Reprinted from DI EUROPE March 2014

A Promise fulfilled...

The story so far.....

Nearly a year ago Diagnostic Imaging Europe had a talk with Dr Theo Diehm, senior pediatric radiologist at the institute of Clinical Radiology and Nuclear Medicine of the University Medical Centre in Mannheim, Germany. At that time, the Institute had just taken delivery of a new system capable of carrying out both fluoroscopy and radiography examinations. Now, several months later we thought that it would be interesting to revisit the Institute and see how things have turned out in practice. Since there is a large number of pediatric cases seen in the Institute, radiation dose is naturally an aspect of importance, so we also wanted to know whether the promise of lower doses had been fulfilled. In fact, the issue of dose is taken so seriously by the team at Mannheim, that they actually carried out a detailed study to objectively evaluate the performance of the new system. We talked to Dr Diehm and his colleagues Dr M Weidner and Prof. K W Neff.

The Institute of Clinical Radiology and Nuclear Medicine is one of 30 individual institutes and clinics making up the University Medical Centre Mannheim (above), which is one of the largest medical research centers in the Rhein-Neckar region of south western Germany.

Q *Hello again, Dr Diehm. Well? How have things been going with the Luminos Agile system since we last spoke? How many patients have you seen - from our last conversation, I guess these are mostly all pediatrics? What about the split between fluoroscopy and radiography? Does the fact that the system can carry out both modalities really help in work-flow planning as you thought it might?*

Dr Diehm: Over the last year, we have examined approximately 6000 pediatric patients with the new system. As we said the last time we spoke, one of the reasons we invested in the new system was the possibility of optimizing the workflow between the radiography and fluoroscopy modalities with a dual-use system. I am happy to say that our expectations in this respect have been borne out in practice. So we did in fact get the advantages of efficient work-flow as well as the advantages of high quality imaging, not to mention the increase in patient convenience.

Q *Any surprises (either positive or negative) now that you've got the practical experience with so many patient cases? When we last spoke there were many features of the new system that you thought could be useful to you. Which have been most useful in practice?*

Dr Diehm: What I personally like best is having the advantages of a bucky table with all its functions incorporated in a fluoroscopy system. And of course having the modern flat detector system with all the benefits associated with that technology.

Q *A year ago you were excited about the possibility of being able to use a flat detector system, which in theory was said to allow lower radiation doses but still result in high quality images. Has this panned out in practice?*

Dr Diehm: As is well known, the issue of radiation dose is currently in the forefront of everyone's thinking. This is all the more important whenever we are dealing with pediatric cases. We attached so much importance to this question that we didn't want to have just a vague, non-quantified feeling about dose and image quality, so in fact two of my colleagues actually carried out a scientific

The use of a phantom enables the generation of objective data concerning image quality. The phantom used in the study at Mannheim was the Primus DL model from IBA Dosimetry GmbH in Schwarzenbruck, Germany.

Despite an almost four-fold reduction in the radiation dose, the quality of the images remained outstanding

study. In this they made an objective comparison of the image quality and required radiation dose using an image intensifier system with a flat detector system. So let me hand over to my colleagues Prof. KW Neff and Dr M Weidner who can explain the method they used and the results they obtained.

Dr Weidner: The aim of the study that we carried out in our pediatric radiology unit was to compare the image contrast, image resolution and radiation dose obtained on the one-hand by an image intensifier-based system with, on the other hand, the same parameters obtained using a solid-state detector-based system. To do this we measured image quality with a phantom with which we were able to measure spatial resolution in line pairs per millimeter (lp/mm). In addition we could measure contrast resolution as well, using a grey scale and eight circular areas on the phantom mimicking tissue of different contrast.

Dose was measured using the dose area product as well as by using an ionization chamber on the surface of the phantom.

In the study, two different modes, one fluoroscopic (20 sec exposure time, 3 pulses per sec, 5 measurements) and one radiographic mode were compared at all possible magnification levels.

All this together meant that we were able to objectively assess the image quality for each system and correlate it with the dose required to achieve this image quality.

Q *The flat detector system that you used was the one incorporated in your new Luminos Agile system ? So how did it turn out in the study?*

Dr Weidner: Before we began our study, we were expecting, and certainly hoping, to see improvements using the new system compared to our old image-intensifier. In practice, the actual results that we measured came out as a big — and positive — surprise. We showed consistently better image quality, particularly in contrast resolution, and this with radiation doses at least four times lower than those we needed with our old image intensifier system.

I can't go into all the details of our results, but the salient points were the following. Image resolution was increased by the solid state detector system in comparison to the image-intensifier system both in the fluoroscopic mode (1.5 lp/mm vs. 1.3 lp/mm) and the radiographic mode (1.9 lp/mm vs. 1.3 lp/mm). Radiation dose was reduced by the solid-state detector system in fluoroscopic mode (0.9 vs. 2.7 mGy, $p<0.0001$) and in radiographic mode (0.4 vs. 2.2 mGy). The same ratio of dose reduction was found when we used the radiation dose/area product method of measurement.

What's more, we know that the performance of all image intensifiers inevitably deteriorates over time, requiring increased dose to maintain image quality. In contrast, the necessary dose and image quality of flat detectors remain much more constant over time. Thus we can have confidence that the improvement in the performance that we saw with the flat detector system will not just be a temporary flash in the pan but will be maintained over a long period.

Q *So what is the overall conclusion you draw from your study?*

Prof. Neff: Simply put, we got better image quality with as little as a quarter of the dose – this really confirms that replacing the older image intensifier equipment with the modern flat detector system was the right decision for us. And this is important not just in pediatrics, where of course image quality and dose are extremely critical for our smallest patients. But it is also true with adult patients. In fact, in all areas of radiology attention is becoming more and more focussed on patient dose — and correctly so.

In contrast to older image intensifier systems, the performance of flat detector systems, such as Siemens Luminos Agile shown above, remains more constant over time. Thus it is expected that the improvement in performance that the Mannheim team measured in their study will be maintained over the long term.

To sum up, based on the experience we have accumulated with the new system and the results of the study we carried out, we have no hesitation at all in recommending the replacement of older image intensifier systems with flat detector technology.

Q *And now back to you, Dr. Diehm, repeating the question we asked you last year, how do you see the future?*

Dr Diehm: Well, it is still true that there will be a certain number of necessary fluoroscopic examinations, particularly in pediatric radiology so the dual functionality of the system will remain an advantage for us. And us my colleagues have already pointed, we all recognise that the question of using as low a dose as possible is not just a temporary fashion phase but will always be a key point in the future.