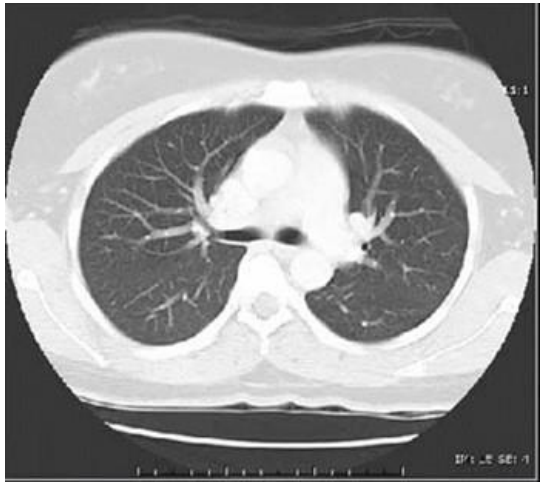
Overview of TG108 Report: Components to establish a successful optimisation programme

Dr Colin J Martin
University of Glasgow, Scotland, UK
ICRP Committee 3 on Protection in Medicine

ICRP

University of Glasgow

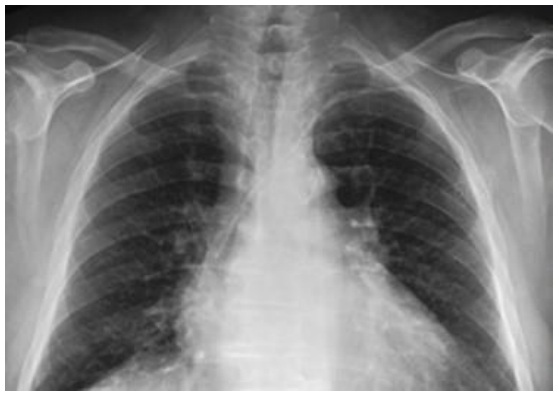
Components to establish a successful optimisation programme



Principles of optimisation

The process of optimisation

- Professional skills and collaboration
- Methodology and technology
- Organisational processes



Levels of optimisation that facilities can achieve

Challenges of digital radiology

Report on x-ray modalities to follow

Importance of training

Core Principles of Optimisation
of clinical images for individual patients

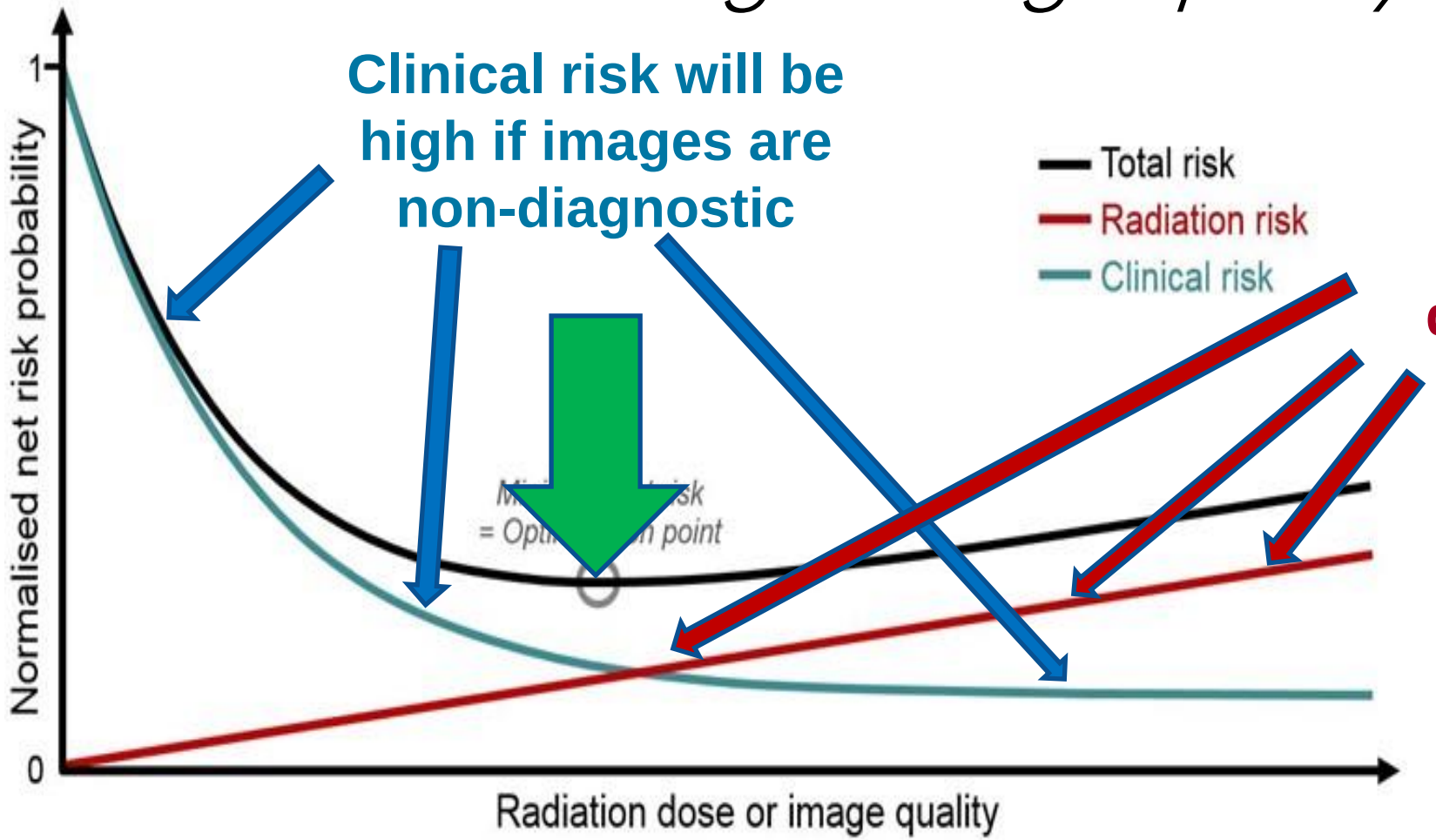
Images should be of sufficient quality to ensure an accurate and reliable diagnosis, and enable correct clinical decisions to be made

