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By Lisa Fratt

A growing number of hospital radiology administrators, radiologists, clinicians and technologists are beginning to consider, and in many cases, plan for a digital radiology department. They hope to follow in the footsteps of dozens of early adopters of digital technology. Radiology departments that were the first to take the bold step of going digital have proven that the benefits of implementing digital medical imaging technologies are far-reaching. They include not only increased productivity and enhanced workflow but also better patient care and improved public relations and staff recruiting efforts.

Digital radiology departments typically include a combination of computed radiography (CR), digital radiography (DR), picture archiving and communications systems (PACS), printers and service to keep everything running smoothly. Over the last decade digital technology has been refined and a wide array of options can be configured to meet the unique needs and objectives of all types of facilities. Indeed hospitals of various sizes and configurations have found that Eastman Kodak Co. (Rochester, N.Y.) is an ideal partner for their foray into digital radiology.

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Living the

Digital technology has been successfully implemented in hospitals of all sizes. The saying "no job too big or small" applies nicely as facilities small and large are benefiting from the scalability and flexibility of digital technologies in ways they hoped for and, in fact, never even imagined.

A Digital Pioneer

St. John Medical Center in Tulsa, Okla., has one of the largest DR installations in the United States. The 750-bed hospital completes 134,000 imaging studies each year, and an additional 70,000 exams are completed at two outpatient centers. St. John Medical Center began its transition to digital in the dinosaur days of digital with the ultimate objective of going completely filmless. Phil Ames, administrative director of radiology, lists other key factors in the hospital's decision. "We are interested in digital imaging technologies because of their ability to improve image quality and efficiency, and ultimately to enhance service to both hospital and referring physicians."

St. John's digital trek began eight years ago with a CR system connected to a laser

printer for portable chest x-rays. Next the hospital laid the groundwork for digital imaging and installed a robust network. After these initial baby steps, the department pushed ahead and purchased four Kodak CRs and imaging workstations.

Ames and his colleagues realized the importance of having referring physicians on board with the digital plan, so the department put stand-alone workstations in the offices of a handful of referring physicians and began to route images to them. "The physicians loved those workstations," Ames says.

The hospital added workstations to the ICU and other floors, and before long purchased a web server for use on the hospital floors. Ames beefed up the department's digital backbone with DICOM upgrades, an RIS interface with worklist software, and a long-term storage archive for electronic imaging files. Its Kodak archive manager complements a GE Radworks PACS.

Ames credits the compatibility of the two systems to Kodak's DICOM expertise. "The two systems work well together. We keep going back to Kodak because their

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FROM LEFT TO RIGHT: KODAK'S DR 5100, DR 7100, AND DR 9000 SYSTEMS

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DICOM is as good as it gets. Other vendors' PACS work well with their products. With Kodak, if it's DICOM, they can work with it."

When DR hit the radiology market, Ames began considering DR vendors, and in 2001 the hospital made the jump to include DR and installed a Kodak DirectView DR 9000 in its main department. "Once we got used to DR, we were amazed at the amount of work coming out of the room," Ames says. "We knew then that DR was the way to go."

How does DR patient throughput stack up against conventional film throughput? According to Ames, the department can handle at least twice as many patients in the Kodak DR room.

This marked increase in throughput is the result of a combination of factors. DR eliminates film processing and cassette handling. The hospital's Kodak DR sys-

tem features a 10-second preview and 35-second cycle time. The secret to St. John's success is not only implementing efficient digital products, but also integrating efficient digital processes to support the deliv-



Phil Ames, administrative director of radiology at St. John Medical Center in Tulsa, Okla., has seen a marked boost in throughput and decline in expenses by utilizing DR and CR.

ery of images and reports to physicians.

These processes are made possible with auxiliary tools such as worklist software and a voice recognition system that con-

verts dictation into radiology reports. Patient data are efficiently entered from a worklist via a link to the hospital's RIS. "Purchasing the RIS interface was one of the smartest things we ever did," confides Ames. Now, patients' names are always spelled and entered accurately. The hospital's voice-recognition software has had a tremendous impact on report turn-around time. Ames says, "Our report turn-around time is phenomenal. With 600 to 800 reports a day, turn-around dropped from an average of 53 hours to less than six hours."

After a resoundingly successful first experience with DR, St. John Medical Center continued to implement Kodak digital equipment. By the end of this summer, the hospital and its outpatient clinics will have a total of eight Kodak DR units. Just over a year before the completion of the planned transition to filmless, Ames

reports, "We've met all of our objectives except going filmless. The hospital is 98 percent digital, with the exception of surgery." Outpatient sites are wholly integrated into the hospital network, and images are available anywhere on campus. In fact, one radiologist even reviewed images while he was vacationing in China.

