CORSO DI LAUREA
TECNICHE DI RADIOLOGIA MEDICA, PER IMMAGINI E RADIOTERAPIA

CORSO INTEGRATO
«RADIODIAGNOSTICA II – RMX013»

ANNO ACCADEMICO 2024/2025

Gemelli 1964 2024

Insegnamento:
TECNICHE DI IMAGING TC E ANGIOGRAFICO
RMX055 - 25 ore MED/50 CFU 2

dic. ’24

2° anno I semestre

Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

Formazione per l'eccellenza

Insegnamento:
TECNICHE DI IMAGING TC E ANGIOGRAFICO
RMX055 - 25 ore MED/50 CFU 2

Diagnostic Reference Levels in Medical Imaging

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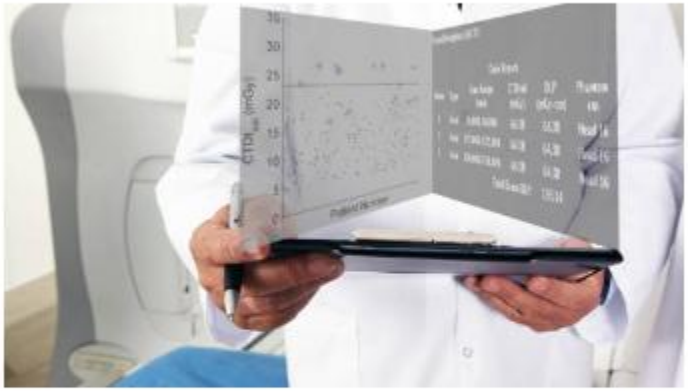
https://www.iaea.org/resources/rpop/resources/online-training-in-radiation-protection#7

Diagnostic Reference Levels
in Medical Imaging

Diagnostic Reference Levels in Medical Imaging



The Diagnostic Reference Levels in Medical Imaging online course, available in English and Spanish, provides continuing education to medical imaging professionals, regulators and others who are interested in establishment and use of diagnostic reference levels (DRLs). It contains 13 modules in which the participant will learn the practical steps for establishing DRLs and their use in clinical practice.

The course aims to help participants:

- Understand the concept of DRLs, what are the DRLs and what is their role in the optimization of protection of patients;
- Understand the DRL process and components that need to be considered;
- Understand dose metrics and values used in the DRL process;
- Learn how to establish and appropriately use DRLs in different imaging modalities;
- Learn about useful sources of information relevant to the DRL process.

The estimated total time for the course is 7 hours. Progress is tracked so the course may be completed in stages. After viewing all modules and passing the final quiz, participants receive a certificate of completion.

This e-learning programme is designed to provide continuing education to medical imaging professionals, regulators and others who are interested in establishment and use of diagnostic reference levels.

Through this course consisting of 13 modules, participants are expected to:

- Understand the concept of DRLs, what are the DRLs and what is their role in the optimization of protection of patients;
- Understand the DRL process and components that need to be considered;
- Understand dose metrics and values used in the DRL process;
- Learn how to establish and appropriately use DRLs in different imaging modalities;
- Learn about useful sources of information relevant to the DRL process.

Duration: **7 h** | Interactivity: **self-study** | Language: **English** | Assessment: **yes (pass mark: 80%)** | Certificate: **Certificate of Completion** | Contact: [to be confirmed]

Objectives

To understand:

- What are DRLs
- DRLs as optimization tool
- Responsibility for setting DRLs
- What are DRLs for and what DRLs are not for
- Effectiveness of DRLs

Radiation protection in medicine

- Employing radiation in medicine must involve a careful balance between the benefits of enhancing human health and welfare, and the risks related to the radiation exposure of people.

> 3600 million diagnostic medical examinations every year

- Two general principles of radiation protection: **justification and optimisation** of protection and safety, are applicable to medical exposure.

Optimization of protection and safety

- Justification of the medical exposure
- Optimization involves compromising between the image quality and dose to the patient
- Diagnostic reference levels (DRLs)

The dose should not be higher than necessary to achieve an image quality

Optimization of protection and safety

- Justification of the medical exposure
- Optimization involves compromising between

Optimization of protection is not minimization of dose. Too low a radiation dose could be as bad equally as too high a radiation dose. The consequence could be that the images obtained are not of suitable diagnostic quality.

