The Transition To Digital Imaging In Medicine

THE INTEGRAL ROLE OF FILM DIGITIZERS

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Introduction

Certain areas of medicine have made significant headway in adopting digital technology. At the top of this list is radiology—where there has been a serious move toward use of digital modalities such as x-ray, MRI, CT, and ultrasound. This revolution in digital imaging has been accompanied by the adoption of picture archiving and communication systems (PACS), which provide electronic storage, retrieval, distribution, and presentation of images from the radiology department. PACS facilitates the handling of digital radiology images so that they can be readily accessed and viewed by a variety of medical professionals in different locations and settings, enhancing patient care and improving operational efficiencies, workflow, and the bottom line for radiology departments and centers.

Even in areas around the world where digital modalities are not as widespread and PACS is not yet the dominant model, there is still a demand for increased efficiency and improved utilization of expert resources. This is demonstrated by the rapidly increasing use of teleradiology as a first step to expand healthcare coverage, especially in remote areas.

The ultimate goal of digital imaging and PACS is to become completely "filmless" due to the related improvements in cost as well as improved patient care. However, the reality is that this dream cannot be realized overnight. Throughout the process, and for quite some time after the transition to a fully filmless environment, the radiology department will face the challenge of how to deal with existing film. These films may be archived in the hospital's file room or come from outside sources. Regardless of origin, these prior images are important for comparison with current images and need to become part of the patient's electronic medical record for ongoing health management. If not made easily available, these critical studies could be overlooked, negatively affecting patient care. Conversely, if a facility does not carefully consider how it will incorporate existing film into its workflow, it will likely incur significant, but uncalculated, costs in film handling that result in lowering the productivity of highly paid personnel.

While some industry experts have predicted a transition to a completely filmless industry in only 10 years in the U.S., others—citing factors such as the existence of many rural facilities that are slower to adopt digital technologies due to financial considerations—have placed this milestone as far away as 30 years.[1,2] In emerging markets, the timelines are expected to be even longer because facilities are just at the beginning of this journey. Because film will remain as a medium for medical imaging for many years to come, medical film digitizers are an integral part of the transition to digital imaging and PACS. They are a critical component in the digital transition and a must for ensuring smooth workflow and maximizing the return on digital investments by quickly providing high-quality digitization of prior analog films for side-by-side digital review. Having digitized priors helps improve patient care and provides numerous cost and workflow benefits to the hospital and radiology department.

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Today's medical-grade film digitizers can offer excellent image reproduction, reliability and ease of use, and are an important component at all steps along the journey toward a fully digital imaging world. It is critical that facilities consider and understand the benefits of incorporating a medical-grade film digitizer for prior film-based studies, as well as the hidden costs of omitting this vital component of a digital imaging solution.

Benefits of Digital Imaging

Digital imaging is associated with a number of important clinical and economic benefits, which have driven the rapid adoption of digital modalities and use of PACS and radiology information systems (RIS) in recent years.[3] These benefits have helped offset the costs of the equipment and infrastructure.

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Digital imaging and PACS allow instant access to radiology studies among the entire patient care team regardless of location—and without duplicating or transporting films, or risking the loss of films.[3] Digital images provide better dynamic range and contrast—reducing retakes and offering the ability to see more levels of gray.[4] Specialized monitors and software allow radiologists to focus in on details and perform other manipulations to the image, and also instantly call up digitized prior studies for comparison, improving diagnostic accuracy.[3] Digital technology also allows the immediate ability to extend radiology expertise beyond the boundaries of the department and hospital to outside clinicians, specialists, and facilities.

Digital imaging and PACS also improve workflow and productivity and reduce costs throughout the imaging process. Streamlined processes allow technologists to handle more patients each day, and fewer rooms may be needed to handle the same number of patient studies—allowing growth in imaging volume without adding staff and expanding facilities, or freeing resources for other, more profitable, activities.[4,5] Improved efficiency means that radiologists can review and report on a greater number of patient studies in digital format compared with analog reading. The RIS can be automatically updated every time a study is completed, saving time and reducing errors. And reporting and billing also are streamlined. There also is the potential to reduce unnecessary and/or repeat examinations—saving money and reducing radiation exposure for patients.[3]

In addition to improved workflow and productivity, digital imaging and PACS allow facilities to eliminate the costs of film and chemicals, and to redeploy personnel who previously handled film processing,

storage, retrieval, and re-filing.[3] The ability to maintain digital film archives frees up film storage space for more productive uses, such as the acquisition of a new advanced modality.

