FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

PROTEÇÃO RADIOLÓGICA

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ESTeSC COIMBRA HEALTH SCHOOL

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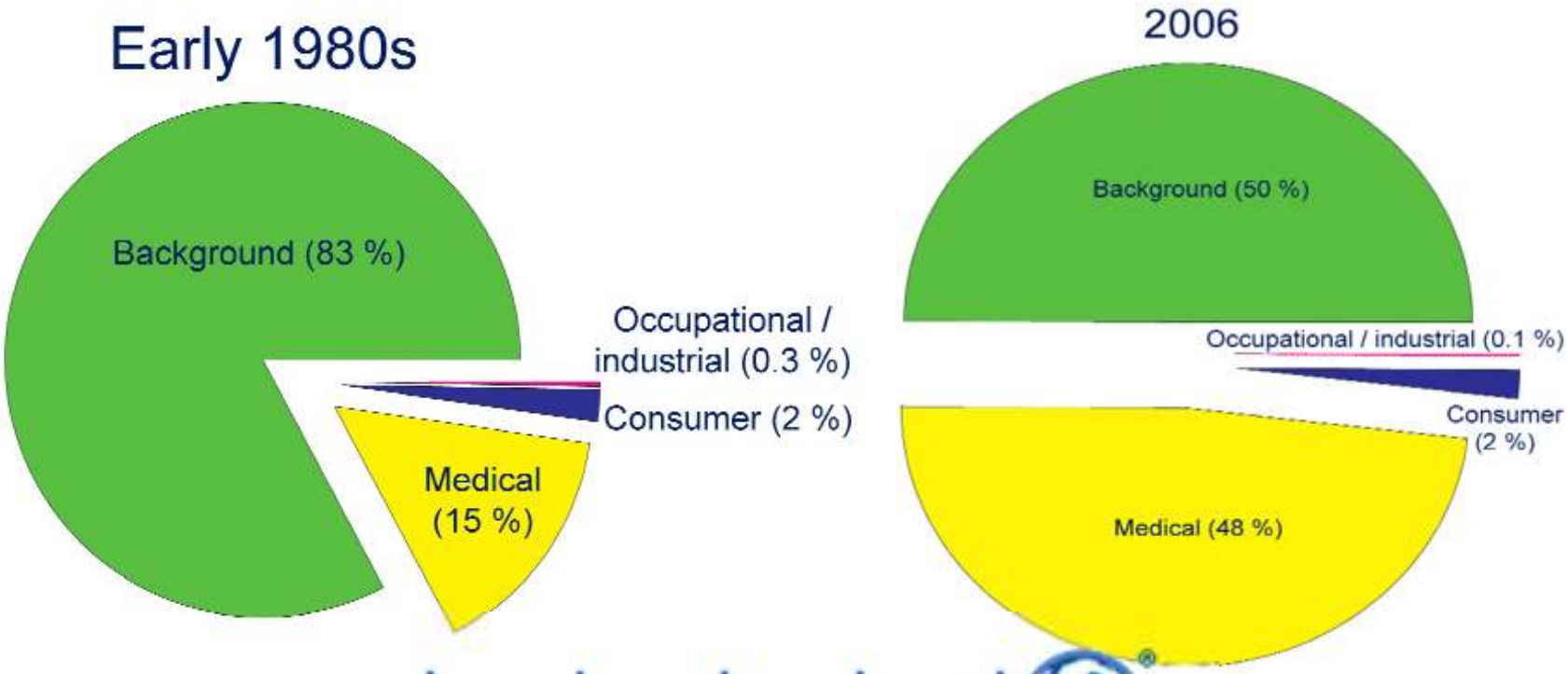
Professora Adjunta, Imagem Médica e Radioterapia

ESQUEMA DE AULA

- Exposição à Radiação Ionizante
- Risco
- Princípios de proteção radiológica
  - **Justificação**
  - Otimização
  - Limites de dose (Segurança do Profissional)
- Perspectivas Futuras
- Conclusões

EXPOSIÇÃO À RADIAÇÃO IONIZANTE

EXPOSIÇÃO À RADIAÇÃO IONIZANTE



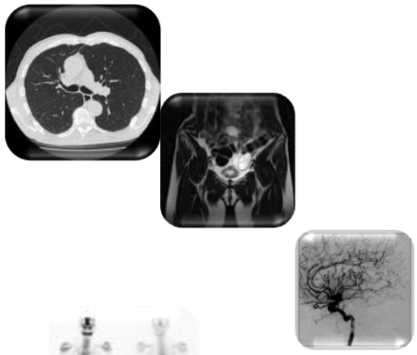
NCRP
National Council on Radiation Protection & Measurements

NCRP Report No. 160

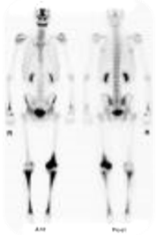
MODALIDADES DE IMAGEM MÉDICA

- Radiografia
- Ecografia

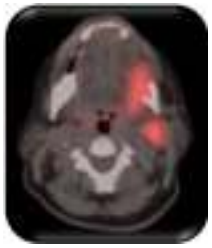
- Tomografia Computorizada (TC)
- Ressonância Magnética (RM)



- Fluoroscopia
- Cintigrafia



- Tomografia por Emissão de Positrões (PET)



PORTUGAL

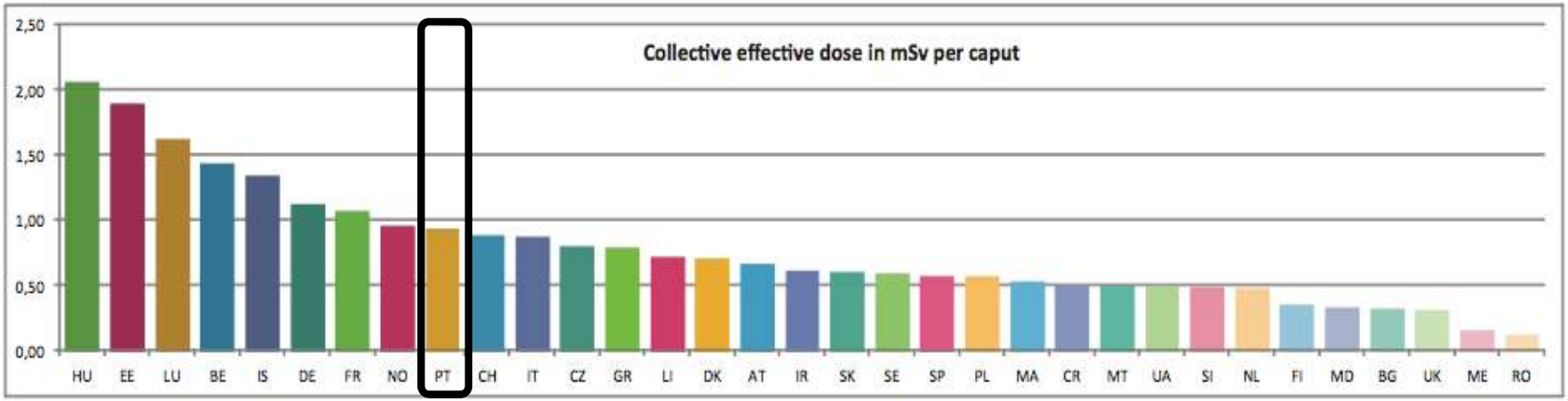


Figure 1. Collective effective dose [mSv] per caput in 33 European countries was estimated using Top 20 method. The data is preliminary data available on 12th March 2012 and will be verified by countries before the Workshop in Athens on 24-26 2012. Some countires have expressed their willingnes to submit their data later during the project.

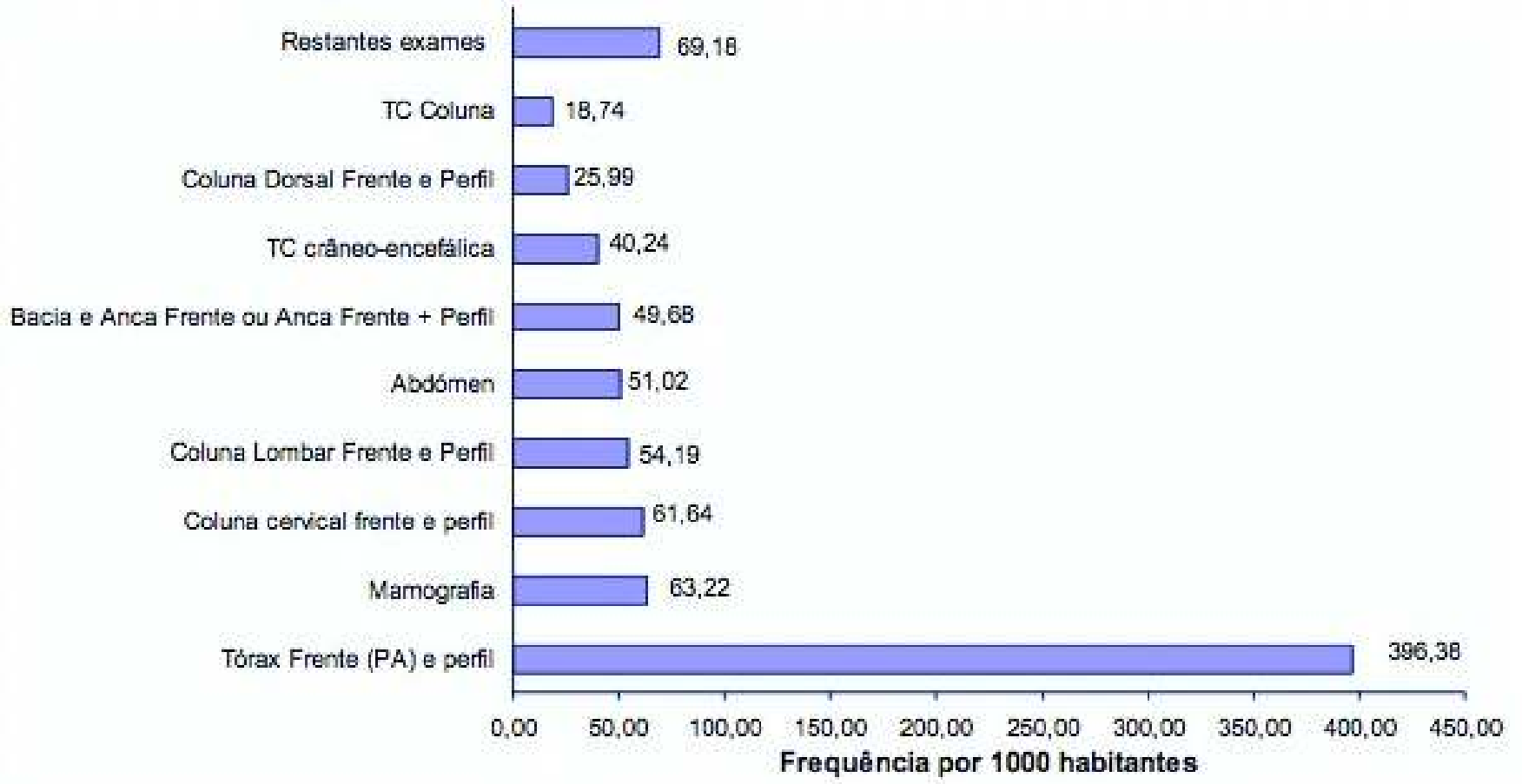
Radiation Protection Dosimetry (2012), pp. 1–13 doi:10.1093/rpd/ncs258