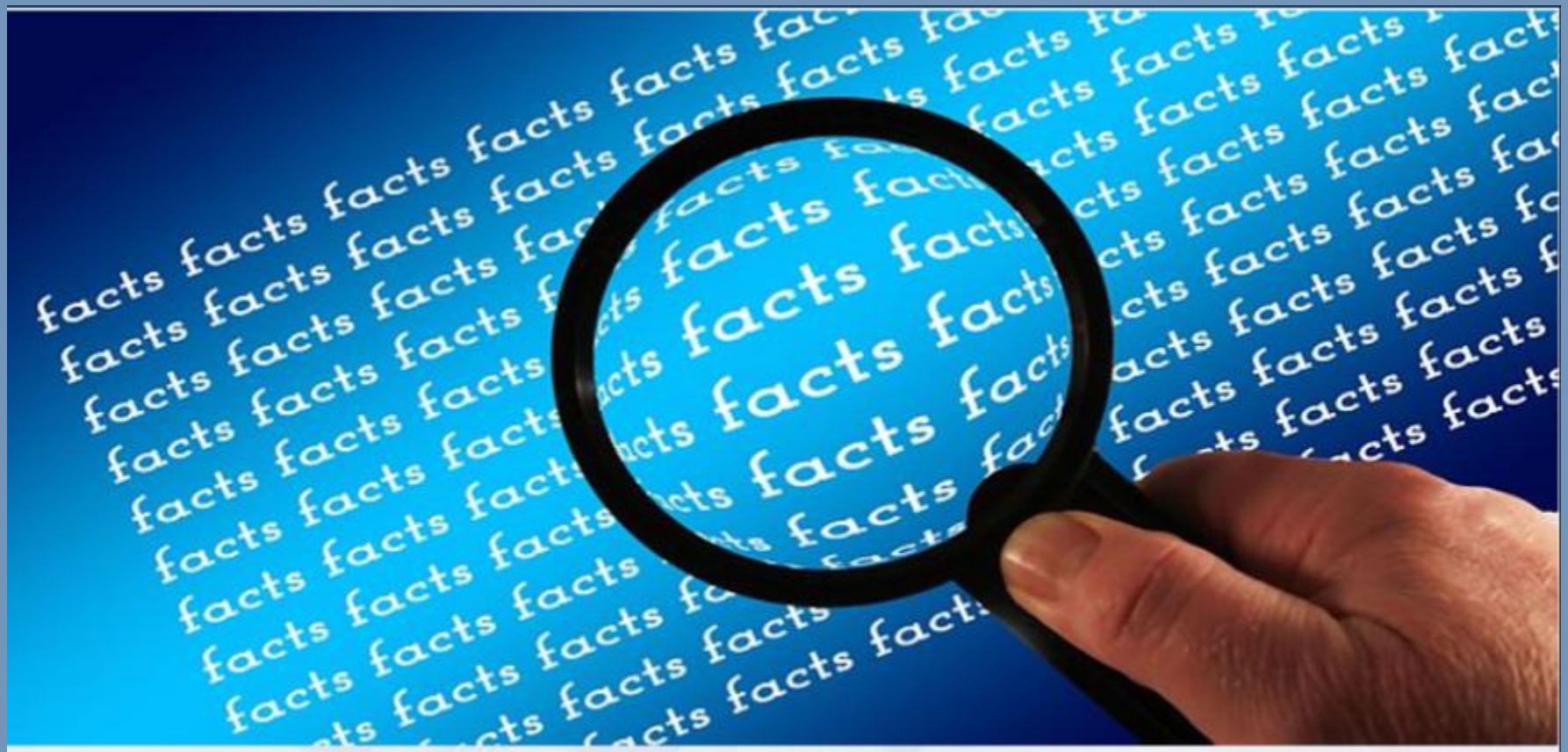
an image quality

What are Diagnostic Reference Levels (DRLs)?

- DRLs are used in medical imaging to indicate whether, in routine conditions, the dose to the patient or the amount of radiopharmaceuticals administered in a specified radiological procedure for medical imaging is
  unusually high, or
  unusually low
  for that procedure.

