A national dosimetry audit for stereotactic ablative radiotherapy in lung

Gail Distefano
Consortium QA Lead

Royal Surrey County Hospital
NHS Foundation Trust
Background and Purpose

- The Consortium advises radiotherapy centres to undergo an independent external audit of their SABR processes and in-house quality assurance within six months of commencing a SABR program.

- A dosimetry audit was designed to assess the accuracy of SABR lung treatment delivery.
Aims

- **Assessing accuracy**
  - Act as a pre-clinical independent check for centres starting lung SABR treatment
  - Independent check of safe implementation
  - Identify problems in the modelling and delivery of each lung SABR technique
Aims

- Provide a snapshot of the range of delivery techniques and algorithms for treatment planning currently being practised.

- Provide baseline data for determination of appropriate tolerances for future audit and trials quality assurance (QA).
Availability

- Initially offered to centres treating Lung SABR at the time.

- Currently still offered at cost.
  - Please contact Julia.Snaith@npl.co.uk at NPL
Method

- A postal audit was conducted, using the CIRS Model 002LFC IMRT thorax phantom (loaned by several NHS Radiotherapy departments)

- Alanine pellet dosimetry (funded by NPL)

- 2-D planar dosimetry using Gafchromatic film (developed and analysed by CCC)

- Centres create a SABR plan using their local SABR planning protocol

- Co-ordination, analysis and final report writing (by RSCH)
It provided a snapshot of the range of delivery techniques and algorithms for treatment planning currently being practised.
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Treatment Planning System</th>
<th>Algorithm</th>
<th>Treatment Technique</th>
<th>No. of centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucletron™, Netherlands</td>
<td>Oncentra® Masterplan</td>
<td>Collapsed Cone</td>
<td>Conformal</td>
<td>2</td>
</tr>
<tr>
<td>Varian Medical Systems, Palo Alto, CA</td>
<td>Eclipse™</td>
<td>AAA</td>
<td>VMAT</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Conformal</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acuros</td>
<td>VMAT</td>
<td>1</td>
</tr>
<tr>
<td>Philips Healthcare, Best, Netherlands</td>
<td>Pinnacle®</td>
<td>Collapsed Cone</td>
<td>VMAT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Conformal</td>
<td>2</td>
</tr>
<tr>
<td>Accuray Incorporated, Sunnyvale, CA</td>
<td>Multiplan®</td>
<td>Monte Carlo</td>
<td>CK</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PB</td>
<td>1</td>
</tr>
<tr>
<td>Elekta AB, Stockholm, Sweden</td>
<td>Monaco®</td>
<td>Monte Carlo</td>
<td>VMAT</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Xio</td>
<td>Superposition</td>
<td>Conformal</td>
<td>1</td>
</tr>
</tbody>
</table>
Assessing Accuracy

- **Parameters Analysed:**
  - Alanine Dose Difference
  - Geometric Accuracy: distance between the centre-of-area points for the two distributions
  - Maximum distances between same value isodose lines were measured for 50% and 100%
**Alanine Results**

- **Median:** +0.6%
- **Range:** -6.1% to 3.2%
The median and range were +0.6% (-6.1% to 3.2%)

However, as expected PB was found to be a notable outlier.

The mean and sd become 0.4±1.4% for alanine and 1.4±3.4% for film.
## Film Results

<table>
<thead>
<tr>
<th>Film analysis metric</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometrical accuracy (mm)</td>
<td>1.3</td>
<td>0.4 to 2.4</td>
</tr>
<tr>
<td>100% prescription isodose-to-isodose distance (mm)</td>
<td>3</td>
<td>-6 to 7</td>
</tr>
<tr>
<td>50% prescription isodose-to-isodose distance (mm)</td>
<td>5</td>
<td>-10 to +19</td>
</tr>
</tbody>
</table>
Film Results cont.

- Geometric Accuracy was better for VMAT and CK compared to conformal techniques.

- For the 50% isodose comparison:
  - conformal plans (-10 to 19mm)
  - VMAT (-5 to 11mm)
  - CK (4 to 7mm)
Conclusion

- All centres were given a report summarising their results and showing where these lay within the overall national audit results (i.e. <2 sd, 2-3 sd or >3 sd of the audit mean).

- Results from this audit could be used as tolerances in future audit and clinical trial QA:
  - 0.4±3.3% (k=2) for alanine absolute dosimetry
  - 1.3±1.1mm (k=2) for geometric accuracy.
Conclusion

- The audit methodology worked well as a postal audit.
- Some differences across dose algorithms with PB not advisable for SABR lung treatment dose calculation.
- Geometric accuracy was better for VMAT and CK compared with conformal techniques.
- Delivery was within +/-3% accuracy for 25/27 SABR treatment plans.
Acknowledgements

- Jonny Lee; Shakardokhtt Jafari; Clare Gouldstone; Colin Baker; Helen Mayles; Catharine Clark
- All NHS trusts who participated in this audit.

gail.distefano@nhs.net