These benefits continue to drive the digital imaging and PACS markets. According to a 2010 report by GlobalData, the PACS market in the United States is forecast to grow by 11 percent annually, reaching $5.5 billion in 2015.[6] The report also found that adoption will be propelled by small and mid-size hospitals looking to cut costs and increase efficiency, as well as large hospitals replacing legacy PACS to take advantage of advanced clinical applications, new software architectures that allow radiologists to access their workspace from any location, and seamless PACS/RIS integration.[6] Other markets are either experiencing or are poised for explosive growth in the coming years as governments place a growing emphasis on expanding quality healthcare coverage.[7]

Avoiding a Common Pitfall in the Transition to Digital

In order for facilities to realize these benefits—and avoid a common pitfall in the transition to digital—it is important to develop and have in place a plan for the smooth handling and review of prior studies, which play a key role at all stages of the digital imaging continuum. Prior films will continue to be a factor for many years, especially films coming from outside sources, and inadequate handling of analog priors adds significant hidden costs. Many facilities fail to address this critical issue, resulting in disrupted workflow, dissatisfaction and frustration among radiologists and staff, increased costs and, ultimately, lower confidence in the diagnosis.

A film digitizer can ensure that work is performed once and in the most efficient manner. For example, the film file room staff should digitize prior studies as needed, ensuring that the films never have to be pulled again. The alternative is significant technologist, radiologist, and staff time and effort wasted pulling patient files, locating the particular film among numerous prior studies and documents, hanging it on a light box (if one is still available), and re-filing it. Because radiologists are paid only for reading the film, this often means spending time on unpaid activities, which erodes profitability.

Further, an environment where radiologists compare primary digital studies on a computer workstation with hard-copy prior films on a light box is cumbersome and time-consuming.[8,9] This hybrid viewing also raises issues of quality and consistency, due in part to the incompatible optical luminance and illuminance levels of the two methods. In this situation, radiologists are exposed to eye and neck strain and other physical effects due to the ergonomic issues inherent in hybrid viewing environments. If no light box is available, radiologists may be unable to read the prior film, or be forced to hold the film up to standard room light for reading.

Experience shows that digital-to-digital comparisons are not only faster, but are less prone to mistakes and, thus, support better patient care. They also support radiologists' natural softcopy reading method that is optimized to aid their visual search for subtle differences in the images.

Numerous other cost and efficiency benefits of digital imaging hinge on having a plan to smoothly handle prior and referral images. Answering key questions during the planning process will help facilities avoid unforeseen problems and maximize their investments in digital technology, including:
• What processes are required to enable radiologist review of prior analog images from our file room?
• How will studies from outside facilities be digitized so they are part of the digital workflow?

Prior Films—an Emerging Markets Perspective
Because regulations regarding film retention vary widely from country to country, patients often leave a facility with their original hard-copy film. As a result, large tertiary referral centers in emerging markets continue to see films brought in by patients on a daily basis, and this issue will continue for many years to come. These centers are creating film archives to provide physicians with access to prior studies in order to improve the quality of patient care and optimize clinical decision-making. For many, the answer is a film digitizer to allow scanning of prior films.

• What staff and other resources will be needed if priors are not digitized, and is this an efficient utilization of resources?
• How will the need to maintain light boxes and other processes for handling analog priors impact the workflow of radiologists, technologists, and staff?
• How can we prevent the problem of a hybrid-viewing environment for comparing prior analog films with current digital studies?
• What is the impact on the quality of patient care if film priors cannot be reviewed?
• What hidden costs are associated with handling analog priors, and how will these costs compare over time with the cost of acquiring a film digitizer?
• What role could a digitizer play in the next phase(s) of our digital transition?

When Do Film Digitizers Become Critical?
For many facilities, the transition from analog to a fully digital environment is an incremental process, and film digitizers play a critical role at all stages of the transition.

Teleradiology
Teleradiology applications are often the first foothold in many countries for digital medical imaging as they allow expanded healthcare delivery in environments where bandwidth is an issue, where there are remote sites, and where there is a radiologist shortage. Teleradiology allows images to be taken in a location convenient to the patient and electronically transmitted for reading at a main hospital or center. It also allows the radiology community to better utilize specialists in the diagnostic cycle. As a result, teleradiology solutions help solve time, distance, and expertise problems preventing timely primary interpretations.

A teleradiology system requires image gateways and specialized communications capabilities, as well as diagnostic-quality workstations. This also is an excellent place for the introduction of a film digitizer at remote sites to send all types of images to an outside expert reader for reporting or consultation. The alternative, transporting analog films by a variety of means over wide distances—even if feasible—results in delays in treatment that can compromise patient care and jeopardize survival.

