Radiation dose optimisation in medical imaging – an Australian Perspective
Daniel Schick

Some context
- Biomedical Technology Services – Queensland Health (Government)
- 16 (imaging) medical physicists across Queensland (pop. 4.7 million)
- 5 certified by ACPSEM
- Australia - New Zealand: 36 certified/registered in radiology
- About 1000 CT scanners across Australia

Outline
- History and what motivates us
- Current status and projects
  - CT
    - National DRLs
    - Profession led projects
    - Local work
  - Interventional Fluoro
  - Nuclear Medicine
Australian Law

ARPANSA RPS No. 14 (Code of Practice)

3.1.8 The Responsible Person must establish a program to ensure that radiation doses administered to a patient for diagnostic purposes are:

(a) periodically compared with diagnostic reference levels (DRLs) for diagnostic procedures for which DRLs have been established in Australia, and

(b) if DRLs are consistently exceeded, reviewed to determine whether radiation protection has been optimised.

Australian MDCT DRLs Est. 2011/12
NM, Interventional Fluoro and Mammography “Late 2016”

Fluoroscopic dose variation – Cardiac Cath Lab
Benchmarking Program (2004-2011)
## CT dose variation – Queensland (Australia) Public Hospital Survey – 2010

<table>
<thead>
<tr>
<th>Exam</th>
<th>Min. DLP</th>
<th>Max. DLP</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>654</td>
<td>1407</td>
<td>x 2.2</td>
</tr>
<tr>
<td>Abdo/pelvis</td>
<td>388</td>
<td>1249</td>
<td>x 3.2</td>
</tr>
</tbody>
</table>

**RANZCR – 10 CT site optimisation project 2009 – Survey 1**

**Mean - Min - Max - 75th Percentile of Median Adult DLP**

**RANZCR – 10 CT site optimisation project 2009 – Survey 1**

**Mean - Min of Median Adult CTDiVol Spread**

*Siemens Sensation 64 using FBP – Image Quality?*
Landmark Australian CT Risk Research

Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians

Conclusions: The increased incidence of cancer after CT scan exposure in the cohort was mainly due to radiation. Because the cancer risk was not measured at the time of exposure, the cumulative lifetime risk from CT scans cannot be determined. Radiation doses from contemporary CT scans are likely to be lower than those in 1985-2005. But scans in the future may result in a lower effective dose than current scans because CT scans should be limited to situations where there is a benefit for clinical indication, with every scan optimised to provide a diagnostic CT image at the lowest possible radiation dose.

Computed Tomography
How is Australia Faring?

<table>
<thead>
<tr>
<th>Country</th>
<th>DLP</th>
<th>CTDIvol</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1000/60</td>
<td>700/15</td>
<td>NCRP 172</td>
</tr>
<tr>
<td>Japan</td>
<td>1350/85</td>
<td>1000/20</td>
<td>50-60kg patient</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>970/60</td>
<td>745/15</td>
<td>NCRP 172</td>
</tr>
<tr>
<td>USA</td>
<td>NA/75</td>
<td>NA/25</td>
<td>NCRP 172</td>
</tr>
</tbody>
</table>

Representative of all scanners?
Australian CT radiation doses

Current CT NDRLs

- Australian CT DRL interface
- Manual data entry
- Up to 20 patients
Professional college initiatives: Royal Australian and New Zealand College of Radiologists (RANZCR)

- State based CT dose optimisation projects
- Conducted 2009-2012 in Queensland, Victoria and South Australia (10 to 20 sites each)
- Intensive data collection/ one day workshop/ reaudit
- Funded approximately $200K per state
Successful in achieving substantial dose reductions
Unsustainable as a large scale intervention

AOCR 2012 (RANZCR led)

Aims
- To determine whether
  - Very limited but clinically achievable dose data collection
  - Benchmarking against peers
  - Brief face to face educational feedback with generic optimisation advice
  - Site specific feedback material
    Can result in clinically important CT dose reduction
- 16 sites from across Australia and New Zealand
- Vendor sponsored – free participation

Site Specific Feedback
What about the children?

- Big problem with:
  - Numbers of scans (non-specialist sites)
  - Data submission to national surveys
- Answer: Phantom scans
Survey 2 - Effective Dose Spread per Paediatric Protocol

Local Projects - Improving data collection and analysis
- CT – Dose Survey Program (DSP)
- Australian government funded project
- Data from DoseUtility (David Clunie) or CARE Analytics (Siemens)

CT-DSP processing
CT-DSP for ARPANSA NDRLD

Format and data cells exactly match ARPANSA WEB interface

Local work - Pre and post optimisation data

- QRef reduced 250 to 200mAs (20% reduction)
- kV optimisation – most patients at 100kV with increased QRef for noise compensation.

Same patient May and July 2015

+ 6kg – expect 11% CTDI increase
CTDIvol decrease 11.5 to 8.7 mGy
Consultancy service

Interventional fluoroscopy

- Preliminary survey from 2013 – very limited range of exams
- (Official) NDRLs not yet published
- Difficulty with procedure definition

Example IGIP report from ARPANSA
Coronary Angiogram KAP distribution

CCL clinician performance impact – Fluoro time exceeding 75th percentile

Clinician feedback influence

Courtesy of Ian Smith, St Andrew's Medical Institute, Brisbane Australia
### NM data collection

<table>
<thead>
<tr>
<th>Category</th>
<th>Date</th>
<th>Isotope</th>
<th>Form</th>
<th>Activity (MBq)</th>
<th>RA (MBq)</th>
<th>RA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocrine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metastatic Oncology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Most common activity (MCA) and reference activity (RA)
Summary/Conclusions

• Australia has law requiring CT dose review
• Other modalities soon to be included
• Media has caught on much like elsewhere
• Some/limited evidence of widespread dose reduction – particularly in CT
• Limited knowledge of typical doses for other modalities
• Much to do!