PACS Training Modules at Texas Children's Hospital

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In 1999, the Performance Improvement Committee of the Diagnostic Imaging Services of Texas Children's Hospital identified the need for smoother integration of the picture archiving and communications system (PACS) technology into the workflow of the rest of the department. An effort was then launched to document prevalent issues, as well as to define the processes needed to implement a department-wide program to acquaint the staff with this new technology. The department's application trainer, with the guidance of the Performance Improvement Committee, spearheaded the design and implementation of the PACS training program and has continued to develop it during the past 2 years. This article describes the format and components of the PACS training modules now in use, and details some of the positive effects of this effort.

KEY WORDS: PACS, PACS training, PACS downtime procedures, PACS service, PACS administration, PACS management

TEXAS CHILDREN'S HOSPITAL (TCH) began investing in a picture archiving and communication system (PACS) in 1991. In 1996, the hospital's Edward B. Singleton Diagnostic Imaging Services embarked on a 5-year project to convert the department to filmless imaging. Although pioneers in PACS, when we began depending on the system for routine services, a number of issues arose among administrators, analysts, and users. Early efforts to provide informal and incidental training of department staff were largely ineffective. In 1999, the Performance Improvement Committee decided to design and implement a department-wide PACS training program. The primary goal of this training program was to educate all new and existing employees of the department about PACS, and to help PACS users integrate this new technology into their work environment.

Texas Children's Hospital has been conducting essentially filmless imaging operations since October 30, 2000. We have a large-scale PACS consisting of 15 computed radiography (CR) units, 5 digital interfaces for fluoroscopy, 2 computed tomography (CT) scanners, 2 magnetic resonance (MR) imaging machines, 2 special interventions units, 8 ultrasound (US) units in an US niche-PACS, and 3 nuclear medicine (NM) systems in a NM niche-PACS. We upgraded to AGFA (Agfa Corporation, Ridgefield Park, NJ) IMPAX version 4.1 during the first quarter of 2003.

The image display subsystem of our PACS includes 48 IMPAX work stations that support 15 clinical services, and Web-based viewers that support another 32 clinical services. We have an Oracle database (Oracle version 8) that manages the images, and four archive servers for long-term storage (two primary servers with Optical Disk Jukeboxes (ODJ), one redundant service that manages a tape library, and one server that is inactive because of software and hardware changes). A radiology information system (RIS; IDXrad version 9.7.1) provides the demographic and exam information. A voice recognition system (AGFA TalkTechnology version 2.1) was installed in November 2001. The TCH PACS also includes laser film

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ICE BREAKER: Unscramble the Following PACS Terms

1. HEVRACI _____
2. IRPD _____
3. EWRVEI NOATSIT _____
4. GINPORCSSE ATSITNO _____
5. YUQER _____
6. RPTATIOR _____
7. BWEB 0100 _____
8. DSNUUTRLAO _____
9. SAPC _____
10. YWATEGA _____
11. LIMF IZERDIIGT _____
12. 0CD7A _____

Fig 1. Ice breaker: Unscramble PACS terms.

digitizers and laser film printers and dry process laser printers for generating hard copies.

EVALUATION

The Performance Improvement Committee recognized the need to identify and address common PACS problems as this new technology continued to grow extensively into the daily workflow of every employee in the department. Miscommunication was common between “those PACS people” and the PACS users. Inconsistencies in the use of nomenclature interfered with service operations, increasing the “ownership problem” for responsibilities. For example, does the term “film processor” refer to a laser printer or a digitizer? Is a “digitizer” a film digitizer or a CR scanner? PACS processes, protocols, and downtime procedures were inadequately documented. “Nobody can use PACS!” was a common phrase around the department.

Several meetings were organized to include representation from every area in the department. Representation included the team leaders of each imaging modality, the department’s quality control coordinator, a film librarian, and a radiologist to represent the medical staff of the department, the Film Library, RIS, and PACS.