The radiation doses used to achieve the images should have been adjusted to the minimum level required to provide an adequate image

Risks in a radiological examination

Many dose savings can be made without affecting image quality

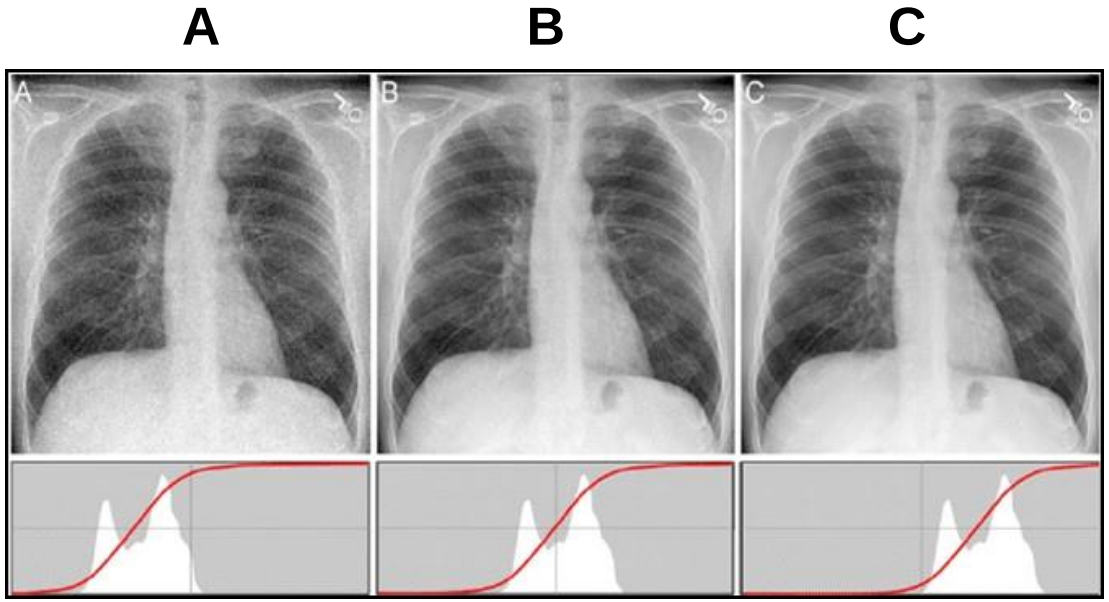
Don't forget image quality



Challenge with Digital Radiology

- The appearance of the image is adjusted to give an acceptable range of grey levels for optimal viewing.
- The superficial appearance gives little indication of the exposure.
- We need to ensure that patient dose and image quality are acceptable

A. Underexposure
B. Optimal
C. Overexposure



Seibert, J. A. and R. L. Morin (2011). Pediatr Radiol **41**(5): 573-581.

Two levels of optimisation

Regular review of every aspect of the imaging process is key to the successful achievement of optimisation.

1) The design and construction of the equipment and installation
2) The day-to-day working procedures performed by the staff involved

Optimisation will only occur if:

1) All staff are properly trained in their roles
2) Equipment operation is ensured through a comprehensive QA programme
3) There is ongoing monitoring, review, and analysis of performance
4) This feeds back into continual development of protocols.

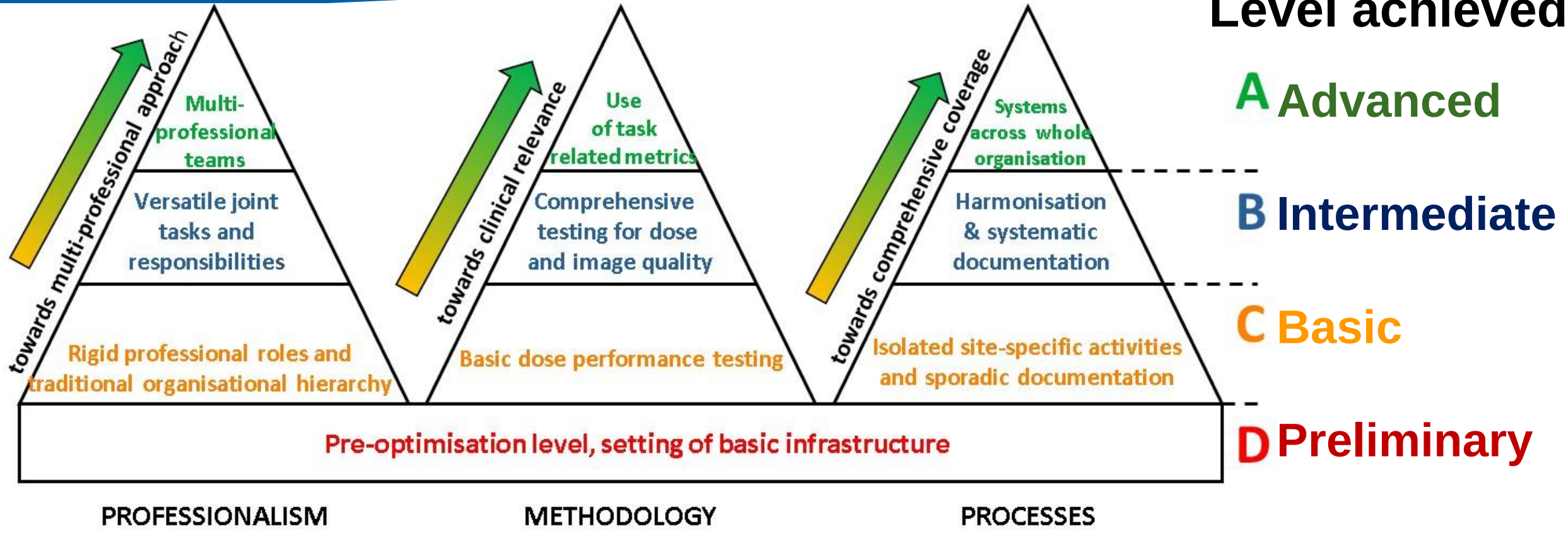
How do we achieve effective optimisation?