DIAGNOSTIC REFERENCE LEVELS

MODULE 1: DRLs in the context of radiation protection in medicine

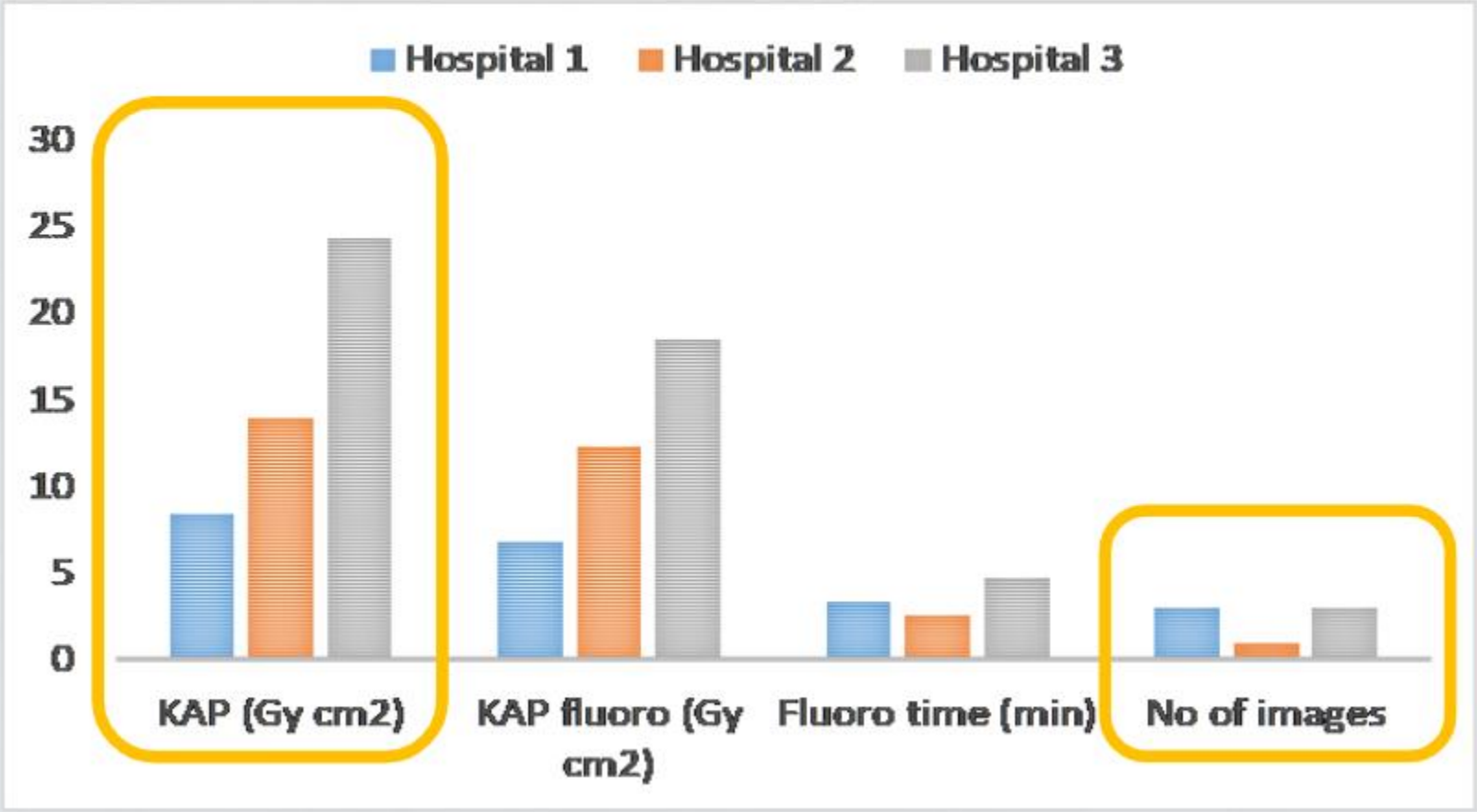


Variation of patient doses for the same procedure in different facilities

Country	Entrance Surface Dose (mGy)					
	Chest, Posteroanterior	Lumbar Spine, Anteroposterior	Lumbar Spine, Lateral	Abdomen, Anteroposterior	Pelvis, Anteroposterior	Skull, Anteroposterior and Posteroanterior
United States [14, 28]	0.25[a]	5.0[a]	—	4.5[a]	—	—
United Kingdom [9]	0.15	5.0	11.7	4.7	3.6	2.3
Australia [25]	0.12	6.1	15.1	4.2	3.9	1.9
Canada [25]	0.11	3.34	—	2.35	—	—
Finland [25]	0.24	8.8	18.2	7.1	6.2	3.4
Greece [26]	0.18	—	—	1.36	—	—
Korea [27]	0.21	2.8	6.17	2.33	2.44	2.04
Taiwan [18]	0.52	5.91	18.9	4.77	5.13	2.6
New Zealand [25]	0.22	22.8	35.5	20.4	21.4	3.0
Present study[b]	0.33	4.07	8.53	3.64	3.68	2.41