In the course of identifying and addressing common PACS problems, a process for documenting PACS processes, protocols, and

Pre-PACS Quiz

1. What is PACS?
2. What is a review station?
3. What does PRID stand for?
4. What is Webb 1000?
5. What is Webb 1000 go live date for the new features?
6. What is annotation?
7. What is the PACS helpline number?
8. What protocol do you use for your area?
9. What is the difference in landscape and portrait?
10. What procedure should you follow for PACS downtime?
11. What is retrieve?
12. What is film digitizer?
13. What is CR?
14. What is ADC compact?
15. Name 2 of the new features for Webb 1000?

Fig 2. Sample pre-PACS quiz.

downtime procedures was developed. A glossary or lexicon of PACS terms was generated. Frequently asked PACS questions were addressed: e.g., “What does PACS mean?” “Who do we call when we have a problem with this new equipment?” “How long do images stay in PACS?”

These ideas were organized and broken into several modules that were developed and eventually incorporated into a PACS Training Manual. A plan was designed for all employees of the department to participate in a PACS training session. The goals of the training sessions were to promote better communication between PACS administrators and the PACS users, as well as to allow the new and existing employees to bring back information from these PACS training sessions to their own work areas. The ultimate goals were to improve PACS performance and PACS customer service to assisting in fulfilling the department’s goals of producing quality filmless images, as well as promoting excellent patient care.

The PACS Modules Training Session is a 2-hour session and the main content is basic PACS knowledge applicable to the diagnostic imaging services of TCH. It is presented and moderated by the Application Trainer of the department. The session is mandatory for all new and current employees of the department. Each attendee receives copy of the PACS Training Manual. A representative from the PACS team is present in each session, and

DIAGNOSTIC IMAGING

Picture Archive and Communication System (PACS)

Definition of Terms

ADAC FORTE Camera	Used in Nuclear Medicine. The images are sent to PACS.
ACU SON Sequoia/128XP/10/Aspen/	Ultrasound acquisition device.
ADC70 Cassettes	These differ in two ways from the old conventional cassettes. First, a memory chip is mounted inside the cassette. Second, inside of the ADC cassette there is no intensifying screen and film; instead there is an imaging plate coated with x-ray sensitive storage phosphor.
ADC Compact Cassettes	See <i>ADC Cassettes</i> . Can only be used on ADC Compact (only with PRID) digitizers and has a microchip that is programmed magnetically instead of electronically.
ADC70 (ADC#) Digitizer	Once the ADC cassette gets identified and exposed, it is carried to the digitizer. In the digitizer, the latent image that is stored on the ADC cassette by the x-rays is transformed into visible light by a scanning laser. The light signal is digitized and the digital image is sent to networked archive and review stations throughout the department and hospital.
ADC Compact	See <i>ADC70</i> . A newer model than the ADC70.
Annotation	Text added to an image after the image has been acquired and before archiving.
Archive	(v) To copy files to a long-term storage medium for backup. Large computer systems often have two layers of backup, the first of which is a disk drive. Periodically, the computer operator will archive files on the disk to a second storage device, usually a tape drive. On smaller systems, archiving is synonymous with backing up. (n) A disk, tape, or directory that contains files that have been backed up.
Archive Server/Station (AS#)	Each AS controls a Magneto-Optical Disk (MOD) jukebox. AS also controls routing of images to Review Stations, PC-based Viewers, pre-fetching of prior studies & a DLT tape. The numbers following AS differentiates the servers/stations.
ATLASFORTE	A Nuclear Medicine image acquisition workstation that controls the FORTE ADAC Camera.
Cache	Pronounced "cash", a special high-speed storage mechanism. It is a reserved section of main memory or an independent high-speed storage device. (e.g. stored locally on that particular RS which means that it can be accessed by any RS on the PACS network).

Fig 3. PACS glossary of terms.

addresses questions or clarifications. After each session, everyone who attended is awarded 2 Category A Continuing Education (CE) credits.

