon approval by hospital management, the P&P is an official statement of hospital rules and regulations. Each P&P establishes organizational responsibility for providing services. P&P are a mechanism for communicating standard operating procedures to hospital and medical staff. P&P serve as a reference document for unusual events, as well as routine procedures. P&P are often reviewed by inspection teams from the Joint Commission on Accreditation of Hospital Organizations (JCAHO) to determine whether the hospital has documented systematic practices. A picture archival and communications system (PACS) provides a new vehicle for providing radiology services. P&P that were designed for conventional film-based imaging are often not appropriate for electronic imaging. Because PACS is new and not yet widespread, good examples of PACS P&P are not yet available. JCAHO has no official requirements for PACS: PACS is viewed only as a means for the hospital to accomplish its work. Successful P&P development is a team effort, drafted by personnel responsible for executing the procedure, assisted by staff proficient in PACS technology, and tested in the field. The P&P should be reviewed and approved by management personnel knowledgeable about hospital and imaging operations. P&P should be written in clear and concise language. Successful P&P development is an ongoing effort. P&P must be periodically reviewed and updated to reflect changes in PACS technology and changes in clinical operations. New P&P must be developed when a deficit is noted. PACS security is a good example of a topic worthy of P&P development, especially in the face of the Health Insurance Portability and Accountability Act (HIPAA) legislation of 1996. What are the provisions for access control? Does the system include a feature for automatic shut-off of the software? Are there "generic" passwords and log-ins shared by a community of users? How are passwords assigned and how frequently are they changed? What security measures are in place to assure passwords are given to the appropriate user? Who grants and denies access? Service calls are another topic for P&P. Who initiates a service call? What is the process for

escalating a service call from the operator level to the vendor? What immediate actions are expected by the operator in order to restore PACS services? How are service events documented? Who is responsible for determining when "downtime" procedures should be initiated or suspended? When our hospital's total electrical system had to be shut down for an extended period, we found that a P&P was lacking for a task as mundane as shutting down and restarting our PACS components. What is the sequence for the shutdown? Who is responsible for shutting down and restarting? How long can the devices operate on uninteruptible power supplies (UPS)? What components are on emergency power? Should we expect the components to survive the switchover to generator power? Developing this P&P was worth the effort: it made the PACS more fault-tolerant and served as a reference document 3 years later when expansion of our physical plant required two more power outages.

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EXAS CHILDREN'S HOSPITAL uses a large-scale picture archival and communications system (PACS) to conduct hospital-wide filmless imaging operations. During the transition from film-based to filmless operations, it became apparent that the policies and procedures (P&P) that were tried and true in our film-based environment were not always appropriate for either normal or emergency situations in the filmless hospital. In developing new P&P, we found that we first had to define the current workflow and the desired workflow, but also to consider the characteristics of the new technology.

Filmless imaging operations are subject to some of the same interruptions as film-based imaging operations, such as electrical power outages. However, the impact may be more far-reaching and more permanent than in a film-based hospital. Filmless operations are subject to additional interruptions, such as network outages, that would likely not affect a film-based operation. In a filmless operation, reporting of equipment malfunctions is more critical, because more complicated equipment is deployed at greater distances, consequences of outages are more global, and there is usually less redundancy of expensive PACS equipment than film processors and lightboxes. Recovery from outages in a filmless operation is also very different.

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Routine operator activities are also different in the filmless hospital. Routine maintenance of PACS equipment is not a topic of instruction at Radiology Technologist schools. Image accountability and quality assurance (QA) is performed in a very different manner in a filmless hospital, where an electronic image can disappear without a trace. Patient confidentiality is more easily accomplished in a film-based hospital than in an electronic environment, where images can be viewed many places simultaneously. This is the number one concern that the Joint Commission on Accreditation of Hospital Organizations (JCAHO) has with regard to PACS. This is not surprising considering the provisions of the Health Insurance Portability and Accountability Act (HIPAA) of 1996.

Our hospital recently made the transition from "mostly filmless" to "virtually filmless" with the installation of computed radiography (CR) and viewers in our Intensive Care Units. This experience illustrates the process of modifying film-based P&P so that they are appropriate for filmless operations. Although the specifics may differ, the methodology for developing new P&P is the same as that for developing any new "system." That is, we needed to define the existing workflow, define the desired workflow, document the desired workflow in P&P, test the P&P, and revise as needed to match the technology and ongoing clinical operation.

