Radiation Protection in the hybrid operating room

BSVS, 21/03/15
Peter Immesoete
AV Controlatom
Overview

• Who am I?
• Quality of the x-ray beam kV mA
• Principles of radiation protection
• Dose (limits, dosemeter)
• Tasks of the health physicist
Who am I

- Qualified health physicist recognised by the FANC since 2004
- Controlatom, certified inspection body since 1965
- Radiation protection of the people and environment
- Mostly in hospitals
Quality of the x-ray beam
Quality of the x-ray beam

- Automatic Exposure Control
- Filtering (Al + Cu)
- Use the collimator: better image, less scatter radiation
Principles of radiation protection

DISTANCE

TIME

SHIELDING
Distance

Inverse square law!
Distance

- Avoid the direct beam
- Use spacers
- Don’t go in the direct beam with lead gloves (AEC)
Time

- Minimise radiation time, cine runs
- Pulsed scopy with minimal framerate
  - No more continuous scopy

- Knowledge of the DAP (skin: 2 Gy ~ 320 Gycm²)
Shielding

- Shielding of the room (2 – 3 mm Pb)
  - Separate control room (with door)
- Shielding in the room
  - Lead curtains at the table to the floor
  - Plexi screen at the ceiling
- Shielding of the operators
  - Lead apron (2 x 0.25 mm Pb minimum)
  - Lead thyroid collar
  - Lead glasses
Personal protective equipment

- apron + thyroid collar + glasses + gloves: 2%
- apron + thyroid collar + glasses: 34%
- apron + thyroid collar + cabin: 1%
- only apron: 9%
- apron + thyroid collar: 54%
Fraction of the radiation under the apron with scatter radiation:

<table>
<thead>
<tr>
<th>kV</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm Pb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>3</td>
<td>6.5</td>
<td>12</td>
<td>19</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>0.25</td>
<td>1.7</td>
<td>4.5</td>
<td>8</td>
<td>13</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>0.3</td>
<td>1.3</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>0.35</td>
<td>0.9</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>0.5</td>
<td>0.3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4.5</td>
<td>5</td>
</tr>
</tbody>
</table>
Position of the x-ray tube
Dosemeter

• Passive dosemeters: 1 under the apron, 1 above the apron to estimate the dose to unshielded organs (ie eyes, brain, ...)

• Effective dose = dose under the apron + 10% dose above the apron (< 20 mSv/year)

• Active dosemeters
Every professionally exposed person has to wear a dosemeter at the chest (....) » Art. 30.6 - K.B. 20.07.01

<table>
<thead>
<tr>
<th></th>
<th>Professionally exposed person (year)</th>
<th>Public (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective dose (total body)</td>
<td>20 mSv</td>
<td>1 mSv</td>
</tr>
<tr>
<td>Equivalent dose (eyelens)</td>
<td>150 mSv</td>
<td>15 mSv</td>
</tr>
<tr>
<td>Equivalent dose (head, hands, feet)</td>
<td>500 mSv</td>
<td>50 mSv</td>
</tr>
</tbody>
</table>
Some examples

- Transatlantic flight Paris-New York: 0.05 mSv (~ 5 µSv/h)
- 1 day in orbit around earth: 1 mSv
- 1 x-ray of lungs: 0.3 mSv
- 1 x-ray of the teeth: 0.1 mSv
- Irradiation of a tumour: 20-60 Gy

- Yearly dose of the vascular surgeon: ?
Tasks of health physicist

- Preliminary protection study
- Verification of new license (hospital + physician)
- Start-up of the installation
- Periodic inspections
- Investigation of incidents (high dose)
- Verification of procedures, measurement equipment, lead aprons, ...
- Emergency waiting role: always a colleague available
Yearly inspection

- Determination of the radiation intensity
- Detection of radioactive contamination
- Tests of radiation protection (lead aprons, lead shielding, ...)
- Dose monitoring
- Safety signs
- Testing of safety interlocks, ...
- Always a report after site visit
Summary

1 - Tube under table
2 – Collimator
3 – Optimal technical parameters
4 – Lead apron (0.5 mm)
5 – Thyroid collar
6 – Lead glasses
7 - Screen at ceiling
8 - Lead curtain at table
9 - Distance
Collective dose

- Medical applications: 43%
- Cosmic radiation: 8%
- Human activities: 1%
- Soil and building: 9%
- Ra: 30%
- Human body: 7%
- Thoron: 2%
Thank you!

AV Controlatom
Jan Olieslagerslaan 35
1800 Vilvoorde
02/674.51.20
www.controlatom.be