STAFF EYE LENS AND EXTREMITY EXPOSURE IN INTERVENTIONAL CARDIOLOGY: RESULTS OF THE ORAMED PROJECT

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ORAMED WP1 CAMPAIGN
EXTREMITY AND EYE LENS DOSES IN IC

- 6 participating countries
  - Belgium, SCK•CEN
  - Greece, GAEC
  - France, IRSN
  - Poland, NIOM
  - Slovakia, SMU
  - Switzerland, CHUV

- summary: 652 IC procedures
- measurements were performed in 22 hospitals
- IC procedures carried out by 146 physicians
SELECTED IC PROCEDURES

- Cardiac angiographies (CA) and angioplasties (PTCA)
  
  In total, 266 procedures were monitored in 22 hospitals

- Pacemaker and Cardiac Defibrillator implantations (PM/ICD)
  
  In total, 183 procedures were monitored in 14 hospitals

- Radiofrequency ablations (RF)
  
  In total, 191 procedures were monitored in 14 hospitals
PARAMETERS THAT WERE USED FOR THE ANALYSIS

- room
- protective equipment
- x-ray tube configuration (below, above or biplane)
- access (radial or femoral)
KAP VALUES FOR MONITORED PROCEDURES

- RFA
- CA PTCA
- PM/ICD

KAP (µGy m²)
STATISTICS IN INTERVENTIONAL CARDIOLOGY
USE OF PERSONAL PROTECTIVE EQUIPMENT

- apron + thyroid collar + glasses + gloves: 34%
- apron + thyroid collar: 54%
- only apron: 9%
- apron + thyroid collar + cabin: 1%
- only gloves: 2%

710 cases
STATISTICS IN INTERVENTIONAL CARDIOLOGY
USE OF THE ROOM PROTECTIVE EQUIPMENT

RP cabin
Ceiling shield
Table shield

501 cases
- none 24%
- table+ceiling 36%
- only table 39%
- only ceiling 1%
USE OF ROOM PROTECTIVE EQUIPMENT

CA / PTCA
- ceiling: 41%
- table: 52%
- floor: 1%
- patient: 2%
- none: 4%

PM / ICD
- table + ceiling: 10%
- only ceiling: 1%
- only table: 23%
- none: 66%

RFA
- table + ceiling: 52%
- only table: 11%
- only ceiling: 7%
- only patient: 4%
- only RP cabin: 3%
- ceiling + RP cabin: 3%
- none: 18%
EFFECT OF ROOM PROTECTIVE EQUIPMENT [CA PTCA]

Effect of ceiling suspended shield on the eyes and hands

Tube below Radial access

<table>
<thead>
<tr>
<th>without/with ceiling</th>
<th>without/with ceiling</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Eye</td>
<td>M Eye</td>
</tr>
<tr>
<td>radial access</td>
<td>radial access</td>
</tr>
<tr>
<td>1,6</td>
<td>2,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Finger</th>
<th>R Finger</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,7</td>
<td>1,3</td>
<td>1,3</td>
<td>1,6</td>
</tr>
</tbody>
</table>
EFFECT OF ROOM PROTECTIVE EQUIPMENT [CA PTCA]

Effect of table shield on the legs

Tube below Femoral access

<table>
<thead>
<tr>
<th>without/with table shield</th>
<th>L Leg</th>
<th>R Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>femoral access</td>
<td>3,5</td>
<td>1,3</td>
</tr>
</tbody>
</table>
Effect of table shield on the legs

<table>
<thead>
<tr>
<th>without/with table shield</th>
<th>L Leg</th>
<th>R Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,6</td>
<td>1,4</td>
<td></td>
</tr>
</tbody>
</table>
Effect of table shield on the legs

Table shield without/with:

<table>
<thead>
<tr>
<th>L Leg (no shield)</th>
<th>L Leg (with shield)</th>
<th>R Leg (no shield)</th>
<th>R Leg (with shield)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td></td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>

Median
Mean
EFFECT OF ROOM PROTECTIVE EQUIPMENT [RF ABLATION]

Effect of ceiling suspended shield on the eyes and hands

<table>
<thead>
<tr>
<th>without/with ceiling</th>
<th>L Eye</th>
<th>M Eye</th>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Finger</th>
<th>R Finger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0,6</td>
<td>0,6</td>
<td>0,8</td>
<td>0,7</td>
<td>0,9</td>
<td>0,8</td>
</tr>
</tbody>
</table>
EFFECT OF TUBE CONFIGURATION [CA PTCA]

Below → Biplane

- Hands, legs: no effect
- Eyes: Tube below higher doses than biplane

The image intensifier of the other tube could provide extra shielding to the eyes
Effect of ceiling suspended shield on the eyes and legs

As expected the eye doses are higher when the tube is above the operating table...

while for the legs the situation is the opposite
**EFFECT OF TUBE CONFIGURATION [RF ABLATION]**

### Median Percent Reduction

<table>
<thead>
<tr>
<th>Location</th>
<th>Median Reduction</th>
<th>Ratio (BP/Below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legs</td>
<td>329%</td>
<td>0.30</td>
</tr>
<tr>
<td>Fingers</td>
<td>53%</td>
<td>1.90</td>
</tr>
<tr>
<td>Wrist</td>
<td>59%</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Reduction comparable to CA PTCA.
PM/ICD: shoulder
RF Ablations: femoral