ESTIMATION OF THE COLLECTIVE DOSE IN THE PORTUGUESE POPULATION DUE TO MEDICAL PROCEDURES IN 2010

Pedro Teles[1,*], M. Carmen de Sousa[2], Graciano Paulo[3], Joana Santos[3], Ana Pascoal[4], Gabriela Cardoso[5], Isabel Lança[6], Nuno Matela[7], Luís Janeiro[8], Patrick Sousa[9], Pedro Carvoeiras[10], Rui Parafita[10], Ana Isabel Santos[5], Paula Simãozinho[11] and Pedro Vaz[1]

http://www.itn.pt/projs/ddm2-portugal/Relatorio_Dose_Datamed2_Portugal.pdf

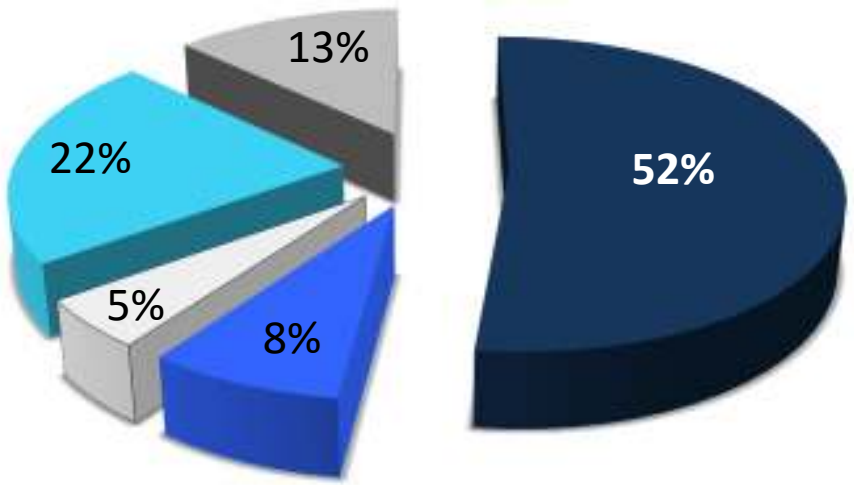
FREQUÊNCIA DE REALIZAÇÃO



Teles, 2012

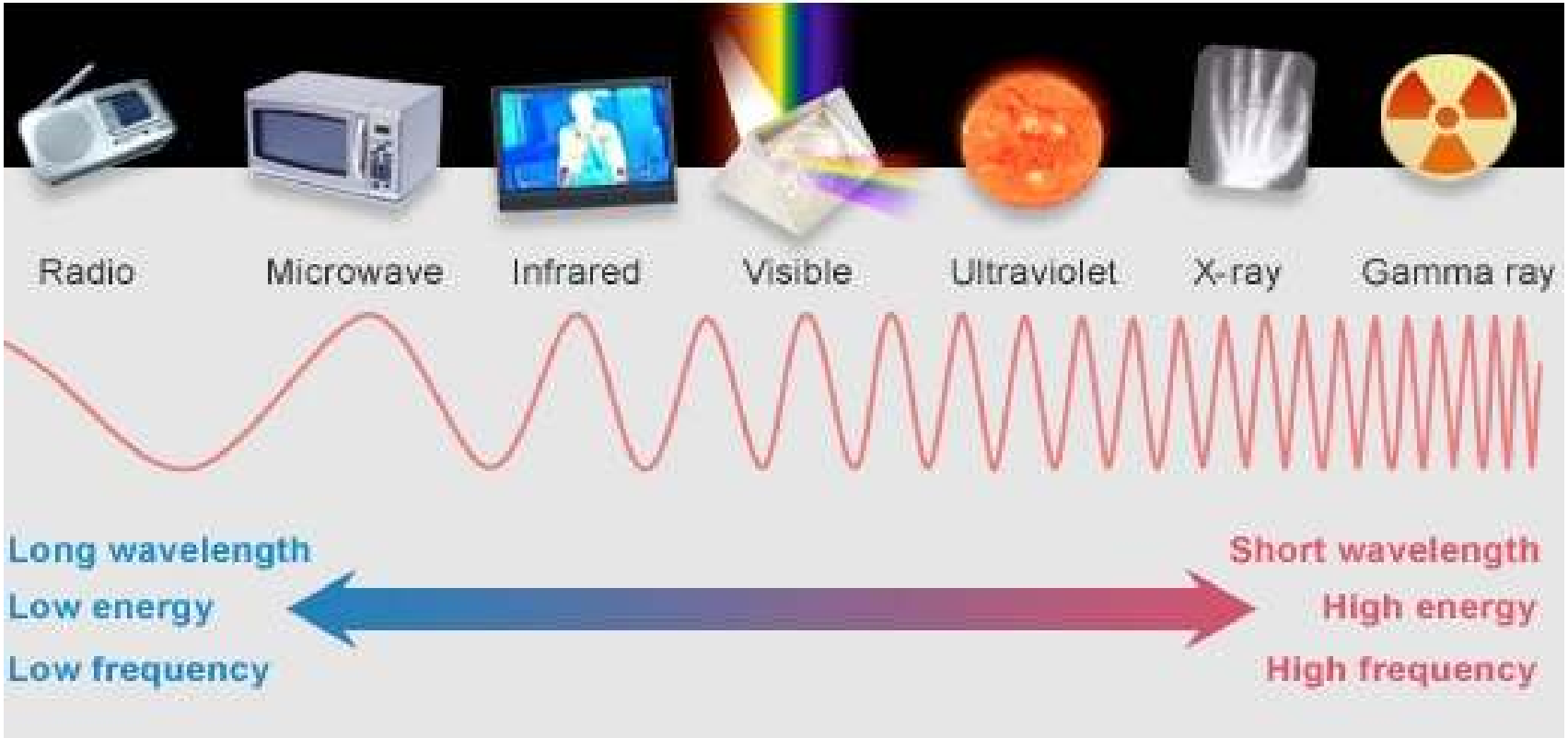
EXPOSIÇÃO POR MODALIDADE

- Tomografia Computorizada
- Radiologia de Intervenção
- Medicina Nuclear
- Radiografia
- Fluoroscopia



