Staff and Patient Protection in Interventional Radiology: a UK Perspective

Claire-Louise Chapple
Newcastle upon Tyne, UK
WHERE I AM FROM...
Newcastle upon Tyne
Newcastle upon Tyne Hospitals
NHS Foundation Trust

- Providing services for > 250 yrs
- One of largest NHS Trusts in England
- Wide range of specialist services
- 6 Sites including Great North Children’s Hospital
- Over 1800 beds
- Includes Cardiothoracic Centre & Major Trauma centre
Society for Radiological Protection

UK IRPA Affiliate Society
1600 members
INTERVENTIONAL RADIOLOGY IN UK
Contribution of Interventional Radiology dose in UK

Figure 2: UK collective dose from different diagnostic radiology examinations carried out in the 1997/98 and 2001/02 financial years, and in the 2008 calendar year

From PHE-CRCE-026 (2016)
FIGURE 3 Comparison by broad type of contributions to UK collective dose from medical and dental X-ray examinations
Most frequent interventional procedures from national dose survey

- Percutaneous transluminal coronary angioplasty
- Pacemaker
- Facet Joint Injection
- Hickman Line Insertion
- Nephrostomy
- Biliary Intervention
- Oesophageal Stent
Highest dose procedures

From 2010 National Review

• Transjugular intrahepatic portosystemic shunt
• Embolisation of iliac artery
• Embolisation of mesenteric artery
• Stenting of abdominal aortic aneurism
REGULATORY CONTROL
UK Implementation of BSS

• Ionising Radiation Regulations 2017
  – Protection of Employees and the Public

• Ionising Radiation (Medical Exposure) Regulations 2017
  – Protection of the Patient
Key Implementation Issues for Interventional Radiology

• Reduction in eye dose limit
  – Increased classification (at 15mSv)
  – Dosimetry problems
• Application of Diagnostic Reference Levels
• Risk/benefit information for patients
RADIATION PROTECTION OF STAFF
Dosimetry used

- **WHOLE BODY** – under apron
- **EYE** - variety of locations
  - Forehead
  - Collar
  - Stem of eyewear
  - Behind eyewear
- **FINGER** – Ring or finger tip dosimeters
Typical Doses (annual)
Dosimetry issues

- Formal eye dose as measured - no correction factors approved
- Infection control for ring dosimeters
- Multi-site working
- Poor culture for wear and return
- High loss rate
Influencing factors on measured eye dose

- Design of glasses
- Position of dosimeter
- Type of dosimeter
- Angle of head to patient
- Height of operator
Staff protection – aprons, collars, glasses
Staff protection – screens
Staff protection – attenuating headwear (no-brainer)
Staff protection – lead gloves

![Graph showing Attenuation vs. kVp for RR1]

- Attenuation on the y-axis
- kVp on the x-axis
- Different data points for Manufacturer, Primary, and Scatter
Staff protection – lead sheets

• Positioning important
  – Patient dose increase of up to 500% if in primary beam with automatic brightness control

• Scatter reduction of up to 60%

• Decrease in patient dose also (cuts scatter from collimator)
Staff protection – positioning (example)

• High doses for 1 individual investigated
• Complex workload (Fenestrated EVAR)
• Lateral projection used
• Positioning of display screen requires standing by tube
• Scattered doses significantly higher than by detector
• Additional display screen ordered
Staff Protection - Training

Information provided on
• PPE – what and how to use
• Dosimetry – storing, wearing and changing
• Positioning – high and low scatter areas
• Local Rules – instructions for working safely
• Doses likely and associated risks
RADIATION PROTECTION
OF PATIENTS
Interventional dosimetry issues

- Consistent units
- Standardisation of dosimetry methods
- Classification of procedures
- Consideration of uncertainties
- Calibration of dose measurement devices
- Collection of factors influencing dose
### National DRLs for interventional procedures

<table>
<thead>
<tr>
<th>Examination</th>
<th>DAP (Gycm$^2$)</th>
<th>Fluoro time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biliary intervention</td>
<td>43</td>
<td>14</td>
</tr>
<tr>
<td>Facet joint injection</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td>Hickman line insertion</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Nephrostomy</td>
<td>13</td>
<td>6.7</td>
</tr>
<tr>
<td>Oesophageal stent</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Pacemaker (permanent)</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Percutaneous transluminal coronary angioplasty (PTCA)</td>
<td>40</td>
<td>11.3</td>
</tr>
</tbody>
</table>
Local doses

Examination Type: Line Insertion (Hickman)

National Reference Level: 3 Gy cm²
Regional 3rd quartile Level: 0.6 Gy cm²

Median DAP (Gy cm²)

Hospital/Room

D3 E3 E4 J3 L4 M1 N2
Calculating effective dose

- Typically involves dose indicator and conversion factor
- Conversion factors variable
  - Beam angle
  - Beam energy
  - Filtration
  - Patient size
Patient protection - equipment

- Modern technology
- Routine Quality Assurance programme
  - Medical physics
  - Local staff
- Room layout
Patient protection - technique

- Frame rate/Low pulse rate fluoroscopy
- Filtration
- Choice of projection
- Experienced operators
Informing patient

• Risk benefit information sheets developed regionally
• Can be used as part of consenting process
• Follow up required if skin effects likely
  – Can use reference DAP or entrance dose display
EPIDEMIOLOGY STUDIES
Paediatric Cardiology study

- Doses assessed from collected technique and dose data with individual Monte Carlo simulated conversion coefficients
- Cancer registry used to determine cancer statistics for patient cohort plus transplant statistics
- Cancer rates high compared to general population
- Linked most strongly to transplant status
  - Immunosuppressants
  - Higher radiation doses
Cancer risks

- Risk of cancer associated with radiation exposures from cardiac catheterizations is relatively low
- Attributable risk of cancer was estimated at around 35 (male) and 133 (female) per 100,000 – for normal life expectancy
- Reduced life expectancy gives greatly reduced radiation-related cancer risks
In Summary

• Staff training is key
• Use combination of PPE, according to practicality
• Screens most effective
• Good dosimetry important for patient and staff
Grazie!