# CASE STUDY: FILMLESS BEDSIDE OPERATIONS

In the final phase of our hospital-wide PACS plan, we replaced darkrooms with CR equipment in our Neonatal Intensive Care Unit (NICU), Post Anesthesia Care Unit (PACU)/Pediatric Intensive Care Unit (PICU), Operating Rooms (OR), and Progressive Care Unit (PCU). These CRs also serve our other Nursing Units for beside examinations. Concurrently, workstations and web viewers substituted for routine film distribution to these areas. Each CR cluster included the capability for acquiring images and performing quality control (QC). Each cluster also included equipment needed to produce hard copy of electronic images and to produce conventional film/screen images in an emergency.

### Initial Filmless Operations: Assumptions

Because our hospital has been conducting filmless operations in our main department and in our outpatient center for years, we made a reasonable assumption that we knew how to acquire and produce CR examinations. We have been performing bedside examinations for many years, so we assumed that we knew where images needed to go. We all knew our roles and responsibilities in providing bedside imaging services. We knew what to do when things went wrong and who to ask for help. We had tested all our equipment to verify that each piece functioned properly, but we assumed that all our equipment was configured to support our clinical operation.

We began filmless bedside operations without defining the routine and contingency destinations for images. Operator actions under normal and abnormal conditions were unknown. Communications channels were not defined: at the time the Portable Supervisor position was vacant. Although we had studied the network infrastructure diagrams, the actual network configuration inside the telecommunications closets was known only to Information Services (IS). Film distribution during downtime was not defined, and retrieving film after downtime was not planned.

We had neglected to accommodate the "human factor" within our own department.<sup>2</sup> On the other hand, we invested significant planning and resources in training our customers outside the Radiology Department. We were absolutely certain that *they* did not know what *they* were doing!

As a result, during initial operations some images went to the wrong destinations while some went nowhere at all. Some examiantions were repeated unnecessarily. During times when we were producing both laser-printed images and electronic images, the technologists gave precedence to distributing the hardcopy over archiving the electronic versions so that film was faster than electrons! At the first sign of trouble, technologists reverted to film/screen, without notifying the PACS staff or the operations manager. No one knew when service was interrupted or restored.

When the technologists reverted to conventional film/screen on their own initiative, they solved the immediate operational problem by delivering images, but created a long-term problem. All images that were recorded on conventional film had to be

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located in order to introduce them into the electronic imaging system. This tedious, time-consuming recovery process took a week and a half to find the films, archive, and manually digitize them. This manual recovery had to be accomplished in order for a radiologist to interpret and dictate, and the hospital bill for the examinations.

#### Analysis of Initial Operations

Our initial experience revealed numerous deficiencies in our P&P for routine and emergency operations. Changes in our workflow were dictated by a change in the technology for getting the job done. In order to unravel what had happened, an ad hoc committee was formed. The committee included participation from several services within the department. The committee was chaired by the Operations Manager and included the supervisors from all shifts of CR services, a PACS analyst, the QA Coordinator, and representation from the Film Library. The plan was first to define the existing workflow in the bedside areas, to define the desired workflow, and to document the desired workflow in P&P. An example of a coordinating draft of a P&P for PACS downtime is shown in Fig 1. Administrative questions for clarification are underlined, while answers are in italics. Ultimately, the P&P are to be collected into a handbook to be distributed to all employees.

There had already been a significant internal effort to develop P&P for PACS.<sup>3</sup> These were written by the PACS staff. They did not always include participation and review by the personnel who would be responsible for carrying out the work. The P&P focused on individual PACS components, with less emphasis on global imaging operations. There was planning for actions during Radiology Information System (RIS) downtime, and for scheduled power outages. Some of the P&P had not been revised to keep up with changes in the PACS components and architecture.

Until the ad hoc committee began to work, the majority of the department had regarded PACS as an isolated entity with little relevance to the work of producing images and reports. Participants in the committee came to recognize that PACS is intimately associated with the work process of the department, and that interference with PACS has consequences on delivery of images and business processes. This has improved the degree of ownership among personnel outside the PACS staff.

