Image quality and dose in Computed Tomography – A regional audit

Nicola Bate – Clinical Scientist
Royal Infirmary of Edinburgh
Background

- Dose audits are good practice and required by IRR99
- Image quality optimisation ideally carried out on all sites
- What variations are there in dose and image quality across the regions I cover?
- Why do these variations exist?
- What factors affect the dose and image quality?
Methodology

- Look at 7 different scanners across the region – two different manufacturers
- Measure noise for three standard examinations – Routine head, Chest-liver, Abdo-pelvis
- DLP information already available
- Also collect protocol information, measure patient size and scan length to allow other trends to be investigated
Data collection

• Approx. 30 patients per exam per scanner
• Region of interest drawn in the ventricle for head scans and the descending aorta for body scans
• Standard deviation of pixel values in the ROI taken as a measurement of noise
Head scans
Results – Routine Head (sequence)

**Sequence Heads - Noise for each scanner**

<table>
<thead>
<tr>
<th>Noise by hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>D - 4.5mm</td>
</tr>
<tr>
<td>G - 9mm</td>
</tr>
<tr>
<td>E - 4.5mm</td>
</tr>
<tr>
<td>A - 8mm</td>
</tr>
</tbody>
</table>

**Sequence Heads - DLP for each scanner from audit**

<table>
<thead>
<tr>
<th>Scanner</th>
<th>Av. mAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>274</td>
</tr>
<tr>
<td>G</td>
<td>260</td>
</tr>
<tr>
<td>E</td>
<td>310</td>
</tr>
<tr>
<td>A</td>
<td>358</td>
</tr>
</tbody>
</table>
Results – Routine Head (spiral)

Spiral Heads - Noise for each scanner in order high-low

Noise by hospital

F - 4mm
B - 5mm
D - 5mm

Spiral Heads - DLP for each scanner from audit

DLP by hospital

F - 4mm
B - 5mm
D - 5mm
Follow up – Routine Head

Review of DLPs after protocol changes

Scanner A                       Scanner B                       Scanner D

DLP (mGy/cm)

Before change

After change

NHS Lothian
Chest-liver scans
Results – Chest/Liver

Chest-liver - Noise

0.0
5.0
10.0
15.0
20.0
25.0
30.0

Noise by hospital and slice width

G - 1mm
F - 1mm
B - 1mm
E - 1.5mm
A - 2mm
C - 2mm

Chest-liver - DLP

0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0

DLP by hospital

National DRL
Results – Chest/Liver

Chest-liver Siemens

Patient cross-sectional area (m²) assuming an oval

Chest-liver Toshiba

Patient cross-sectional area (m²) assuming an oval
Abdo-pelvis scans
Results – Abdo/pelvis

Abdo/pelvis-noise

- E - 1.5mm
- F - 1mm
- B - 2mm
- G - mix of 1 and 2mm
- C - 2mm
- A - 2mm

Abdo/pelvis-DLP

- E - 1.5mm
- F - 1mm
- B - 2mm
- G - mix of 1 and 2mm
- C - 2mm
- A - 2mm
Results - Abdo-pelvis

![Abdo-pelvis Siemens](image1)

![Abdo-pelvis Toshiba](image2)
Next steps - Chest/Liver, Abdo/Pelvis

- Reduce overlap
- Can adequate MPRs be made with 2mm slices? - reduce dose and noise
- Why difference technique, same hospital?
Comparing hospitals across all three exams

- Image optimisation aims to achieve both low noise and low DLP/CTDI
- Can use a Figure of Merit
- FOM = 1/(Noise*DLP/CTDI)
- Normalising to maximum then summing gives overall rank of each scanner of those tested
- Max. value of 3
Conclusions

• Dose audit only gives half the picture
• Scan length is an important factor
• It is possible to achieve the same noise outcome with very different settings
• Less variation in noise than might have been expected
• More work to be done to optimise those scanners with high DLP and high noise