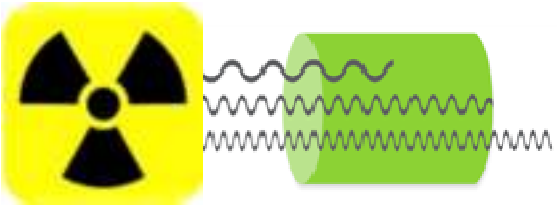
Adaptado de DDM2,2012

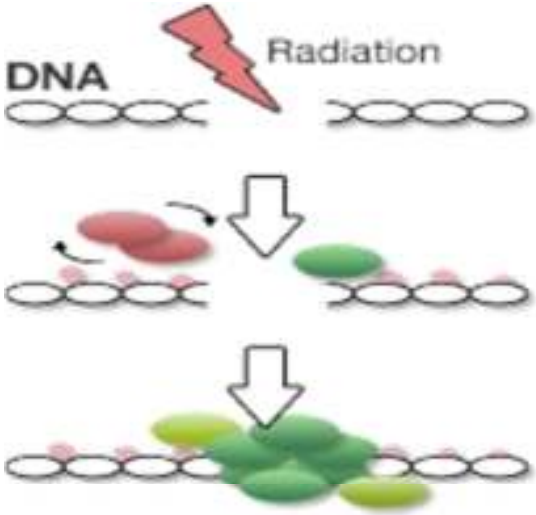
ESPECTRO ELETROMAGNÉTICO

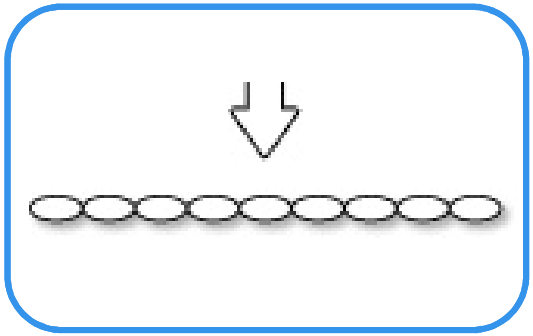


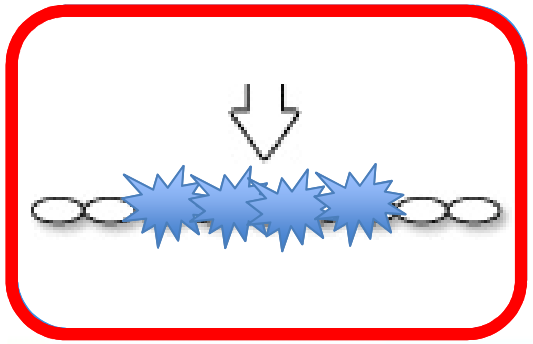
Não Ionizante	Ionizante

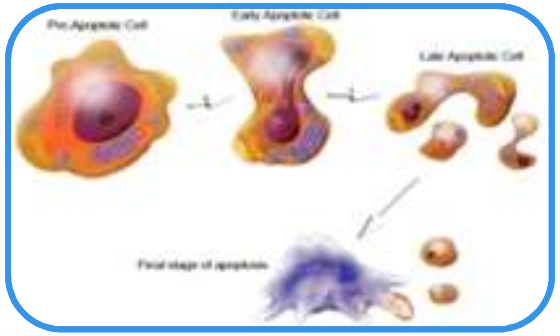
EXPOSIÇÃO À RADIAÇÃO IONIZANTE



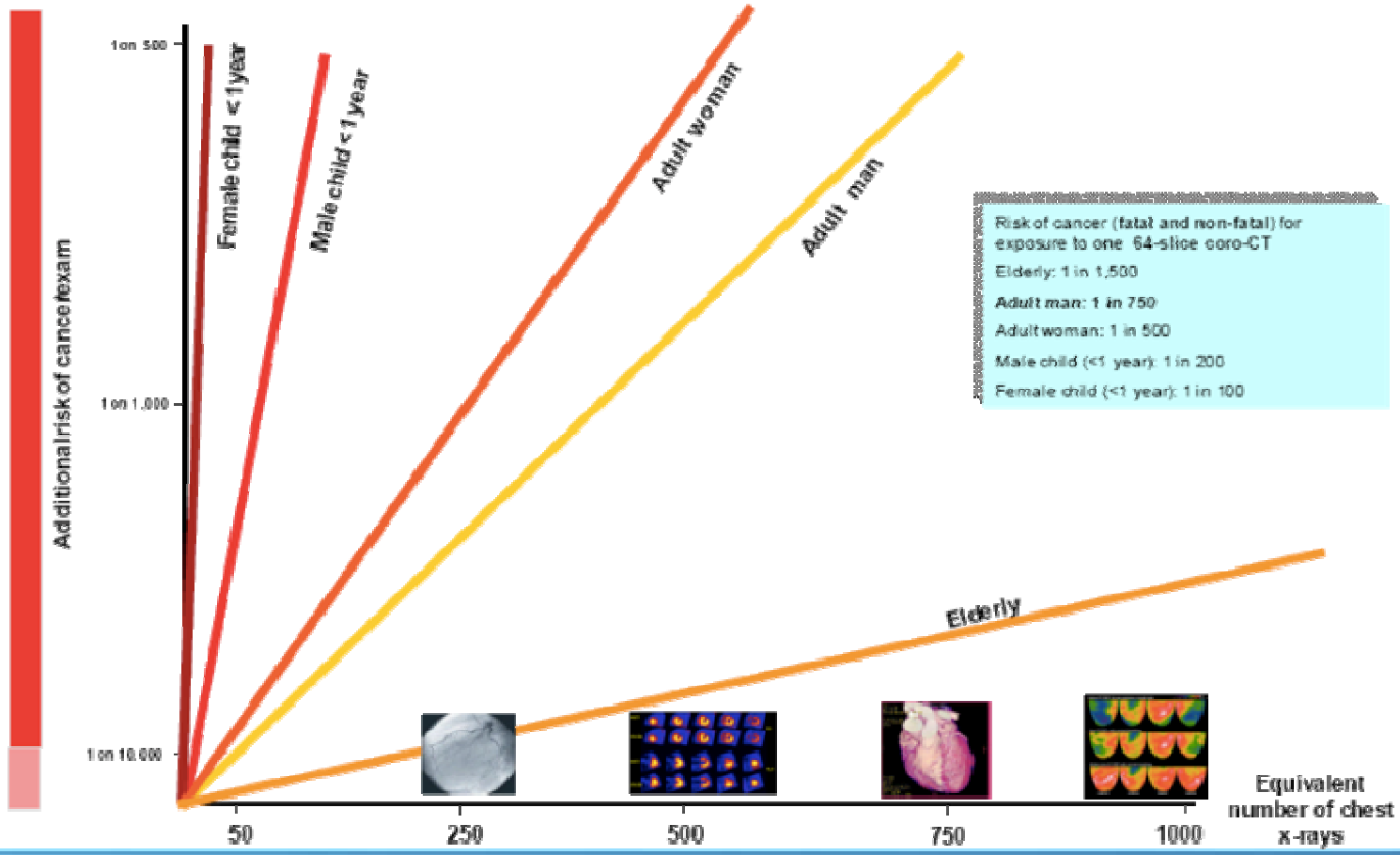








RISCO



*Picano E, BMJ 9 October 2004, updated with **BEIR VII**, 2006*

TABLE 1: TYPICAL EFFECTIVE DOSES OF RADIATION DURING DIAGNOSTIC MEDICAL EXPOSURE (8)

Diagnostic procedure	Typical effective dose (mSv)	Equivalent no. of chest x-rays	Approximate equivalent period of natural background radiation*
Radiographic examinations			
Limbs and joints (except the hip)	<0.01	<0.5	<1.5 days
Chest (single PA film)	0.02	1	3 days
Skull	0.06	3	9 days
Thoracic spine	0.7	35	4 months
Lumbar spine	1.0	50	5 months
Hip	0.4	20	2 months
Pelvis	0.7	35	4 months
Abdomen	0.7	35	4 months
CT head	2.0	100	10 months
CT chest	8.0	400	3.6 years
CT abdomen or pelvis	10.0	500	4.5 years
Radionuclide studies			
Bone (technetium-99m)	4.0	200	1.8 years
PET head (F-18 FDG)	5.0	250	2.3 years

**UK average background radiation is 2.2 mSv per year; regional averages are 1.5–7.5 mSv per year.*

Abbreviations: FDG, fluorodeoxyglucose; PA, posterior–anterior; PET, positron emission tomography.

PROTEÇÃO RADIOLÓGICA

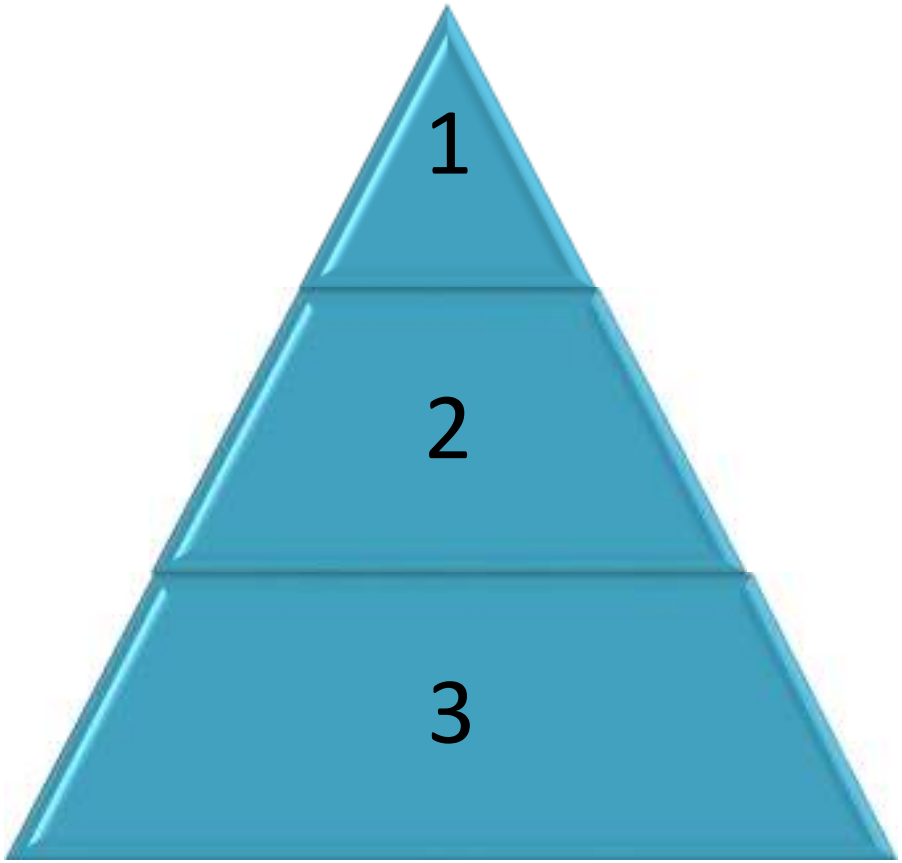
PROTEÇÃO RADIOLÓGICA

International Commission for Radiological Protection (ICRP)

- Justificação
- Otimização
- Limites de dose

- *Radiation Exposure situation should be more good than harm*
- *Should result in sufficient individual or societal benefit to offset the detriment it causes*

