Comparison of measured eye lens doses at the forehead and at collar level

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New dose limit on the dose for the lens of the eye

- New EU BSS - Directive 2013/59/EURATOM

- 150 mSv/y → 20 mSv/y

- In force in DK regulation since 02 February 2018
About comparison
- Pilot measurement project

- Screening period from 2014 to 2018

- All participating on a voluntary basis

- All exposed workers were instructed to use two dosimeters at the same time during the procedures carried out
  - One dosimeter at the forehead
  - One dosimeter at the collar level, outside lead apron

- Measurement period was agreed from time to time
  - The most used measurement period was 1 month

- Participant were asked for information on the practices and profession of each worker, and in most cases this information was provided
Participants in survey

− 10 departments participated

− 8 different practices:
  − Angiography
  − Cardiology
  − CT-guided Intervention
  − Endoscopy
  − Neuro Radiology
  − Nuclear Medicine
  − Surgery
  − Urology

− 231 individual dose measurements

<table>
<thead>
<tr>
<th>Profession</th>
<th># Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td>74</td>
</tr>
<tr>
<td>Nurse</td>
<td>45</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Radiographer</td>
<td>88</td>
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<tr>
<td>N.A.</td>
<td>23</td>
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</table>

<table>
<thead>
<tr>
<th>Practice</th>
<th># Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiography</td>
<td>28</td>
</tr>
<tr>
<td>Cardiology</td>
<td>26</td>
</tr>
<tr>
<td>CT-guided intervention</td>
<td>15</td>
</tr>
<tr>
<td>Endoscopy</td>
<td>38</td>
</tr>
<tr>
<td>Neuro radiology</td>
<td>20</td>
</tr>
<tr>
<td>Nuclear Medicine</td>
<td>9</td>
</tr>
<tr>
<td>Surgery</td>
<td>9</td>
</tr>
<tr>
<td>Urology</td>
<td>2</td>
</tr>
<tr>
<td>N.A.</td>
<td>84</td>
</tr>
</tbody>
</table>
Dosemeter used at the forehead

- Used PHE EYE Dosemeter

- The dosemeter element is of the Harshaw EXRAD™ type, and is enclosed behind a 1.5 mm PTFE (Teflon) filter in a sealed PVC pocket

- The dosemeter have been tested to measure Hp(3) on the ORAMED phantom

- A phantom very similar to the ORAMED phantom have this year been introduces as reference phantom in ISO 4037 for Hp(3) calibrations
Dosemeter used at the collar level

- Used SIS Whole body dosemeter

- The dosemeter consist of a Harshaw™ Multi-element Card Dosimeter inserted in pp-plastic (polypropylene) badge. The used element is behind a 3 mm pp filter

- The dosemeter have been tested against DS/EN 62387:2016 for measuring Hp(3) on the ICRU slab phantom (ISO 4037) for beta and gamma
Results of survey
Measurements on forehead compared to collar
Results of survey
Measurements on forehead compared to collar

- The measured doses are generally low
  - 93% of the doses measured at the forehead are lower than 1 mSv
  - 62% of the doses measured at the forehead are lower than 0.1 mSv

- The dose at the collar level are generally higher than the dose at the forehead
  - 59% of measurements of dose at collar level is higher than dose at forehead
  - 95% of measurements of dose at collar level is higher than half the dose at forehead
Correlation between collar and forehead doses

- Measurements
- $dose_{forehead} = dose_{collar}$
- $dose_{forehead} = 2 \times dose_{collar}$
Correlation between collar and forehead doses

- $d_{\text{forehead}} = d_{\text{collar}}$
- $d_{\text{forehead}} = 2 \times d_{\text{collar}}$
Professions

![Graph showing dose distribution by profession]
Practices
What is Angiography

- Angiography or arteriography is a medical imaging technique used to visualize the inside, or lumen, of blood vessels and organs of the body, with particular interest in the arteries, veins, and the heart chambers. This is traditionally done by injecting a radio-opaque contrast agent into the blood vessel and imaging using X-ray based techniques such as fluoroscopy.
Routine monitoring using dosemeter worn at collar level

Data from NDR September 2018 to April 2019

- 1 Monthly monitoring period
- Dose data for 38 workers
- Doctors and workers involved in interventional radiology receive highest doses
- The monthly average dose indicate that a few workers could exceed the yearly dose limit of 20 mSv
- One worker has received a very high dose
  - Currently under investigation

<table>
<thead>
<tr>
<th>Profession</th>
<th>No. of workers monitored</th>
<th>Average dose Hp(3) (mSv)</th>
<th>Median dose Hp(3) (mSv)</th>
<th>95% quartile Hp(3) (mSv)</th>
<th>Maximum dose Hp(3) (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td>24</td>
<td>0.48</td>
<td>0.27</td>
<td>1.4</td>
<td>6.7</td>
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<tr>
<td>Nurse</td>
<td>12</td>
<td>0.26</td>
<td>0.10</td>
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<td>1.0</td>
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<tr>
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<td>0.00</td>
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<tr>
<td>Interventional Radiology</td>
<td>30</td>
<td>0.48</td>
<td>0.18</td>
<td>1.4</td>
<td>6.7</td>
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<tr>
<td>Surgery</td>
<td>4</td>
<td>0.34</td>
<td>0.26</td>
<td>1.2</td>
<td>1.4</td>
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<tr>
<td>Other</td>
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<td>0.31</td>
<td>0.11</td>
<td>1.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Conclusion

- Only a few workers are likely to receive more than 20 mSv per year

- Generally, the dose to the lens of the eye for occupationally exposed workers in Denmark is low, well below the dose limit

- The study also indicates that doctors, especially those involved in angiography procedures, receive the highest doses

- A whole body dosemeter worn at the collar level outside any personal protective apron can be used as an investigation tool on whether the dose limit is likely to be exceeded
  - It is more convenient to wear the dosemeter at the collar level?

- Need for special follow up in some cases (high doses)
  - Including investigation on influence from use of lead glasses
Thank you for your attention