Several different components are needed in hospital systems:

- **Professional skills and collaboration:** Radiologists, radiographers, and medical physicists working together
- **Methodology and technology:** Measurement of performance and evidence based preparation of protocols
- **Organisational processes:** Documented arrangements for equipment testing and dose audit, and established links for implementation and monitoring of optimisation

All require facilities, training, and time to develop the experience, structure and organisation

Components required to achieve optimisation



Within each component, levels of performance achieved will vary in different organisations.

Levels of Optimisation

The degree to which an organisation has implemented optimisation will depend on the, equipment, facilities, funding, personnel, and level of knowledge and experience available.

The Report sets out broad categories within the different aspects for the systems that would be in place to achieve different levels of optimisation

D: Preliminary (level for those setting up facility)

C: Basic

B: Intermediate

A: Advanced

We recommend that managers and staff of imaging facilities use the document

1. To assess the level they have achieved
2. To guide their decisions about the next step to take as they continue actions to optimise

Radiological professionals working together

C. Basic: Radiologists, radiographers, and medical physicists perform roles separately and independently of each other.

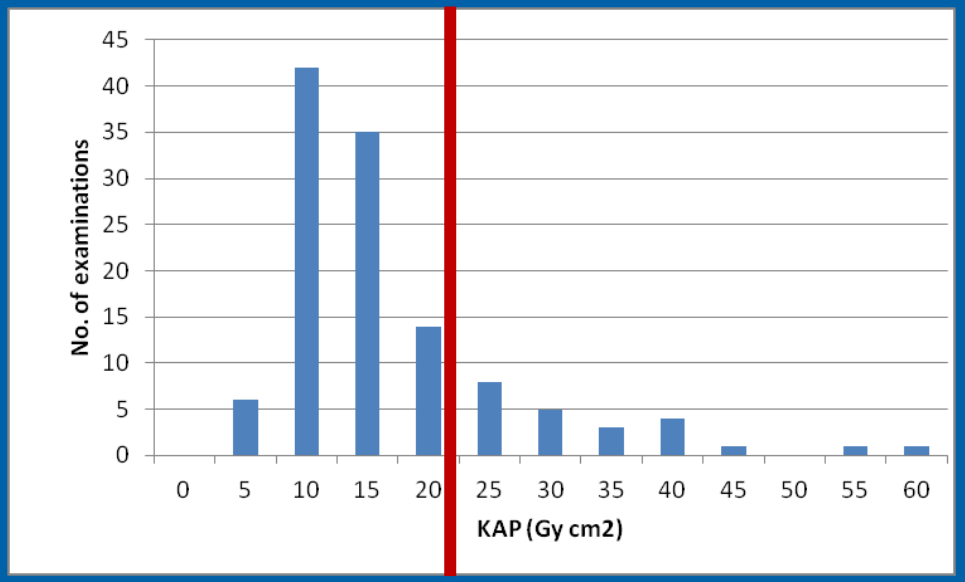
Establishing Diagnostic Reference Levels (DRLs) is involved in move from level C to B.

B. Intermediate: Optimisation Teams comprising radiographers, radiologists, and medical physicists established.

Comparison of dose survey results with DRLs, followed by review and optimisation of protocols for some modalities

A. Advanced: The whole Optimisation Team is involved in regular review of clinical protocols for all modalities.

Patient dose audits



- Knowledge of the doses delivered to patients is the first step in the optimisation process and personnel involved in performing the exams should have ownership or involvement in the process of dose audit.
- A multi-disciplinary team approach helps to ensure that results of dose surveys are fed back to operators who make changes that are needed

Methodology to achieve optimisation

C. Basic: Radiological evaluation of image quality

X-ray equipment performance testing and calibration

Initial surveys of patient doses

⬇ ⬇ ⬇

B. Intermediate: Patient dose audit – comparing results with DRLs

Evidence based preparation of protocols and choice of exposure factors

⬇ ⬇ ⬇

A. Advanced: Analysis and evaluation of radiological images by professional team

Improving protocols based on experience and comparison with benchmarks by regular review

Measurement of image quality replicating clinical tasks

Processes that are in place

C. Basic: Ad hoc arrangements for equipment testing & dose audit
Protocols based on local experience
Limited documentation of procedures

⬇ ⬇ ⬇

B. Intermediate: Documented arrangements for testing & dose audit
Quality system for periodic dose surveys and review of DRLs
Evidence based clinical protocols under regular review