NÍVEIS DE JUSTIFICAÇÃO



Individual por doente

Por Procedimento

Em Medicina

LEI

European Commission

Official Journal of the European Communities

COUNCIL DIRECTIVE 97/43/EURATOM

of 30 June 1997

MINISTÉRIO DA SAÚDE

Decreto-Lei n.º 180/2002

de 8 de Agosto

ISSN 1977-0677
doi:10.3000/19770677.L_2014.013.eng

Official Journal
of the European Union

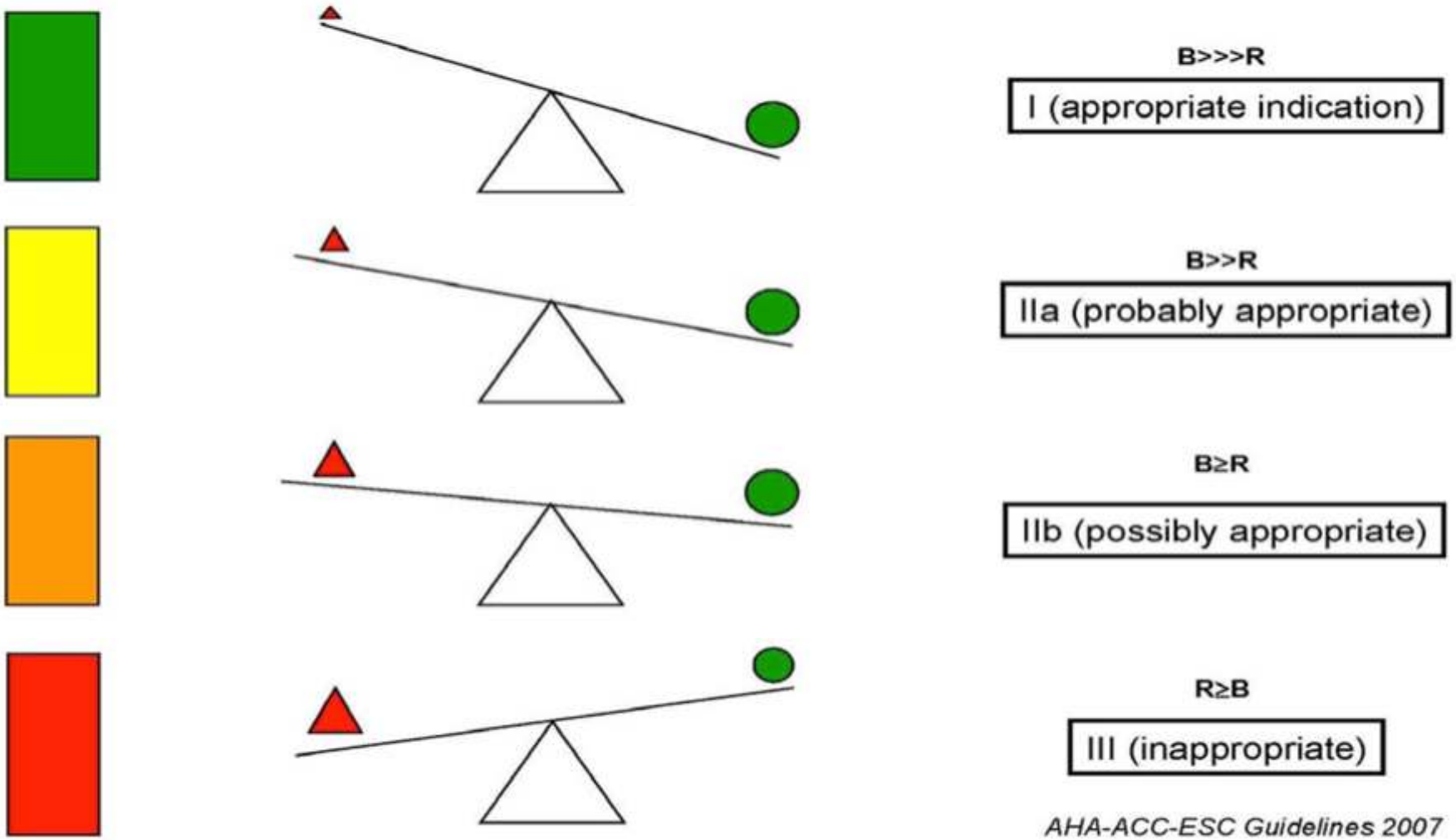
L 13
Volume 57
17 January 2014

BASIC SAFETY STANDARDS

6 Fevereiro 2018

http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2014:013:SOM:EN:HTML

Risk vs Benefit: The code of appropriateness

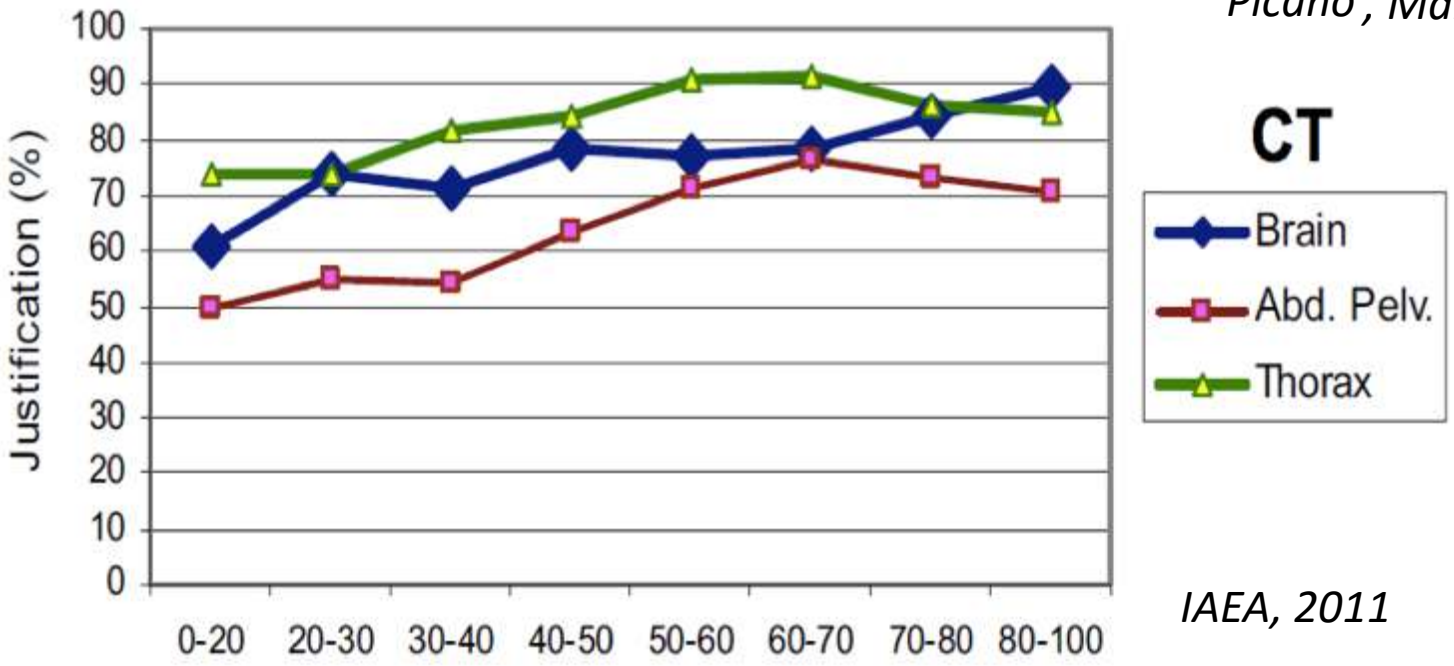


Int. J. Environ. Res. Public Health **2009**, *6*, 1649-1664; doi:10.3390/ijerph6051649

EXAMES INJUSTIFICADOS

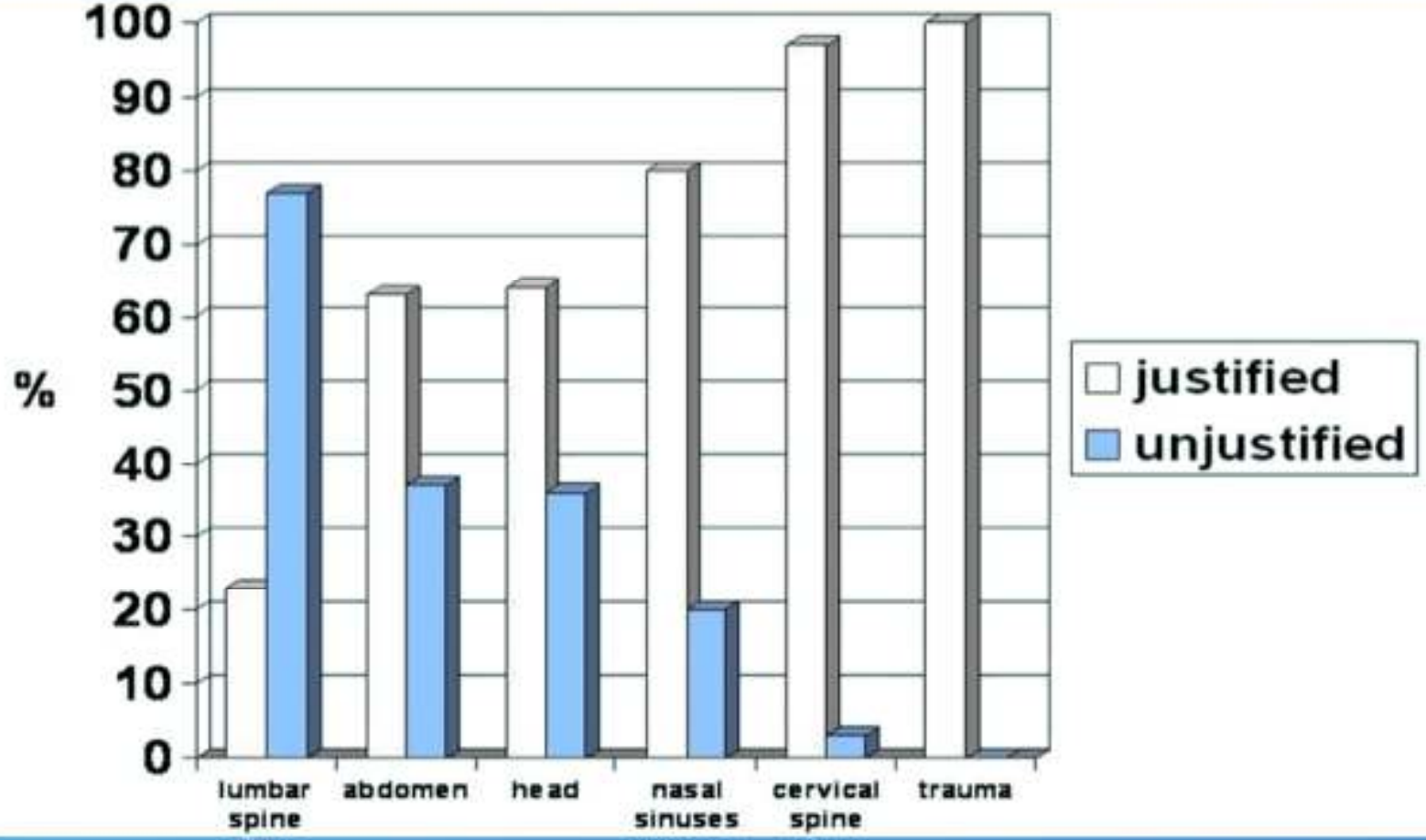
- 30-50% dos exames de diagnóstico por imagem são parcial ou totalmente inapropriado
- 20-50% dos exames radiológicos são inapropriados
- 20% das radiografias da coluna lombar e do joelho são injustificadas

Picano , Malone , Remedios



IAEA, 2011

TC JUSTIFICADOS VS INJUSTIFICADOS (%)



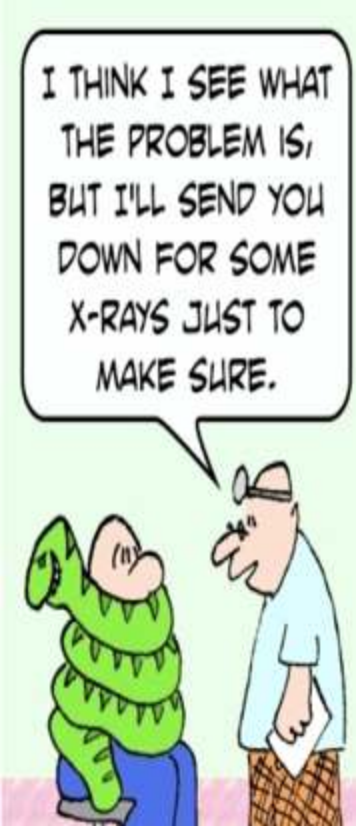
http://dx.doi.org/10.1594/ecr2009/B-789

RAZÕES

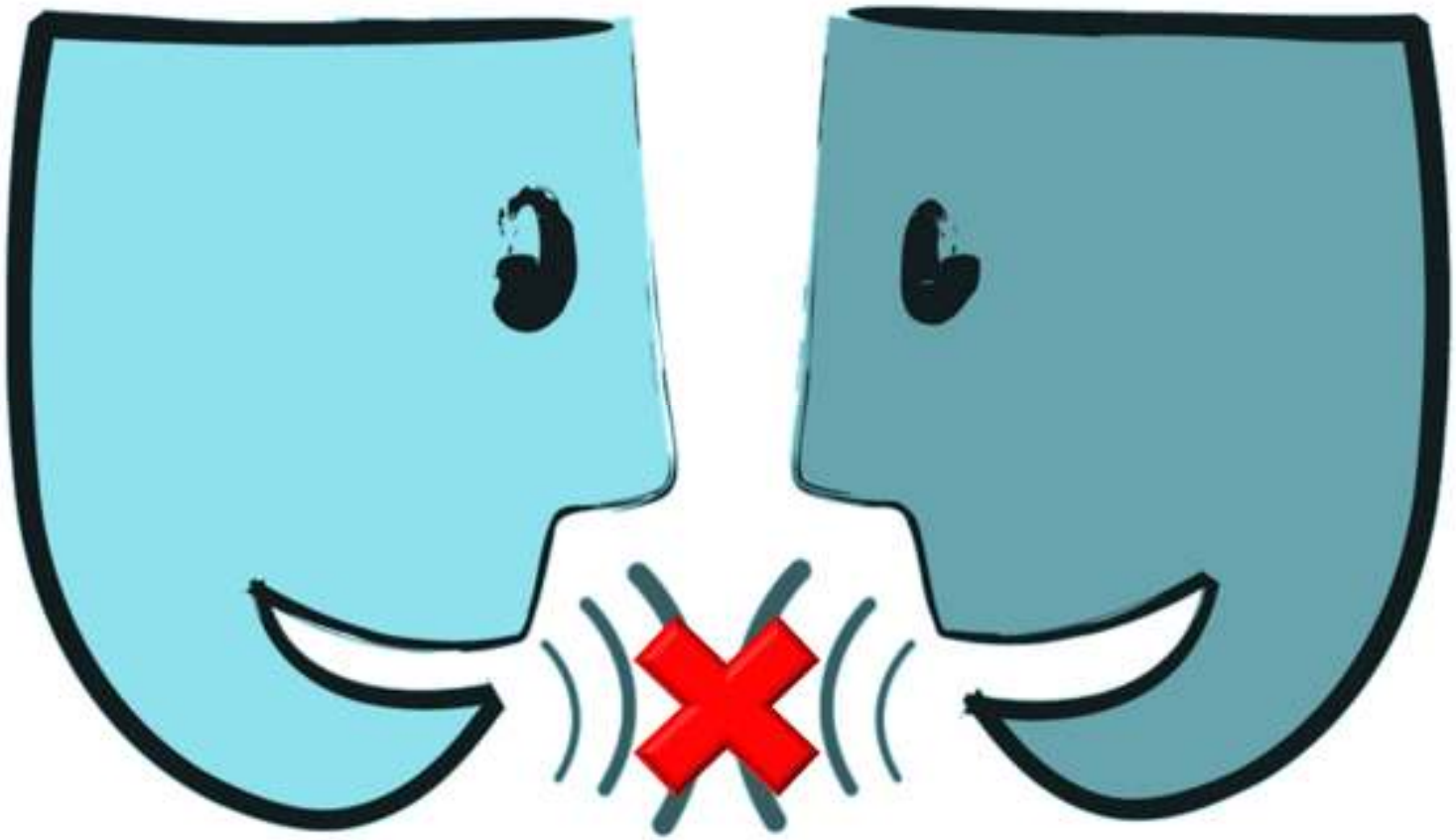
World Health Organization

- Falta de informação sobre o risco associado à exposição à radiação
- Não possuir *guidelines* no seu local de trabalho;
- Confiança no diagnóstico vs expectativas dos doentes e família;
- Auto-prescrição, rastreios disponíveis, medicina defensiva;
- Pressão de outros especialistas (*O que se irá visualizar numa TC?*);
- Pressão do mercado e da tecnologia;
- Não possuir a modalidade de imagem mais indicada (Eco, RM);
- Repetições de exames por estudo em diferentes unidades de cuidados de saúde.

