TG 108: Equipment Life Cycle & Patient Dosimetry

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Optimisation

Optimisation is hard to pin down - but is the key to protection.

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

Major Factors

The design, specification and installation of the equipment

The day-to-day working procedures performed by the staff involved

Optimisation most likely if:

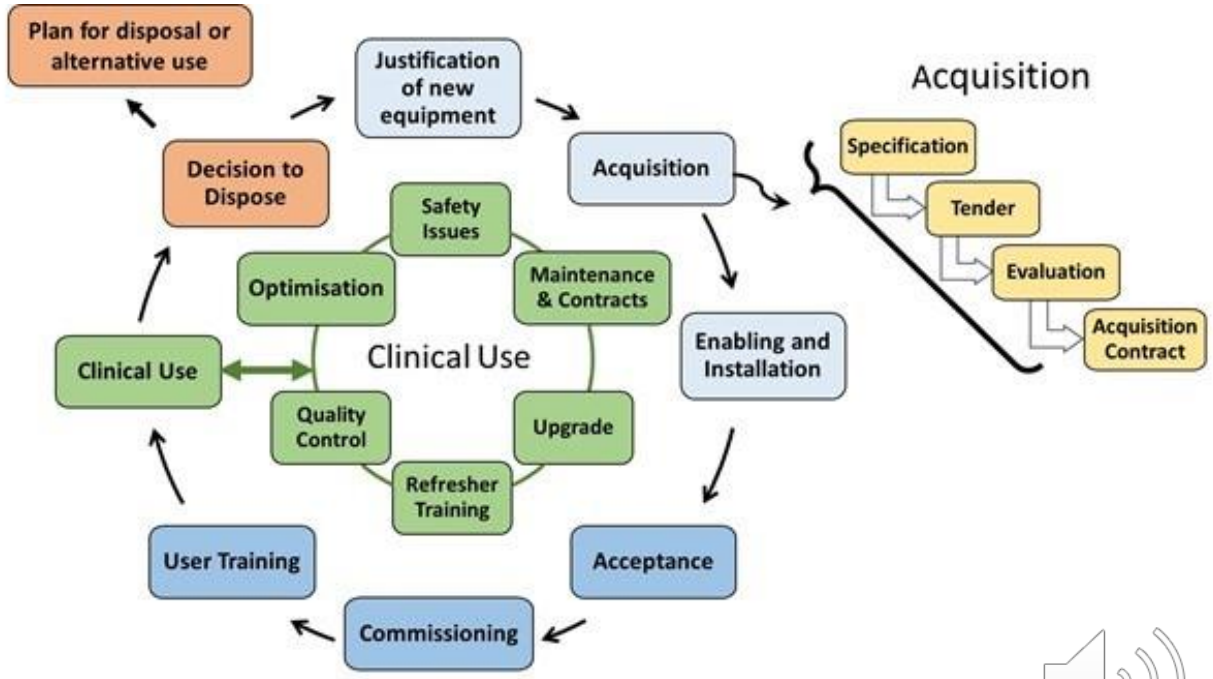
1) Radiologists, radiographers, and medical physicists work together
2) All staff are properly trained in their roles
3) Equipment operation is assured through a comprehensive QA programme
4) There is ongoing monitoring, review, and analysis of performance that feeds back into continual development of protocols.

Optimisation

Life Cycle

- Justification
- Acquisition
- Installation
- Acceptance and Commissioning
- User Training
- Clinical Use
- Disposal

- Optimisation is a continual process and is inextricably bound up with the minutiae of the imaging equipment life cycle.
- Each element of the life cycle contributes to successful optimisation and is discussed in the report.



Optimisation

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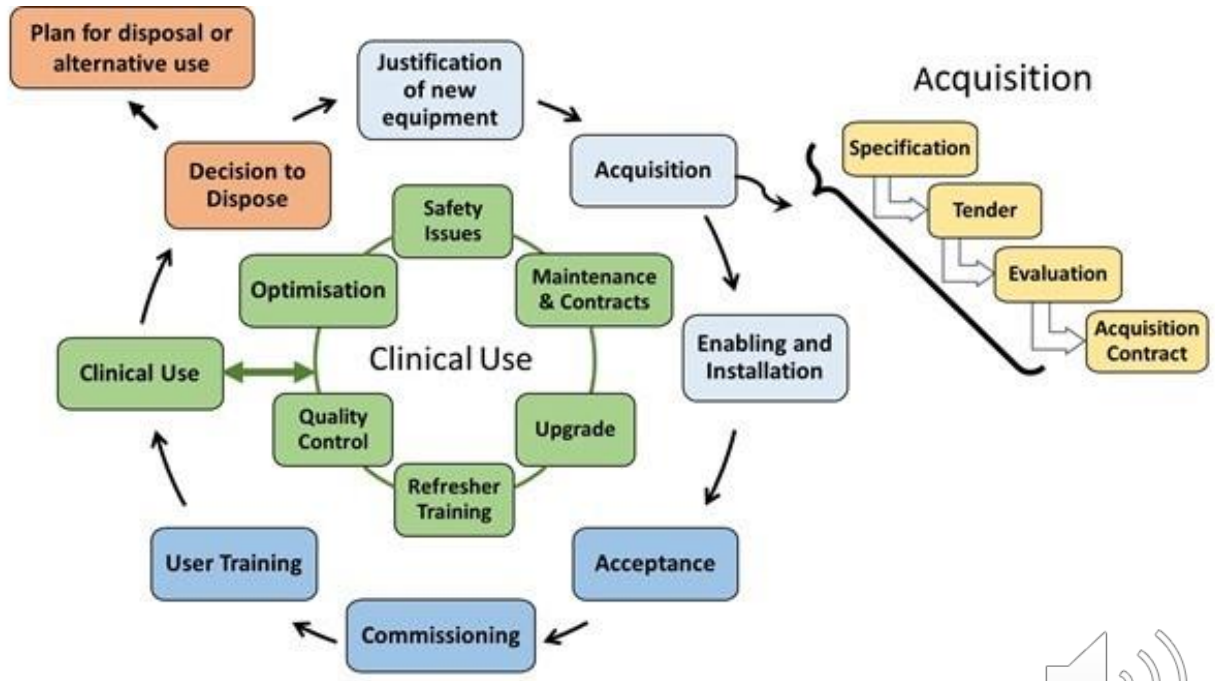
- The procurement of all medical imaging equipment needs to be justified, both in terms of clinical need and radiation dose.
- Justification should be evidence driven and take into account present and future clinical applications and revisions of workflow whilst ensuring that there is no unnecessary proliferation of equipment.