PACS TRAINING SESSION FORMAT

Ice Breaker and Definitions

To begin the training session, participants play a short game that involves unscrambling PACS terms (Fig. 1). A definition of PACS is then given, followed by a general discussion. A 15-minute video is presented, which focuses on

the 1999 SCAR (Society for Computer Applications in Radiology) conference hosted by TCH. It includes interviews with the department's Chief Radiologist and another radiologist as primary users of PACS, as they share the impact of PACS—newly installed at that time—on their workflow. This provides a historical perspective and an inspiring dimension to the material.

Pre-Assessment of the Material

After the video a short quiz is given to evaluate participant's knowledge of PACS terms (Fig 2). In addition of allowing participants to

Fig 4. Texas Children's Hospital site diagram.

consolidate their knowledge of PACS, this quiz assists the Department Trainer in assessing staff needs for PACS information as she continues to develop the program.

PACS Training Manual

The next step in each training session is distribution of PACS Training Manual. The various modules within the manual are then discussed:

1. Definitions of PACS terms (Fig 3). An alphabetical list of variant terms provides definitions that include ways in which a word's meaning differs among employees. For example, the word "archive" for a PACS analyst versus "archive" for a technologist.
2. Equipment, and Quality Control Networks. As an aid to understanding the network, this section includes a site diagram of PACS equipment at TCH (Fig 4) and a layout of the PACS equipment for each area and

imaging modality, including PACS equipment at services and clinics outside the Diagnostic Imaging Department (Fig 5). These site diagrams are followed by glossary of terms describing the function of each piece of PACS equipment. Quality control is of great importance in operating a successful PACS network. The next section of the manual lists quality control and preventive maintenance activities performed on each piece of PACS equipment and the staff member responsible for performing each activity. For example, acquisition processing is performed by the technologists on images, SMPTE patterns, etc (Fig 6).

3. Service/Problem Solving and Communication. PACS administration has a customer service component that involves problem solving, image flow, and system protocols and communication. This section of their training manual refers to the portion on each equipment layout under "List of Equipment and Networks" the first call for problems with equipment in their area (Fig 5). It

Fig 5. PACS equipment layout for the Radiology/Fluoroscopy Area.

includes a list of the various services a PACS analyst can provide (Fig 7).

The major function of PACS involves flow, retrieval, and archiving of images. This section provides the flowcharts for each imaging modality, depicting the movement of images from the time the patient arrives until each image has been archived in PACS and a copy becomes available at the image display workstations (Fig 8).

The primary importance of protocols for the flow of images in PACS requires communication of who is responsible for each step in the process (Fig 9).

Like the operating protocols, downtime procedures during a PACS planned and unplanned downtime need to be understood by all staff

members whose work is affected by such activities.

The training manual concludes with a list of frequently asked questions about PACS, including numbers to call, who authorizes overtime for service calls, etc.

Role-Playing

To demonstrate the purpose and operation of the PACS Help Desk, role-playing between a PACS user and a PACS analyst illustrates a typical exchange. Typically, the scenario involves one of the common problems the PACS Help Desk is called upon to resolve. During this segment, clarifications of the reporting process for PACS problems are reiterated.

QC of PACS Equipment

- The quality control monitors most often performed are:**
- Preventative equipment maintenance (Biomedical)
 - Equipment calibration (Biomedical)
 - Processor maintenance (Biomedical)
 - Measures of processor characteristics compared to set parameters (Biomedical)
 - Integrity of shielding equipment (2nd shift Rad/Fluoro Teamleader)
 - Film badge exposures (Rad / Fluoro Manager)
 - Films reject analysis (Team Leaders)
 - Record of fluoroscopy times (Rad Fluoro Technologist)
 - Acceptance testing (Medical Physicist)
 - Usage of technique charts (Team Leaders)
 - Standardized examination protocols (Radiologists)
 - Film critique by radiologists (Radiologists)
 - Radiation exposure measurements for major examinations performed on equipment. (Biomedical)

