Sic et Non: Is Digital Radiography a Technological Imperative?

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Yes!

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Digital radiology, both computed radiography (CR) and digital radiography (DR), is a technological imperative for large institutions. The benefits to a site using a picture archiving and communications system (PACS) are huge. While benefits of PACS are widely recognized for the native digital modalities such as CT and MR, they are equally applicable to CR and possibly DR. Soft-copy reading is essential for CT and MR, particularly for the newer multislice and spiral CT systems that can generate examinations with 2,000 or more images. With digital x-ray the real benefit is improved patient care by enabling “real-time” radiology, and reducing retakes and lost films. The real Achilles heel of PACS is enterprise distribution. However, several solutions are emerging that will enable enterprise image distribution. These points will be discussed in greater detail below.

One of the prime reasons to pursue any new medical technology is, or should be, improved patient care. This is a key benefit of digital x-ray, and PACS in general, as it allows images to be in several places at one time. The patient can now have an examination and be seen by a referring physician immediately without having to wait in radiology for the examination to be read, then taking the films and reporting to the clinic, a process that can cause significant delays on busy days in radiology. This benefit is available even if films are being printed in an environment that has a radiology-only PACS system without enterprise distribution capabilities.

Enterprise-wide distribution is a real problem that currently has few good solutions. This is a serious roadblock to reaping one of the real financial benefits of digital x-ray: the elimination of film. It is unrealistic to think that an institution will deploy hundreds of thick-client PACS workstations, and many of the available Web-based systems do not have sufficient functionality to be clinically useful. An answer to this problem is emerging in the new breed of thin-client, Web-vendible, full-function PACS solutions. These will enable enterprise-wide image distribution and provide even greater benefits to using digital x-ray systems. This is a key to gaining the real financial benefits of digital imaging, the holy grail, a truly filmless environment. It will occur only when image access points are as readily available as light boxes.

Digital x-ray also improves patient care by providing increased latitude. Films that would have been unreadable can now be read without requiring a “re-ray.” This reduces patient radiation exposure and will help to increase throughput by reducing examination time.

There is no doubt that the cost of DR is hard to justify. Though its technical superiority over CR is significant, the clinical impact has not been demonstrated. On the other hand, the cost of CR has dropped substantially in recent years; the cost of low volume units can be below $50,000. Although this figure is compared to relatively inexpensive film processors, the cost of film processing has the associated costs of chemistry (including environmental costs), plumbing, and site preparation, as well as the limitations they pose on remodeling. There also are the costs of handling the film, in addition to the cost of the film, which, if not eliminated, can often be substantially reduced, even from the outset. So,? the cost of digital x-ray is becoming quite reasonable, even for smaller clinics.

A major problem that affects patient care, legal liability, and revenue is that of lost films. In a large trauma center environment, the number of lost films can exceed 10% of examination volume; with digital x-ray, this figure is nearly zero. In reality, the number of lost films is much higher if you consider a film to have been read only if it is read contemporaneously in a way to affect patient care. This is the number that institutions should be looking at. It does little good for the radiologist to interpret the femur fracture seen on a film 2 days after the patient is out of the operating room for repair of the fracture.

In summary, digital x-ray is a product whose time has come. It has minimal impact on a properly designed PACS and its network infrastructure. It will improve patient care in many ways. It will generate additional revenue and help reduce legal liability. Overall, it has many positives with few negatives and many of these problems have realistic solutions in sight. These benefits are real and achievable in larger institutions today and, with the rapid advances and decreasing cost of computer hardware and PACS software, will be attainable goals for smaller institutions in the near future.

No!

EDITOR'S NOTE: We wish to acknowledge the willingness of both authors to contribute opinions on this topic, and to qualify the argument of Andrew D.A. Maidment, PhD, who agreed to assume the always unpopular role of the devil's advocate and argue the "No" side of this question. The opinion expressed under his name does not necessarily represent the opinions of the author, but rather is representative of the arguments against the implementation of digital radiography.