Cost-savings with the combination of Kodak DR and CR has been significant. Ames says, "Our volume has increased 5 percent a year every year for the last five years, but we are spending \$1.6 million less on expenses this year than we did five years ago."

How is it possible? For starters, Ames' radiology department currently operates eight technologists short, but because of the increased efficiency of DR, Ames has been able to provide superior service without filling those positions. In fact, he says the department could have justified 11 new tech positions based on its volume, but with digital imaging, it doesn't need to add new technologists. Film costs also have dropped despite the fact that the hospital is completing more studies and printing them on dry lasers, which uses more expensive media. With Kodak DR and CR systems in place, the department is performing, and then printing fewer retakes. As a result the hospital has saved \$120,000 in service and chemical expenses since installing Kodak DryView laser imagers. "Kodak dry lasers pay for themselves in a year," confirms Ames.

Selecting the right equipment configuration and developing effective processes are absolutely key to digital success. There is one final factor in St. John's digital success story. St. John Medical Center turned to Kodak's Professional Services organization for training and design support. According to Ames, Kodak's Professional Services team provides first-rate systems and network design. He continues, "Their training has also been excellent. Kodak's application specialists are very knowledgeable and do a wonderful job of training."

The Fast-track Alternative

St. John Medical Center was one of the first DR converts in the country. As other institutions follow in its footsteps they can capital-

ize on its experience. **Avera Sacred Heart Hospital** (Yankton, S.D.) actually skipped several generations of imaging technology and converted directly from film-screen to DR. The 144-bed hospital completes 24,000 radiology studies a year and was able to replace two conventional rooms with one Kodak DirectView DR 9000 system.

Radiology Director Robin Berke says, "We had been thinking about digital for a long time. We started with a digital fluoroscopy room, and we made sure that every new piece of equipment we purchased was DICOM-compliant because we knew we would eventually be integrating PACS." Berke, however, would never have guessed that the PACS conversion would happen just four short years after the hospital's first digital purchase. Sacred Heart plans to implement PACS within the next year.

The fast-track PACS plan is rooted, in large part, in a very successful transition to Kodak DR systems. Sacred Heart's conversion to digital was driven by the need to replace outdated x-ray equipment. The hospital evaluated DR and CR and selected DR for a variety of reasons. Berke explains, "We knew the productivity would be greater with DR because we could replace two rooms with one. With CR, the technologists still need to handle cassettes and take them to a reader." In fact, the ability to replace two systems with a single system was a significant factor in obtaining budget approval for the digital project. Still, CR will play a pivotal role in the new, state-of-the-art radiology department. Sacred Heart plans to install CR to handle portable films and IVPs.

The hospital set out with a primary goal of reducing film costs and eventually doing away with film, which, says Berke, it has achieved. But, he adds, "There are other advantages to digital. There is a lot more to be gained from it." The hospital has virtually eliminated its lost film problem, and it has enabled multiple physicians to concurrently review images.

Sacred Heart has already transitioned to a second stage of the digital mindset. Berke says, "Two or three years ago, we were saying 'DR is great for radiologists.' Now we're asking, 'What can we do for referring physicians?' The answer: A lot. For starters, referring physicians at Sacred Heart will

have the images as available as the radiologist's report. And when PACS is integrated, physicians will be able to access the report and images from any computer on the hospital network.

Small, Rural and Digital

When **Innovis Health** (Fargo, N.D.) opened the doors to its new, small rural hospital in 2000, it did so with a state-of-the-art, all-digital radiology department. The commitment began with a full-range of Kodak CR products; the new department sports two Kodak DirectView CR 800 systems and a DirectView CR 900 system to serve the main radiology department. Wall-mounted Kodak DirectView remote operations panels located in the surgical recovery area and CCU/ICU area allow techs to enter patient identification and review information without leaving the exam room. Three Kodak DryView 8700 laser imagers eliminate the need for plumbing and film processing. Despite the countless benefits of digital radiography, the initial plan for the new hospital was actually a traditional film-screen department.



Innovis Health's Director of Radiology, Shawn Worley says CR has widened image distribution and increased efficiencies at his facility.

Then the hospital hired its new Director of Radiology Shawn Worley. Worley came on the scene and convinced hospital administration that CR was the smart choice. "What sold them was the cost-savings model and increased efficiencies," he says. "They also like the other benefits of CR such as wide area distribution and anytime/anywhere access to images." The hospital installed a more powerful network to lay the groundwork for CR and selected Kodak products to meet its digital goals.

