Why radiation protection matters?

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A definition for radiation protection

Radiation Protection is a combination of rules, requirements, guidelines, technologies, operations and behaviors for the protection of people (occupational, patients, public) and environment against the harmful effects of ionizing radiation.
The aim of radiation protection

- Minimize patient radiation exposure to ionizing radiation without sacrificing the diagnostic information or the therapeutic effect

- Ensure protection of health professionals and general public
The principles of radiation protection

- **Justification of practices:** Any decision that alters the radiation exposure situation should do more good than harm

- **Optimization of protection:** All exposures should be kept as low as reasonably achievable (ALARA)

- **Limitation of exposure:** The total dose to any individual should not exceed the dose limits recommended by the ICRP

*ICRP 103 2007, The 2007 recommendations of the International Commission on Radiological Protection*
## Dose Limits

<table>
<thead>
<tr>
<th>Equivalent Dose (mSv/yr)</th>
<th>Occupational</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens of eye</td>
<td>150</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Skin</td>
<td>500</td>
<td>50</td>
</tr>
<tr>
<td>Hands/Feet</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>Effective dose</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

!!! Dose Limits are not applicable to patients

*International Commission on Radiological Protection 2011 Statement on tissue reactions ICRP 4825-3093-1464, April 2011*
Why radiation protection is important?

- Harmful effects of ionizing radiation
- Increased frequency of X-ray examinations
- High radiation doses
Why radiation protection is important?

Harmful effects of ionizing radiation

- **Stochastic effects**
  - The probability of occurrence increases with increasing absorbed dose
  - The severity of the response is not proportional to the dose
  - No threshold dose
  - Cancer, genetic effects

- **Deterministic effects**
  - Occur only after high dose exposure (> 0.1 Gy)
  - The severity increases with absorbed dose
  - Have a dose threshold
  - Skin lesions, fibrosis, erythema, cataracts
Why radiation protection is important?

Harmful effects of ionizing radiation

NCI skin toxicity grade 4. (a) Central area of deep necrosis surrounded by indurated and depigmented skin within an area of prolonged erythema at 30 weeks after coronary angioplasty (b) Same patient 38 weeks after the procedure.

Balter et al. 2010. Fluoroscopically Guided Interventional Procedures: A Review of Radiation Effects on Patients’ Skin and Hair
Why radiation protection is important?

Harmful effects of ionizing radiation

Radiation injury in a 60-year-old woman from neurointerventional procedure for the treatment of acute stroke. Fluoroscopy time > 70 min.

Balter et al. 2010. Fluoroscopically Guided Interventional Procedures: A Review of Radiation Effects on Patients’ Skin and Hair
Why radiation protection is important?

Harmful effects of ionizing radiation

Radio-induced crystalline lens opacity in an interventional radiologist submitted to high levels of radiation using an X-ray tube above the table. Region 1 indicates posterior subcapsular opacity; Region 2, perinuclear punctate opacities.

Why radiation protection is important?

<table>
<thead>
<tr>
<th>Examination</th>
<th>No of examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>Conventional Radiology</td>
<td>39,586,000</td>
</tr>
<tr>
<td>CT</td>
<td>1,387,000</td>
</tr>
<tr>
<td>Interventional (non-CT)</td>
<td>247,000</td>
</tr>
</tbody>
</table>

+ 59%                     
+ 78%

Why radiation protection is important?

Radiation doses

- New techniques and applications (MDCT, CT biopsy...) delivers high radiation doses

- In interventional procedures (IR), both patients and medical staff receive high radiation doses:
  - complicated procedures
  - high fluoroscopy times
  - acquisition of large number of images
  - high dose rates
Why radiation protection is important?

Patient radiation doses

Why radiation protection is important?

Data from the Hellenic Record of Radiation Doses, Greek Atomic Energy Commission, 2011
Why radiation protection is important?

### Occupational radiation doses

<table>
<thead>
<tr>
<th>Fluoroscopically-guided procedures</th>
<th>Effective dose per procedure (μSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac</strong></td>
<td></td>
</tr>
<tr>
<td>Diagnostic catheterization</td>
<td>0.02-38</td>
</tr>
<tr>
<td>PCI</td>
<td>0.17-31.2</td>
</tr>
<tr>
<td>Ablations</td>
<td>0.24-9.6</td>
</tr>
<tr>
<td><strong>Non-cardiac</strong></td>
<td></td>
</tr>
<tr>
<td>PCNL</td>
<td>1.7-56</td>
</tr>
<tr>
<td>Vertebroplasty</td>
<td>0.1-101</td>
</tr>
<tr>
<td>Biliary tract procedures</td>
<td>2.0-46</td>
</tr>
<tr>
<td>TIPS</td>
<td>1.8-53</td>
</tr>
<tr>
<td>ERCP</td>
<td>0.2-49</td>
</tr>
</tbody>
</table>

Kim et al. 2008. *Occupational radiation doses to operators performing cardiac catheterization*

Kim et al. 2010. *Occupational radiation doses to operators performing fluoroscopically-guided procedures*
Conclusion

Radiation protection....

- Constitutes a very important issue for the safety of occupational, patients and public in every Radiology Department

- Requires education and training of health care workers as well availability of appropriate protection tools and equipment (shielding, personal protective devices)

- Should be an integral part of clinical routine
Thank You!