The Process of Converting to a Near Filmless Operation at the University of Utah, Department of Radiology

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The Department of Radiology at the University of Utah Health Sciences Center has made the transition from a traditional film-based department to a near filmless operation. The University of Utah is a large teaching hospital and the transition from film in an educational facility will be discussed. This transition has had its difficulties and its success is dependent on the support of departmental leadership and hospital administration. We have had more than 100 years of experience with film, and current procedures were efficient given the limitations of the medium. While motivated by the traditional reasons for moving to a picture archival and communications system (PACS), such as film savings, unavailable films, and faster reports, we found the intangibles to be the larger issue, as well as a source for the largest benefits. This report will discuss the implementation process and the affect it had on all areas of the hospital, including its impact on hospital physicians, radiologists, file room personnel, and technologists. Procedure changes to the flow of patients, film, and electronic images will also be described. This process cannot be viewed as a one-time change, but must be viewed as a continuous process as areas of improvement are identified and new and improved technologies are developed.

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AT THE UNIVERSITY OF UTAH Hospital and Clinics, we are in the process of converting to digital imaging with the implementation of our version of picture archival and communications system (PACS). We currently have the capability to capture all computed tomography (CT), magnetic resonance (MR), computed radiography (CR), and nuclear images in our archiving system. We are currently implementing the necessary hardware and software to video frame capture angio and fluoro images and pass them to the archive, and will begin the process to link ultrasound into the archive in the near future. Soon we will have nearly all of the images taken at the hospital and clinics available digitally for review and interpretation.

Review stations are available in all our reading rooms in the department. We have provided diagnostic stations for use by the radiologists and consult stations for use by the referring physicians. We have consult stations in a few clinics and in our Emergency Department. In addition, all our archived images are sent out to a web server, where they remain for approximately 2 days. There is a

plan to expand the size of the image cache as the demand/need is demonstrated.

However, converting to digitized images is far larger than simply installing the hardware and software to support the system. Converting to digitized images has affected our basic work processes and has required extensive effort in many areas, including identifying any unique work flow requirements and establishing routing and prefetching rules that meet these requirements; revising procedures for handling images and providing ongoing training for all involved in the new procedures and systems; and providing system support to the users as they transition to a new way of doing business. In addition, we have discovered that the individual users can be the greatest stumbling block to a quick conversion. The users need time and support to adjust their work habits to efficiently use the new tools provided to them.

This report will discuss our experiences with the conversion process, identifying issues we have encountered and providing solutions as we have identified them.

IDENTIFYING WORKFLOW REQUIREMENTS

The workflow processes for delivering images to the radiologists for interpretation had been in place, and working well, before the conversion to digital imaging. It was important to us to maintain and improve the efficiency of this workflow process with the conversion to digital imaging. On the other hand, the delivery of images, or image interpretations, was not working particularly well to areas outside of the department, such as the hospital clinics, the Emergency Department, etc. It was an important goal of the conversion to improve on this delivery as much as possible.

The data management component of our archive system has provided us the means to automate the

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0897-1889/99/1202-1012\$10.00/0*

image delivery process by establishing rules for autorouting and prefetching. Autorouting is the process of identifying where the image is to be delivered so no human intervention needs to occur to get the digitized image to the radiologist for interpretation. Prefetching is the process of identifying images in the archive that are needed by the radiologist for comparison and delivering those images to the appropriate view station. For prefetching to work, there must be integration between the archive and the radiology information system (RIS), allowing for scheduled patient visits to be known by the archive before the completion of the patient examination.

To be able to use the data management system most efficiently and meet our goals of improving the delivery of images, we asked ourselves a series of questions that would help us to create the rules we needed for autorouting and prefetching.

1. Who Does the Primary Interpretation of Each Examination Type and Where Does That Person Work?

Early in our planning process, we decided to route images to specific view stations, rather than to a specific radiologist. This decision was due in part to the structure of our department and our resident training program. We are set up by sections, Bone, Chest, Neuro, Nuclear, etc, with one or more view stations available for use by the radiologists and residents in each section. Each resident spends a period of time with a staff radiologist in a section learning to read that type of examination. It is necessary that we route the correct examinations to the view stations that are being used by the staff and residents of that section.