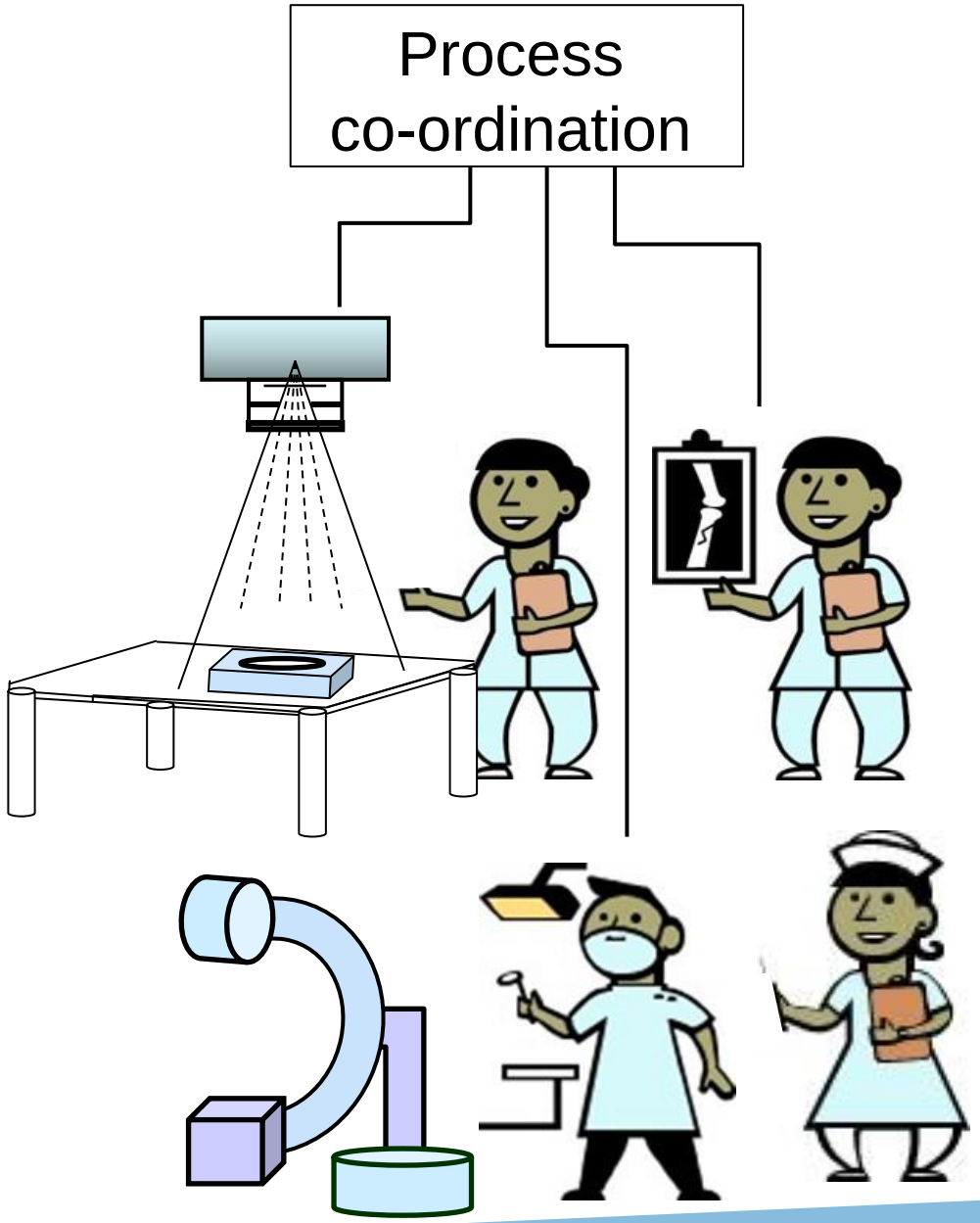
⬇ ⬇ ⬇

A. Advanced: Systems for establishing clinical protocols, performance testing, dose surveys, etc. applied across whole organisation and monitored through quality system

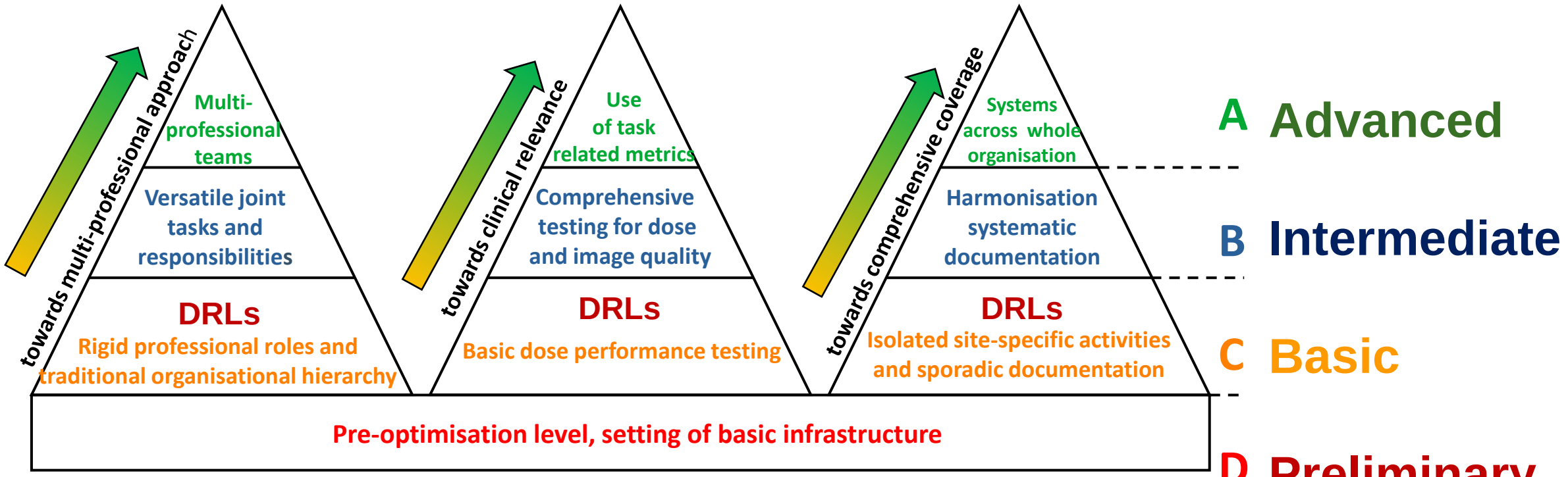
Continual live review and optimisation of imaging protocols

