BY WOLFRAM STILLER

Appropriate image quality of diagnostic imaging procedures: Wishful thinking or concept for ensuring quality and safety?

Ensuring and improving the quality and safety of diagnostic imaging procedures for the benefit of the patients is one of the challenges faced by radiology departments in daily routine, especially in view of the ever-increasing complexity of examinations.

While this is true independent of imaging modality, computed tomography (CT) deserves special attention inasmuch as its application is, on average, associated with the highest radiation exposure to the patients among imaging procedures that require the use of ionising radiation. Currently, CT is one focus of the EuroSafe Imaging campaign, the flagship radiation protection initiative of the European Society of Radiology launched in 2014, which has, among others, the objective of promoting appropriateness in radiological imaging.

With 'appropriateness' being defined as 'the quality or state of being just right for the requirements', achieving an image quality appropriate for a particular radiological examination implies that the quality of the resulting image data has been set to a level just good enough for answering the specific clinical question with high diagnostic accuracy and confidence, but without being excessively 'brilliant'. In view of 'appropriate' CT examinations, in turn this means their acquisition has been performed at the lowest radiation exposure achievable, i.e. resulting in the lowest potential harm to the patients.

Despite being subject to various limitations, several subjective and objective metrics for measuring image quality have been introduced and are currently in use, e.g. for comparing imaging hardware, for quality assurance (QA) and for the optimisation of imaging procedures. However, even when related to the radiation exposure associated with a particular examination, physical image quality measurements are only meaningful in clinical routine if these can be directly related to diagnostic quality of the image data acquired in patients. Therefore, defining 'appropriate image quality' in diagnostic imaging (e.g. CT) is a very challenging task, as robust, clinically meaningful and easy-to-use measurement methods for image quality are still missing to date.

Furthermore, the image quality of actual clinical examinations is influenced by several factors such as patient characteristics (e.g. size, weight, age, etc.) as well as the imaged body region. Consequently, image quality achieved in practice will vary even if examinations are acquired using the same set of parameters, i.e. using the same acquisition protocol resulting in equivalent nominal radiation exposure.

In addition, image quality will also depend on the technical status of the imaging hardware and software employed. For example, CT systems might feature iterative image reconstruction technology, the use of which can significantly alter image data appearance and can be exploited for reducing radiation exposure by adjusting acquisition parameters.

The level of image quality that is deemed 'appropriate' for answering a particular clinical question with high diagnostic accuracy and confidence needs to be specific to each clinical indication. The 'appropriateness' of the image quality of a procedure should therefore only depend on the diagnostic task, while being independent of factors such as patient characteristics or the imaging hardware and software used for the examination.

Since the radiation exposure of imaging procedures employing ionising radiation, e.g. of CT, is required to stay within diagnostic reference levels (DRL), these need to be accounted for by any future concept or metrics with regard to the appropriateness of image quality. This is especially true for clinical DRLs no longer defined by examined body region, but instead specific to particular clinical indications. Work on the definition of clinical DRLs for CT examinations is currently ongoing as part of the EuroSafe Imaging campaign.

While successfully defining criteria for the 'appropriateness' of image quality for each clinical question would ideally result in a technology-independent 'ground truth' for confident and reliable diagnosis, quantitative metrics for easily measuring the 'appropriateness' of image quality based on patient image data are lacking to date. Their development should be part of future research in medical radiation protection, since reproducibly achieving appropriate image quality in clinical routine should be the ultimate goal of every optimisation of imaging procedures. In order to render these efforts for ensuring quality and safety of imaging procedures sustainable, a review process in view of the appropriateness of image quality and, if applicable, the radiation exposure associated with the modality employed should be implemented in clinical routine.

Dr. Wolfram Stiller is a physicist at University Hospital Heidelberg, Germany, dedicated to research in the field of x-ray computed tomography. He is a member of the ESR Radiation Protection Subcommittee and the EuroSafe Imaging Steering Committee.

EuroSafe Imaging Session

Thursday, March 2, 10:30–12:00, Room X

EU 2 Focus on appropriate image quality: what we have to know

Moderators: W. Stiller; Heidelberg/DE
J. Damilakis; Iraklion/GR

- **EuroSafe Imaging on 'appropriate image quality': introduction**
  S.T. Schindera; Aarau/CH
- **Metrics and methods for quantitative image quality determination: a physicist's perspective**
  C. Hoeschen; Magdeburg/DE
- **Balancing diagnostic image quality and radiation exposure in clinical routine: a radiologist's perspective**
  H. Geijer; Örebro/SE
- **Image quality assessment via model observers: connecting objective and subjective perspectives**
  F.R. Verdun; Lausanne/CH
- **Implementing a review process on image quality: experiences from a EuroSafe Imaging Star**
  F. Deferme; Antwerp/BE

This session is part of the EuroSafe Imaging campaign.