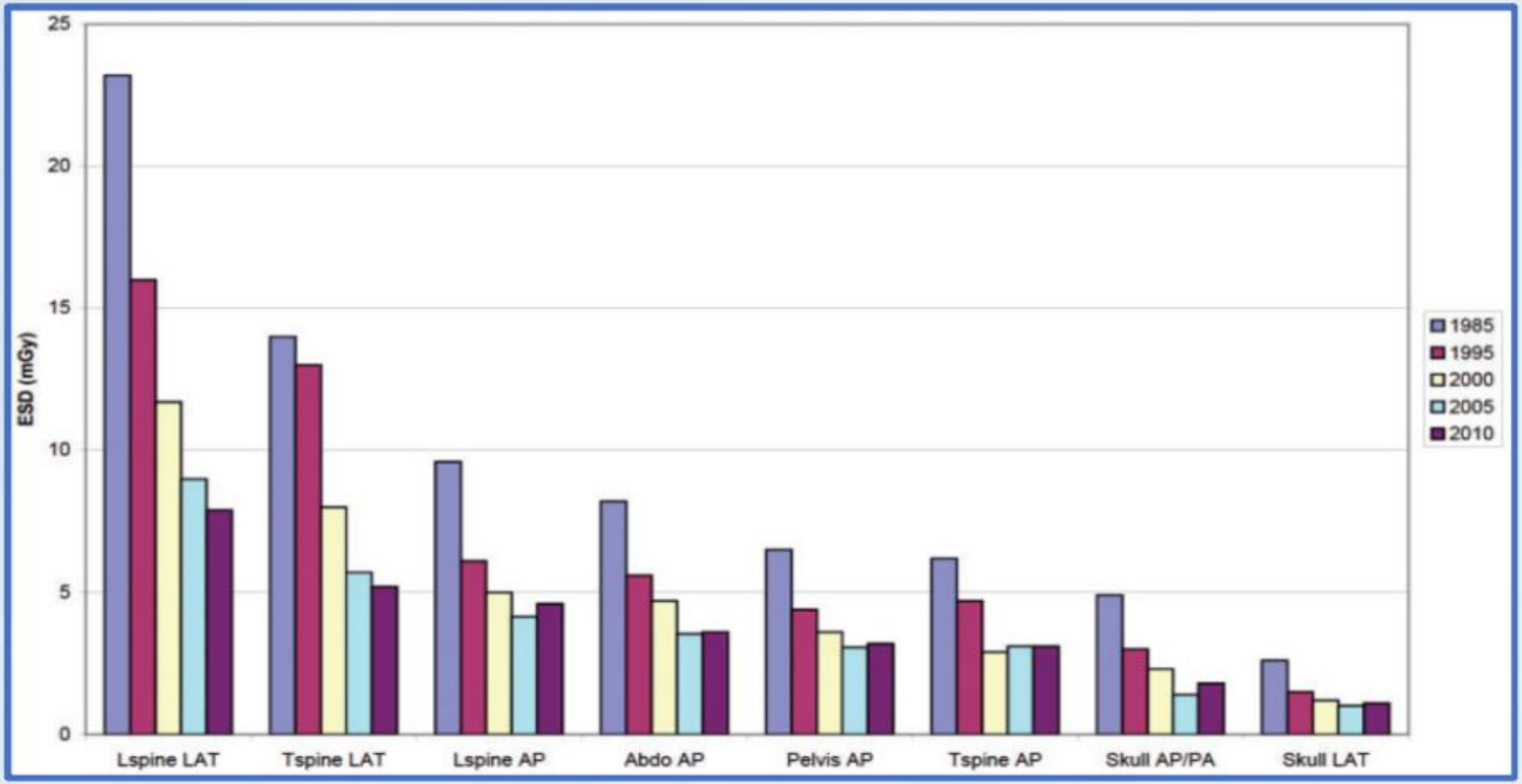
Muhogora et al. Patient Doses in Radiographic Examinations in 12 Countries in Asia, Africa, and Eastern Europe: Initial Results from IAEA Projects AJR **190** (2008) 1453-1461

Variation of patient doses for the same procedure in different facilities



DIAGNOSTIC REFERENCE LEVELS

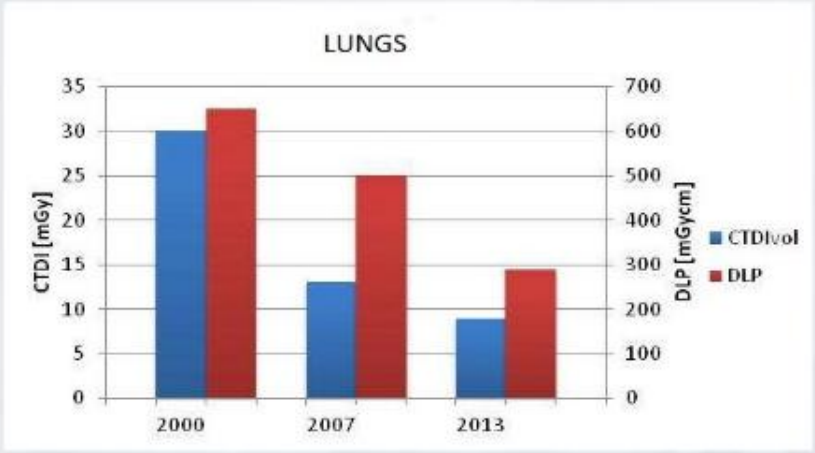
MODULE 1: DRLs in the context of radiation protection in medicine

