Digital from the source

making the most of digital X-ray

Improving communication is a key factor in improving standards of medical care. This is reflected in the work of Prof. Dr. med. Berthold B. Wein, senior radiologist and associate professor of the general radiology department of the University Hospital Aachen (head: Prof. Dr. med. Rolf W. Günther). This is evident in his work with the IHE, an initiative that brings together hospital personnel and healthcare equipment manufacturers to work on optimising standards for the interoperability of digital systems in clinical environments (with a particular focus on DICOM and HL7).

Prof. Dr. med. Berthold B. Wein, University Hospital Aachen

WHO/WHERE

The University Hospital
Aachen, Germany
1000-bed hospital
consisting of 30 clinics
and 21 institutes

Prof. Dr. med. Berthold Wein

CHALLENGE

Improve inter-disciplinary
communication in the clinic

SOLUTION

Digital X-ray throughout
the diagnostic chain with
Philips DigitalDiagnost VR

It is also reflected in the design and development work he has invested in an internet-based system for sampling, logging, sharing and archiving radiological reports in the Aachen University Hospital. Apart from its scientific focus in interventional radiology and magnetic resonance imaging (MRI), Aachen is recognised as a centre of excellence for digital communication and organisation.

As with any system, whether digital or analogue, the quality of the information source plays a vital role in how successful it can be. Only the information from the source can be propagated through the system. Information that is not captured at the source cannot be recreated downstream. So when the opportunity arose to equip an entirely new radiological unit as part of the emergency department, Prof. Wein was keen to have as much high-quality digital equipment as possible. Alongside fluoroscopy, sonography, MRI and computed tomography , there are 3 Philips digital plain X-ray machines, including a DigitalDiagnost VR. It is clear that radiology has an important part to play in the emergency unit, given its role in the diagnosis of poly-

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trauma and out-patients. Before the recent installation, a polytrauma patient had to be stabilized, transport had to be organised and the patient had to be transferred to and afterwards back from the general radiology unit, 7 stories above, for an examination to be made – which meant, among other things, that the stabilization of the patient had to take place without fully understanding the patient's condition. Now the patient can be stabilized on an X-ray Bucky table, and the necessary imaging information is available in parallel. This cooperation with the emergency staff has already reduced the average time for the whole procedure by more than half – from what was previously 2 to 3 hours down to 1 hour – and the goal is to get the time for the combined stabilization and diagnosis under 30 minutes.

"It´s about making good pictures in the best possible way"

Lower dosages

The whole radiology unit is scheduled to go digital in the next year or two, Prof. Wein's overall goal being to completely decouple the making of images from the images themselves, and thus reducing the X-ray dose through the use of higher-sensitivity X-ray sensors. Conventional X-ray film is simultaneously the detection and the documentation medium, and the image can never be better than the original examination. A certain X-ray dosage is necessary to ensure the proper contrast to make the image useful. On the other hand, digital X-ray produces a signal which is displayed independently, which means post-processing is available after the picture has been made. By being able to enhance the contrast and the readability of the image, independently of the dose, the X-ray doses required may be much lower. The Philips DigitalDiagnost VR is a particularly good example, as it has an even higher X-ray sensitivity than other recent digital X-ray machines or conventional film-screen systems, which means X-ray doses of between 1/3 and 1/2 of the conventional dose.

In terms of the result itself, "there is no significant difference between a good digital image and a good conventional X-ray image", according to Prof. Wein. But the image is available more easily, with a lower dose, and the result can be viewed in different ways. For example, examining an area of soft tissue from a full chest X-ray is easily done by windowing, and thus increasing the contrast of the region, to reveal detail that would otherwise be lost as a uniform-looking grey. As Prof. Wein puts it, digital X-ray "is not just about making good pictures, it is about making good pictures in the best possible way".

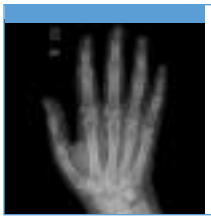
Tuning the image

Given the degree of subjectivity in what makes a good X-ray image, getting the automatic post-processing right is an important part of the system implementation. Obviously, in more extreme cases, manual post-processing of the picture will still be necessary. Prof. Wein estimates that this should be no more than 5% of cases. For the rest, the system configuration should produce highly acceptable results automatically.

There are about 8 different parameters that determine how the signal from the DigitalDiagnost VR is converted to a picture. Adjusting them correctly is a science in itself. According to Prof. Wein, in the ideal case the radiologists will spend a few days with an experienced applications specialist to make most of the adjustments, to get images they feel comfortable with and can work with easily, and to learn the scope of the system. This should be followed by a period of gathering experience using the system under different circumstances, after which the applications specialist should return to fine-tune the operation.

Prof. Wein adds that in terms of expectations "it isn't necessarily meaningful to compare digital with

Used vertically for chest X-ray



"A very popular instrument, because it´s so practical and easy to handle"

conventional X-ray. The resulting documentation of the X-ray radiation, because of the post-processing, is very different than for a conventional image. One can see much more". Getting used to what such a system adds is an important part of getting the most out of it.

Improved communication

After the advantage of more useful images from lower doses, it is the ability to share pictures easily that is the second attraction of digital systems. In Aachen, images from the emergency unit can already be accessed and assessed in the main department, seven stories above. For example, if a junior doctor has a complicated case, he can call a more experienced colleague for advice, who has access to the same pictures. This saves both the doctors, and the patient, the time taken to get to the emergency unit for a consultation at a light box, and minimizes the disturbance to work in the general radiology unit. This type of distribution is due to be extended throughout the hospital soon, which should mean easier, and therefore more frequent and extensive discussions between the radiologists and other clinicians.

