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Digital Radiography Special Supplement - Making Digital Radiography more Efficient

Results of a Study of Workflow and Dose Reduction

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There is much research and study taking place across Europe to anticipate the advent of the digital hospital. Since imaging is at the heart of medical healthcare services, it makes sense that studies need to take place now, in anticipation of the needs of a fully-electronic imaging department, to ensure that the patient receives the best possible services. 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. In this article, I will present the results of a study that took place with the support of Kodak/Carestream Health, in cooperation with the Centre for Biomedical Engineering (CBME) and the Technical University of Frankfurt.This study examined not only the comparison of the latest CR and DR systems to check which is the best future contender, it also examined what happens to the quality of the image when the dose is reduced. Can we cope equally well with a lower dose?

Progress in Digital Radiography

Digital detectors have come a long way since the initial Digital Subtraction Angiography (DSA) systems in the 1970's, which were rapidly followed by CR in the eighties, DR in the nineties and later on, flat panel technology. 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, amongst others. What this adds up to finally, is improved image management.

CR Vs. DR – Summary

Computed Radiography (CR), uses photo-stimulable phosphor plates to obtain digital images, and can be implemented by updating the cassettes you use in your current x-ray system. Digital Radiography (DR) requires the use of newer x-ray systems with an integrated digital detector. Presently, the latter option is more expensive though it enhances workflow due to the added advantage that it is no longer necessary to handle the cassettes. Thus, while the most common solution is to use CR with mobile systems, there are already mobile x-ray units with an integrated flat panel digital detector on the market using a phosphor plate.

Although digital imaging systems have the potential for dose reduction, the most common outcome is that this dose reduction is not realised, since over-exposure goes undetected, unlike with film where the image turns dark or black. In digital imaging, by contrast, the image becomes clearer when it is over-exposed. Also, there is a tendency to take more images than necessary. Exams levels per patient seem to increase with the use of digital systems. Further, it is very easy to delete images, and technologists tend to repeat exposure if the image is not satisfactory. Thus digital imaging is likely to increase not only the number of exposures but also patient dose.

What's on the Market?

Digital radiography's 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. As well as 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.

The main technology driving CCD-based digital radiography (DR) systems is the CCD cameras themselves. Currently, there are several CCDbased digital x-ray systems available with the primary technological difference between the CCDbased systems being the number of CCD cameras that each system uses. Among those companies opting for the multiple CCD configuration are Swissray, which uses four CCD cameras and Wuestec Medical Inc., which uses two CCD cameras in its current system. Companies that use a single CCD configuration include Nucletron B.V., Imix, Trex Medical and Imaging Dynamics.

Workflow Comparisons

As with any new technology, digital detectors have their disadvantages. Aside from the cost of digital detectors, one must also account for the cost of converting previous records to digital, the inconvenience of learning to use the concept and the fact that this system can produce more images than are actually required. Also, it is the consensus that for digital detectors, higher doses result in a better image quality.

However, we set out to clarify what exactly was the outcome when comparing workflow across three different systems: in conventional film screen systems in daylight processing, CR in a PACS environment and DR in a PACS environment, of which the latter involved the least number of steps in routine workflow.

Creating the Winning Formula: Dose Reduction and Digital Radiography

As noted above, there is a certain consensus that without a higher dose, digital radiography does not perform to its best. Part of our trials involved shattering this myth to clarify whether DR systems are the best future investment option for medical healthcare facilities. This study on the dose reduction rate up to the limit of diagnostic utilisation compared Philips Horizontal Diagnost H, a screen-film system using Kodak/Carestream Health's skeletal insight SC 200/SC 400 and Kodak/Carestream Health's DirectView DR 7100

The three-phase trial was designed to evaluate image quality advantages in digital equipment versus analogue equipment. In phase one, the objective was to do exactly this, using a contrast-detail phantom trial. In phase two we then aimed to evaluate the minimum required dose to obtain acceptable images for diagnostic purposes which was performed on extremities from cadavers and finally we repeated this on 85 patients.

Resolution and Evaluation

A total of eight radiologic technicians worked on the project, examining key areas such as resolution, contrast, articulation and soft tissue areas, to assess whether with DR one could reduce the dose and still achieve an acceptable image. Through the examples we used, we could still ensure a quality image with a relatively low dose per study and no loss of detail. In our research laboratory we then used post-processing steps to fine-tune the images and provide the best detail. With this key step involved, we were able to implement a 50% dose reduction without overall loss of quality.

Conclusion

As this study proved, it is paramount to analyse workflow as otherwise, potential benefits to the workflow may be unrecognised. It is also important to include the patient's needs in the study protocol. It is highly possible to implement DR and using fine tuning to incorporate a significant dose reduction. We are gaining expertise all the time.

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