PACS Quality Control

- Quality control monitors specific to PACS are:
- All of the items listed for non-PACS imaging departments, plus issues concerning
 - Review stations
 - Luminance Reading (P&P exists, current?)
 - Reboot schedule
 - Cache levels - autopilot
 - General cleaning
 - Keyboards
 - Mouse
 - Hard Drive
 - Monitors
 - Digital displays (monitors, process stations, Prid, ADC, Drystar, Solo)
 - Pixel (resolution) – Medical Physicist
 - Delete images for space
 - Cache levels - autopilot
 - General cleaning
 - Keyboards
 - Mouse
 - Hard Drive
 - Monitors
 - Acquisition processing and collimating-RF
 - Tech
 - Verify demographic information
 - Technique
 - Measuring patient and recording in IDXRAD
 - Select patient from work list or use bar code scanning (not typing demographic information)
 - Exporting fluoro images at end of the exam
 - Teamleader or designee
 - Exposure level check
 - W/L range check
 - Demographic information (MR#, Acc#,
 - Proper exam (body part) for proper processing
 - Position
 - Markers
 - Orientation
 - Inhalation 14-16 right side ribs
 - Post acquisition procedures
 - Archiving area to confirm images are on system- Web 1000 or Review station
 - Technologist completes exam in IDX- supplying start /end times of exam; # of images
 - PACS Analyst confirms images are on archive using IDX scan report

Fig 6. A segment of the list of quality control monitors of PACS equipment.

Assessment of the Material

After the instructional aspects have been presented a short quiz is given to evaluate what the participant have learned. Like the opening quiz, this assists the Department Trainer to assess the effectiveness of the training session format of the class.

Scavenger Hunt

During the last segment of the training class, participants are asked to return to work and identify the PACS equipment located in their respective work areas. For the purposes of this

“scavenger hunt,” each piece of PACS equipment in their area has been tagged with some kind of a label or code (i.e., animal shape). The employee fills out a form, writing down the name of the PACS equipment that corresponds to each code. When the participant returns this form to the application trainer, the course requirements have been met and the 2 CE credits are awarded with a signed certificate of completion.

DISCUSSION

Earlier training efforts that were strictly PACS initiatives were largely disregarded by the

PACS SERVICES / PROBLEM-SOLVING

PACS analyst performs the following functions:

- provide for continuity of clinical operations of the PACS network
- add/update components to the PACS network, including managing and documenting physical and software configuration of the equipment
- provide software and hardware technical support to users of PACS equipment, including managing local storage space
- update the IMPAX gateway tab as new modalities, workstations, and RIS procedure codes is added.
- setup routing of current examinations and prefetching of their priors
- fix examinations:
 - fix invalidated (wrong demographic information) examinations
 - split out images to correct accession numbers
 - merge examinations as needed
 - update demographic information
 - update examinations sent as STAT for valid accession number
- validate archived examinations with those scheduled in IDXRad on a daily basis through the PACS Scan Report
- respond to user trouble calls via the PACS Help Line
- troubleshooting of
 - ☐ exam problems and errors such as missing examinations on review stations and web-based viewers, patient demographics, etc.
 - ☐ assure examinations are transmitted to correct destination(s) in a timely manner
 - ☐ PACS system functionality and performance
 - ☐ PACS hardware equipment
- initiate PACS downtime procedures
- setup/update user accounts and provide training for the following PACS systems:
 - ☐ IMPAX
 - ☐ Web1000
 - ☐ Stentor
 - ☐ PACSCube

Fig 7. Basic PACS services offered.

rest of the imaging department. The team approach to compiling and documenting the PACS training modules generated a sense of ownership in PACS among department staff that was previously lacking. Working in committee made it possible for each area representative to provide personal experiences and feedback regarding PACS. By brainstorming, ideas began to evolve which resulted in a detailed training program. The program would be designed not only to provide information but also to allow the trainees to act as participants. Each session is directed by the Application Trainer, who serves as facilitator, but the Team Leaders and a designated PACS Analyst attend each meeting to respond to any questions or concerns voiced by participants. One of the goals of the training program is to allow open communication among all areas, which is achieved through role-playing, which can lead to sharing aspects of PACS that may not be known to everyone. Also, we would like staff

to be able to walk away feeling comfortable to orient new employees in their respective work areas with the role of PACS in their workflow.