Teleradiology provides a lifeline for many patients and clinicians who otherwise would have no way to access vital radiology services. If new modalities are added to the remote site, such as CT or ultrasound, they can use the same teleradiology gateway and communications infrastructure.

In many countries, it is common practice to provide a set of films and the report to the patient. In these cases, staying with analog or "wet" film, as opposed to using "dry" or printed film, can save hundreds of thousands of dollars over a five-year period. These short-term cost savings could be used to fund the future migration to PACS or other digital modalities.

Analog Image Distribution

For the many hospitals using wet or analog film, another first step to digital may be to adopt an image distribution system. Films requested by or taken in the emergency department or intensive care unit are digitized in the radiology department immediately after processing, and the digital images are sent back to the care units for immediate use. The digitizing station can also feature a micro-PACS archive.

This real-time image distribution capability leads to better patient care because images are quickly made available to authorized viewers throughout the facility. This approach also allows the radiologists to continue to read from film and ease into the acceptance of new technology. In contrast to the high costs that accompany film duplication or CR/DR solutions and dry film printers, digitized images can be distributed to multiple care units with no extra cost per study. There also is no lost revenue due to films being removed from the radiology department before the radiologist is able to read them, and staff time to track down missing films is eliminated.

PACS

The term PACS can encompass highly varied levels of integration and support, and the first step may be going filmless for a specific department or modality. Regardless of how a facility's digital journey is planned, it should ensure that once radiologists begin reading images in softcopy, all images delivered to them are also softcopy. If the radiologist is spending time sorting through studies to find what

is needed, one of two negative consequences will result: Either the radiologist will spend too much critical time acting as a file clerk, or the radiologist will simply stop using the priors—potentially missing critical diagnostic information and putting the patient and facility at risk.

Some facilities make the mistake of thinking that a fully digital PACS environment eliminates the need for a film digitizer. In reality, however, the same digitizer that brings them from teleradiology or analog image distribution to digital image management will continue to play a key role once the PACS is in place. Digitizers are needed to support legacy equipment, as well as to digitize priors from the film archive and those coming from outside facilities for review. Prior images also should become a permanent part of the patient's electronic medical record. By establishing a digitizer as the fully functional "conversion" solution throughout the transition to digital imaging, facilities can avoid interrupting workflow when a patient arrives with a hard-copy x-ray. It only takes one analog prior per day to cause significant disruption of workflow.

Special Concerns About Digitizing Mammography Priors

Digital mammography brings its own set of requirements in regard to review and archiving of prior film-based studies. In fact, in no area of radiology is it more necessary to review prior studies than mammography. Significant workflow issues accompany the need for mammographers to

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The Hidden Costs of "Stopping Half Way to PACS"

Clinics and centers in emerging markets that have adopted digital image capture technology such as CR or DR in place of wet processing but have not yet acquired a full PACS face unique challenges. Without the ability to transmit, review, and store softcopy digital images, they are forced to print dry film, which significantly increases costs—often by as much as 50–100 percent compared with continuing to use wet film. In this type of environment, a film digitizing solution can be a much better fit and helps avoid the enormous costs associated with printing dry studies.
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review and compare current digital studies with prior analog films.[10,11] Mammographers have limited time for reading mammography exams and, as with other radiologists, the need to move from digital workstation to light box and back is cumbersome, time-consuming, and compromises the quality of patient care.[8,9] As a result, medical film digitizers play a vital role in the implementation of digital mammography by allowing side-by-side digital review of current and prior-year studies.[11] When digitizing mammography film, facilities also should be aware of special software requirements, such as the need to use the DICOM MG standard to label films for easy side-by-side comparison.[11,12]

The Issue of Film Retention

In the United States, a number of variables affect the length of time a facility should keep a medical record, such as state and federal laws, medical board and association policies, and the type of record (i.e., an adult patient versus a pediatric patient record) or study (i.e., general radiographic or mammography). Similar regulations concerning record retention exist across the globe. As a result, radiology departments large and small must deal with film storage issues that accompany existing film-based studies—in terms of the space required, as well as labor costs involved in filing and retrieval.

Films can be mislaid, misfiled, or inadvertently retained by clinicians rather than returned for filing and reuse by other clinicians. Digitizing prior films provides a viable solution, and many facilities are utilizing film digitizers to transform their archives into a digital format, increasing access to the images and eliminating the issue of lost studies.