Requirements for Optimisation

- Team of multi-professional skills
- Evaluation of equipment performance - utilising parameters that are relevant to clinical use
- Evaluation and integration through organisation-wide processes to ensure:
  - Monitoring of performance and patient dose are carried out
  - Results of monitoring are used in improving optimisation.



Including DRLs and image quality in Optimisation Strategy



PROFESSIONALISM

Optimisation team closes audit loop; acting on results of audit against DRLs by adjusting exam parameters or protocols, taking account of clinical image quality

METHODOLOGY

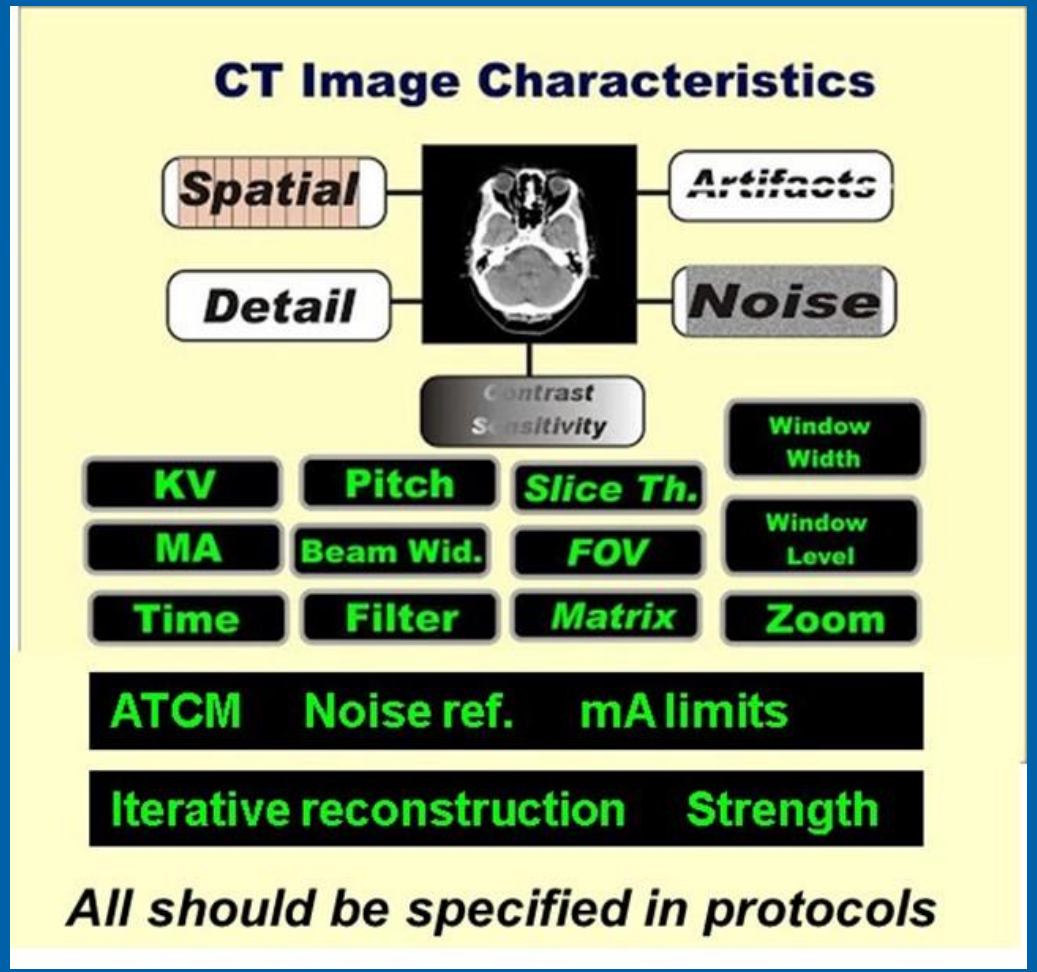
Patient dose audit results compared with DRLs and equipment testing data

PROCESSES

System for regular dose audit included in procedures

Requirement for optimisation

Digital X-ray Technology



- Digital x-ray equipment is becoming more complex
- Features allow dose levels to be reduced significantly without compromising image quality
- Patient doses could be unnecessarily high if wrong settings are used, with staff being unaware that anything is amiss

Operation of digital x-ray equipment

- Successful operation of digital x-ray equipment requires high levels of knowledge and skill from clinicians, radiographers and medical physicists.
- Settings should be agreed by members of the multi-professional imaging team and documented in protocols
- All members of the team must be given the necessary expertise through training and experience
- Training must be updated regularly, so everyone fully understands equipment operation

ICRP Task Group 108

Optimisation of radiological protection in digital radiology

Report 1 **Optimisation of Radiological Protection in Digital Radiology Techniques for Medical Imaging**