In the process of developing this training session, we found that our original program was based on a “train-the-trainer” approach,^{1,2} and incidental training was inadequate; we continued to encounter major communication difficulties between users and analysts.^{3,4} Users were still largely ignorant of PACS workflow and analysts were generally ignorant of examination workflow.⁵ We had been planning comprehensive training as an orientation for new personnel, and so decided to expand that training program to include existing Diagnostic Imaging personnel.

Several positive comments and constructive results came from the implementation of this department-wide education program. The role-playing between the PACS team and PACS users during the sessions was quite helpful in

NM Image Acquisition, Verification and Storage

Fig. 8. Image flowchart in nuclear medicine.

ironing out the procedures for handling requests called into the PACS Help Desk. Some users have said that they feel less intimidated by PACS, and others said, “I did not know PACS

that well after all!” The sessions allowed them to hear that staff from other areas in the department were encountering similar problems. It also provided an opportunity to learn the

MODALITY PROTOCOLS

ULTRASOUND

	Process	Responsible Party
Step 1	Patient arrives for exam.	Tech
Step 2	Check for orders.	Tech
Step 3	Patient is taken to the examination room and explained the procedure.	Tech
Step 4	Patient demographics are verified.	Tech
Step 5	The correct transducer is selected according to patient age and size.	Tech
Step 6	The exam is performed.	Tech
Step 7	Images are reviewed for quality purposes.	Tech
Step 8	A radiologist reviews the images.	Radiologist
Step 9	If applicable, a radiologist rescans the patient.	Radiologist
Step 10	The exam is completed and the appropriate documentation made in IDX RAD.	Tech
Step 11	The patient is released.	Tech
Step 12	Check the web for images.	Team leader
Step 13	Exam is complete.	Tech

Fig. 9. Protocol in ultrasound for image flow and corresponding responsible party.

PACS equipment used in other areas for different functions. Having a copy of the Training Manual gave each participant an excellent resource for answers to their common PACS questions. Participants also appreciate the presence of a member of the PACS team at every training session. Most people walked away satisfied that the session had been generally helpful and beneficial.

This PACS training program has proven beneficial for both current staff and incoming staff in understanding the level of PACS knowledge required in each of their positions. It has also served to familiarize staff with the variety of services the PACS team offers the department and the rest of hospital, and to appreciate those services. Participants also report improved understanding of the process of submitting PACS issues or trouble calls to a PACS analyst. The level of training provided has also assisted the PACS administrators in handling work requests, and it has facilitated communication with the rest of the department.

For new employees, implementing the mandatory PACS training program complements the PACS orientation specified on their competency check list for each work area.

One of the major challenges we encountered in this undertaking is maintaining current in-

formation in the training manual. Things change with major expansions and renovations, PACS hardware upgrades, or new or updated policies and procedures. The PACS administrators and the department's Application Trainer work closely and remind each other constantly of updates that need to be included in the training manual.

We are considering expanding this program to include conducting mock PACS downtimes, conducting extensive role-playing between the PACS team and PACS users (possibly by area), continuing to gather results and feedback from the training evaluations, and continually implementing improvements noted from this program.

CONCLUSIONS

The Texas Children's Hospital has found that formal training in basic PACS terminology and operations is essential for all personnel in the filmless diagnostic imaging department. This fundamental training is not provided by PACS vendors, and must be tailored to the individual institution's structure and organization. Developing this training program has had an immediate beneficial effect by defining and documenting local PACS procedures, by pro-

moting a common vocabulary for communications, and by creating a sense of ownership of PACS among department personnel.

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