The radiology department of the 77-bed, not-for-profit Innovis Health performs 65,000 diagnostic procedures annually. In

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less than two years the department has met some of its digital objectives. Worley relates, "We've achieved a wide area distribution of images and we archive digitally. We also are definitely more flexible. If we lose a film, it is easy to reprint." Innovis physicians can review x-rays in their office or even at home, which is a 'big plus' says Worley. Wide distribution of images has also increased efficiency. Physicians no

longer need to trek to the hospital in the middle of the night to look at films. Studies can be pulled up on their home computer.

Worley says his department has found CR's high image quality to be a true asset. "Improved image quality is probably our best benefit," Worley says. "CR gives you much more latitude and images are far superior to what they would be with film-screen." Chest x-rays and IVPs, in particu-

lar, are much better with CR.

Innovis Health has not yet completed its digital journey. The hospital does not yet have an RIS or PACS, so it has not been able to take its next step, which is filmless soft-copy reading. Worley envisions tremendous benefits when the hospital takes that step. "If we had an RIS and PACS [in conjunction with our Kodak digital equipment] our efficiency would be awesome. I believe it would be ten-fold of what it is now."

"Digital imaging is a wise investment—even for a smaller, rural hospital like ours—because of the advantages it offers in terms of image quality, image distribution and staff productivity as well as patient care."

Patient Care: The Digital Way

Digital technology can enhance workflow and increase staff productivity. It also can bring about cost-savings. These are important reasons to implement digital technology. But hospitals also are primarily in the business of providing patient care. And hospitals that have taken the digital route are realizing a number of patient-care benefits. Virtually everyone agrees that the most significant patient difference between a digital and conventional department is the elimination of the plague of conventional radiology-lost films. Image quality also represents a digital plus. And anytime/anywhere access for multiple physicians certainly aids patient diagnosis and care. Finally, patient care is just plain faster with digital technology.

Everyone in the radiology business knows the lost film drill. But Mary Super, director of imaging services at **St. Cloud Hospital** (St. Cloud, Minn.), identifies another dimension to the problem. "Copies of conventional film are not as diagnostic as the original. The beauty of digital is you can make another original and send it off again."

Image quality with digital technology represents another important patient-care benefit. Phil Ames, administrative director of radiology at **St. John Medical Center** in Tulsa, Okla., reports, "The image quality of Kodak's DR portfolio is outstanding, even when compared with other DR systems. We performed a series of test images using a line pair resolution phantom with the Kodak DR system.

Images from the Kodak system were of noticeably higher quality." Improved latitude and image quality mean that there are far fewer retakes at digital institutions.

With Kodak's digital imaging technology several physicians can review a study concurrently. This not only facilitates accurate diagnoses, but can also speed up the entire diagnostic process. Without Kodak's CR products, patients at **Innovis Health** (Fargo, N.D.) would have to wait for a physician to arrive at the hospital to review his films. Now that same physician can pull up a study from his office or home 24/7 to make a diagnosis.



"A big part of the patient-care benefits [of digital] is convenience. It actually takes longer to take a patient to radiology than it does to do the images."

Robin Berke, radiology director of Avera Sacred Heart Hospital

Robin Berke, radiology director of **Avera Sacred Heart Hospital** (Yankton, S.D.), says, "A big part of the patient-care benefits [of digital] is convenience. It actually takes longer to take a patient to radiology than it does to do the images. An exam takes about 10 seconds and it's over. And physicians can actually review the films as we take them." In its pre-digital days, films at **Brigham and Women's Hospital** (Boston) might travel the entire length of the hospital before ending up in the right diagnostic hands. Digital, however, eliminates many of the interim steps of film radiography, so that patient diagnosis is faster and more efficient. In the end, the patient-care benefits represent an important complement to digital workflow and efficiency gains.

Strategic Digital Plan

St. Cloud Hospital (St. Cloud, Minn.) is a regional level 2 trauma center that handles 120,000 exams annually. The hospital initiated a four-phase digital plan in 1998 with the twin goals of connecting to other CR-based regional hospitals and moving to filmless.

Phase one laid the groundwork for the digital plan. The hospital replaced older radiology equipment with DICOM-ready, digital platforms, and it installed a network so that the hospital could transfer images to a storage archive. The hospital purchased three Kodak DirectView CR 900s, two CR 800s and three Kodak DryView 8700 laser printers. The next phase entailed putting in the infrastructure for PACS. Phase three, the current phase, consists of hardware purchases. St. Cloud Hospital selected review stations, workstations and the hardware for referring physicians to review images.