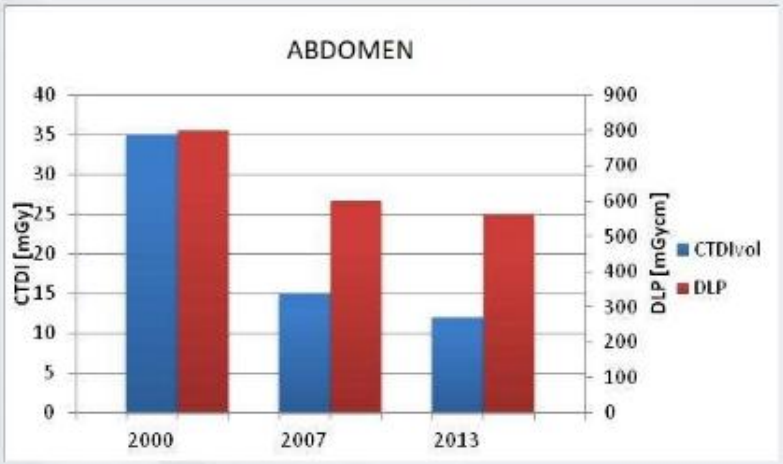


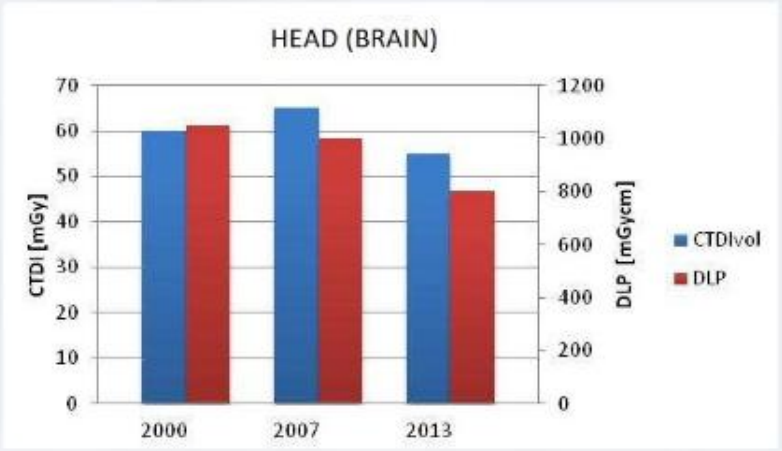
HPA-CRCE-034: doses to patients from radiographic and fluoroscopic x-ray imaging procedures in the UK - 2010 review,
© Crown copyright. Reproduced with permission of Public Health England.