REALIDADE DA JUSTIFICAÇÃO



REALIDADE DA JUSTIFICAÇÃO



Falta de diálogo

GUIDELINES PARA JUSTIFICAÇÃO

IAEA 3A INITIATIVE

Staff deve estar envolvido

Awareness

Entender o risco
Comunicar a dose e o risco
Relação Risco-Beneficio

Appropriateness

Disponibilidade e uso de guidelines
Comunicação entre prescritores e excutantes

Audit

Adequação da informação clínica
De acordo com as “referral guidelines”

Cornelius Lewis, 2013

IAEA E IMAGE WISELY

IAEA 3A initiative

Awareness

Appropriateness

Audit

USA : 4A Innovation Model

Awareness

Accountability

Ability

Action

JUSTIFICAÇÃO CORRETA

Avoid inappropriate examinations by asking yourself:

A. Has it been done already?

B. Do I need it?

C. Do I need it now?

D. Is this the best examination?

E. Have I explained the clinical problem?

Adapted from: iRefer: Making the best use of clinical radiology. Royal College of Radiologists

http://www.rcr.ac.uk/content.aspx?PageID=995

- Pedido adequado;
- Urgência da realização do procedimento;
- Caracterísiticas do procedimento (exposição);
- Características individuais do paciente;
- Informação relevante obtida em outros procedimentos radiológicos.

IAEA, 2013

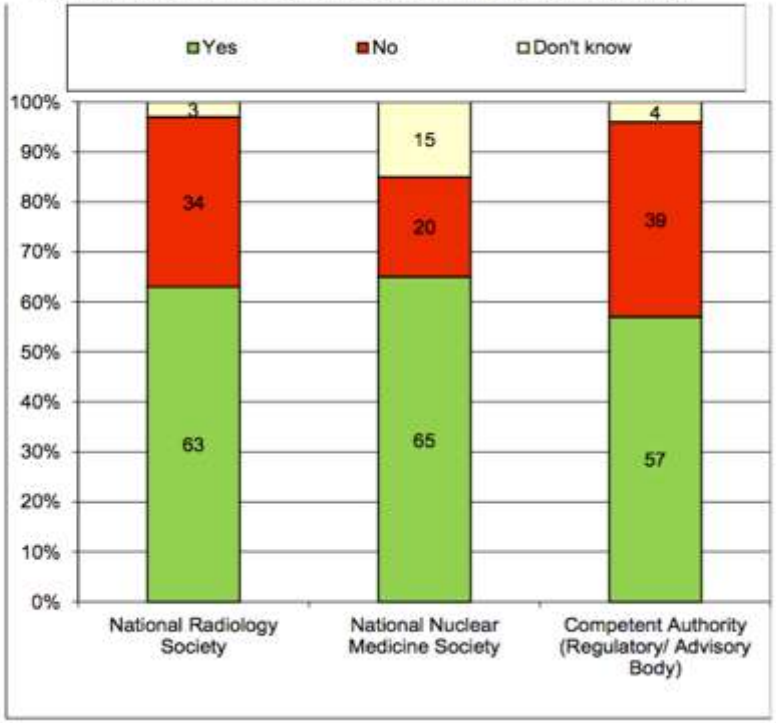
IAEA

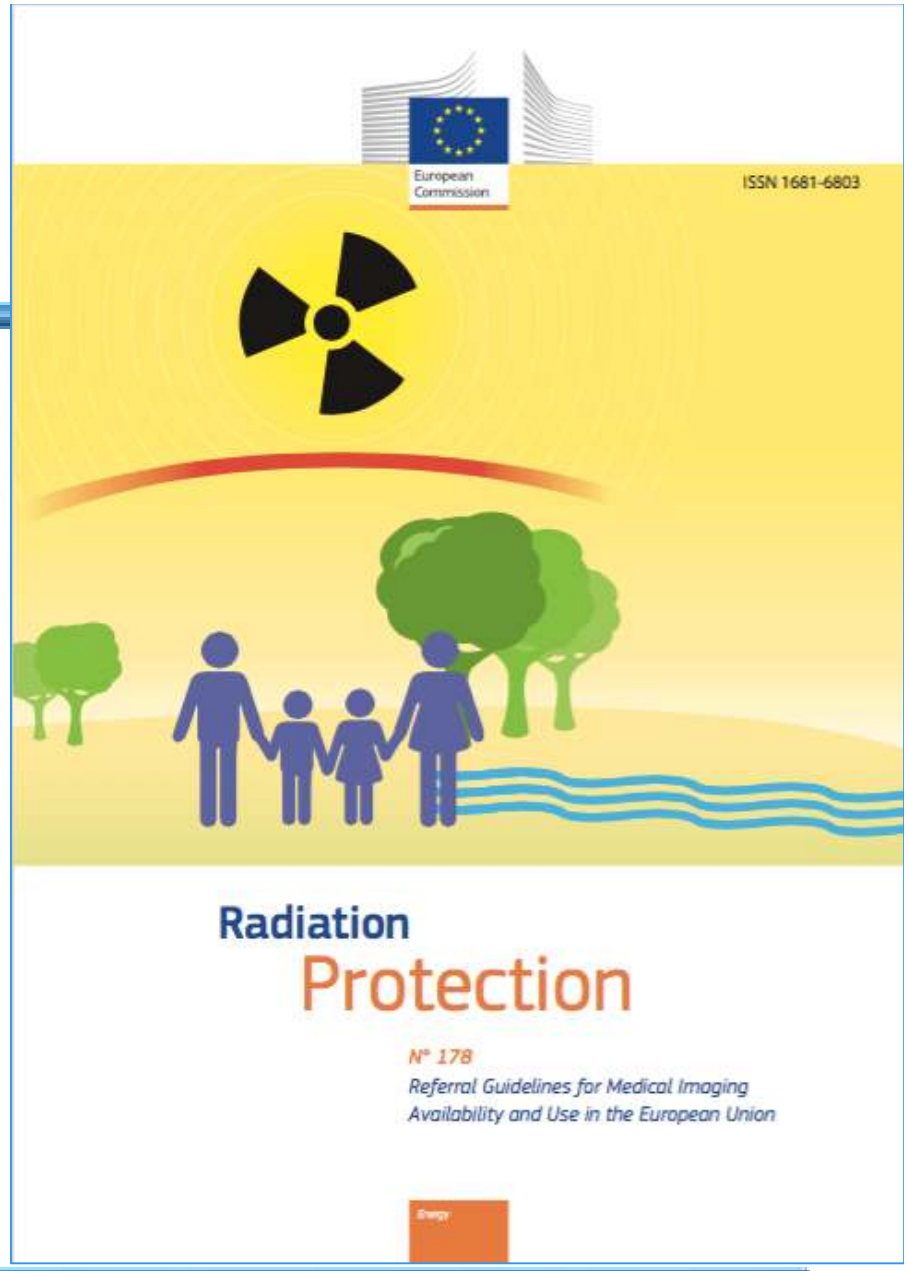
http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1532_web.pdf

UNIÃO EUROPEIA

RP 178

Figure 1: Guidelines Survey: Responses (by national societies or competent authorities) as to the legal requirement for imaging referral guidelines in 30 European countries





http://www.eurosafeimaging.org/wp/wp-content/uploads/2015/05/Radiation-Protection-178.pdf

ACR

www.acr.org

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ACR Appropriateness Criteria®

Access the appropriateness criteria ratings tables and narratives

Best viewed in Firefox 15+, Chrome 15+, Internet Explorer 9+, and Safari 5+

Use the buttons below to access the AC rating tables and narrative documents.
"Basic Access" lists topics by panel and does not require login.

BASIC ACCESS » Browse the list of AC topics and ratings tables

ADVANCED SEARCH » Search and filter AC topics and ratings tables (login required)

The ACR Appropriateness Criteria® (AC) are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. Employing these guidelines helps providers enhance quality of care and contribute to the most efficacious use of radiology. Learn More

November 2015 Update — The latest release of the ACR Appropriateness Criteria includes **three new and 19 revised topics** covering a total of 211 clinical conditions.

ACR - SIMBOLOGIA DE DOSE

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Date of origin: 1998
Last review date: 2015