Digital images are also more attractive because they are more elegantly archived, organised and retrieved. In a university hospital, the large number of complex cases often means following the course of a treatment, which means retrieving earlier images and images from other modalities, such as sonography or CT for correlation and comparison. Direct retrieval from a digital system makes this quick and easy. This ease of retrieval also makes the digital archive very useful for research and teaching. For example, the reports' database can be searched for specific criteria to gather a large sample of cases in a short amount of time. These can then be used as part of the process of training medical students how to read X-rays.

Digital archiving has also taken the pressure off the handling of physical images. The patients no longer need to carry all their previous X-rays around with them to make sure that everything that should stay together is kept together. Now the existing images can stay on the ward, and it is easier and cheaper to produce a new printout if something gets lost, than it is to control the careful transport of the irreplaceable films.

Adapting and benefitting

Prof. Wein estimates that total cost of ownership of a complete digital X-ray system is lower than a conventional system if it is taken in isolation. Examination times and potential throughput, constant and excellent image quality, and safer, more accurate documentation are amongst some of the benefits to be considered. The adoption of new technology also raises additional considerations. Digital X-ray in Aachen has had to integrate with existing systems and processes. Network capacity is one example where improvements were necessary to cope with the increase in data quantities that digital imaging systems have

Used horizontally for hand X-ray

brought with them. The visual physiology of making findings from a display is another: Most light boxes for examining X-ray pictures use lights with a frequency of over 150 Hz. In comparison, the 84 Hz frequency of a monitor can result in flicker for some, particularly younger, users in rooms with ambient illumination provided by tubes at 50 Hz or 60 Hz – the fluorescent tubes had to be changed for incandescent light in the diagnosis rooms in Aachen.

Prof. Wein also stresses that the process of examining pictures on a display requires some familiarization. For example, when using a magnifying glass with a film X-ray, the full size of the image and the relationship of the part to the whole are constantly apparent. On the other hand, for somebody accustomed to working with film, windowing an image on a computer display requires developing a new sense of the context of what you are looking at and a new awareness of

scale. As with many computer-based processes, the manipulation of the X-ray image using a mouse is also more indirect, and it takes time to achieve the same fluency and comfort that many years of handling films have developed.

"I have been involved in digital evaluation for a longer period", says Prof. Wein, "and it took me around two months to feel fully comfortable. You can enlarge a hand on the monitor, so that a single finger fills the screen. It's wonderful, you can see the trabeculae, but you have never seen them like this before, so you are not sure at the beginning whether the finger is right or wrong. Or hard windowing, which wasn't possible before. All of a sudden you can see blood vessels in the lung in the periphery. Again, at the beginning, you wonder whether it is right or wrong. The benefit is obvious, but it takes a while to develop the feeling for this kind of thing".

Concrete advantages

Though it was not part of the original requirement, the fact that the Philips DigitalDiagnost VR can be used both vertically for chest X-rays, and horizontally, for hand or arm X-rays – or even larger X-rays of small children – was what made the final decision in its favour. The high-sensitivity Caesium-Iodide detector features rod-shaped transmitter needles that bundle the light to the detector and minimize scattering. This increases the DQE by further ensuring the sharpness of the image at lower doses.

During an examination, the Philips DigitalDiagnost VR automatically loads the necessary information from the radiology information system (RIS), performs the necessary pre-collimation, labelling, electronic shuttering and then provides the picture for viewing within seconds. For the radiographers that operate the DigitalDiagnost VR, it is smoother, easier and quicker than other X-ray machines. The lack of film-handling means no more running about the place with heavy cassettes. As well as freeing up time and energy to devote to making the procedure more pleasant for the patient, Prof. Wein has noticed that "the radiographers are definitely more relaxed when they work with the DigitalDiagnost VR. It is a very popular instrument, because it is so practical and easy to handle".

To avoid dependence on a single manufacturer, Philips is one of the two suppliers of radiological equipment used by the department. Prof. Wein appreciates how Philips has been very accommodating over the years, particularly in the grey areas between his expectations as a user, and their more strictly defined contractual obligations as a supplier. Another of Philips advantages is their picture archiving and communication system (PACS), which Prof. Wein rates among the best currently on offer. This currently gathers and handles all of the digital information in the emergency unit, but will be potentially extended to the general radiology unit as it goes digital.

Continuing development

The proven versatility and popularity of the DigitalDiagnost VR makes it an obvious candidate for the changeover to digital in the general radiology unit. The change will also increase the urgency of an extension to the inhouse internet-based system for sharing radiological findings. At the moment this system, which is developed and programmed by Prof. Wein, lets the various wards call up the evaluations from the radiologist, but the pictures are transferred physically. Prof. Wein is currently looking at ways of using Philips EasyWeb to link the digital images to the evaluations.

Prof. Wein foresees that sharing digital images will encourage both the quantity and quality of communication with other departments. While the benefit of a quick, expert radiological opinion should be obvious to other clinicians, the more fluent communication should also help his department to better understand the requirements of other parts of the hospital. By seizing the possibilities of better access to distributed information, and using the time saved by more efficient capture and management, Prof. Wein is applying digital technology to contribute to an altogether more effective delivery of healthcare.

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