Optimisation :

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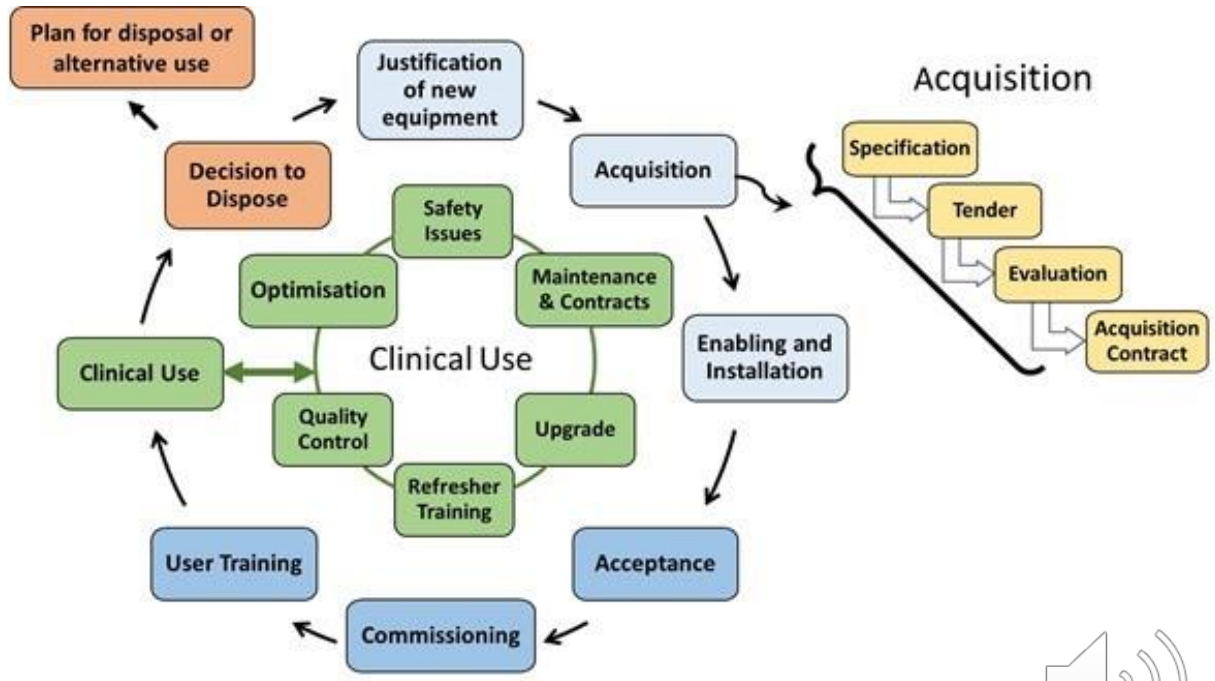
- It is essential that a full performance specification of the entire system is established before any purchases are made.
- The performance specification should include consideration of the intended clinical use of the equipment and also technical requirements relating to patient dose and image quality.



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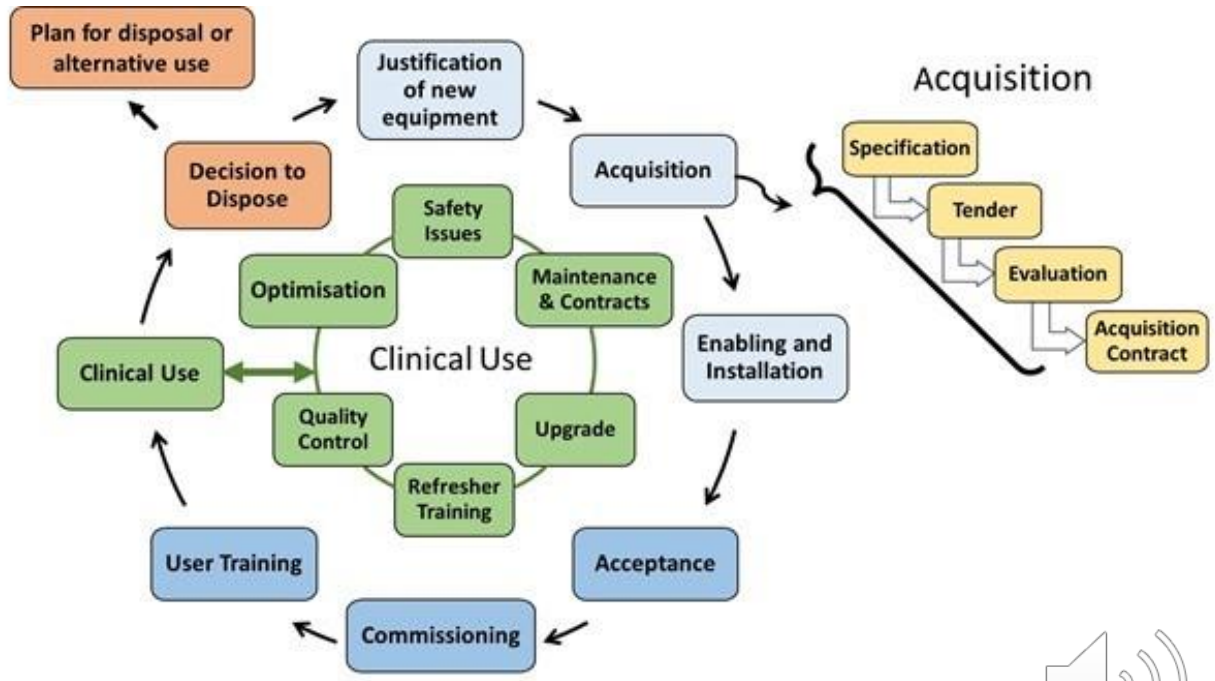
- Planning and construction of the x-ray room, protection, electrical and other services all need to be prepared beforehand, and consideration given to facilitating the appropriate movement of the patient and positioning of the attending staff



