Latest advances in digital radiography

Today, digital radiography offers many advantages and possibilities, including the reconstruction and reformatting of images, easier image processing, a wide range of acquisition, rapid storage and retrieval, better distribution and more controlled viewing and analysis. This finally adds up to improved image management. The University Hospital of Frankfurt has been involved in this progress since the first day with CR and digital radiography

Projection radiography is in the middle of the transition from conventional screen-film imaging and digital image acquisition modalities, mainly based on imaging plates (CR) to flat-panel detectors. The flat-panel detector technology is currently of specific interest to improve workflow, image quality and, in particular, to reduce the patient dose.[1-3] The focus on the technology is flat-panel detector systems which show a similar flexibility as standard film-screen systems and storage phosphor systems already established on the market.

Across Europe much research is taking place to anticipate the advent of the digital hospital.[4,5] Since imaging is at the heart of medical healthcare services, it makes sense to anticipate a fully-electronic imaging department to ensure that the patient receives the best possible treatment. One of the ways we can do this is to make our facility as efficient as possible, examining the steps necessary in the workflow to improve throughput and image quality with a reduced patient dose.

Recent developments and their likely/ potential impact on the provision of care

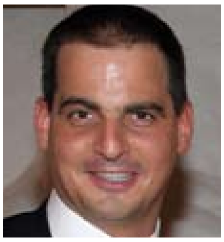
Digital radiography's (DR) current array of technologies, which are being examined by the different manufacturers, include CR, photoconductor drum, direct DR, indirect DR and charged coupled device (CCD) DR. Manufacturers are competing to provide the most efficient system. Companies like Fuji, AGFA and Kodak/ Carestream Health, Hologic, Toshiba, Canon, GE, Philips, Siemens, Imix, Swissray, Imaging Dynamics, and Delft Diagnostic Imaging are involved in the development of a variety of different technologies using storage phosphor plates, flat-panel detectors and CCD in different combinations. Direct radiography systems allow improved image quality and/or dose reduction due to their higher detective quantum efficiency and enable faster workflow because of prompt image availability.

Direct radiography systems based on large-area amorphous silicon active matrix arrays (flat panel) has been commercially available for the last five years and basically exist in two different types. The ones based on a layer of amorphous Selenium which are coated on a thin film transistor (TFT) array. This technology is changing the X-ray beam into an electrical signal without the use of light. Such a direct DR system, made by KODAK (now Carestream Health Inc), was already installed in 2001 in our X-ray department.

The main improvement was the flat-panel detector installed in an X-ray unit allowing to perform all kinds of X-ray procedures. Preview images are displayed within seconds on a monitor allowing the radiographer to do administrative work around the patient (check image quality, positioning etc) without leaving the X-ray room.

Currently a flat-panel detector as scintillator based on CsJ technology is state-of-the-art. Driven by the improvement of the workflow, due to shorter preview times and therefore a higher throughput of patients, a decision was made to replace the direct DR system with a DR system also provided by Carestream Health (former KODAK HI), but allowing faster access to preview images by reducing the patient dose per examination. Other steps in the development are dual detector systems, based on CsJ detectors, with autopositioning functionalities improving the workload for the radiographers. Autopositioning of the overhead tube crane (OTC) and/or bucky table can be preprogrammed and linked to X-ray procedures. Radiology information system codes allow opening the procedure and pre

Thomas J Vogl
Qualifications?



Thomas Lehnert
Qualifications?
Department of Diagnostic and Interventional Radiology, University Hospital
Johann Wolfgang Goethe-University, Frankfurt am Main
Germany

E: T.Vogl@em.uni-frankfurt.de

positioning the X-ray unit in a controlled way, while the radiographer can call or position the patient into a room. Autotracking of either tube or detector bucky helps the radiographer to position the patient in an easier way. The workflow for those flat-panel equipped X-ray rooms can be improved also due to more flexibility in X-ray techniques, including dose reduction possibilities. The trend towards a dose reduction for the patient continues. While formerly for extremity examinations of a 200 speed class was common, the flat-panel technology allows speed classes of 400 and 600 and higher with equivalent image quality.[2]

Practise

Digital imaging provides rapid and improved flow of diagnostic information. Electronic images can potentially be viewed on a screen immediately after acquisition, rather than waiting for a film to be processed. In practice, images are available for viewing less than a minute after they have been taken.