2. Where Else Outside the Department Will View Stations be Located and What Images Need to be Routed to Those Stations?

Initially, we were only installing view stations within the department, but this plan changed early on. Because of the need to improve delivery of images to locations outside the department, it was decided to locate view stations in a few clinics that are high-volume users of Radiology services and in the Emergency Department. With this decision came the need to identify which images would be routed to these view stations and to establish routing rules to automate the delivery.

3. Do the Images Need to Go to Different Locations During the Night and/or on Weekends?

In our department, we use residents and on-call radiologists to support the needs of the department 24 hours a day, 7 days a week. To improve efficiency, we have established one view station as the off-hours work location. All images taken during off-hours need to route to the one view station being used during the off-hours.

The data available to perform the autorouting and prefetching functions are the data delivered from each modality to the archive data management system. Two issues identified early in our conversion were that the data were not consistent and standard for every examination, and that some of the critical routing data were not being sent to the routing fields on the archive data management system. For our data management system, we needed both the image source (the modality on which the image was taken) and the examination description. The image source was consistent and was being delivered to the correct routing fields. But, we soon discovered that the examination description information was not standard, since it was being input free-form by the technologists and, from some modalities, it was not even being put into the correct Digital Imaging and Communications in Medicine (DICOM) field in the data management system. For example, the GE (Milwaukee, WI) MR scanner placed the examination description into DICOM Tag 0008 1030, while the Picker (Cleveland, OH) put the examination description into DICOM tag 0018 1030 by default, and did not have a way to fill in 0008 1030. After some research and a software upgrade on the scanner, the Picker was then able to fill in the DICOM tag 0008 1030. This was an important discovery for us, as it then allowed the possibility of using this description as a key to routing images in the archive. To solve the routing issues, we needed to develop a method to obtain a specific, consistent examination description for every examination completed that could be used in our routing rules.

We knew we had a unique examination code for each unique type of examination already established for use by our RIS (IDXRad, Burlington, VT). By consulting with the radiologists, we were able to identify the viewing locations for each examination code. We were also able to identify some special routing codes we would need to use to route to locations outside the department. For

example, if the examination was being performed for a patient from the Emergency Department, we established the code ER1 to tell us to route that examination to the view station located in the Emergency Department, as well as the general routing of that image.

Weekends and nights were another unique challenge for us. Since our archive data management system does not route on time of day of examination, we had to establish a code that meant the examination was taken during off-hours. We established 99 as this code and wrote routing rules to assure the examination would be delivered to the view stations used during off-hours.

Once we had identified all the unique codes, we trained the technologists to enter the codes, at the modality, in a field that would be displayed in the examination description field in the data management system. Since the IDX codes are printed on our work-order forms, they are able to enter these same codes at the modality without too great of an error rate. In addition to the IDX code, they enter the specialty codes, like ER1, to route the examinations to additional view stations when appropriate. If the technologists forget to enter the special routing code, the images are then routed manually from one of two gateway machines that we have in the department.

Because we have to depend heavily on the input by the technologists for the routing of images, we established a quality-review process to review routing errors. If the error was caused by incorrect input, we provide feedback to the technologist so they identify their mistake and correct it in the future. We have implemented an error percentage standard that is part of the technologist's review as a means to help them focus on this aspect of their job. Documentation of a verified error can be time-consuming, but is essential for continuous improvement.

REVISING PROCEDURES AND TRAINING

A conversion to a new way of doing business is only complete once the procedures are in place and the people are trained. We have experienced significant delays due to the lack of concrete procedures and our inability to effectively train all the divergent users of our system. Below are some of the significant areas where we experienced the need to revise procedures and provide extensive training.