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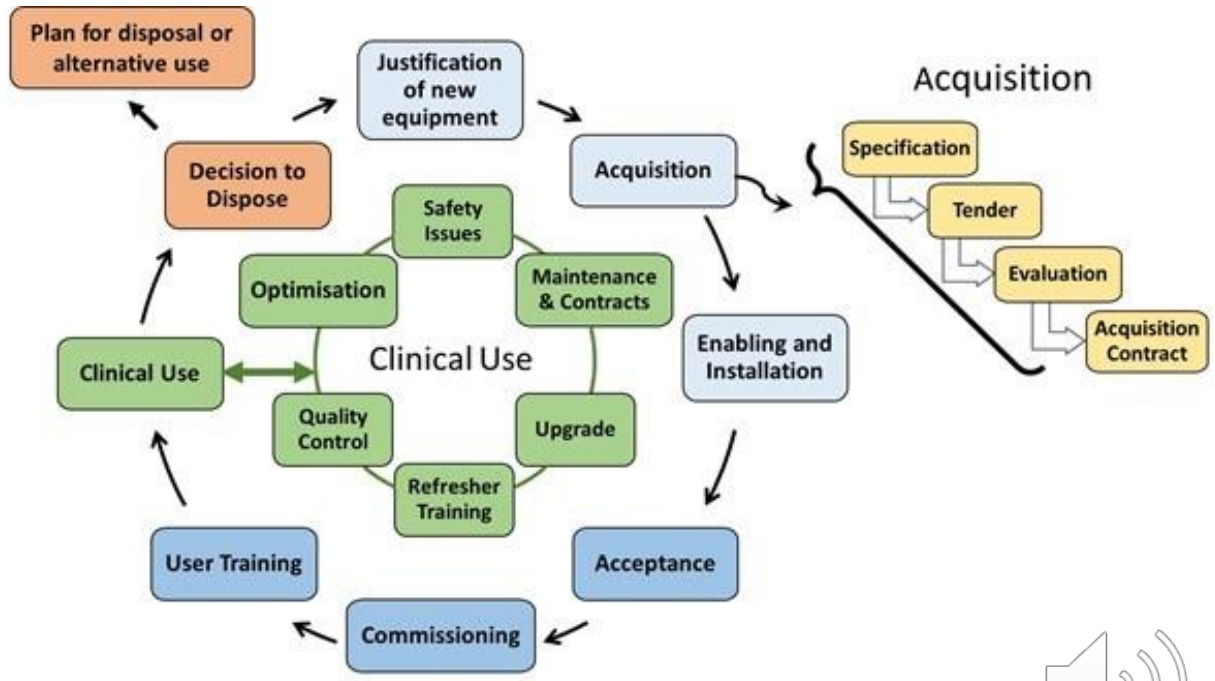
- The purchaser needs to satisfy themself that the equipment supplier has provided what has been ordered
- They also need to ensure that the equipment is ready for clinical use and establish baseline values against which the results of subsequent routine performance tests can be made