C. J. Martin, K. Applegate, I. Hernandez-Giron, D. Husseiny, M. Kortesniemi, M. Del Rosario Perez, D.G. Sutton, J. Vassileva

Out for public consultation at www.ICRP.org until 28th October 2022

Report 2 **Practical Aspects in Optimisation of Radiological Protection in Digital Radiography, Fluoroscopy, and CT**

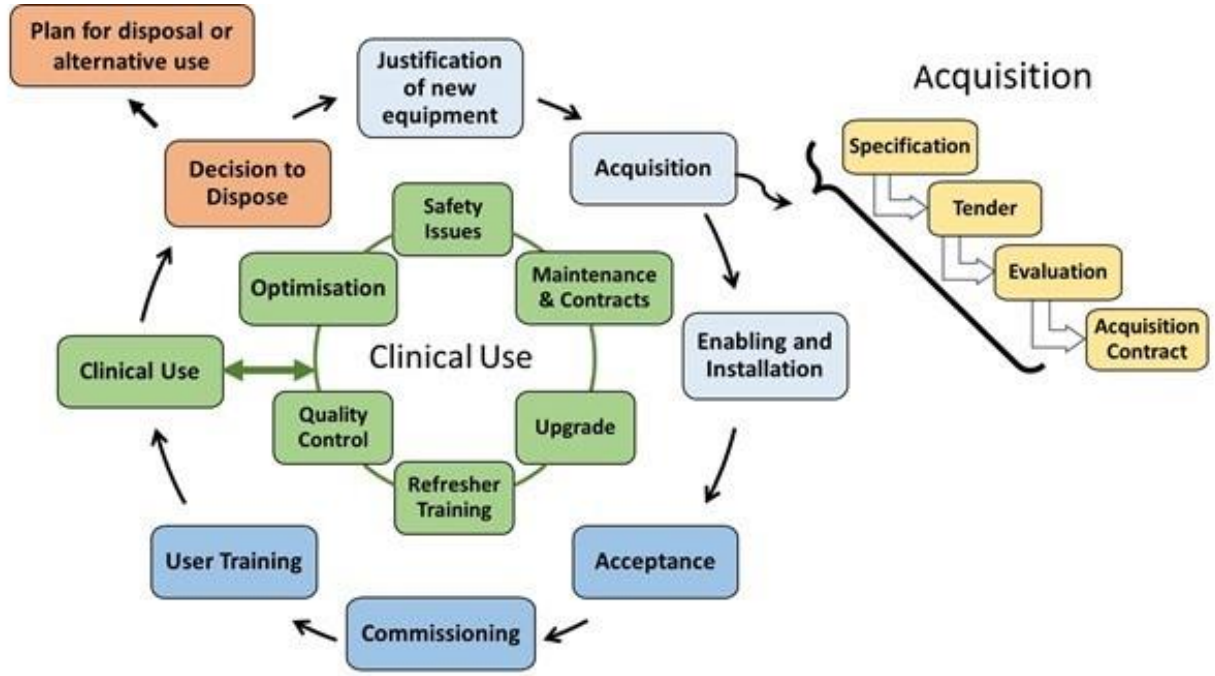
C. J. Martin, K. Applegate, J. Damilakis, I. Hernandez-Giron, M. Kortesniemi, H. Khoury, K.H. Ng, D. Pekarovic, D.G. Sutton, J. Vassileva

Public consultation late 2022 or early 2023

Report 1: Optimisation of Radiological Protection in Digital Radiology Techniques for Medical Imaging

- The installation and equipment life-cycle
- The optimisation process
- Analyses of patient dose
- Evaluation of image quality
- Training of clinical staff

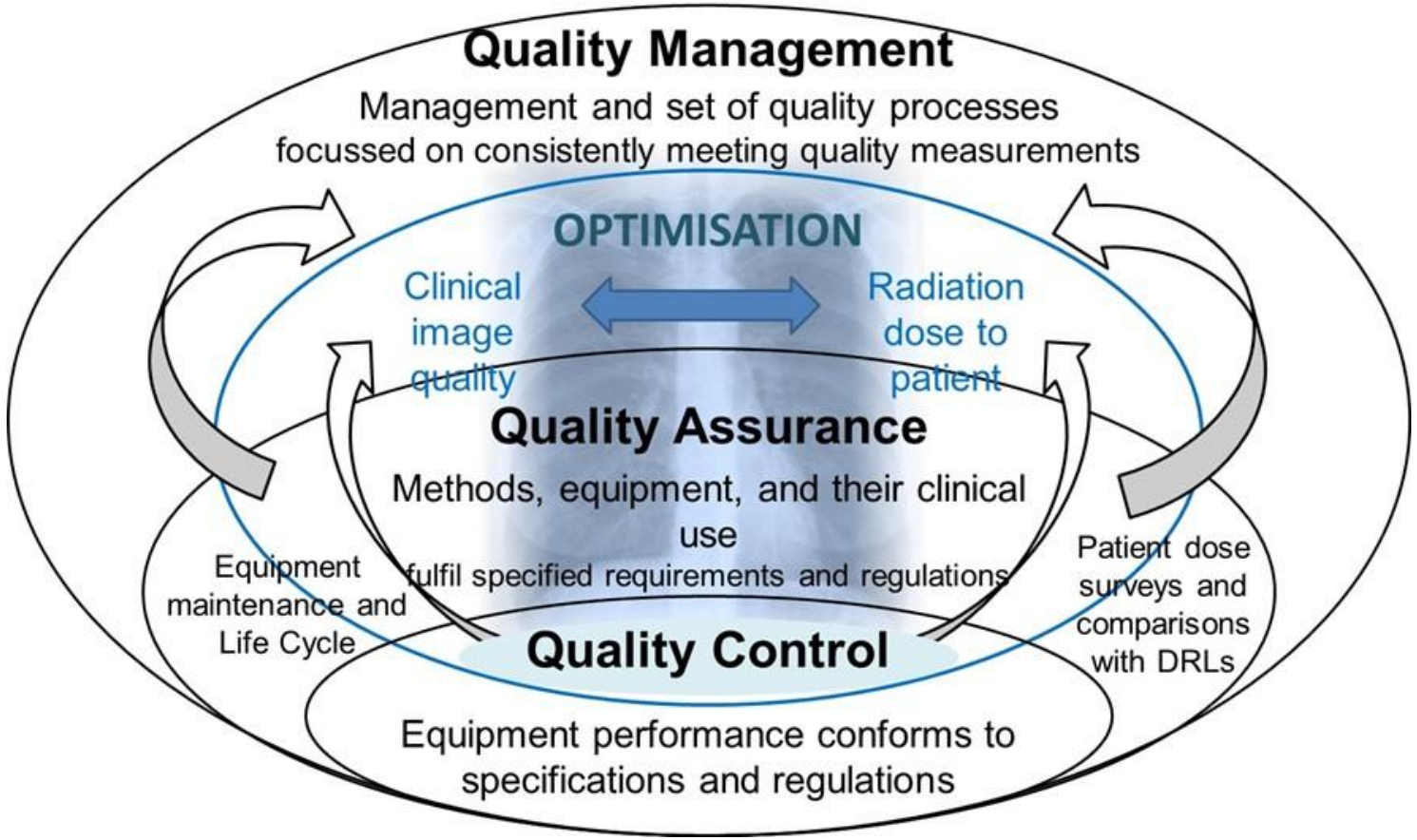
- Commissioning and user training on new equipment are crucial stages
- Regular review of protocols taking account of dose and imaging performance are key to achieving optimisation