EXEMPLO

Dor torácica inespecifica

Date of origin: 1998
Last review date: 2015

American College of Radiology
ACR Appropriateness Criteria®

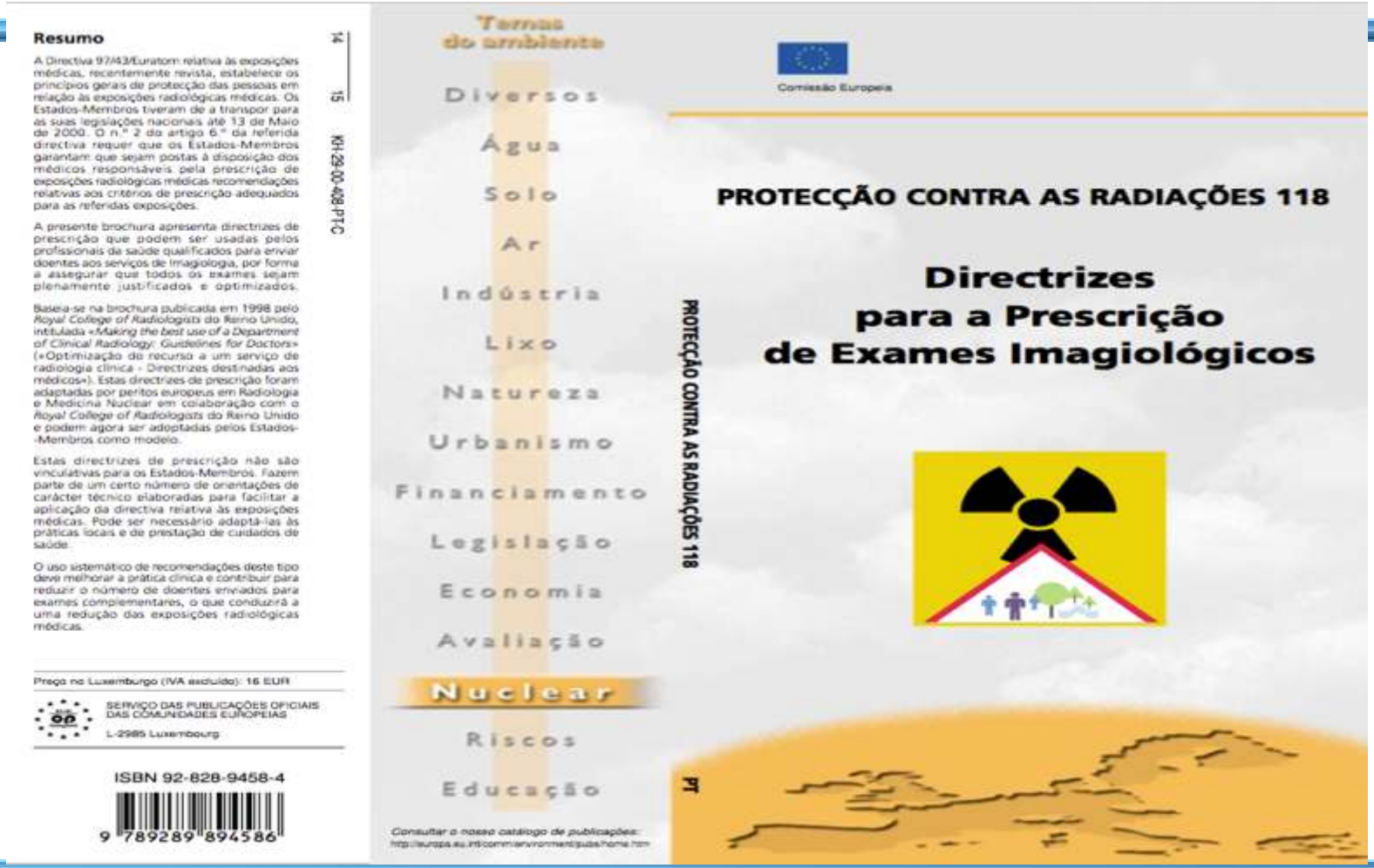
Clinical Condition: **Acute Nonspecific Chest Pain—Low Probability of Coronary Artery Disease**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9	X-ray, CTA, and US are generally nonoverlapping and can be used sequentially.	☢
CTA coronary arteries with contrast	7	X-ray, CTA, and US are generally nonoverlapping and can be used sequentially.	☢☢☢
CTA chest with contrast	7	X-ray, CTA, and US are generally nonoverlapping and can be used sequentially.	☢☢☢
US echocardiography transthoracic resting	7	X-ray, CTA, and US are generally nonoverlapping and can be used sequentially.	O
SPECT MPI rest and stress	6		☢☢☢☢
Tc-99m V/Q scan lung	5		☢☢☢
X-ray rib views	5		☢☢☢
MRA chest without and with contrast	5		O
MRI heart stress perfusion without and with contrast	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	O
MRI heart function and morphology without and with contrast	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	O
US echocardiography transthoracic stress	5		O
MRA chest without contrast	4		O
X-ray barium swallow and upper GI series	4		☢☢☢
X-ray thoracic spine	4		☢☢☢
US abdomen	4		O
MRI heart function and morphology without contrast	4		O
US echocardiography transesophageal	2		O
Arteriography coronary	1		☢☢☢

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

PORTUGAL



Resumo

A Directiva 97/43/Euratom relativa às exposições médicas, recentemente revista, estabelece os princípios gerais de protecção das pessoas em relação às exposições radiológicas médicas. Os Estados-Membros tiveram de a transpor para as suas legislações nacionais até 13 de Maio de 2000. O n.º 2 do artigo 6.º da referida directiva requer que os Estados-Membros garantam que sejam postas à disposição dos médicos responsáveis pela prescrição de exposições radiológicas médicas recomendações relativas aos critérios de prescrição adequados para as referidas exposições.

A presente brochura apresenta directrizes de prescrição que podem ser usadas pelos profissionais da saúde qualificados para enviar doentes aos serviços de Imagiologia, por forma a assegurar que todos os exames sejam plenamente justificados e optimizados.

Baseia-se na brochura publicada em 1998 pelo *Royal College of Radiologists* do Reino Unido, intitulada «*Making the best use of a Department of Clinical Radiology: Guidelines for Doctors*» («Optimização do recurso a um serviço de radiologia clínica - Directrizes destinadas aos médicos»). Estas directrizes de prescrição foram adaptadas por peritos europeus em Radiologia e Medicina Nuclear em colaboração com o *Royal College of Radiologists* do Reino Unido e podem agora ser adoptadas pelos Estados-Membros como modelo.

Estas directrizes de prescrição não são vinculativas para os Estados-Membros. Fazem parte de um certo número de orientações de carácter técnico elaboradas para facilitar a aplicação da directiva relativa às exposições médicas. Pode ser necessário adaptá-las às práticas locais e de prestação de cuidados de saúde.

O uso sistemático de recomendações deste tipo deve melhorar a prática clínica e contribuir para reduzir o número de doentes enviados para exames complementares, o que conduzirá a uma redução das exposições radiológicas médicas.

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PROTECÇÃO CONTRA AS RADIAÇÕES 118

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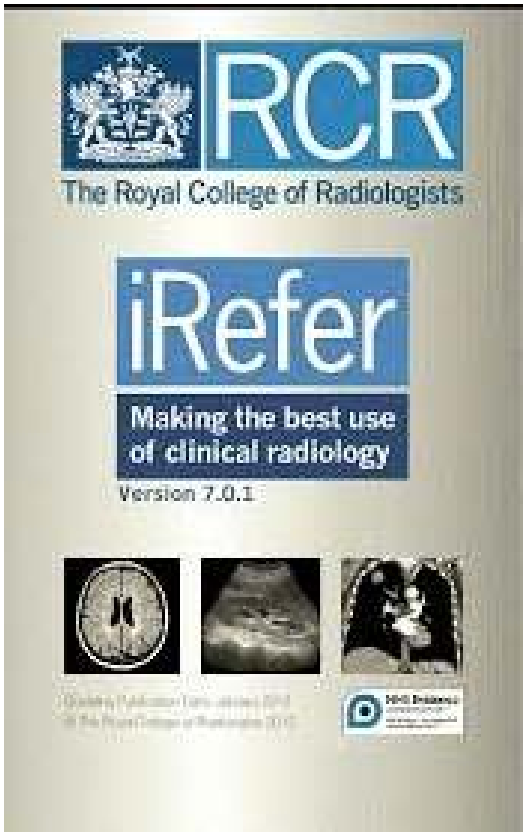
PROTECÇÃO CONTRA AS RADIAÇÕES 118

Directrizes para a Prescrição de Exames Imagiológicos

http://www.sprmn.pt/pdf/Directrizes_Prescricao_de_Exames_Radiologicos_Radiation_Protection_118_pt.pdf

REFERRAL GUIDELINES



2012

http://www.irefer.org.uk/index.php/about-irefer

RCR The Royal College of Radiologists

iRefer Making the best use of clinical radiology

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Referral guidelines | Paediatrics | Gastrointestinal system | Acute abdominal pain in children

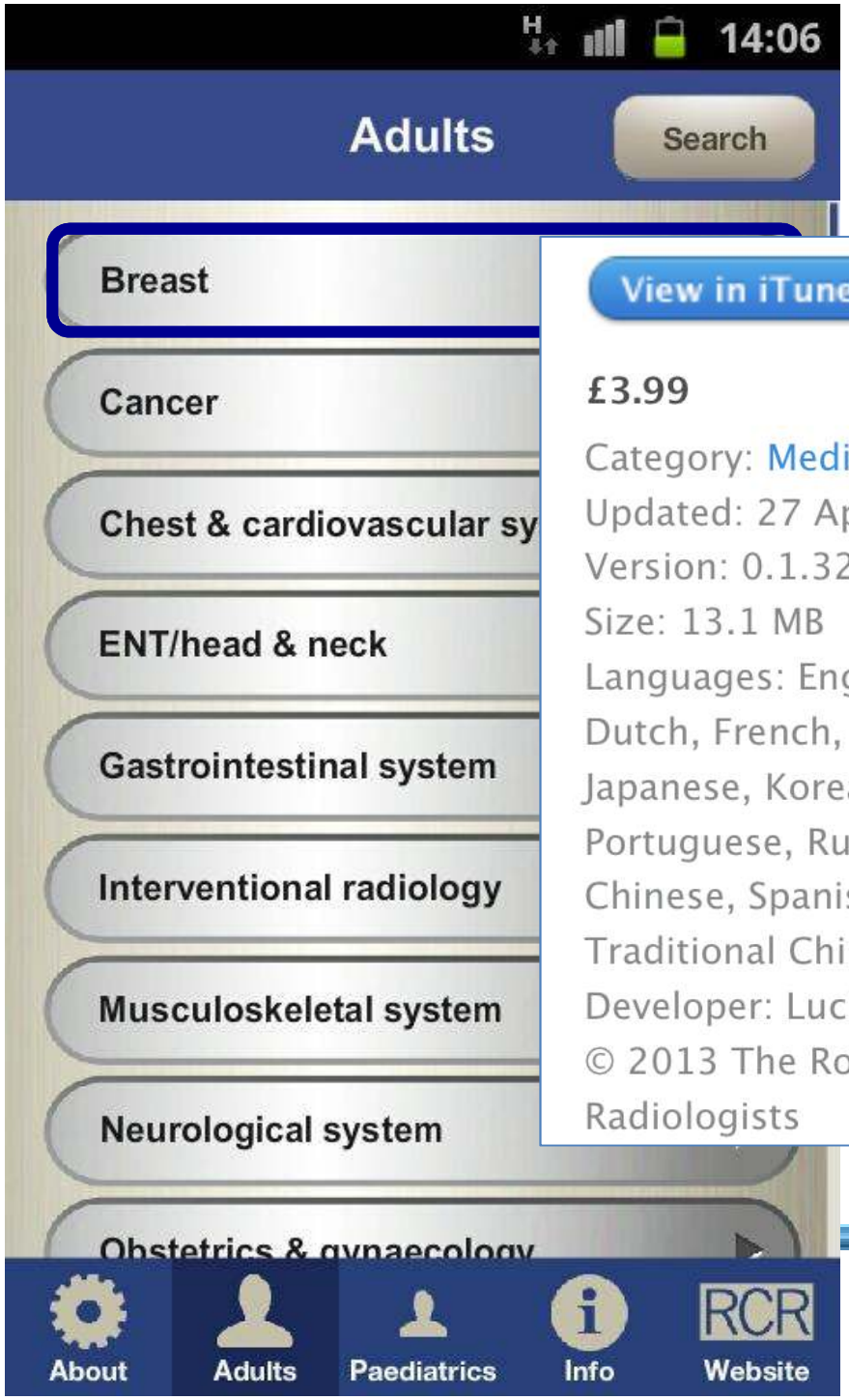
Related Guidelines

- Chest & cardiovascular system
- ENT/head & neck
- Gastrointestinal system
- Musculoskeletal system
- Urogenital & adrenal

- P21: Intussusception in children
- P22: Ingested foreign body in children
- P23: Blunt abdominal trauma in children
- P24: Projectile vomiting in infants
- P25: Recurrent vomiting in children
- P26: Persistent neonatal jaundice
- P27: GI bleeding (per rectum) in children
- **P28: Acute abdominal pain in children**
- P29: Constipation in children
- P30: Palpable abdominal/pelvic mass in children

Investigation	Dose	Recommendation [Grade]	Comment
US	None	Indicated [B]	There are many causes of acute abdominal pain. US is a useful first investigation but needs to be guided by clinical findings.
AXR	☢	Specialised investigation [C]	AXR is rarely of value and is best performed under specialist guidance. Generally AXR is not undertaken before US.
CT	☢☢☢	Specialised investigation [B]	Although CT is more sensitive than US for the diagnosis of appendicitis, specificities are similar and the strategy for imaging should take into account radiation dose and clinical features.
MRI	None	Indicated only in specific circumstances [B]	Following abdominal US, when TVUS is not feasible, MRI is occasionally helpful for evaluating pelvic masses in girls.

