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Optimisation of Radiological Protection in Digital Radiology Techniques for Medical Imaging

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Mandate

The increased use of imaging in the management of medical patients means that optimisation of radiological protection aspects has become more important. Radiation doses from medical applications make up a significant component of the radiation dose received by populations around the globe. The core principles of optimisation of radiological protection relating to clinical images are:

1. the images should be of sufficient quality to ensure an accurate and reliable diagnosis, and enable correct clinical decisions to be made, and
2. the radiation doses used to achieve the images should have been adjusted to the minimum level required to provide an adequate image.

The move to digital imaging has enabled versatile image acquisition and presentation with options that adjust for optimal viewing. This means that the appearance of an image is unlikely to give any indication if the dose is high. The aim of TG108 is to prepare guidance on optimisation of radiological protection in digital radiology. Two reports have been prepared, the first on the approach to optimisation and the second on practical aspects linked to different modalities.

The Components of Optimisation in Digital Radiology

Several components that contribute to successful implementation of optimisation of protection in radiology need to be developed. They each play a role either in ensuring the expertise that is available is fully utilised or that tasks are performed.

1. **Professionalism:** Collaboration between radiologists/ clinicians, radiographers, and medical physicists (the 'core team'). The different professionals will contribute to the process more effectively when individuals work together as a team and respect each other's unique expertise and distinct roles.
2. **Methodology:** Appropriate methodologies and technologies to assess performance in relation to the clinical task, with the knowledge and experience required to use each effectively and interpret the results.
3. **Processes:** Organisational processes that ensure required tasks, such as tests of equipment performance, patient dose surveys, setting DRLs, and reviews of protocols are carried out regularly.

Levels of Optimisation

There are wide ranges in equipment, funding, and imaging expertise around the world, and most facilities do not have all the tools, nor the professional expertise to fully embrace all the possibilities for optimisation of radiological protection. Therefore, broad levels of performance are set out in the report, through which each centre can potentially progress incrementally. These levels are described as D: Preliminary, C: Basic, B: Intermediate, and A: Advanced (figure 1).

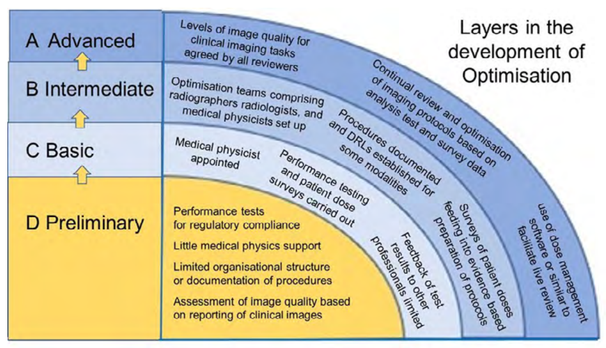

Fig 1. Illustration of layers linked to resources and activities that would be added as optimisation is implemented within a radiology department. Imaging facilities can use the report to guide decisions about the next actions to take in optimising their imaging services as they add layers to enable them to move up through the hierarchy D to A.

Analysis of Patient Dose and Image Quality

The choice of exposure factors influences both dose and image quality and depends on the patient, the clinical question, the examination, the equipment used to image the patient, the operator and the person interpreting the image. These factor should be monitored and controlled under a quality management system (figure 2). Knowledge of the doses delivered to patients by imaging is gained through surveys of doses to real patients and is essential in the development of a dose management strategy. The results of patient dose surveys can be audited by comparison against the Diagnostic Reference Level (DRL). Dose data can be retrieved from radiology information systems or patient exposure monitoring systems and this enables data for large numbers of patients to be collected in surveys for auditing and setting DRLs (ICRP, 2017).

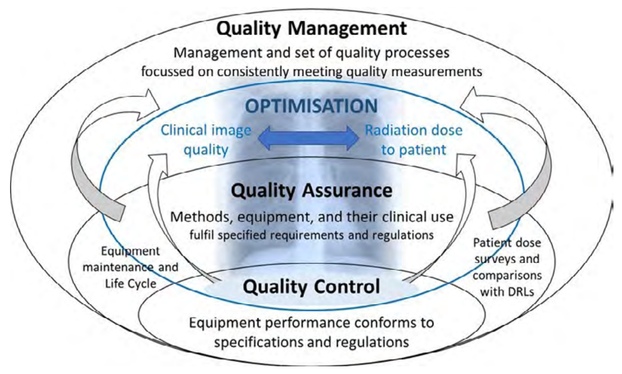

Fig 2. Processes and tasks for optimisation within a quality system

The image quality in medical imaging relates to the capability of providing anatomical or functional information to informscare decisions. Basic image quality , characterised by contrast, resolution and noise , is assessed through QC tests. Subjective evaluation of clinical image quality by radiological medical practitioners forms part of the routine self-assessment process included in QA programmes. Anthropomorphic phantoms can be used in protocol optimisation using arrangements that mimic the clinical setup. Artificial intelligence is likely to provide versatile methods for a range of optimisation related tasks in the future.

Staffing Level, Training and Education of Staff

The key elements in running a radiology imaging service are having the appropriate equipment and trained staff running the service. Therefore, the staffing level must be adequate and all staff, i.e., radiographers, radiologists and other radiological medical practitioners, and medical physicists, need to have the knowledge, skills, and competencies to contribute effectively to the work of the optimisation team. Imaging staff should have undertaken appropriate university or college education, training and certification, but training should continue throughout their working life with a commitment to continuous professional development. Training programmes can be provided by professional societies, educational institutions, vendors of imaging equipment , and web-based packages provide useful additions.

Publication of ICRP Reports on Optimisation

The first report on the general principles of optimisation that apply to all digital radiology equipment has been approved and is currently being prepared for publication (ICRP, 2023). A second ICRP report, which deals with the individual digital radiology imaging modalities, radiography, fluoroscopy and CT, considers imaging of paediatric patients and pregnant patients, and builds on information provided in earlier modality specific ICRP publications, Is in the final stages of preparation.