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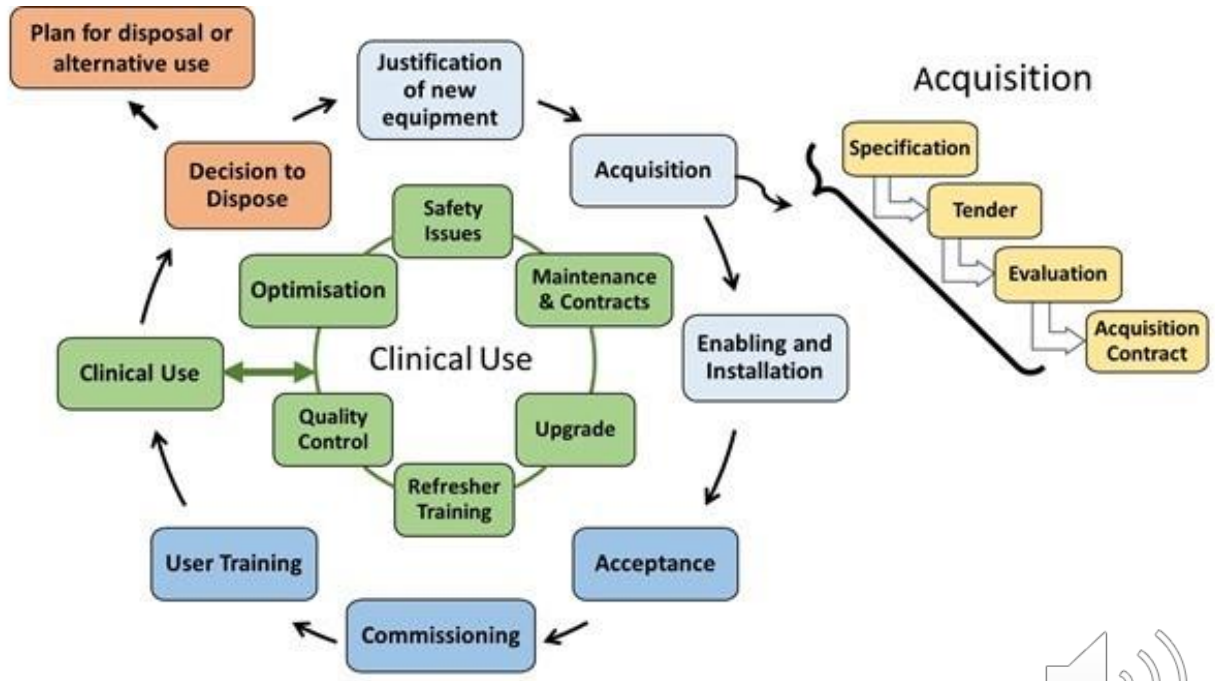
- User training on new equipment is a crucial stage in optimisation



Optimisation

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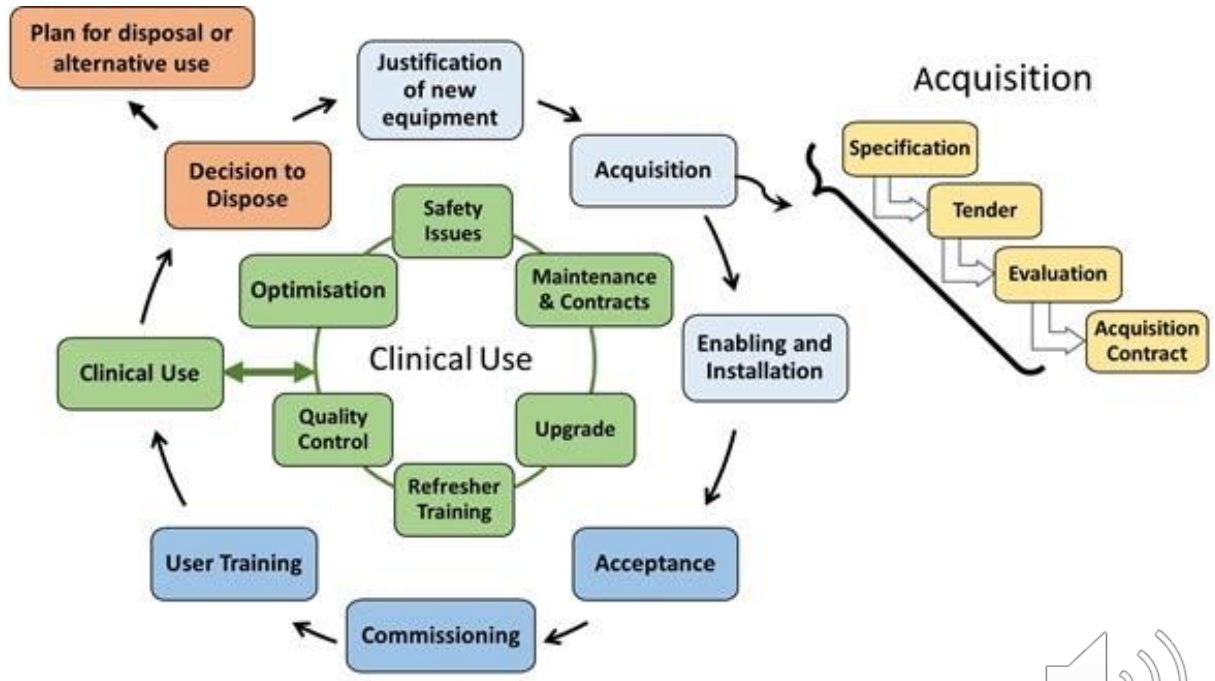
- Regular review of protocols taking account of dose and imaging performance are key to achieving optimisation



