Perspectives on Radiation Protection of the Patient: An Update

Progress and Necessary Improvements from a Local Perspective

Anthony Wallace
Director, Medical Imaging Section
ACPSEM Certified Radiology Physicist
Topics

• Aspects of Radiation Protection of the Patient
• Progress
  – Codes of Practice & Safety Guides
  – Diagnostic Reference Levels
• Necessary Improvements
  – RPOP medical graduate education
  – Referral Guidelines
  – Radiologist as Gatekeeper
  – Optimisation
Medical Radiation Exposure

Radiation dose from medical procedures has for the first time in history overtaken all other sources, both natural and man-made, as the most important contributor to exposure of humans. Diagnostic imaging is by far the largest contributing factor, with CT and molecular imaging alone contributing 75 percent of total medical radiation exposure.
US Background Radiation

NCRP Report No. 160, Ionizing Radiation
Exposure of the Population of the United States

Early 1980s

- Background (83%)
- Occupational / industrial (0.3%)
- Consumer (2%)
- Medical (15%)

2006

- Background (50%)
- Occupational / industrial (0.1%)
- Consumer (2%)
- Medical (48%)

<table>
<thead>
<tr>
<th></th>
<th>Early 1980s</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective effective dose (person-Sv)</td>
<td>835,000</td>
<td>1,870,000</td>
</tr>
<tr>
<td>Effective dose per individual in the U.S. population (mSv)</td>
<td>3.6</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Age Dependent Risk

Fig. 1. Lifetime risk of excess cancer per sievert as a function of age at the time of exposure. Data from the A-bomb survivors. While the average risk for a population is about 5% per sievert, the risk varies considerably with age; children are much more sensitive than adults. At early ages, girls are more sensitive than boys.
MDCT Scans per Age Cohort & Lifetime Risk of Excess Cancer/Sv at Age of Exposure
Mathews, et al (2012) † Paediatric CT risk ~ 2 mSv

Japanese Atomic Bomb Survivors ~50 mSv
Stages of the Imaging Cycle

- Clinical Action
- Pre-procedure
- Clinical Question
- Request
- Patient Preparation
- Technical Performance
- Presentation / Work-up of Images
- Perception of Images
- Interpretation of Images
- Communication of Diagnosis
- Clinical Action

Post-procedure

Procedure
ARPANSA Preferred Outcomes

- Referral
- Optimization
- Gatekeeper
- Dose Report
- DRL
Radiation Codes & Safety Guides

2004

NDRP
RPS 6

2008

Medical Code
RPS 14


Safety Guides

2008
RPS 14.1

2008
RPS 14.2

2008
RPS 14.3
Radiation Protection

NDRP

RPS 6

Direct & Indirect Regulatory Drivers

- ARPANSA Code of Practice
- Local Regulatory Requirements
- Medicare Practice Accreditation (DIAS)
ARPANSA
NDRL MDCT
Survey
Registered Practices by State/Territory

[Bar chart showing registered practices by state/territory for the years 2011, 2012, and 2013. The chart compares Vivid (VIC), New South Wales (NSW), Queensland (QLD), South Australia (SA), Western Australia (WA), Tasmania (TAS), Australian Capital Territory (ACT), and Northern Territory (NT).]
Compliant Survey Submissions by Practice Type & Year

- Private Clinic
- Private Clinic in a Private Hospital
- Private Clinic in a Public Hospital
- Public Clinic in a Public Hospital

Year:
- 2011
- 2012
- 2013
- All
### DRL Facility Report Pages

#### Australian National Diagnostic Reference Level Survey

**Report For:** Healthcare Imaging Services Knox  
**Protocol:** Abdo/Pelvis  
**Age Group:** Adult  
**Machine:** SOMATOM Definition AS+  
**Radiology CT**  
**Start Date:** April 1st 2011  
**End Date:** April 20th 2011

#### Survey Outcome

<table>
<thead>
<tr>
<th>Dose Metric</th>
<th>PRL</th>
<th>Australian Adult DRL</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLP</td>
<td>526</td>
<td>700</td>
<td>This PRL is within the Australian Adult DRL.</td>
</tr>
<tr>
<td>CTDIvol</td>
<td>21</td>
<td>15</td>
<td>This PRL is greater than the Australian Adult DRL. Unless clinically justified, the implementation of an optimization process is recommended. Information on optimization can be found on the ARRASA website: <a href="http://www.ARRASA.asn.au">www.ARRASA.asn.au</a></td>
</tr>
</tbody>
</table>

#### Australian Adult MDCT DRLs

<table>
<thead>
<tr>
<th>Protocol</th>
<th>DLP (mGy.cm)</th>
<th>CTDIvol (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>1900</td>
<td>60</td>
</tr>
<tr>
<td>Neck</td>
<td>600</td>
<td>30</td>
</tr>
<tr>
<td>Chest</td>
<td>450</td>
<td>15</td>
</tr>
<tr>
<td>Abdo/Pelvis</td>
<td>700</td>
<td>15</td>
</tr>
<tr>
<td>Chest/Abdo/Pelvis</td>
<td>1200</td>
<td>30</td>
</tr>
<tr>
<td>Lumbar Spine</td>
<td>900</td>
<td>40</td>
</tr>
</tbody>
</table>