Hanging Protocols

With the introduction of digital images, we started to reduce the number of films that were hung on the alternators. In addition, if the previous images were not on the archive yet, we established a process to digitize the previous. Our biggest issue with this procedure was that not all of the radiologists could agree to which images they were comfortable reading off PACS and which they still needed to read off film. We are working through this by doing dual functions, hanging both new and previous, even though the images are available on the PACS viewers. We are gradually moving away from hanging film, but it is a slow process since we have so many radiologists and residents rotating through the sections.

Unread Images (not yet dictated)

File room personnel are responsible for identifying the examinations that have not been dictated within 24 hours. These examinations are returned to the radiologists and are to be read as a priority. Before PACS, unavailable films were a problem affecting report turnaround time. However, by storing the images in a digital format, we are now able to report on films that have left the department before a radiologist has seen them. With the introduction of PACS, we have changed the process so that all unread images are retrieved from the archive and sent to the correct reading room without having to hunt down the films and rehang them.

General View Station Use

Being able to effectively use the view stations to replicate the productivity and performance experienced with alternators was a huge challenge for our department. Several issues stood out that we had to resolve: training all the physicians that use the view stations; providing easy-to-use guides for using the view station for those physicians who use it infrequently; assuring that the quality of the images on the view station was as high if not higher than the quality on the alternators; and assuring no reduction to the productivity of the radiologists reading the images off the view stations.

Resolving these issues is an ongoing challenge and one that will continue to take extensive amounts of time. To train all of the physicians means offering sessions frequently and at all times of the

day. We discovered it is necessary to be available to train those who do not attend sessions when they are actually at the view station trying to use it. Many of the infrequent users are the clinicians and referring physicians that come to the department for consultations. Often they are trying to retrieve and review images without a radiologist present to assist them. We have yet to develop a user-friendly *quick reference guide to assist these users.*

Image quality was an issue, since several of our radiologists thought the images were better when viewed on the alternators. This is partly due to their preference for what they are accustomed to, but we did consider this a serious issue. We have been working closely with our vendors to improve the image quality and as a result discovered that it was necessary to make adjustments to the technologist's protocol in the case of our plain CR images.

The perceived or real reduction in radiologist productivity is an issue we have not yet resolved. As is the case when anyone begins using a computer for the first time, productivity is affected until work habits are adjusted and efficient use of the system is learned. We have found this to be true for our radiologists. We have found it critical to assure all functions are in place to assist the user to become more efficient. We are closely reviewing how all of our radiologists work to be sure we are delivering the images in the most time-efficient manner. We are working with our vendor to be sure they are providing productivity assisting functions for those radiologists who need to read large volumes of images in one sitting.

PROVIDING USER SUPPORT

Most users, new to a system, are either unwilling or unable to resolve on their own unclear or unfamiliar situations. Extensive system support is usually needed at the beginning of any new project. In addition, new systems often experience a greater amount of downtime as the "bugs" are worked out. Since it is usually not possible to overstaff in the systems support area, it is best to prepare those involved for extensive interruptions in their daily life, by users in need of assistance. We experienced the need to provide assistance for simple problems, like the user was not able to find an image simply because they forgot how to query. We also have been needed to assist with true system problems like when a view station was displaying lines through all the images and was not able to be used.

The need for assistance continues to be high during the nights and weekends also. Often users working at these times have been unable or unwilling to attend training so are unfamiliar with the system, are unwilling to try to fix the problem themselves, and are unwilling to wait for delays in their work schedule while someone comes into the hospital to assist them.

One method we used to resolve some of the drain on our small system support staff was to train a file room employee to resolve the simple, user-unfamiliar type of questions. We established a position specific for this purpose, the PACS Technician. At this time, this person only works the day shift, but has become the first point of contact during those hours and has been able to resolve many of the problems without having an impact on our systems staff.

THE HUMAN FACTOR—USER IMPACTS AND CONSIDERATIONS

It is difficult to explain and nearly impossible to quantify the impact this type of change has on the individuals involved. All individuals within the radiology department, as well as many outside the department, are impacted by being asked to perform their job differently. Even if all understand the ultimate value of the new way of doing business, change is resisted, in some manner, by nearly everyone. Some of the major areas of resistance we encountered are identified below.