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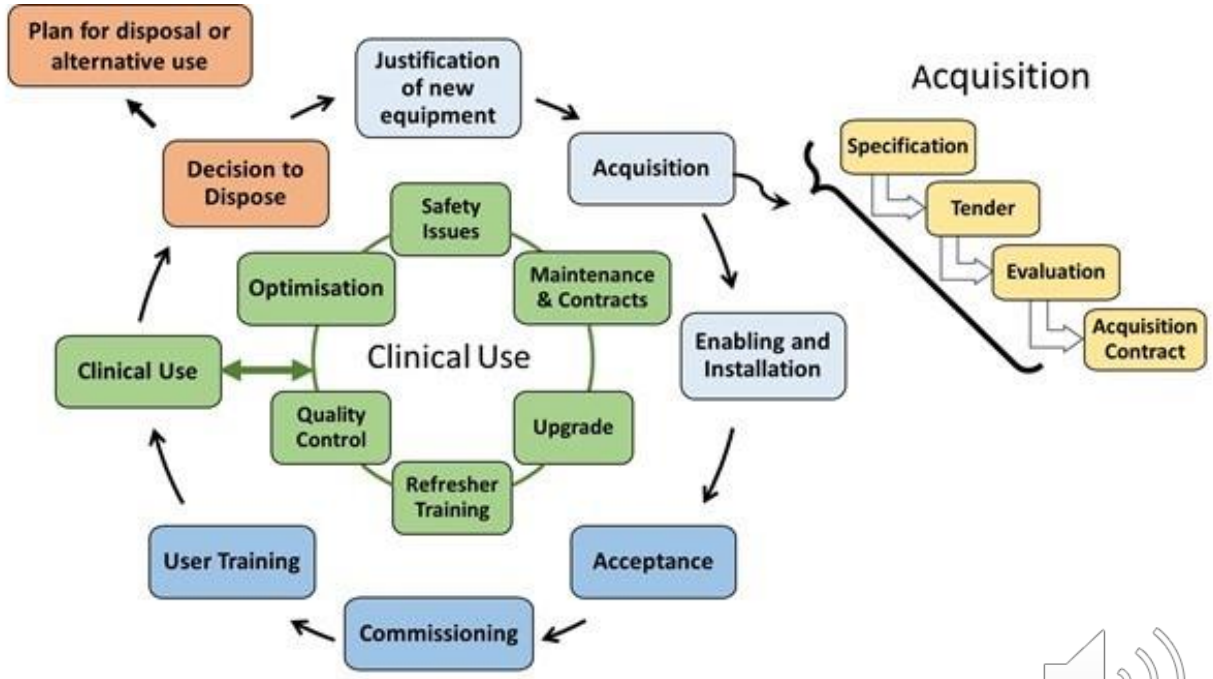
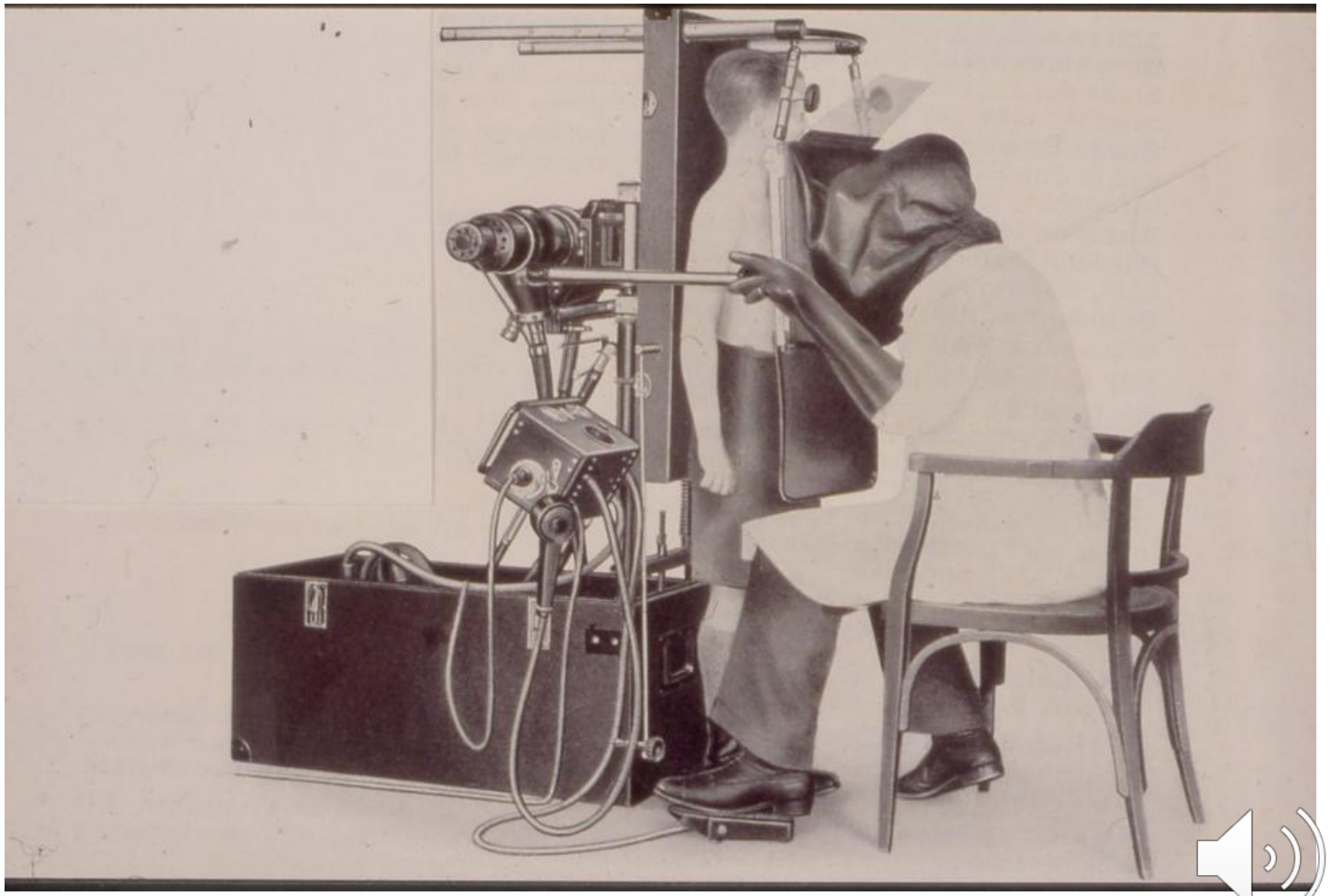