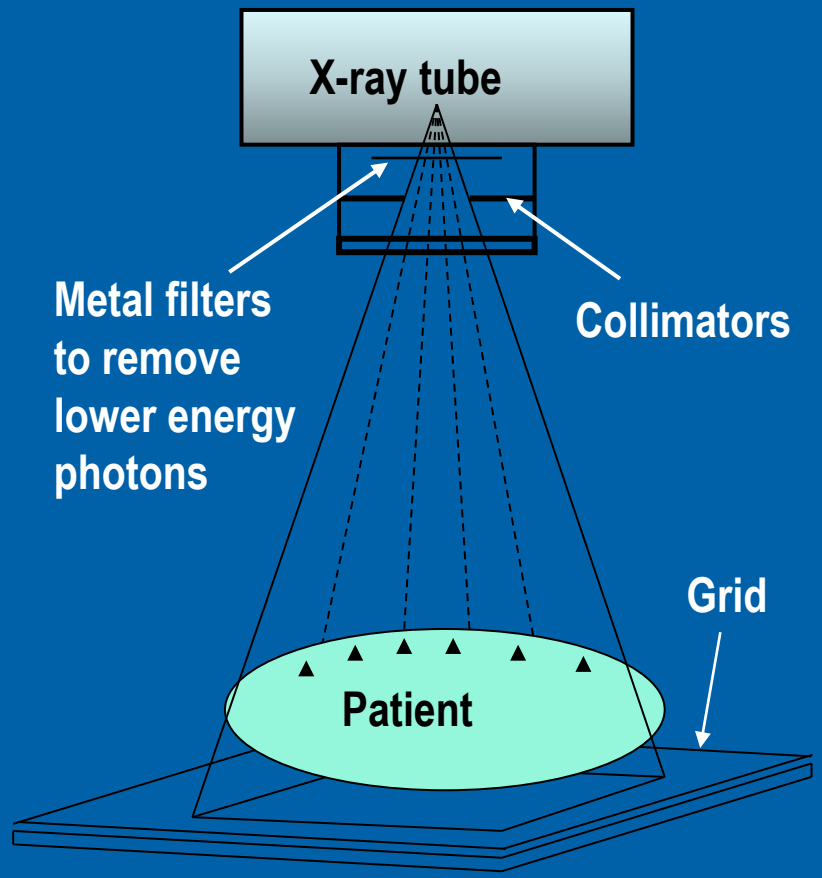
Report 2: Practical Aspects in Optimisation of Radiological Protection in Digital Radiography, Fluoroscopy, and CT

- Digital radiography
- Interventional and fluoroscopy procedures
- Computed tomography
- Paediatric procedures
- Pregnant patients

Optimisation of techniques for different radiology modalities



Digital Radiography



- Establish **appropriate kV and mAs values** for different examinations, patient characteristics, and clinical questions
- **Calibrate automatic exposure control (AEC)** devices to suit characteristics of the detector.
- **Collimate** the x-ray beam
- **Monitor the exposure index** and compare readings with target values to check exposure levels

Fluoroscopically Guided Procedures

- **Design features** should be **tailored to the clinical tasks** and required level of image quality
- **Exposure factor programmes** should be **set up during commissioning** with the vendor's representative and clinical staff
- **QC programmes** should evaluate performance of all exposure modes to aid selection of appropriate options