CA / PTCA

- Radial 36%
- Femoral 64%
EFFECT OF ACCESS OF THE CATHETER [CA PTCA]

<table>
<thead>
<tr>
<th></th>
<th>L Eye</th>
<th>M Eye</th>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Finger</th>
<th>R Finger</th>
</tr>
</thead>
<tbody>
<tr>
<td>radial/femoral</td>
<td>1.2</td>
<td>2</td>
<td>2.4</td>
<td>2.8</td>
<td>4.8</td>
<td>2.6</td>
</tr>
</tbody>
</table>
CA / PTCA
LOCATION OF THE MAXIMUM

Location of maximum dose using annual dose limits
## CA / PTCA
### Maximum Doses

<table>
<thead>
<tr>
<th>Hp(0.07) [mSv]</th>
<th>L Finger</th>
<th>R Finger</th>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Leg</th>
<th>R Leg</th>
<th>L Eye</th>
<th>Middle Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>0.5</td>
<td>1.8</td>
<td>0.6</td>
<td>1.6</td>
<td>1.2</td>
<td>0.8</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>type</td>
<td>CA &amp; PTCA</td>
<td>CA</td>
<td>PTCA</td>
<td>CA &amp; PTCA</td>
<td>PTCA</td>
<td>CA &amp; PTCA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>experience</td>
<td>low</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>tube access</td>
<td>below</td>
<td>below</td>
<td>biplane</td>
<td>biplane</td>
<td>biplane</td>
<td>biplane</td>
<td>below</td>
<td>radial</td>
</tr>
<tr>
<td>protective</td>
<td>table, patient</td>
<td>table, ceiling</td>
<td>table</td>
<td>table</td>
<td>table</td>
<td>table</td>
<td>table</td>
<td></td>
</tr>
<tr>
<td>equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KAP [μGym²]</td>
<td>23597</td>
<td>19881</td>
<td>40458</td>
<td>38409</td>
<td>6827</td>
<td>-</td>
<td>19152</td>
<td></td>
</tr>
</tbody>
</table>
PM / ICD
LOCATION OF THE MAXIMUM

- Middle Eye: 3%
- L/R Eye: 3%
- L Leg: 11%
- R Leg: 15%
- L Wrist: 12%
- R Wrist: 6%
- L Finger: 32%
- R Finger: 18%

Position of the maximum dose/annual dose limit in Pacemaker procedure
**PM / ICD**

**MAXIMUM DOSES**

<table>
<thead>
<tr>
<th></th>
<th>L Finger</th>
<th>R Finger</th>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Leg</th>
<th>R Leg</th>
<th>L/R Eye</th>
<th>Middle Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Dose (mSv)</td>
<td>6.54</td>
<td>4.33</td>
<td>4.82</td>
<td>3.83</td>
<td>7.82</td>
<td>5.00</td>
<td>1.08</td>
<td>0.81</td>
</tr>
<tr>
<td>Protective equipment</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Tube configuration</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
</tr>
<tr>
<td>Comments</td>
<td>Hands in beam</td>
<td>Hands in beam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RF ABLATION
POSITION OF THE MAXIMUM

Position of the maximum dose when the annual limit is taken into account
# RF Ablation Maximum Doses

<table>
<thead>
<tr>
<th></th>
<th>L Finger</th>
<th>R Finger</th>
<th>L Wrist</th>
<th>R Wrist</th>
<th>L Leg</th>
<th>R Leg</th>
<th>L/R Eye</th>
<th>Middle Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$H_p(0.07)$ [mSv]</strong></td>
<td>0.90</td>
<td>0.45</td>
<td>1.84</td>
<td>0.53</td>
<td>1.82</td>
<td>0.78</td>
<td>0.88</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>table + ceiling</td>
<td>table</td>
<td>table + ceiling</td>
<td>none</td>
<td>ceiling</td>
<td>patient</td>
<td>table</td>
<td></td>
</tr>
<tr>
<td><strong>Tube</strong></td>
<td>biplane</td>
<td>below</td>
<td>biplane</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
<td>below</td>
</tr>
<tr>
<td><strong>Total KAP (µGy.m²)</strong></td>
<td>25400</td>
<td>16300</td>
<td>25400</td>
<td>5394</td>
<td>20400</td>
<td>24900</td>
<td>16300</td>
<td></td>
</tr>
</tbody>
</table>
SUMMARY OF IC PROCEDURES

Average Hp(0,07)

Average Hp(0,07)/KAP
CONCLUSIONS

**Protective equipment**
- Table shield, when used properly, can reduce the leg doses up to 4 times
- For CA and PTCA procedures and radial access there is a reduction of the eye doses up to 50%

**Tube configuration**
- When the tube is above of the operating table the doses at the eyes are higher 3 times compared to the ones that the tube is below
- For biplane systems lower doses for the eyes are observed than in the cases where the tube is below the table due to the extra shielding of the image intensifier of the lateral tube. The opposite effect is observed for the hands.

**Access**
- The doses to the eyes, wrists and fingers are lower (1.2 to 4.8 times) for the femoral access compared to the radial one
Thank you for your attention!