Unscheduled Downtime

- 1. In the event of an unplanned downtime of the PACS system components, call the PACS Help Line: 4-XXXX. (who and what information needs to be supplied?) The user will contact us with which component is not working appropriately, what area they are from, contact name, and a call back number. The PACS Analyst may also be reached by calling PACS Pager: dial ext. 4XXXX or the Oncall On Call Cell Phone: 713-XXX-xxxx.
  If the occurrence happens after hours or Holidays the Manager On-
  - It the occurrence happens after hours or Holidays the Manager On-Call will be notified by the PACS Analyst on-call or designee(by whom?)
- 3. The PACS Analyst or designee is responsible for notifying Information Services @X3512 (IS) and the On-Call DI Manager who will contact all HP (who is this? And how will they be notified?) of the event via email and if necessary by phone. The PACS Manager or DI On-call Manager will act as point of contact between Diagnostic Imaging and IS/ building SCIVICCS.
- The PACS Analyst will perform the necessary power down sequences and procedures found in the PACS Manual.
- 5. If digital viewing is unavailable, the imaging areas will return to printing film for each exam completed during the downtime. The Team Leader for each area will notify the Film Library that films are being printed. (How does the film library know if the films are conventional for digital, this will effect the recovery of digitizing film?) see note below

Note: Exams done conventionally should not be scheduled with the "CR" modifier.

Portable Technologists will print two (2) copies of exam. One copy will be left at the patient's bedside, the second copy will sent to the Film Library by the technologist executing the exam or designee as soon as possible. (who takes the copies, when?)

Fig 1. Work in progress P&P excerpt.

The analysis of workflow was an exercise in distinguishing real from imagined processes from the request for examination through the delivery of the images to the radiologist and clinician. For example, routine operations during first shift were rough, but second shift was a nightmare. First shift included a technical assistant who took care of scheduling and completing examinations in the RIS. Second shift had only technologists, whose primary job is performing examinations. The second-shift technologists often performed examinations without scheduling them in the RIS, and sometimes neglected to complete them in the RIS. The consequence of this is that examinations that are not scheduled in the RIS are sequestered in PACS: these images are not available for viewing by the radiologist or clinician, unless acquired as "STAT" examinations. The technologists were not aware of the impact of unscheduled examinations

in PACS or the mechanism for bypassing this check. Supervision and QC of images on all shifts was performed in the Main Department.

#### Validation by Testing

The final step in the development of successful P&P is to perform a test or rehearsal of the procedures to see if they will in fact work. This rehearsal also serves to train the staff on the specifics of the P&P. For example, our P&P for interruption of communications between the CR clusters and the PACS Archive called for the CR clusters to continue to acquire examinations independently and to produce laser-printed film for distribution to the radiologists and clinicians. This procedure assumed a fault-tolerant network structure, shown in Fig 2, in which all cluster components are connected into the same switch or hub so that they can continue to communicate with each other. This topology was depicted in IS diagrams that were reviewed during installation.

In order to rehearse our downtime procedure, we arranged to disconnect the NICU cluster from the hospital network backbone. The cluster components could not communicate. Upon further investigation in the telecommunications closet, we discovered the actual topology shown in Fig 3. Each component was connected to a separate switch, so communication between components required the function of the hospital backbone. This failure caused a complete visual and functional inventory of all PACS connections in the hospital, including all the CR clusters. Upon reconfiguration of the switches, the test was repeated successfully.

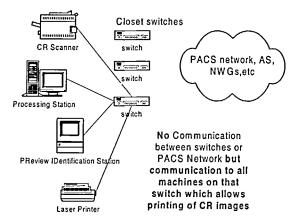


Fig 2. Fault-tolerant network structure.

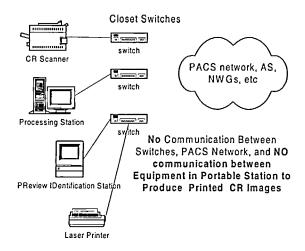


Fig 3. Actual network structure.

We have also exploited other opportunities to test our P&P. Some of these opportunities arose as a result of the extensive modification and expansion of our hospital physical plant. These included local and global network outages, electrical power outages, and an interruption of HVAC in our PACS data center that required shutdown of the core PACS components. Other opportunities occurred during scheduled and unscheduled maintenance operations, such as the upgrade of our PACS software version and the shutdown and restarting of our image database and archive servers. P&P are constantly reviewed and revised when deficiencies are discovered.

#### CONCLUSIONS

The better you understand your own operations, the better your PACS will run. P&P development is a vehicle for defining desired operations, roles, and responsibilities. The best P&P is useless if written in a vacuum or left untested. A team approach to developing P&P is important for assuring relevance and for instilling a feeling of ownership in PACS. P&P development is a continuous process to assure that they remain relevant to the technology and workflow.

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