The VIDAR Family of Medical Film Digitizers

Medical imaging solution providers, radiologists, mammographers, and other clinicians have long looked to VIDAR Systems Corporation for film digitizers that deliver clinically proven image quality, the highest reliability in the industry, and unmatched value. VIDAR is the world's leading provider of high-quality medical film digitizers for a variety of applications, including PACS, mammography, computer-aided detection (CAD), teleradiology, oncology treatment planning, orthopedic surgery, and dentistry. This is evidenced

by the fact that more than 20,000 devices have been placed worldwide.

The company's singular focus on medical-grade film digitizers over the past 20 years has allowed it to pioneer a series of product innovations that have dramatically changed the field, and VIDAR products are backed by world-class customer support. When used at any stage in the transition to digital, VIDAR digitizers facilitate significantly improved productivity, workflow, and patient care quality.

Features such as modality worklists allow VIDAR digitizers to query for patient demographics and study data from a DICOM Modality Worklist server, eliminating the need to retype patient study information and minimizing the possibility of data-entry errors and misplaced images. Importing and exporting patient image CDs can also be integrated on the same workspace, moving these incoming and outgoing study management tasks to the file room staff and maintaining the efficiency of technologists and radiologists.

A Medical-Grade Film Digitizer vs. a Scanner

Film digitizers used for medical applications must perform at a significantly higher standard than commercial products whose primary function is scanning paper documents. Simple office product "scanners" use reflective technology (designed for paper) and simply take a picture of the film—the scanned image quality is limited because the sensors were not intended for use with grayscale transmissive films representing a broad range of grayscale values.

VIDAR film digitizers use very specialized optics and sensors optimized for grayscale transmissive use. When looking at specifications, "OD" or "DMAX" measurements often don't make sense, but medical film digitizers look at Clinical Optical Density, which takes "noise" and linearity into account. Typical high-quality scanners are able to capture details only up to a certain level before the scanned image loses all definition and is essentially black, noisy, unreadable, and unable to pick up and show details present in film, rendering them unsuitable for medical applications.

Film digitizers are regulated medical devices. They must comply with local medical regulations and standards, which are often predicated on FDA (U.S. Food and Drug Administration), CE-MDD (European Medical Device), and ISO-13485 (an ISO standard specific to the design and manufacture of medical devices). Depending on the system type, a medical-grade film digitizer might need to be validated and/or specifically approved along with the software (this is often the case for oncology applications).

The American College of Radiology (ACR) was among the first to set critical standards for resolution and bit depth requirements for secondary capture images and soft copy diagnosis. These specifications have been held by many as a global standard, so any medical film digitizer chosen should meet them. All VIDAR film digitizers meet or exceed these ACR specifications, and they have been validated in several clinical studies by organizations such as Johns Hopkins and the Mallinckrodt Institute of Radiology.

In contrast, typical flatbed scanners are composed of an inexpensive plastic box with a lid, piece of glass, lighting system, and CCD detector, sometimes with the addition of a transparency adaptor. The only standards they must meet are basic electrical and safety requirements. Also, while facilities should not risk damage to a medical film digitizer by scanning paper—the filaments and paper dust can disrupt the imaging performance—software solutions are available that allow them to run both a medical film digitizer and an inexpensive paper scanner.

VIDAR submits its medical film digitizers to systems solution providers for testing in a variety of clinical applications. It has designed its digitizers to meet the specific needs of medical imaging professionals, including:
- Scanning in gray scale—not black and white or color
- Optics optimized for transmissive as opposed to reflective media

- Reliable multi-sheet feeder
- A removable LED light source for long life and easy field replacement
- VIDAR's patented HD-CCD™ imaging technology, which allows resolutions as fine as 44 microns in mammography applications
- An automatic digitizer calibration (ADC) system, which guarantees the best image and gray scale data possible from each and every scan

Conclusion

The adoption of digital imaging in conjunction with PACS can deliver tangible benefits to radiology departments and centers worldwide, including raising the standard of patient care, streamlining workflow, and reducing costs. Digital imaging helps physicians do their jobs better and gives patients greater confidence. Sites contemplating a transition to digital, however, need to evaluate numerous topics such as hardware and software components, cost, service contracts, and the ability of the system to integrate with the hospital network and outside facilities.