DIAGNOSTIC REFERENCE LEVELS

MODULE 1: DRLs in the context of radiation protection in medicine







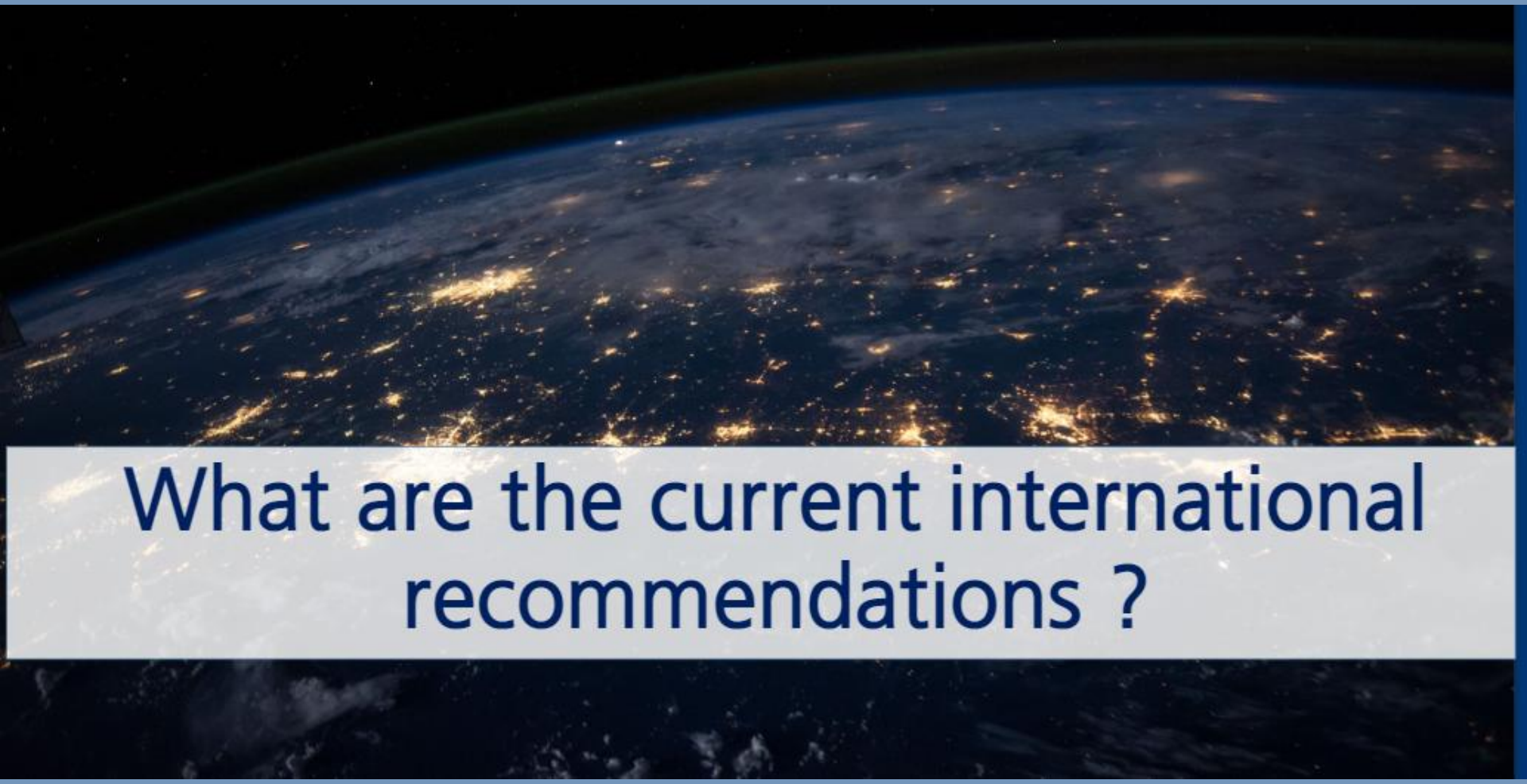
Courtesy: Petra Tenkanen-Rautakoski, Elina Hallinen, STUK, Finland

Effectiveness of DRLs

- The DRL process:
  - Is an effective tool for optimization
  - Should be applied in a continual manner.

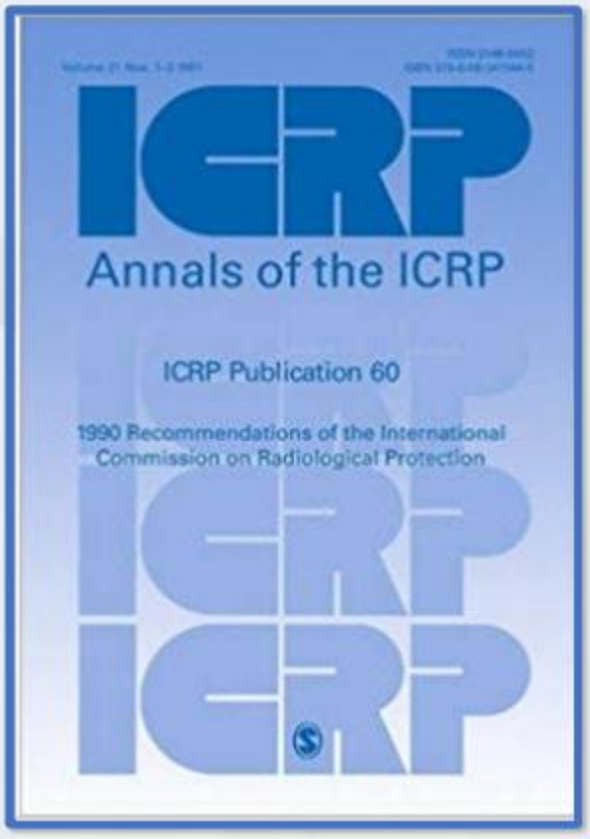
DIAGNOSTIC REFERENCE LEVELS

MODULE 1: **DRLs in the context of radiation protection in medicine**



Why are we using DRLs?