Andrew D.A. Maidment, PhD

The appeal of digital radiography (performed either with photostimulable storage phosphor imaging systems or so-called DR technology-flat panels, etc) to large medical institutions is undeniable. The benefits of an installed picture archiving and communications system (PACS) with existing digital technology such as CT and MRI are clear. Computerized display of images in large 3-D datasets is essential, and the concomitant benefits of digital image transmission and storage allow for efficiencies not otherwise achievable. The difficulty, however, lies in the method by which such data are communicated to others, such as referring physicians and surgeons. The convenience of film is so great, and the infrastructure costs of remote electronic viewing are sufficiently great, as to make it difficult to convert anything outside the radiology department to be filmless. As such, the benefits of converting analog radiography rooms to digital are less compelling. The most common arguments are improved throughput and the institution of a single system for handling images (elimination of the film file room). The arguments in favor of digital conversion become even more tenuous when dealing with smaller imaging centers. Thousands of such centers exist throughout the United States, yet it is inconceivable that digital radiography will be profitable or beneficial to these centers. In the following, each of these points is discussed in more detail.

First, film remains a powerful medium for communicating radiographic results. It has great dynamic range and contrast, longevity, minimal capital costs, and ease of viewing in its favor. Films can be and frequently are viewed with a bright window or a fluorescent room light. While neither is optimal in terms of image quality, the convenience and portability of film are inarguable, when compared to computer workstations tethered to a wired network and power supply. Web-based viewing applications, small portable computers, and wireless networks promise to provide digital viewing solutions. But when will such resources be so ubiquitous that turning to a computer will seem as natural as picking up a sheet of film or a piece of paper? Furthermore, we cannot expect casual users of medical images to invest in any specialized hardware or software, solely to display these images. Thus, the necessary equipment must be in place for other purposes before it will be used for image viewing.

Today, the most common method of providing images to referring physicians at imaging centers is film, regardless of whether a PACS is being used. Why, therefore, would someone want to produce a digital radiographic image that will ultimately be printed as film? This is one of the reasons digital radiography (which in the form of photo-stimulable phosphor systems has been around almost as long as CT, MRI, and ultrasound) has not flourished. Why invest hundreds of thousands of dollars or even millions in capital equipment for a system that will ultimately be producing films, when a film processor and wet chemistry can achieve virtually identical results? Agreed, digital radiography introduces new opportunities that may either result in improved image quality (advanced processing techniques) or allow computer-aided diagnosis, but these just further add to the costs and have yet to show their potential.? In a year in which the Medicare physician conversion factor has been cut again by 5.4%, can we really expect that digital radiography will prosper without an increase in reimbursement, as has been seen in digital mammography?

Ultimately, the greatest motivators of a technology are reimbursement and public and peer pressure (patients or referring physicians asking for the latest technology). Neither is likely for digital radiography.

Consider also the demographics of radiography facilities. The majority of x-ray rooms in the United States are in small, often single tube facilities located in surgeon's offices, chiropractic facilities, and similar sites. These facilities, often served by a local radiologist, exist because of their convenience. They may process 5 to 20 patients per day, 2 to 4 days per week. These facilities cannot afford to go digital. The promise of a new digital radiography suite that can handle twice the number of patients of a similar film-based suite is predicated upon the existence of twice as many patients. According to the 2000 Market Research Study of Mammography Sites, IMV Medical Information, Des Plaines, Ill, mammography rooms are used to perform between 1,687 and 3,298 procedures per unit per year. In an American practice, a mammography machine should be able to handle 6,500 patients per year (25 per day, 5 days per week). In Canada and Europe, the same machine will be used to process 20,000 patients or more per year (in screening). Arguably, we have an excess capacity of between twofold and eightfold in mammography. In general radiography, the excess capacity is much greater. Digital radiography simply promises to increase our excess capacity from, say, fivefold to tenfold. Oh, the benefits technology provides! Do we really want to sacrifice the convenience of getting a chest film in our doctor's office?

Undoubtedly, digital radiography will have a role everywhere. Digital technology has virtually replaced analog audio technology. The same is occurring in the video industry. The time for digital radiography will come, but only when the ease of digital radiography makes film radiography seem inconvenient. That day is many years in the future, when the technologies needed to power the dissemination and display of radiographic images are endemic and very inexpensive-ie, when consumer products have the capabilities needed for medical image display. That day will come, but it will not be in the next 10 years, maybe not even in the next 20 years.

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