Multi-detector Computed Tomography

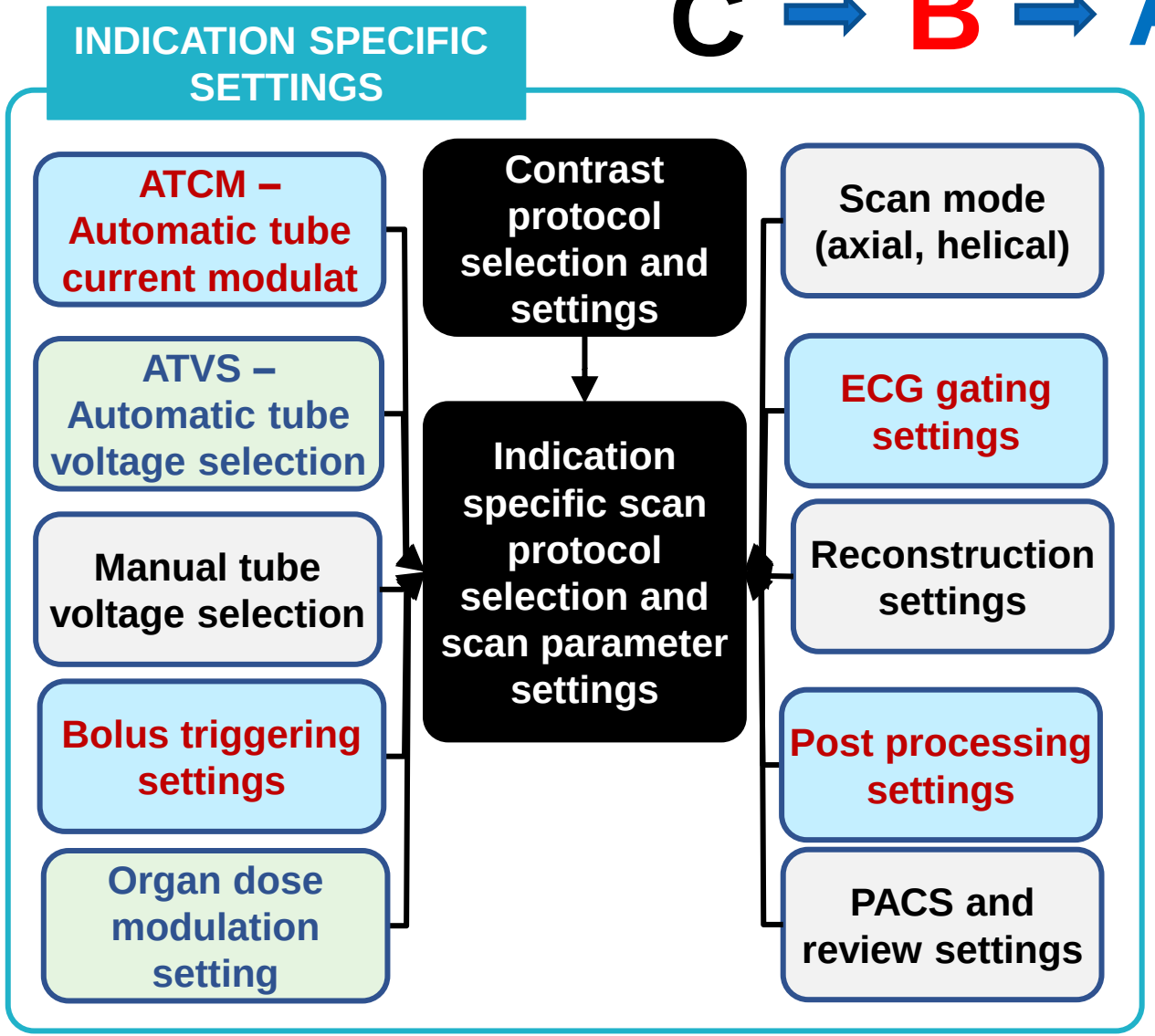
- Appropriate **selection of scanning parameters**, e.g. using 100 kV with iodine contrast for smaller patients
- Image reconstruction methods and **use of iterative reconstruction**
- Use of **Automatic Tube Current Modulation** to adjust for differences in x-ray attenuation
- **Settings agreed by radiology team** and established when a CT scanner is installed and commissioned.
- **Protocols** should be developed with input from tests and clinical performance and **reviewed regularly by the team**

Development of facilities and experience

Facilities will be able to implement more CT features available as they move through the levels of optimisation and gain more expertise

Examples of CT features that might be implemented at different optimisation levels

C ➡ B ➡ A



Requirements to achieve optimisation

- Optimisation depends on the equipment itself and the people with the knowledge and experience to make proper use of the equipment.
- Failure to adjust imaging protocols to patient size or to the clinical question, can result in unnecessarily high (or low) doses or poor image quality

Two important aspects are:

Proper training of operators, investment in training ensures:

- Staff understand and are familiar with new technology and appropriate settings.
- Staff are able to fine tune equipment settings to achieve better results

Ongoing monitoring, review and analysis

- Ensures that performance levels are maintained and improved

Message to take forward

- Consider the different aspects involved in the optimisation process and identify those needing improvement in your facility
  - Professionalism – Team work
  - Methodology – Equipment performance, testing methods, and dose audit
  - Processes – Harmonisation, documentation, quality systems that trigger actions
- Radiologists, radiographers and medical physicists should work together as a team. Each should feed in results from their practice and measurements to continually develop, improve and optimise protocols
- Patient dose audit is an essential tool, but so are checks on image quality. Do not reduce dose to a level that affects the diagnostic quality of images
- Make optimisation of protocols a continual process that is part of imaging

I acknowledge contributions from the members of

ICRP Task Group 108

Kimberly Applegate
John Damilakis
Irene Hernandez-Giron
Dina Husseiny
Mika Kortesniemi
Helen Khoury
Kwan Hoong Ng
Maria Perez
David Sutton
Jenia Vassileva

Thank you for your attention

www.ICRP.org