---

#### Australian National Diagnostic Reference Levels Survey

**Computed Tomography Dose Index (CTD\textsubscript{vol})**  
**Adult:**

---

---

---
### Australian Adult MDCT DRL

<table>
<thead>
<tr>
<th>Protocol</th>
<th>DLP (mGy.cm)</th>
<th>CTDI\textsubscript{vol} (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>1000</td>
<td>60</td>
</tr>
<tr>
<td>Neck</td>
<td>600</td>
<td>30</td>
</tr>
<tr>
<td>Chest</td>
<td>450</td>
<td>15</td>
</tr>
<tr>
<td>AbdoPelvis</td>
<td>700</td>
<td>15</td>
</tr>
<tr>
<td>ChestAbdoPelvis</td>
<td>1200</td>
<td>30</td>
</tr>
<tr>
<td>Lumbar Spine</td>
<td>900</td>
<td>40</td>
</tr>
</tbody>
</table>

### Australian Baby (0-4 yr) MDCT DRL

<table>
<thead>
<tr>
<th>Protocol</th>
<th>DLP (mGy.cm)</th>
<th>CTDI\textsubscript{vol} (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>470</td>
<td>30</td>
</tr>
<tr>
<td>Chest</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>Abdomen</td>
<td>170</td>
<td>7</td>
</tr>
</tbody>
</table>

### Australian Child (5-14 yr) MDCT DRL

<table>
<thead>
<tr>
<th>Protocol</th>
<th>DLP (mGy.cm)</th>
<th>CTDI\textsubscript{vol} (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>600</td>
<td>35</td>
</tr>
<tr>
<td>Chest</td>
<td>110</td>
<td>5</td>
</tr>
<tr>
<td>Abdomen</td>
<td>390</td>
<td>10</td>
</tr>
</tbody>
</table>
May13-Sept14 DLP - 95% CI Variation with Iterative Reconstruction

Habitus (No IR/With IR)

DLP (mGy.cm)

DLP -IR (304 FRLs)
DLP +IR (541 FRLs)
Room For Improvement
Where Are The Throttle Point(s)?

- Referrer Knowledge & Guidelines
- Radiologist as Gatekeeper
- Optimized Acquisition

Optimisation

Justification
Fourth to sixth year medical students enrolled at a Western Australian university and interns from three teaching hospitals in Perth were recruited. Participants were asked to complete a questionnaire consisting of 26 questions on their background, knowledge of ionising radiation doses and learning preferences for future teaching on this subject.

Up to 54.8% of respondents underestimated the radiation dose from commonly requested radiological procedures. Respondents (11.3 and 25.5%) incorrectly believed that ultrasound and MRI emit ionising radiation, respectively. Of the four subgroups of respondents, the intern doctor subgroup performed significantly better than each of the three medical student subgroups.

JMIRO, 54 (2010) 17-23
RPOP Medical Graduate Education

• “Most doctors (76%) reported never having undergone any formal training on radiation risk. Seventy percent would have preferred to have received more teaching on the topic of radiation exposure and risks at medical school.”

• “Overall,... Doctors underestimated radiation exposure of frequently used diagnostic imaging and the associated risks. Underestimation of doses and risks may lead to doctors requesting more diagnostic imaging than they would if they had accurate knowledge.”

Keijzers & Britton, MJA, Vol 183, No 8, 2010
International Referral Guidelines
Who is In Control?

• Referral as an ‘Order Form’ or ‘Request for Specialist Consultation’?

• Radiologist as Gatekeeper
  – Rebate for chasing referrers

• PACS puts radiologists at the rear of the process
Optimization

• Balancing diagnostic image quality and radiation dose
• Improved by Iterative Reconstruction
• Requires
  – Expert advice
  – Rigorous methodology
  – Ongoing iterative program
  – Embedded within clinical audit
In Contentious Conclusion

Strictly from a Radiation Protection of the Patient perspective;

- We have poorly educated undergraduate and graduate doctors in terms of radiation safety and radiation protection of the patient
- Generating imaging referrals without access to local appropriate referral guidelines or appropriateness criteria
- Sent to an imaging practice where the referral may be treated simply as an order form rather than a request for consultation
- Where the referral may or may not be reviewed by a consultant radiologist for appropriateness
- With the images acquired on equipment that may or may not have been optimised for image quality and dose performance
It Raises the Question

How well does Australian management of radiation protection of the patient in diagnostic imaging meet world’s best practice?
Conclusion

Everything might be ok

It’s an assumption

Little data to validate this assumption

Problems express themselves slowly and not in individually accountable timeframes

We may have unrecognised problems

Is anyone looking?

Fractionated levels of responsibility

Substantial lack of data
THANK YOU

CONTACT ARPANSA

Email: info@arpansa.gov.au
Website: www.arpansa.gov.au
Telephone: +61 3 9433 2211
Freecall 1800 022 333
General Fax: +61 3 9432 1835