Upcoming publication of ICRP on “Managing Patient dose in multi-detector computed tomography”

In 2000, ICRP published a report on “Managing Patient Dose in Computed Tomography” (ICRP Publication 87). At that time there was an urgent need to focus the attention of radiologists, physicians, medical physicists and other personnel involved in CT on the relatively higher doses to organs in individual patients, increasing frequency of CT examinations, changes in clinical applications and the increasing contribution of CT to the collective dose. Further, the technology in use dominantly utilized a single row of detectors (SDCT), permitting scanning of only a single slice at a time in either a discrete (sequential acquisition) or continuous fashion (spiral acquisition). Multiple detector rows along the z-axis (longitudinal axis of the patient, i.e. head to toe) permit simultaneous scanning of more than one slice. MDCT was in its infancy at the time of the 2000 report and thus there was brief mention in the report of its impact on radiation dose. The concrete data and experience was insufficient to make any judgement. In the following years there has been a phenomenal increase in use of MDCT and technology has been advancing very rapidly to move from 4 slice to 8, 16, 32, 40 and 64-slice. The improved speed of MDCT scanning has also meant new applications (cardiac CT, whole body scanning) as well as improved patient throughput and workflow.

In 2005, the Commission realized that essentially all new CT systems are MDCT, and that a number of new dose reduction tools have become available commercially. Thus, to address these new tools, continued growth in CT applications, and the consequent growth in the contribution of CT to medical collective doses, it was decided to update ICRP publication number 87. In addition to reviewing these technology changes in CT, a number of issues have been addressed, such as:

- Has MDCT caused an increase or decrease in patient doses?
- In cases where patient doses have increased, why is this so?
- How does new technology contribute to dose minimization?
- What actions are needed by the scanner operator?
- Are there specific educational actions still required?
The main summary points of the upcoming report are:

Modern generations of CT scanners employ multiple rows of detector arrays allowing rapid scanning and wider scan coverage.

All new CT systems are MDCT with single or dual x-ray source, and a number of new dose reduction tools have become available commercially.

There are a number of new parameters specific to MDCT that systematically increase or decrease patient dose compared to single-detector row CT scanners (SDCT).

Initial reports after the introduction of MDCT indicated increased patient doses relative to SDCT; more recent reports show comparable or decreased patient doses.

If the user selects settings identical to those used in SDCT, there can be an increase in patient dose. Settings must be determined appropriate to specific scanner model.

With emergence of cardiac MDCT applications, many cardiologists have also become primary users of MDCT scanners. Commission recommends appropriate training in radiation protection for cardiologists.

As with earlier stages of CT technology, there is potential for dose reduction, but the actual dose reduction depends upon how the system is used.

It is important that radiologist, cardiologists, medical physicists and CT system operators understand the relationship between patient dose and image quality and be aware that often image quality in CT is greater than that needed for diagnostic confidence.

It must be remembered that appealing pictures are not essential for all diagnostic tasks, but rather a level of quality will need to be chosen – whether low noise, medium, or low dose - dependent on the diagnostic task.

Objective measures such as image noise or contrast-to-noise ratio may not completely capture all of the features relevant to making a correct clinical diagnosis. Thus, determining “optimal” image quality can be a complex task, as both quantitative metrics (e.g., noise) and observer perceptions are involved.

There are indications that awareness on adapting exposure factors to manage patient dose is increasing, but the rate at which technology is changing may overtakes adoption of effective dose management.
Automatic exposure control (AEC) systems do not reduce patient dose per se, but enable scan protocols to be prescribed using measures related to image quality. If the image quality is appropriately specified by the user, and suited to the clinical task, then there is a reduction in patient dose for all but the obese patient. In obese patients, the dose is increased to improve the image quality.

AEC does not imply total freedom from operator selection of scan parameters. Be aware about your system. While CT systems without AEC require operator selection of mA or mAs, AEC systems require understanding of newer concepts such as noise index, reference mAs and reference images in order for AEC to be operated effectively. Understanding of some parameters, like the standard deviation of image pixels or a noise index, is not intuitive and entails the opportunity for error.

The selection of image quality parameters in AEC systems is not a straightforward process. There is lack of consensus on how image quality is to be specified with the result that there are significant differences in the ways different companies achieve exposure control. It is important that users are aware of the behaviour of their system.

Justification of CT use is a shared responsibility between requesting clinicians and radiologists. It includes justification of the CT study for a given indication and classification of clinical indications into those requiring standard dose CT and those for which information can be obtained with low dose CT.

Scanning parameters should be based on study indication, patient size and body region being scanned so that radiation dose can be adapted based on these parameters.

Guidelines must be set so that inappropriate studies can be avoided. Studies of questionable value should be triaged to non-radiation based imaging technique, when appropriate.

Training of requesting physicians and CT staff can help in the optimization of scan indications, protocols and radiation dose.