Optimisation

Patient Doses

NB Perceived Image Quality is Task & Reader Dependent



Optimisation

Patient Doses - Aspects discussed in the report

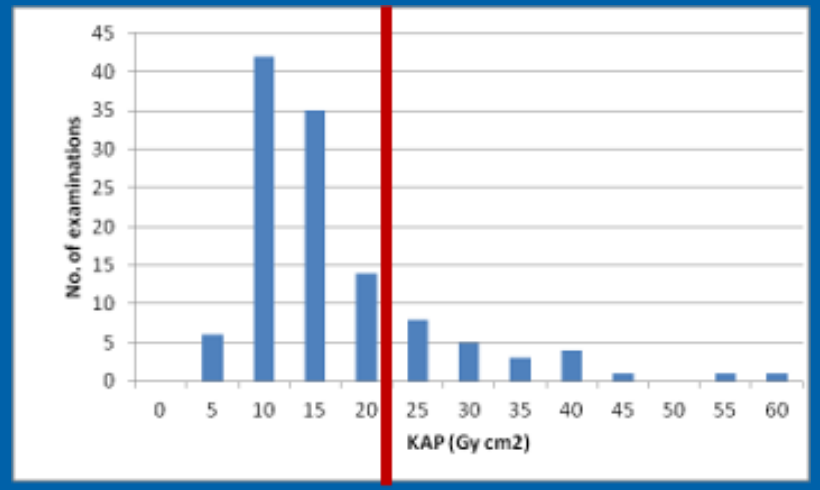
- The influence of exposure factors on radiological images
- Surveys and audit of patient dose data
- Measurement & retrieval of patient dose data
- Analysis and feedback of patient dose data
- The outcome of the audit process
- Patient radiation exposure monitoring / management systems

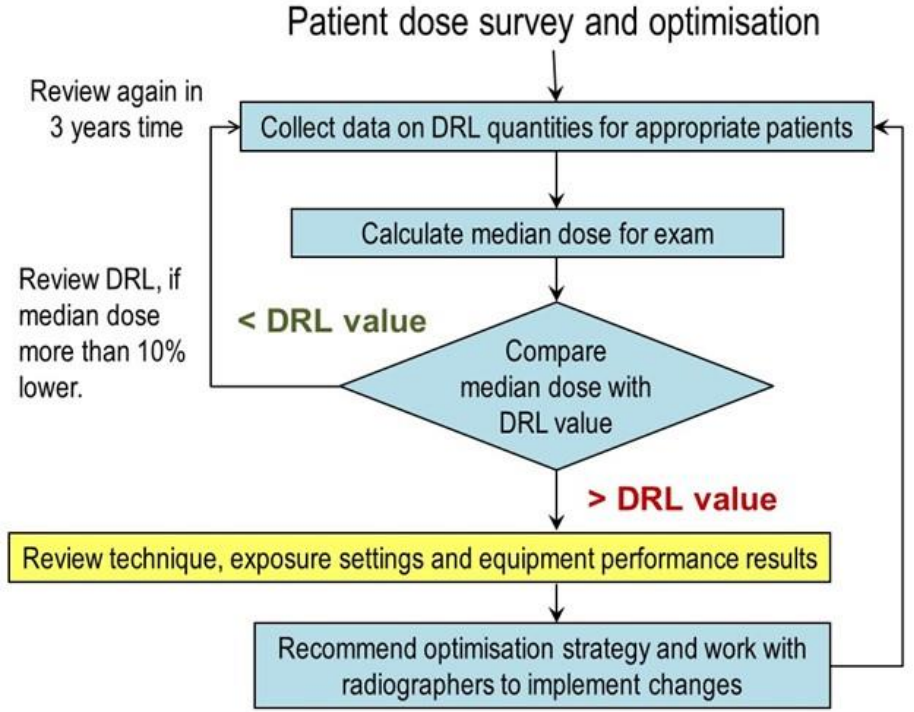
Equipment factors affecting patient dose & image quality

Factor (single factorial)	Effect on Patient Dose (to maintain same Air Kerma at detector)	Image Quality
Increase field size	Increased P_{KA}; $K_{a,e}$ constant	Increase scatter
Introduce anti scatter grid	Increased P_{KA} ; $K_{a,e}$ increased	Decrease Scatter
Increase beam filtration	P_{KA} reduced; $K_{a,e}$ reduced	Reduce Contrast
Increase FID	None	Reduce unsharpness
Increase focal spot size	None	Increase unsharpness
Increase anode angle	None	Increase unsharpness, (increase useful FOV)
Decrease patient to detector distance	P_{KA} reduced; $K_{a,e}$ reduced*	Decrease unsharpness, but increase scatter at detector

Methodology: Dose Audit – an important step in the optimisation process

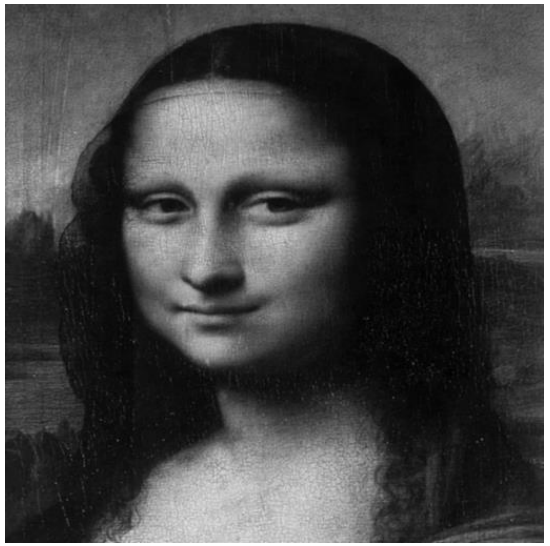
See ICRP Publication 135





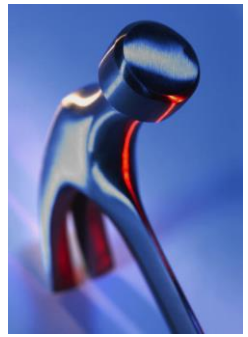
- Knowledge of the doses delivered to patients is one of the first steps in the clinical optimisation process and personnel involved in performing the exams should have ownership or involvement in the process of dose audit.
- A multi-disciplinary team approach helps to ensure that results of dose surveys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

Diagnostic Reference Levels



Task dependence. What colour are her eyes?