It also is imperative that film digitizers be considered an integral component of the transition to digital imaging, not a secondary accessory. Digitizers serve as a cost-effective conversion solution, solving the ongoing "film problem" and ensuring that radiologists and staff remain productive after implementing a teleradiology, analog image management, digital image distribution, or PACS solution. Using a DICOM-based film digitizer with state-of-the-art software is the best way to ensure that prior studies—which are critical to improving clinical outcomes—are available for comparison with new digital studies without disrupting workflow, frustrating staff, increasing costs, and eroding the benefits of digital imaging. High-quality, affordable, and fast film digitizing solutions, such as those offered by VIDAR Systems Corporation, are helping facilities worldwide realize the full benefits of digital imaging and PACS. ■

Asking the Right Questions

When planning for the transition to digital, facilities need to do their homework in order to fully understand how the new technology will impact operations and costs now and in the future. Asking the right questions is key to preventing unforeseen problems that can disrupt workflow, frustrate staff, and generate hidden costs.

Q: We don't get paid to scan old films, so why incur the added cost of a film digitizer?

A: Reviewing prior studies is critical for good clinical decision-making. Whether these studies are from your own file room or come in with the patient, you will need to handle prior film for many years to come. Handling analog priors disrupts workflow and adds significant hidden costs that over time rise well above the cost of the digitizer. Comparing analog films on a light box with digital studies on a monitor also is cumbersome and difficult for radiologists, and reduces the standard of care. Incorporating a film digitizer into your digital planning will ensure that these problems don't negatively impact your facility and staff.

Q: We only expect to deal with old film for 3–6 months after transitioning to digital imaging, so why is it so important to digitize prior films?

A: While the need to access some types of prior films from your film archive may decrease over time, keep in mind that for some film types such as mammography the timeline is much longer. In addition, you will forever need to deal with analog film from outside sources. Just one analog film a day can result in a significant disruption to workflow.

Q: The proposal we received from our digital imaging solutions vendor doesn't include a film digitizer. Wouldn't one be included if we need it?

A: Vendors and systems solution providers may focus on digital image acquisition components and PACS technologies and may overlook key elements such as the film digitizer. A film digitizer is vital at every stage in the transition to digital imaging and only adds minimal cost, so if one is not included in your proposal, be sure to ask about adding it in order to facilitate the handling of analog prior images.

Q: Should we consider getting a used digitizer to save money?

A: Used digitizers may be less expensive, but facilities should be aware of potential issues that may arise. For example, most used digitizers are not factory certified, do not have the necessary software (which may need to be purchased separately and for which the license may not be transferable), are not under warranty, and lack recent or proper maintenance. The selling party also may not know the condition of the equipment. These issues could result in unforeseen costs and headaches, so extra caution is advised. If you are considering this method with a VIDAR film digitizer, contact VIDAR with the serial number of the digitizer, and the company can look into the service record and provide a product evaluation. Though the company cannot guarantee your purchase, it can help you make a more informed decision about the hardware, as well as review your software needs.

Q: We've heard that it is a lot of work to digitize old films and the image quality isn't all that good—what are the facts about these issues?

A: Today's film digitizing solutions can offer high levels of automation—so scanning takes just seconds per film. The key is to make sure the digitizer you select has advanced software with DICOM Modality Worklist support, which minimizes the time and effort needed to digitize films. In addition, it is important that facilities choose a medical-grade film digitizer rather than a general-purpose scanner with a transparency adaptor.[13] Medical film digitizers have been proven in numerous studies to provide high-quality images, with no difference in diagnostic quality compared with hard-copy film.[14,15]

Q: We are a small facility and can't afford to spend much to solve this problem. What should we do?

A: With today's new products and programs, it's much less expensive than you think to add a digitizer. It doesn't hurt to ask the vendor putting together your system to include one in the proposal. As outlined in this white paper, the alternative—not utilizing a film digitizer—is much more expensive over time than you think due to the hidden costs and workflow disruptions. In order to achieve the full benefits of digital imaging, a film digitizer is a must.

Q: Our national healthcare system does not require us to keep patient films, so the only time we need to scan films is when patients come in the door for a new examination with films. Can we avoid buying a digitizer?

A: Even in countries where facilities have no obligation to keep patient films, it is recognized that prior radiology exams provide important information during the diagnostic and treatment cycles. All it takes is a few films a day to disrupt your whole "digital" workflow. Your facility still makes or prints films for your customers because the film and report are the work product of a quality examination. As a result, you will continue to see film returning from your own work and outside sources for many years to come—making a film digitizer a must. Accommodating any volume of hard-copy film means that the facility needs to keep light boxes in place, as well as all of the systems, procedures, and people to handle film. As a result, your facility will not achieve all of the efficiencies that you expected when you purchased digital technology and PACS—and hidden costs will eat away at your profitability.

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