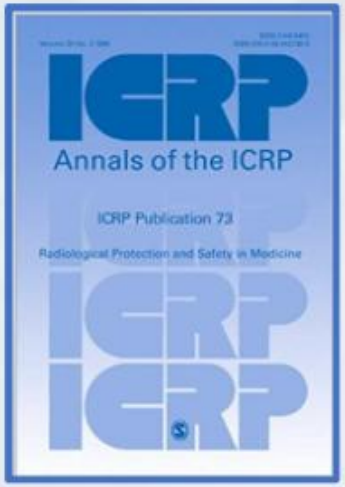
- ICRP Publication 60 (1990) Recommendations of the International Commission on Radiological Protection"
  - Stressed the importance of the control of medical exposure;
  - Noted that there is considerable scope for dose reductions in diagnostic radiology;
  - Recommended that consideration should be given to the use of dose constraints or investigation levels for some common types of examination.

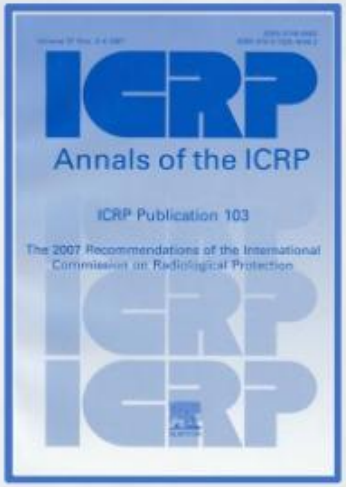


Why are we using DRLs?

ICRP Publication 73
"Radiological Protection and Safety in Medicine"

- The term Diagnostic Reference Level (DRL).





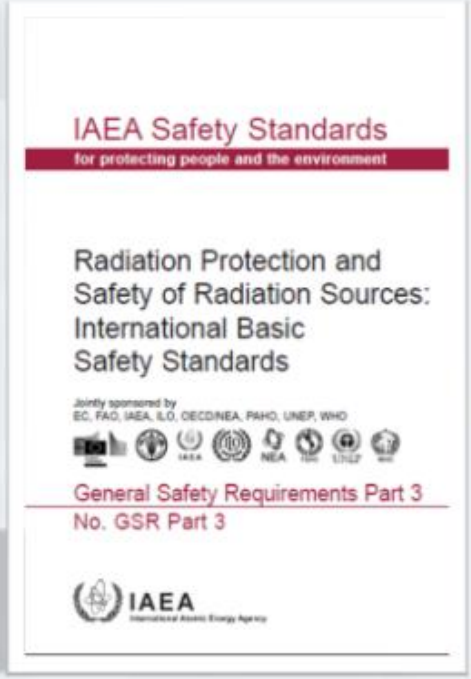
ICRP Publication 103 "2007 Recommendations of the International Commission on Radiological Protection"

- Reinforcement of the concept of DRLs;
- Use the DRL approach is the optimization of protection for patients.

Who is responsible?

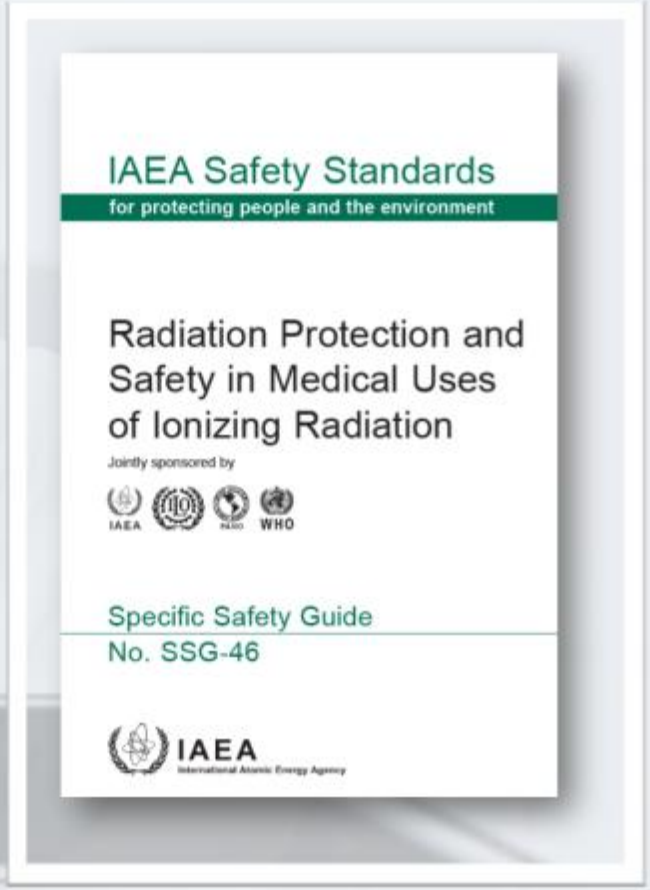
The government shall ensure that as a result of consultation between the health authority, relevant professional bodies and the regulatory body

a set of diagnostic reference levels is established for medical exposures incurred in medical imaging, including image guided interventional procedures.