Kodak's DryView 8700 laser imager

Mary Super, director of imaging services, reports, "We have about 90 percent of the equipment installed and are in the applications and training part of this phase."

Physician training, says Super, has proceeded quite smoothly. "Our physicians absolutely love it. I don't think

they would go back to having a piece of film in their hands.”

Members of the hospital staff, however, have not acclimated quite as quickly. Her advice to her colleagues? “I would spend more time educating people if I were doing this again. A lot of it is common sense and understanding.” Simple, one-on-one tutorials explaining not only the hows of digital imaging, but also the whys, is well worth the time and can make a dramatic difference in the staff’s acceptance of digital technology.

The final phase of St. Cloud Hospital’s digital project, phase four, will be the integration of PACS with the radiology information system. At that point, the hospital anticipates its greatest cost-savings. It expects to eliminate 80 percent of its film costs. At the same time, St. Cloud Hospital will continue to reap the other primary benefits of digital technology — increased workflow and productivity and enhanced patient care.

Inside the Mega-Digital Department

Brigham and Women’s Hospital (Boston) is a large, 700-bed teaching hospital with a fairly extensive radiology department that completes 300,000 exams a year. The hospital recognized that implementing digital imaging technology would improve workflow and productivity and set out to develop a digital plan. Michael Viera, associate director of radiology administration, explains the decision. “We knew that PACS would be very beneficial within the radiology department. That’s a given. Our initial goal was to improve image access for referring physicians and inpatient units located throughout the hospital. The secondary goal was to make our radiology department as efficient as possible.”

Brigham and Women’s initiated a gradual PACS implementation process. Viera says, “We converted the digital modalities, CT, MR, ultrasound and nuclear medicine first. These studies are already acquired in a digital format and we felt that these would be the quickest modalities to convert.” The next step, the conversion of traditional film, was divided into two parts. The hospital first converted portable chest radiography to CR and purchased Kodak’s DirectView CR 800 sys-

tem to manage this radiology imaging subset. The second phase of the implementation at Brigham and Women’s Hospital was the most intimidating—finding a digital solution for the hospital’s plain film exams. The radiology department completes 120,000 plain



The operator console of Kodak’s DR 5100 and DR 7100 systems features a user interface consistent with Kodak CR systems for efficiencies in training and use.

studies annually, so this phase represented a fairly momentous task.

Viera says, “We looked at various DR manufacturers to see who could address our specific issues.” We found that early DR technology was still unproven and very expensive. The hospital expected to increase productivity, but also wanted to find a digital partner with a versatile, future-oriented technology vision that would meet the department’s imaging needs for the next several years. Finally, it needed a program that would work well with its RIS. Ultimately, Brigham and Women’s Hospital selected Kodak and purchased an additional nine CR 800 systems for its Ambulatory Division. Viera explains, “Kodak’s web-based technology was very intriguing for us. With this hardware, there is an opportunity to integrate other processes.”

Most recently, Brigham and Women’s has begun its final conversion, and has pur-

chased two DirectView DR 9000 systems the first of which has been installed in a radiology room located within the Brigham Emergency Department.

Where does Brigham and Women’s stand against its initial objectives? Viera opines, “We feel we have made major strides in making our radiology department as efficient as possible.” What does the ultra-efficient radiology department look like? Before the conversion to digital, it was fairly common for radiologists to move five or six times a day to the various reading rooms located around the department as well as the various ICUs and conference rooms located throughout the hospital. Now the hospital has started to consolidate reading rooms, enabling the radiologists to spend the day in the radiology room reading films from multiple locations and modalities on a workstation, which naturally makes them more efficient. On the other hand, the department has not yet completed one of its original goals of providing 100% access for its referring physicians. Brigham and Women’s is a leader in the implementation of digital, and some of its affiliated institutions are still in the process of upgrading the infrastructure needed to efficiently access digital studies completed at Brigham and Women’s, hence this goal is a work in progress.

Viera sees an overall benefit to the bottom line with digital technology. “It is difficult to measure our cost-savings, but the institution as a whole is saving money.” The savings is primarily due to increased efficiency. Patients are diagnosed faster and released faster, and they can make appointments faster. The hospital also is realizing a decrease in costs due to reduced usage of film.

Digital and Filmless

For many hospitals, even some on the cutting edge of digital technology, filmless is the future. Not so, for **North Kansas City Hospital** (North Kansas City, Mo.). The hospital began installing Kodak CR and PACS in July 2000 and is completely filmless with the exception of mammography.

North Kansas City Hospital actually fast-tracked its digital undertaking and was able to complete the project in a mere five months. Radiology Systems Manager Peggy

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Wollnik recalls, "We had a new piece of equipment going in every three or four days."