RCR: Abdominal pain in children


14:06
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£3.99
Category: Medical
Updated: 27 April 2014
Version: 0.1.32
Size: 13.1 MB
Languages: English, Czech, Dutch, French, German, Italian, Japanese, Korean, Polish, Portuguese, Russian, Simplified Chinese, Spanish, Swedish, Traditional Chinese, Turkish
Developer: Lucid Graphics Ltd
© 2013 The Royal College of Radiologists
RCR iRefer
Making the best use of clinical radiology
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Adults
Search
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cancer, including those
mily history and previous
stinal radiotherapy
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investigation (B)
investigation (B)
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es (B)
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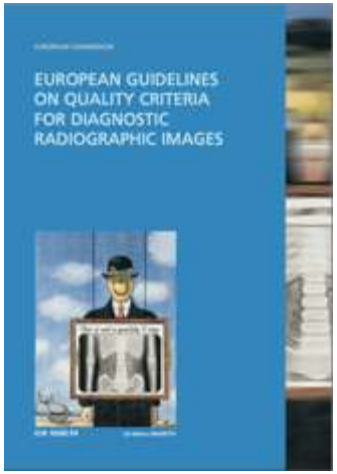
OTIMIZAÇÃO

PRINCÍPIO FUNDAMENTAL

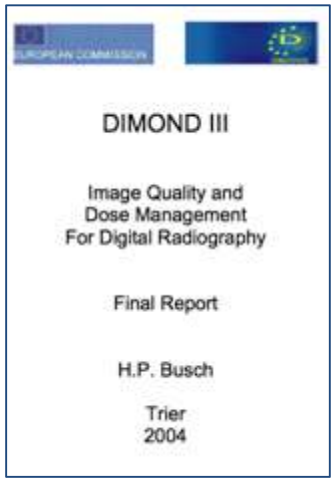
ALARA

As Low As Resonably Achievable

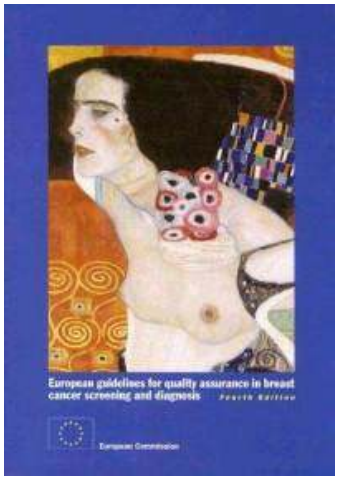
GUIDELINES POR PROCEDIMENTO



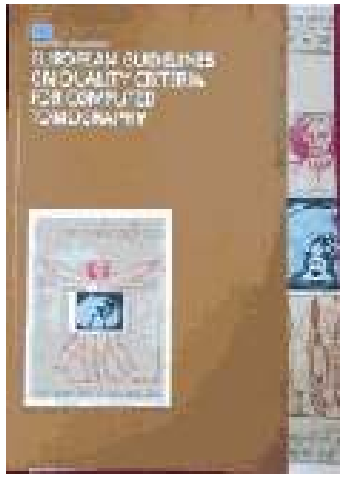
EUR16260, 1996
S/F



EU, 2004
Digital radiography



EURFER, 2006
Mammography

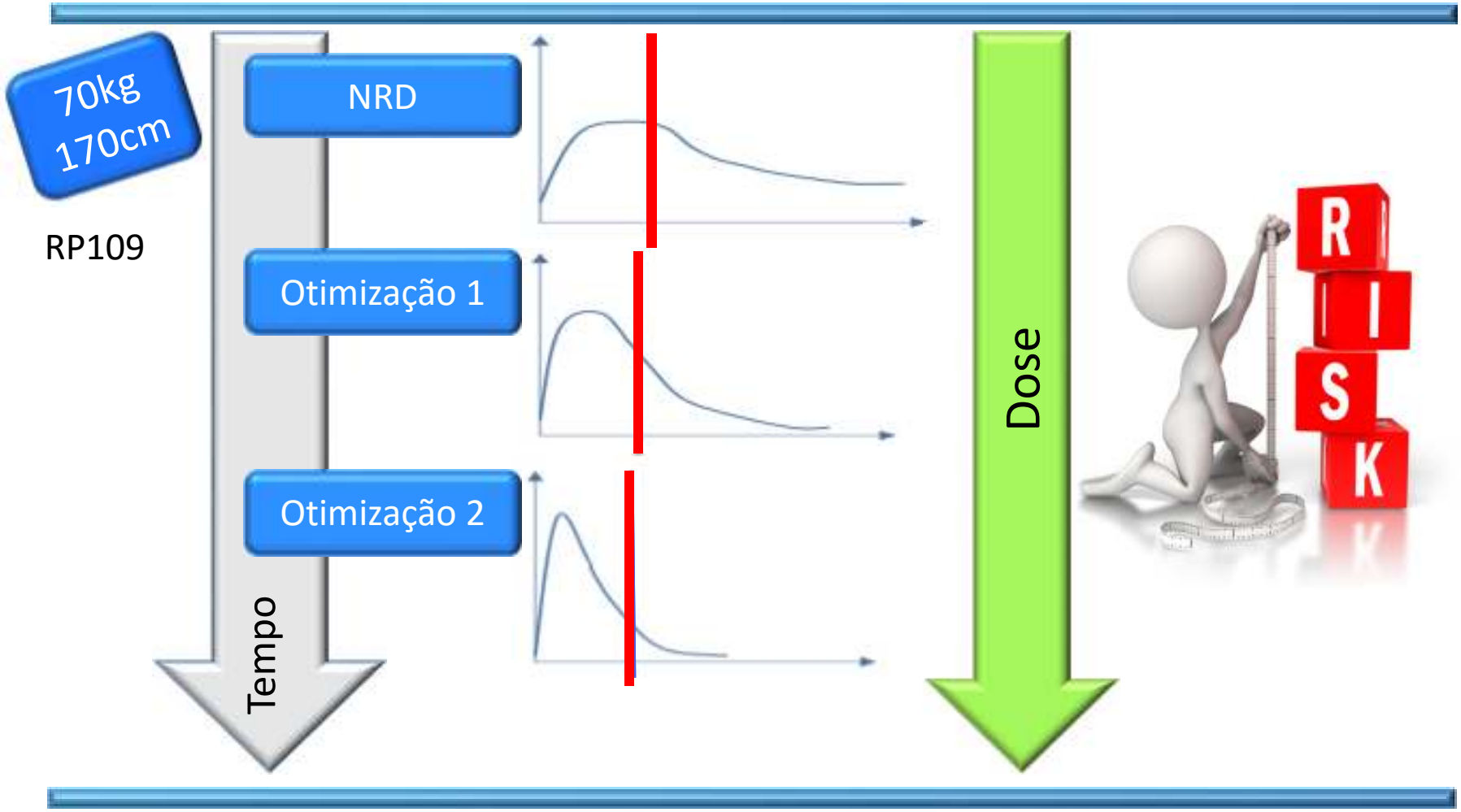


EUR16262, 1996
TC

G. Bongartz, 2004

http://biophysicssite.com/html/msct_quality_criteria_2004.html

NÍVEIS DE REFERÊNCIA DE DIAGNÓSTICO



Baseado nas International Commission Radiation Protection Report (2007)