For what purpose we use DRLs?

- DRLs are an important tool for optimization of protection and safety
- Optimization of protection and safety should be reviewed if the comparison shows that:
  - the facility's typical dose exceeds the DRL;
  - the facility's typical dose is substantially below the DRL.



DRLs are…

- DRLs are typical dose values for "standard sized patient" at particular examination;
- DRLs are representative for the practice in the country or region;
- DRLs are indication of amount of radiation used for specified procedure;
- DRLs are a tool for optimization of protection.

DRLs are not…

- DRL values are not intended for individual patients;
- DRLs are not dose limits;
- DRLs are not border between good and bad practice.

Radiation metrics used for DRLs

- The radiation metric used as a DRL quantity should be easily measured or available;
- Effective dose should not be used as a DRL quantity:
  - Does not assess the amount of ionizing radiation used to perform a medical imaging task directly;
  - Introduces extraneous factors that are not needed and not pertinent for the purpose of DRLs;
  - Is not always calculated in the same way.

Issues with the current use DRLs

- Misuse of DRL values for **individual** patients;
- Misuse of DRL values as a **limit for individual patients** or individual examinations;
- Use of **phantoms** or inappropriate measures of radiation output to set DRL value;
- Establishment of DRL values when **technology and image quality requirements are different**;
- Use of **effective dose** to set DRLs.

Issues with the current use DRLs

- Lack of sufficient patient dose data;
- Lack of specification of Imaging procedures and indication based protocols;
- Image quality is not confirmed;
- DRLs for standard adult patient are not suitable for optimization of paediatric protocols;
- DRLs adopted from other countries;
- DRLs are not updated regularly;
- Tendency to assume that being below DRLs means adequately good practice.

DRLs in wider perspective

- All individuals involved in the imaging process should be aware of this concept (radiologists, radiographers, medical physicists, etc);
- DRLs should be included in the education and training programs of the health professionals involved in the medical imaging;
- DRLs are not static - periodic revision;
- Balance between dose and clinically acceptable image quality.

DRLs champion story

- Involvement of regulatory authorities;
- Explicit legal demands for DRLs;
- Cooperation between authorities and professional societies or clinical and medical physics experts;
- Periodic stakeholder reviews and provision of mutual feedback or consultations with the hospitals and clinical experts.

Future of DRLs

- Diagnostic Reference Levels are tightly built into the regulatory structure;
- Audit and reaudit is catching trends and promotes awareness of radiation protection;
- New technologies are emerging, "digital" is no guarantee of lower patient doses;
- Complex examinations can be audited, but careful definition of procedures is needed;
- This will put high demands for the future dose audits.

Summary

- DRLs are an optimization tool and used in medical imaging to indicate whether the dose to the patient or the amount of radiopharmaceuticals administered in a specified radiological procedure for medical imaging is unusually high or unusually low for that procedure;
- DRL values are not intended for individual patients, they are not the dose limits or border between good and bad practice.

Module 1 Quiz

This is a quiz section of the module. Please read the question and click on the most appropriate choice listed under the question. All questions have only one correct response. Explanation will be provided upon correct response.

Click on the TAKE THE QUIZ button to start.

TAKE THE QUIZ

DIAGNOSTIC REFERENCE LEVELS

MODULE 1: **DRLs in the context of radiation protection in medicine**

A young and enthusiastic medical physicist has become familiar with the DRL concept and the newly established national DRLs for radiographic procedures in his country. He decided to start using DRLs as soon as possible, and initiated patient dose measurements in his facility. The measured entrance surface air kerma for a chest PA radiography of a large patient was two times higher than the national DRL. What should he do now?

A	Ask ahead of the radiology department to immediately stop using this particular X ray unit
B	Continue with patient dose measurements
C	Calculate the effective dose and compare this to the dose limits

Again, a young medical physicist has decided to implement the DRL concept in his hospital. He was wondering what quantity to select for his DRLs. Then he remembered that his hospital had recently purchased new software for the calculation of effective dose. He realized that he could use this software to calculate an effective dose for each patient and use it both for DRLs and for risk communication. What do you think, is he right?

A	Yes
B	No

DIAGNOSTIC REFERENCE LEVELS

MODULE 2: Overview of the DRL nomenclature

DIAGNOSTIC REFERENCE LEVELS

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MODULE 2: Overview of the DRL nomenclature

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