Technologists

We have not had to ask our technologists to make big changes, but have needed their support for several minor adjustments to their normal protocol. For example, our technologists need to enter either the IDX examination code or a unique routing code when they are completing the job at the console. After training, we found that we needed to provide follow-up coaching to get all of them to enter the codes routinely and needed to add the expectation to their annual review. As we begin to turn off the film, the technologists will have to make another transition, to quality-check their image off the display console, rather than the film. This possibility has already raised much concern and statements about it being impossible. However, given time, they will become adjusted to this new way of working also.

File Room Personnel

To begin the transition process for the File Room personnel, we created three new job titles, explained the duties of the job titles, and asked all individuals to "post" for the position or positions they wanted. We then interviewed everyone and "hired" him or her into the new job. By doing this, we established the expectations for their new roles and got them ready and anxious for training and for additional responsibilities. We expect at a time in the future to be able to reduce headcount in our file room and realize that will be a difficult situation to handle.

Staff Radiologists and Residents

Our staff radiologists and residents are having the most difficult time making the transition to our new way of doing business. They are the group that is the most affected and they are resisting the changes the most.

The biggest challenge we are trying to overcome is the perceived or real reduction in productivity being experienced. Our radiologists are accustomed to having the images they are to read prehung on the alternators. Adjusting to searching for the patient from a list of patients is difficult. In addition, the luminescence is different on the view stations as compared with the alternators. The brightness of our high-end monitors is about 100-foot lamberts with a typical lightbox output being about 400-foot lamberts. This causes them to take more time to read the image to be sure they do not miss a diagnosis. Though they now have the capability to enhance the image through various menu options never available on an alternator, which potentially could improve their diagnostic capabilities, at this time these functions are seen as reducing productivity. Experience at other sites has shown that as physicians adjust to soft-copy reading, the time required to review a film decreases. We are not yet far enough into this new mode of operations to see this decrease from our physicians yet. We are tackling this issue by going slowly and not taking away the method of work they are comfortable with while providing them the training and opportunity to try the new method. We are doing a lot of individual listening and support and making changes as we can to the set up of the screens and workflow to help them be as comfortable as possible.

Another issue has been the unwillingness of this group to understand that systems, especially new ones, will at times "go down." Some of them are unfamiliar with computer operations and do not tolerate system problems. We have found it essential to provide them with a pager contact to ask for assistance when problems arise. It is still essential that we continue to provide the ability for them to move quickly from the view stations to the alternator to complete their work in the event of a system problem. This solution does cause double work in that we have to maintain the film as well as send the images to the view station, but we believe it is essential to help everyone be as comfortable as possible with all of the new systems being introduced. We are in the process of developing down-time procedures, but have not had enough experience as to the various reasons for down-time to have a policy in place for all events. We have a saying here that "Murphy has taken up permanent residence here."

Referring Physicians and Clinicians

In our large hospital setting, more than just our Radiology Department is affected by our conversion to digital images. We originally made a strategic decision to establish the digital imaging systems primarily in the Radiology Department first, to work out the bugs, before we installed view stations in other parts of the hospital. Even if we had stayed with that decision, we would have had physicians in our department unable to view images unless we continued to hang them on alternators or found a way to train them on the usage of the alternators. Now, we have revised our plans and decided to install view stations in several clinics in the hospital. This expands our need to train and provide user and system support throughout the hospital. This was due to the high demand for images. The outside departments quickly saw the value in soft-copy reading and have made strong cases that they should be included in the initial roll out of the software, despite all of the growing pains.

SUMMARY

An area of immediate improvement that we have seen is the ability to have "films" in more than one place at a time (clinics, emergency room, operating room, and reading rooms all at the same time). Another improvement has been the immediate elimination of "lost films" as we began to capture

the digital images in our archive. Eliminating lost films has allowed us to reduce report turnaround time and late fees going to the hospital billing system.

Significant improvements in efficiencies and productivity have not yet been realized at this stage

of our conversion to digital images. We need to expand the training of all involved, resolve some of the issues identified here, and begin to reduce the printing of film. We have only just begun to see the improvements we hope to realize in the coming months.