- Based on the premise that if most radiologists agree that a particular dose produces an image that is diagnostic then it probably is diagnostic.
- A blunt tool that acts as a guide guide to the – indistinct – border between good / normal practice and bad / abnormal practice.
- Just a step on the road to optimisation.



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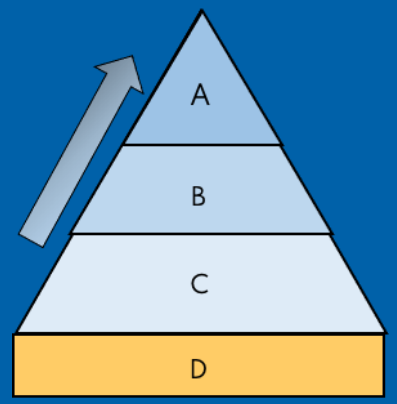
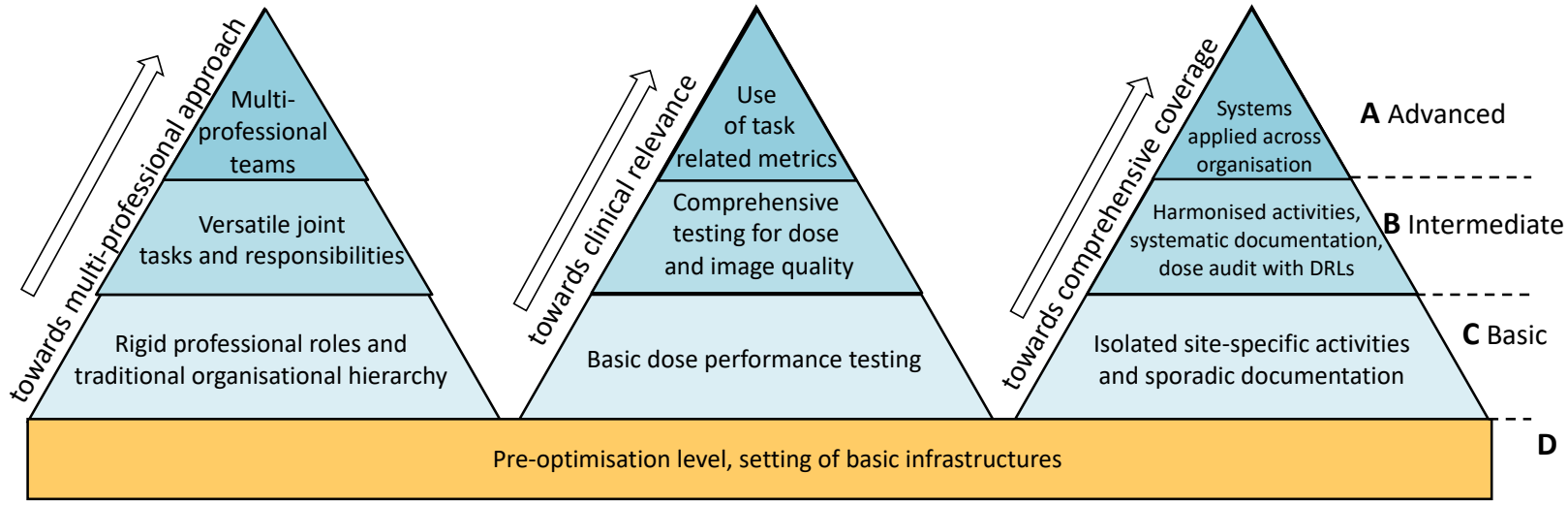
Patient Dosimetry, Dose Audit & Optimisation



D: Pre-optimisation level (Basic infrastructure)	• Availability of radiation instruments for measurement of radiation dose and exposure parameters • Availability of simple protocols setting out measure equipment performance. • Purchase of range of instruments sufficient for carrying out QC tests on all imaging modalities. • X-ray equipment has displays of dose parameters (e.g. KAP for radiography and fluoroscopy and displays of $CTDI_{vol}$ and DLP on CT scanners)
C: Basic (Level D plus)	• Calibration of all KAP meters, and displays of $CTDI_{vol}$ and DLP • Dose audits performed every 3 years • Dose audit results fed back to radiographers and radiologists periodically • In process of developing national DRLs
B: Intermediate (Levels D and C plus)	• Standardisation of protocol names for procedures • Radiologists have agreed arrangement for development of examination protocols • Agreed codes for identifying more complex examinations • National DRLs established for a wide range of procedures • Annual survey of patient doses on wide range of procedures • Local DRLs and typical values set by organisation linked to local dose surveys • Results of patient dose audit included in annual review of examination protocols
A: Advanced (Levels D, C and B plus)	• Continual feedback and comparison of patient dose results with typical values • Application of dose management system software • Comparison of $CTDI_{vol}$ values with other results at time of CT examinations • Alignment of protocols for standard indications throughout organisation