The hospital decided to step up the pace of the conversion to filmless in part because it was adding a new outpatient center connected to the hospital and didn't want to introduce conventional radiology chemicals. The other motivating factors for the fast-track project were the typical frustra-

tions and inefficiencies associated with conventional film. Wollnik says, "CR made sense. There was hardly any justification. It all came together as part of the cost of the new building."

Today at North Kansas City Hospital, radiologists read soft-copy images on workstations. With the hospital's HIS and RIS, images and preliminary reports are

routed to the PACS for physicians' review. The radiology department has realized dramatic gains in efficiency. "We're very much aware of improved workflow and increased patient throughput," Wollnik says. "Our increased productivity was evident even in the beginning. Our portable turn-around time is incredible." Techs access portable studies from readers on the hospital floors, which hastens turn-around time. Radiologists also have realized efficiency gains. Prior to installing CR, radiologists had to pull and hang films. CR eliminates that time-consuming step. Images are available to radiologists with the click of a button on workstations.

Although the rapid move to filmless may not be the right choice for every institution, it certainly worked well for North Kansas City Hospital. According to Wollnik, radiologists, clinicians and administrators have discussed the rapid transition to filmless and agree that they would do it again in the same way. One reason for the successful transition is a savvy project management team that included a project manager from Kodak, Wollnik and several other members of the hospital staff. The team was able to set, and adhere to, a strict timeline.

Digital Benefits

Hospitals that have pioneered digital technologies demonstrate that institutions of all sizes can realize a host of benefits when they adopt Kodak's digital imaging technologies. These hospitals have found that digital technology yields significant productivity increases; both radiologists and technologists become more efficient. Cost-savings consist of both reduced film and supply costs and reduced labor costs. However, there are less tangible cost benefits associated with digital including improved access to images, image quality, reductions in lost images, and reallocation of space when rooms are converted. Further, patients can be scheduled sooner and released in a timelier manner. There is also the positive public relations effect of being seen as a technical leader. Finally, there are a whole host of patient-care benefits associated with digital technology too.

Peeking Into the Digital Future

Most digital technology pioneers envision integrating additional technology to augment their already efficient digital departments.

The DR-based radiology department at **Avera Sacred Heart Hospital** (Yankton, S.D.) is considering a voice-recognition transcription package to hasten turn-around time on results. Radiology Director Robin Berke confides, "We're pretty ambitious. We not only want to go filmless, we want to go paperless, too."

Filmless is the ultimate goal at **St. John Medical Center** in Tulsa, Okla. The radiology department has set a target date of October 2003 to coincide with a radiology department remodel. Phil Ames, administrative director of radiology, says, "The biggest part of this is getting our referring physicians on board. That's where web access comes in. We added web access two years ago and were getting 300 hits a month. Now, we average 7,000 hits a month." As a result, Ames predicts a successful transition to filmless.

Shawn Worley, director of radiology for **Innovis Health** (Fargo, N.D.), looks forward to implementing a radiology information system (RIS), which will enable the hospital to transition to all soft-copy interpretations. The impact on the 77-bed hospital's budget will be tremendous; it will save up to \$1 million annually in film costs. Worley also predicts that a RIS-PACS-CR combination would yield a dramatic, 10-fold efficiency increase.

North Kansas City Hospital (North Kansas City, Mo.) is installing its own network with an interface to the HIS and RIS. Peggy Wollnik, radiology systems manager, says, "We feel like we can add anything we want—DR, voice recognition or web browsers with our own network." The hospital is planning to add DR within the next year and plans to move some of its Kodak CR systems to hospital floors when it installs a DR system.



"We feel like we can add anything we want—DR, voice recognition or web browsers with our own network."

Peggy Wollnik,
radiology systems manager,
North Kansas City
Hospital

At **Brigham and Women's Hospital** (Boston), associate director of radiology administration Michael Viera looks forward to some more mundane, but equally important, technical advances. He says, "We've become more efficient, but we still need to work on some of the ancillary issues." These ancillaries, such as software enhancements for dictation as well as worklist links, will continue to unburden the hospital's radiologists of the support function responsibilities that radiologists have assumed over the last decade. More efficiency will be gained when these functions

are managed by advancements in software and not valuable professional resources.

Not everyone can be a digital pioneer. But there are advantages to getting into the digital game at this point. Ames says, "We were learning about DICOM with our vendors. It's much easier now." Moreover, Kodak offers its customers a much wider array of digital products now tailored to customer need. Ames concludes, "Going digital is a tough change, but it's worth it in the long-run."



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