The ability to manipulate a digital image offers a tremendous diagnostic advantage over film. Software on viewing workstations permits the radiologist to utilise zoom for a close-up of specific areas, stacking of images for serial viewing and other benefits. Precise measurement of objects is possible. In addition, clinically important findings can be annotated for clinical and educational purposes. The ability to digitally highlight such findings is helpful for subsequent readers of the image.

Digital radiology software allows simplified comparison of studies; for instance, side-by-side viewing of radiographs taken days, weeks, or even longer before enables the radiologist to quickly notice fine differences in appearance. The number of images that can be stored is limited only by the storage capacity of the archival system. Images stored digitally, with proper backup mechanisms, are much less likely to be misplaced, misfiled, or potentially destroyed; they are easily available to anyone who has proper access to them regardless of time of day or location.[6]

Implications for hospital provision of services

Digital images can be viewed simultaneously at different locations rather than being limited to diagnostic information existing on a single piece of film. This enhances clinical care by permitting multiple care providers to view information that previously existed in only one location on a single film. In addition, consultation and discussion from multiple locations may occur, either from within the hospital or at satellite locations such as remote offices or consultants' homes.

Digital radiology allows remote access to radiographic images. The advent of high-speed networks and the internet have expanded the range of remote viewing to be essentially any place with network and/or internet access.[7] Remote access to images relieves radiologists of the requirement of being physically in the hospital at all times.

The limitations of teleradiology are generally related to the limits of the technology that is used in the process, such as remote access network speed and file size. These limitations are generally minimal with the use of newer technologies. Through the use of teleradiology, even small hospitals can have access to high-quality radiology interpretation on a consistent basis.

Contentious issues

The cost of digital radiology equipment is a major consideration. The initial implementation of an extensive digital radiology system (including workstations, software, networks, and digital archives) requires financial resources and institutional commitment. The major financial benefit of digital systems is due to reduction of film costs and staff. Film costs include processing, handling, storage space, and, of course, the film itself. Information technology and digital radiology system administrators need to be hired, but overall staff needs are reduced because of the elimination of the film library functions and increased productivity of technologists and radiologists.[8]

Another financial justification for digital radiology has been the recovery of charges that were previously unbillable due to misplaced or lost films. Earnings that are otherwise lost from films without a final interpretation have been shown to be a significant source of reimbursement.[9]

There is also a financial benefit due to improvements in risk management and the corresponding reduction in liability costs as well as operational advantages resulting in improved productivity and reduced length of stay, but these issues are dependent on numerous specific organisational changes.

Conclusion

Digital radiology is a technologic advancement that is becoming increasingly more prevalent throughout the world. There are clear benefits in digital technology, including rapid access to images, simultaneous viewing by multiple physicians, and image manipulation, with other exciting advances such as computer-aided diagnosis. However, there are still unanswered challenges to its implementation, with the need to establish quality electronic viewing, reduction of errors, and protection of patient information. Multiple operational questions need to be evaluated and answered. Regardless of the unresolved issues, digital radiology results in numerous benefits for physicians and patients. ■

References

1. Bacher K, et al. Image quality and radiation doses on digital chest imaging: comparison of amorphous silicon and amorphous selenium flat-panel systems. *AJR Am J Roentgenol* 2006;187:630-7.
2. Lehnert T, et al. Variation in X-ray dose quantity using an amorphous selenium based flat-panel detector - a study on the dose reduction rate up to the limit of diagnostical utilization. *Rofo* 2006;178:278-86.
3. Hamer OW, et al. Chest radiography with a flat-panel detector: image quality with dose reduction after copper filtration. *Radiology* 2005;237:691-700.
4. Korner M, et al. Advances in digital radiography: physical principles and system overview. *Radiographics* 2007;27:675-86.
5. Nitrosi A, et al. A filmless radiology department in a fully digital regional hospital: quantitative evaluation of the increased quality and efficiency. *J Digit Imaging* 2007;20:140-8.
6. White FA, et al. Emergency department digital radiography: moving from photos to pixel. *Acad Emerg Med* 2004;11:1213-22.
7. Ruggiero C. Teleradiology: a review. *J Telemed Telecare* 1998;4:25-35.
8. Huang HK, et al. Digital radiology at the University of California Los Angeles: a feasibility study. *J Digit Imaging* 2003;16:70-6.
9. Stiell A, et al. Prevalence of information gaps in the emergency department and the effect on patient outcomes. *CMAJ* 2003;169:1023-8.