The role of Diagnostic Reference Levels in Optimization

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Thursday 19th September
9:15 – 9:35
www.itn.pt/prs2013/uk_index.html
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2. DRLs for interventional procedures.
3. Future actions on DRLs by ICRP.
4. Topics for discussion.
Diagnostic Reference Levels in medical imaging

1. Still a **lack of knowledge** on the concept of Diagnostic Reference Levels (DRLs) in the medical community.

2. Sometimes DRLs are **used as limits and applied to individual patients**.

3. The name “diagnostic reference levels” **may be confusing** when applied to interventional procedures.

4. Potential to **improve the use** of DRLs.
ICRP and DRLs (5 years periods: 1990; 1996)

- ICRP Publication 60 [1991] proposed some recommendations on Diagnostic Reference Levels (DRLs) that were later expanded in ICRP Publication 73 [1996].

  “These levels, which are a form of investigation level, apply to an *easily measured quantity*, usually the absorbed dose in air, or in a tissue-equivalent material at the surface of a *simple standard phantom or representative patient*” (par100, P73)
ICRP and DRLs (5 years periods: 1990; 1996; 2001; 2007)

- ICRP published in 2001 “additional advice” on the application of DRLs in diagnostic and interventional radiology, and in 2007, included a summary of these recommendations in Publication-105.
ICRP created in 2012 (5 years after 2007), a Working Party to revisit DRL for diagnostic and interventional imaging

- Need to expand the application of the DRL concept to interventional procedures, nuclear medicine procedures, and other procedures that use more than one imaging modality.
- Based on the initial discussions at its next meeting, C3 will consider setting up a Task Group.
ICRP-103 (2007): Reference Levels and DRLs are different

- In emergency or existing controllable exposure situations, the reference levels represent the level of dose or risk, above which it is judged to be inappropriate to plan to allow exposures to occur and for which therefore protective actions should be planned and optimised.

- **Diagnostic reference level.** Used in medical imaging with ionizing radiation to indicate whether, in routine conditions, the patient dose or administered activity from a specified procedure is unusually high or low for that procedure.
Main Points:
- DRLs should be used by regional, national, and local authorised bodies.
- The concept of DRLs allows flexibility.
- ICRP advice does not specify quantities, numerical values, or details of implementation for DRLs.
- The ICRP rationale for its advice is to improve the management of patient doses in medical imaging.
ICRP supporting Guidance on DRLs (2001a)

• Achieving **acceptable image quality or adequate diagnostic information**, consistent with the medical imaging task.

• DRLs are used **to help manage the radiation dose to patients** so that the dose is commensurate with the clinical purpose.

• Authorised bodies, **working in concert** with **professional medical groups**, to establish DRLs for medical imaging tasks.

• The **purpose is advisory**. Local review if consistently exceeded.

• DRLs are **not for regulatory or commercial purposes**, not a dose constraint, and not linked to limits or constraints.
ICRP supporting Guidance on DRLs (2001b)

• Selection by professional medical bodies, using a percentile point on the observed distribution for patients, and specific to a country or region.

• The quantities should be easily measured, such as absorbed dose in air or tissue-equivalent material at the surface of a simple standard phantom or representative patient for diagnostic radiology.

• There are exceptions where the approach uses ‘achievable levels’ indicative of more optimum conditions, mentions dose constraints, or incorporates a dose limit or suspension level (only for mammography used for screening).

• A number of different quantities have been used for DRLs.
ICRP supporting Guidance on DRLs (2001c)

- The numerical value of the DRL should be tied to defined clinical and technical requirements for the medical imaging task.
- The relative tissue dose distribution in the body should not change appreciably among patients undergoing the selected medical imaging task.
- A reference group of patients is usually defined within a certain range of physical parameters (e.g. height, weight). If an unselected sample of patients were used, it would be difficult to interpret the results.
- A diagnostic reference level is not applied to individual patients.
For fluoroscopically guided interventional procedures, **DRLs could be used** to promote the management of patient doses with regard to avoiding unnecessary stochastic radiation risks.

A potential approach is to take into consideration not only the usual clinical and technical factors, but also the relative ‘complexity’ of the procedure.

**More than one quantity** (i.e., multiple diagnostic reference levels) may be needed to evaluate patient dose and stochastic risk adequately.

DRLs are **not applicable to the management of deterministic radiation risks** (i.e., radiation-induced skin injuries) from fluoroscopically guided interventional procedures.
Clinical and Technical Determinants of the Complexity of Percutaneous Transluminal Coronary Angioplasty Procedures: Analysis in Relation to Radiation Exposure Parameters

Guglielmo Bernardi, MD, Renato Padovani, PhD, Giorgio Morocutti, MD, Eliseo Vano, PhD, Maria Rosa Malisan, PhD, Massimo Rinuncini, MD, Leonardo Spedicato, MD, and Paolo M. Fioretti, MD

Approx.
Medium = 1.5 x simple
Complex = 2.0 x simple
A pilot study exploring the possibility of establishing guidance levels in x-ray directed interventional procedures

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Approx.

Medium = 1.5 x simple

Complex = 2.0 x simple
ICRP Working Party on DRL and Optimization. Topics for discussion

- Possibility of deriving trigger (alarm) levels from DRLs (values 2 or 3 times higher than DRLs?) to investigate individual cases of high dose values.

- Exploitation of the full individual patient dose distributions in addition to DRLs, to help with optimization.
CIRSE 2007. Establishment of procedure specific dose trigger levels in interventional radiology to be used for clinical follow up.
All cardiac procedures

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<th>Min</th>
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• X-ray systems **should be properly settled and verified** during acceptance and constancy checks.

• Practitioners and operators **should know the appropriate protocols** to be used for the different clinical tasks.

• Patient **dose values and other relevant parameters** to help in optimization, as number of series, number of images, fluoroscopy time, percentage of dose for the different acquisition modes, etc, should be **archived and analyzed**.
Differences between x-ray systems in the entrance dose rate for the routine setting for a phantom equivalent to a medium size patient (SERVEI-SENTINEL Spanish survey)

Factor 4.6
The use of DRLs in practice

• DRLs are still not widely used by many health centers and optimization is a challenge in many of the new imaging modalities and new image acquisition protocols.

• In the past, mean or median values of different dosimetric quantities were calculated using a small sample of procedures.

• With the introduction of **digital systems**, it is now possible to **easily collect and archive** dosimetric and demographic data of all the imaging procedures.
1. The use of **phantoms versus patient dose values** needs some refinement (consider **protocols and operator impact**).

2. Link between **DRLs and image quality or diagnostic information** (including post-processing) for different clinical tasks.

3. Standardization and consensus on the **levels of complexity** for some common procedures and the impact on DRLs.

4. Possibility of **deriving trigger (alarm) levels** from DRLs to investigate individual cases of high dose values.

5. Exploitation of the **full individual patient dose distributions** in addition to DRLs, to help with optimization.

6. Balancing the **relevance of several dose related quantities** used to set DRLs (e.g. KAP, cumulative Air Kerma, number of cine or DSA images, fluoroscopy time, rotational, CBCT, etc).

7. Recommended **periodicity to update DRLs**, and factors to be considered to establish such periodicity.
Thank you

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