Including Dose in an Optimisation Strategy – Level C



PROFESSIONALISM

Separate Roles for staff groups

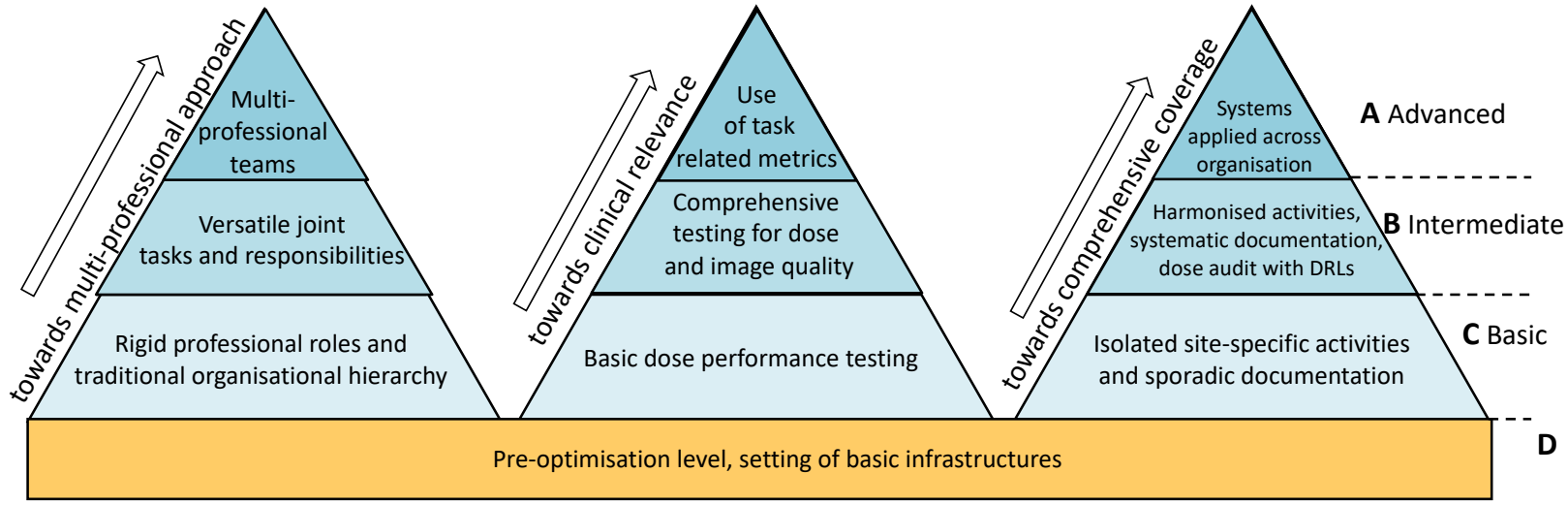
METHODOLOGY

Surveys of patient doses

PROCESSES

Ad hoc arrangements for equipment testing & dose audit

Including Dose in an Optimisation Strategy – Level B



PROFESSIONALISM

Optimisation team closes audit loop; acting on results of audit against DRLs by adjusting exam parameters or protocols.

METHODOLOGY

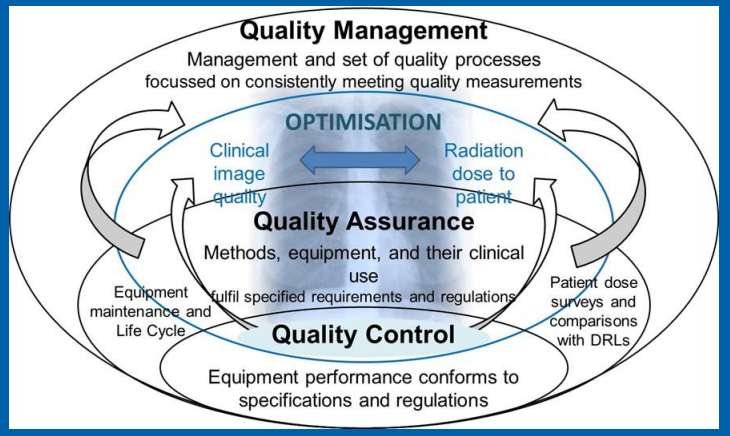
Patient dose audit results compared with DRLs.

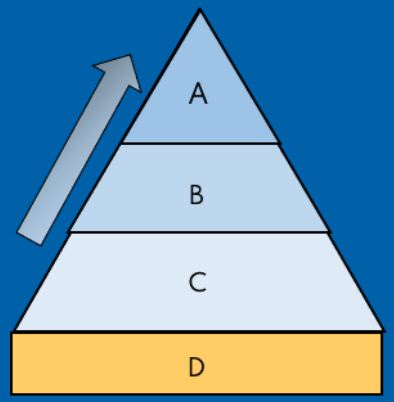
PROCESSES

System for regular dose audit included in procedures

Quality

Quality Management
Quality Assurance
Quality Control





Quality Management	Management of processes with: • Improved clinical outcome • Continual improvement of quality and safety [Plan-Do-Check-Act cycle (PDCA)] • Reviewing established quality criteria and policy • Ensuring adequate resources • Alignment with organisational purpose and strategy • Leadership commitment • Fostering no-blame culture
Quality Assurance	Planned and systematic procedures for: • Clinical image quality evaluation • Patient dose surveys and comparisons with DRLs • Image reject and retake analysis • Equipment maintenance and life cycle (incl. acceptance and commissioning) • QC and QA documentation • Test frequencies and tolerances • Self-evaluations and audits • Staff roles and responsibilities • Training and knowledge • Research and development aspects of quality
Quality Control	Planned and systematic procedures for: • Technical equipment performance tests including technical image quality tests and radiation output tests • Radiation safety tests • Technical safety tests

Thank you for your attention

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