Computed Tomography Doses in Nuclear Medicine

DDM 2 Workshop
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CT in nuclear medicine departments

• Attenuation correction
  Traditionally with SPECT devices a low dose CT (typically 120 kV 2,5 mA DLP~100 mGy*cm) (GE Hawkeye etc.)

• Location of radiopharmaceutical accumulation
  Typically ‘normal CT’ with SPECT 120 kV 20-25 mA
  New SPECT-CT can be used as ‘low dose’ -> diagnostic

• Normal diagnostic CT
  Typically with PET or in some cases with new SPECT
Numbers today
• 24 SPEC-CT devices
• 8 (10) PET-CT devices (1 mobile unit)
Collective dose from x-ray and NM

- Collective effective dose from x-ray: 0.45 mSv/inh. (2008)
  - 58% from CT
- Collective effective dose from NM: 0.03 mSv/inh. (2009)
  - 7.5% of x-ray collective dose
  - DDM2 preliminary results 3.7%
- Number of NM procedures ->
Number of NM procedures in Finland

Year | Number of NM procedures
---|---
1975 | 60,000
1982 | 90,000
1994 | 50,000
1997 | 50,000
2000 | 40,000
2003 | 40,000
2006 | 30,000
2009 | 30,000
Number of NM procedures in Finland

- **PET** is increasing: + 70% in 2006-09 total 4258
- **PET-CT** procedures are increasing:
  - In 2009 **3324 PET-CT**, about 8 % of all diagnostic NM and **78%** of all PET
  - DDM2 preliminary results 9 % PET(PET-CT)
- Low-dose CT attenuation correction (SPECT-CT) 1298 in 2009 mainly cardiac examinations
What is the effect of PET-CT on collective effective dose?
Hybrid doses in Helsinki University Hospital (HUS) Nuclear Medicine department (HUSLAB) 2011

• Background information: 1 PET-CT, 3 SPECT-CT, 2 SPECT
• Data from QPati patient administration system
• FDG Body PET-CT in: 1060
  – 22 children (age 16 or less)
• Brain FDG PET-CT: 75
  – 30 children
Activity F-18-FDG given to children
## PET-CT protocols (Philips Gemini GXL 16) in HUSLAB

<table>
<thead>
<tr>
<th></th>
<th>kV</th>
<th>mAs</th>
<th>CTDI, mGy</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 kg or less</td>
<td>90</td>
<td>25</td>
<td>0,8</td>
</tr>
<tr>
<td>33-47</td>
<td>120</td>
<td>25</td>
<td>1,8</td>
</tr>
<tr>
<td>50-&gt; (Small adult protocol)</td>
<td>120</td>
<td>40</td>
<td>2,8</td>
</tr>
<tr>
<td>55-&gt; (Adult protocol)</td>
<td>120</td>
<td>50</td>
<td>3,5</td>
</tr>
<tr>
<td>Large adults</td>
<td>140</td>
<td>60</td>
<td>6,6</td>
</tr>
</tbody>
</table>

**ATTENTION!** mAs-readings for first two rows corrected 20 -> 25 mAs
After update the 25 mAs has been the minimum value available!

p=0,625
Automatic tube current modulation NOT used
## Children's PET-CT doses in HUSLAB

<table>
<thead>
<tr>
<th>Patient group</th>
<th>18-F-FDG dose</th>
<th>NM Eff. Dose</th>
<th>DLP</th>
<th>CTDI</th>
<th>Calc. phantom</th>
<th>CT protocol</th>
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<th>Dose comparison CT/NM</th>
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<tbody>
<tr>
<td>Age ~1 weight &lt;10 kg</td>
<td>62 MBq</td>
<td>5,9 mSv</td>
<td>43 mGy* cm</td>
<td>0,8 mGy</td>
<td>Baby</td>
<td>90/20</td>
<td>1,9 mSv</td>
<td>32 %</td>
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<tr>
<td>Age ~5 weight 15-25 kg</td>
<td>87 MBq</td>
<td>4,9 mSv</td>
<td>51 mGy</td>
<td>0,8 mGy</td>
<td>Child</td>
<td>90/20</td>
<td>1,4 mSv</td>
<td>29 %</td>
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<tr>
<td>Age ~10 weight 21-33 kg</td>
<td>137 MBq</td>
<td>5,1 mSv</td>
<td>64 mGy</td>
<td>0,8 mGy</td>
<td>Child</td>
<td>90/20</td>
<td>1,5 mSv</td>
<td>30 %</td>
</tr>
<tr>
<td>Age ~15 weight 55-58 kg</td>
<td>315 MBq</td>
<td>7,6 mSv</td>
<td>243 mGy* cm</td>
<td>2,8 mGy</td>
<td>Adult</td>
<td>120/40 (small adult)</td>
<td>2,9 mSv</td>
<td>38 %</td>
</tr>
</tbody>
</table>

CT eff. doses calculated with CT-Expo
NM eff. Doses calculated with ICRP 106 conversion factors
## PET-CT Doses in HUSLAB

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<td>2,9</td>
<td>38</td>
</tr>
<tr>
<td>Adult normal</td>
<td>355</td>
<td>6,3</td>
<td>332</td>
<td>3,5</td>
<td>Adult</td>
<td>120/50</td>
<td>4,0</td>
<td>63</td>
</tr>
<tr>
<td>Adult large</td>
<td>385</td>
<td>7,3</td>
<td>532</td>
<td>5,5</td>
<td>Adult</td>
<td>147/60</td>
<td>6,3</td>
<td>86</td>
</tr>
</tbody>
</table>
Cardiac perfusion

- Most common attenuation correction procedure
- Only attenuation correction
- 500 cardiac examinations annually 80-90 % with att. corr.

- Rest + Stress on a same day at HUSLAB

<table>
<thead>
<tr>
<th>99mTc-tetrofosmin</th>
<th>Stress</th>
<th>Rest</th>
<th>NM Eff. Dose</th>
<th>DLP</th>
<th>Calc. phantom</th>
<th>CT protocol</th>
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<th>Dose comparison CT/NM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient group</td>
<td>MBq</td>
<td>MBq</td>
<td>mSv</td>
<td>mGy/cm</td>
<td>kV/mAs</td>
<td>mSv</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>All adults</td>
<td>265</td>
<td>726</td>
<td><strong>6.8</strong></td>
<td>80</td>
<td>Adult</td>
<td>120/25</td>
<td><strong>1.2</strong></td>
<td>18</td>
</tr>
</tbody>
</table>
Bone SPECT-CT

- In HUSLAB ~100 annually
  - GE Infinia 4-slice, low-dose CT device

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<tr>
<td>All adults</td>
<td>675</td>
<td><strong>3.8</strong></td>
<td>127</td>
<td>3.16</td>
<td>Adult</td>
<td>140/2.5</td>
<td><strong>1.2</strong></td>
<td>32</td>
</tr>
</tbody>
</table>
Conclusion

• Most important factor is the CT in PET
• CT can almost double the total effective dose from PET-CT procedure to 10-15 mSv per study
• Not yet a major contribution to the collective dose
• Based on 2011 numbers
  – x-ray: 0,45 mSv/ inh. NM: 0,03 mSv/inh.
  – 8% NM was PET
-> even if all PET was PET-CT and the dose was doubled not a major contribution to collective dose
  – Number of PET-CT must be monitored
It’s not the tools, it’s how you use it...