DIFICULDADE

DOSE

QUALIDADE DE IMAGEM

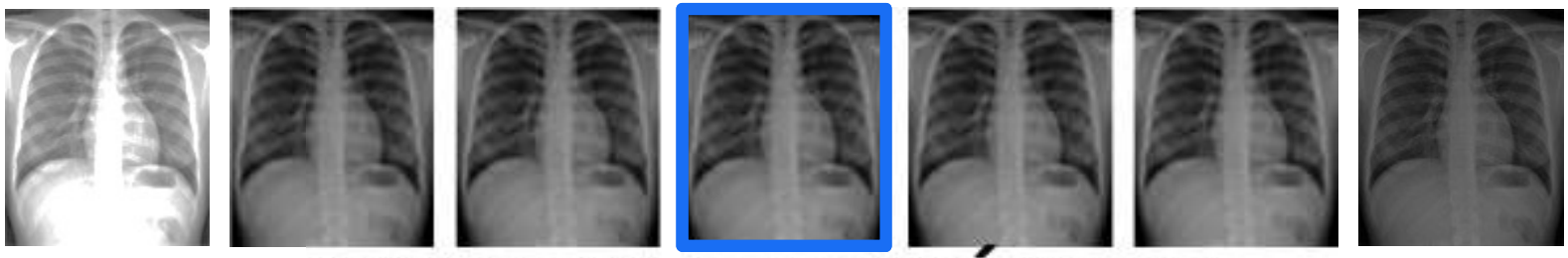


IMAGEM DIAGNÓSTICA

OTIMIZAR

http://rpop.iaea.org

IMAGE WISELY®
Radiation Safety in Adult Medical Imaging

http://www.imagewisely.org

ESR EUROSAFE IMAGING

http://www.eurosafeimaging.org

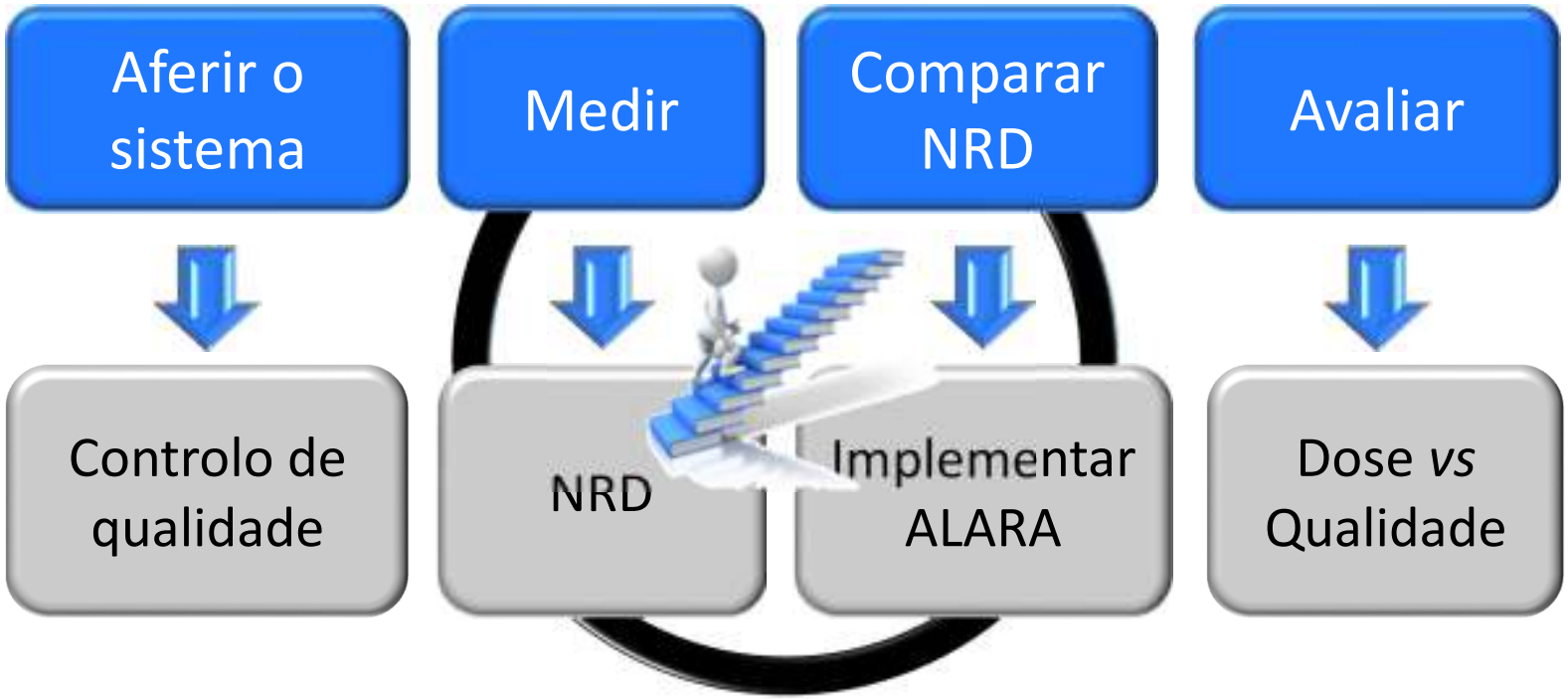
image gently®

ONE SIZE DOES NOT FIT ALL...

PROCESSO DE OTIMIZAÇÃO

Aferir o sistema	Medir	Comparar NRD	Avaliar
⇓	⇓	⇓	⇓
Controlo de qualidade	NRD	Implementar ALARA	Dose *vs* Qualidade

PROCESSO DE OTIMIZAÇÃO



LIMITES DE DOSE

EXPOSIÇÃO À RADIAÇÃO IONIZANTE

	Parâmetros de Exposição	Tensão (kV), corrente (mAs), tempo de exposição(ms)
Dose	Doente	DAP(Gy.cm^2), ESD, CTDIvol, SSDE (mGy), DLP (mGy.cm)
	Profissional	Dose Efetiva (mSv)
	População	Estimativa de DE (mSv)

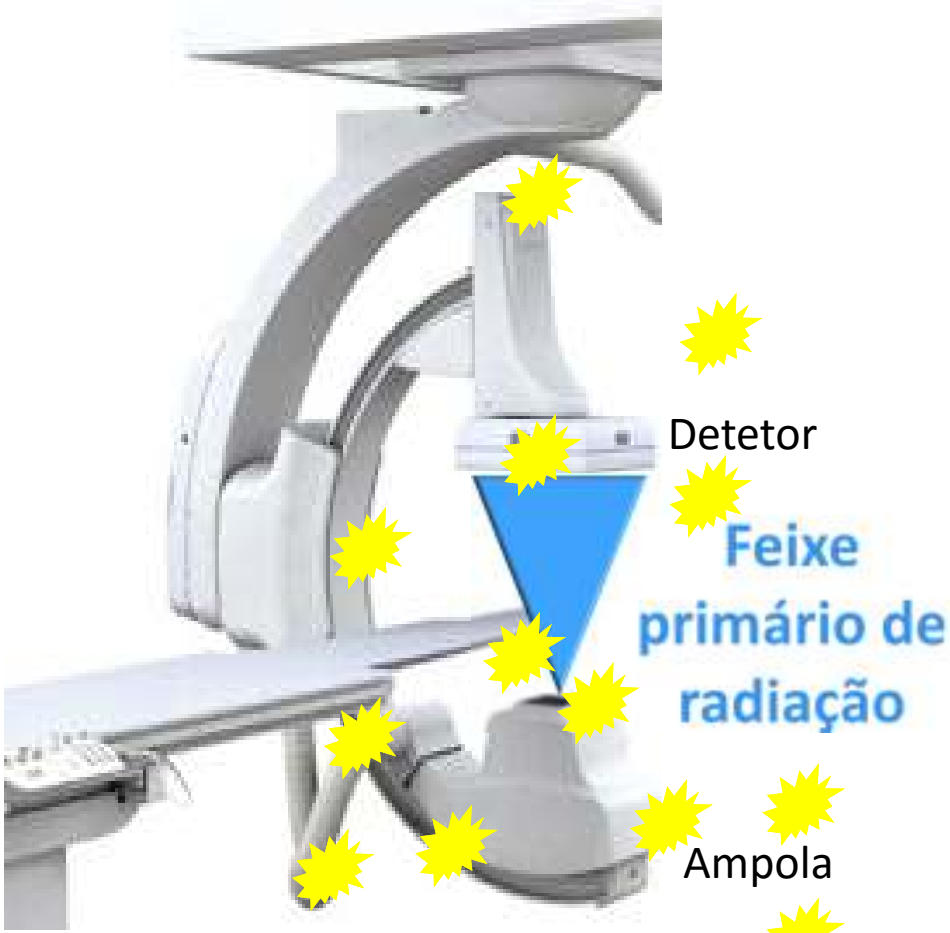
ICRP 37, 2007

DEPARTAMENTOS COM EXPOSIÇÃO

- Radiologia
- Medicina Nuclear
- Radioterapia
- Bloco Operatório
  - Ortopedia,
  - Urologia
  - Neurocirurgia
  - Cardiologia
  - ORL…
- Gastroenterologia
- Enfermarias
- …

REAÇÃO DOS PROFISSIONAIS

RADIAÇÃO DISPERSA



Radiation safety in Interventional Radiology, Vol13, Set 2010

PRINCÍPIOS BÁSICOS

Tempo

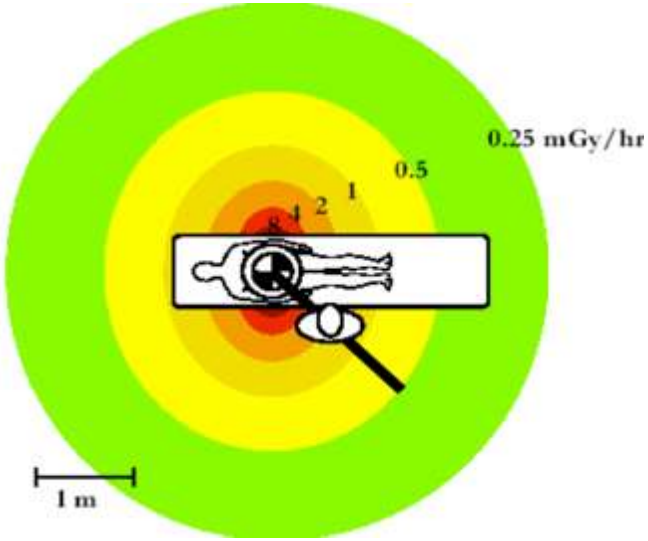
Barreiras

Distância

ICRP 21, 1991

PROTEÇÃO PESSOAL

COMPORTAMENTO



MONITORIZAÇÃO

Região torácica esquerda por baixo do avental

Investigação

EYE-D ™

VALORES DE DOSE

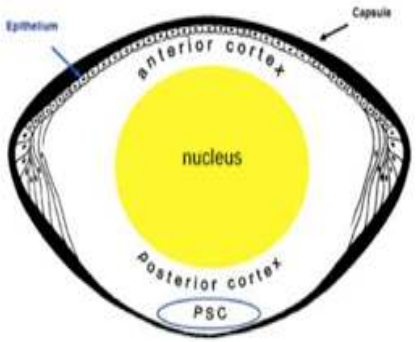
Aplicação	Trabalhadores	Público
Dose efectiva	20 mSv/ano em média para 5 anos Dose anual máxima: 50 mSv	1 mSv/ano
Dose equivalente anual		
Cristalino	20 mSv 150 mSv	15 mSv
Pele	500 mSv	50 mSv
Extremidades (mãos e pés)	500 mSv	

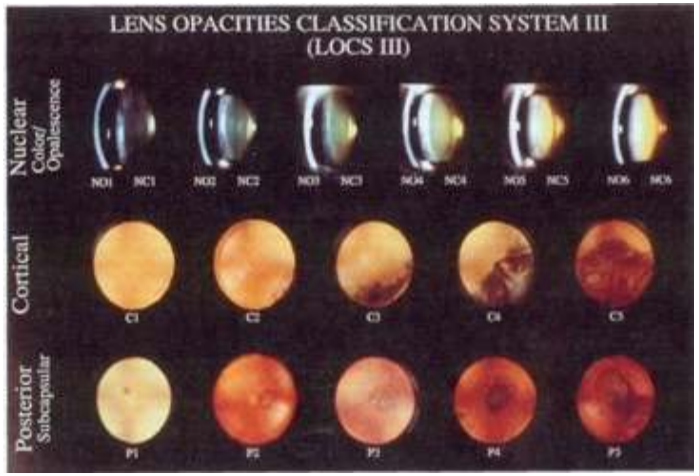
Decreto-Lei 222/2008

ICRP, Maio 2011

CONSULTA MEDICINA TRABALHO

- Hemograma
- **Exclusão** da radiografia do Tórax do check-up
- Estudo de órgãos radiosensíveis:
  - Ecografia Tiróide
  - Ecografia Mama
  - Cristalino





PERSPECTIVAS FUTURAS

MUDANÇA DE PARADIGMA

- Reapreciação de pedidos por Médicos Radiologistas;
- Justificação clínica realizada por Radiologistas;
- Consentimento informado relativo ao risco à exposição;
- Informação obrigatória do valores de exposição do doente;
- *Clinical Decision Support* - SIS disponíveis nas instituições.

ESR iGUIDE
EUROPEAN SOCIETY OF RADIOLOGY

Março, 2016

IAEA

World Health Organization

BONN CALL FOR ACTION
10 Actions to Improve Radiation Protection in Medicine in the Next Decade

Enhance the implementation of the principle of justification

CONCLUSÕES

EXPOSIÇÃO

Injustificada

Desadequada

Não otmizada

Reduzida para o estudo

Desnecessária

Overexposure

Adequação da exposição

Imagem Médica

Medicina

FMUC FACULDADE DE MEDICINA
UNIVERSIDADE DE COIMBRA

OBRIGADO PELA ATENÇÃO !!!

joanasantos@estescoimbra.pt

IMAGEM MÉDICA E RADIOTERAPIA
COIMBRA HEALTH SCHOOL

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