Co-60 or Ir-192 for HDR Brachytherapy?
Evaluating Source Parameters, CTV & OAR Doses, Optimal Prescribing & Economics
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Purpose
An analysis is presented of the various clinical, physical and economic factors to be considered when choosing between a high-activity Co-60 source and the more common Ir-192 source for HDR Brachytherapy.

Method
At Portsmouth, UK, we have experience of using both Co-60 and Ir-192 sources with the IBt-Bebig HDR MultiSource®Brachytherapy unit. A series of trials were carried out to compare the two sources, with the following prescription regimes:

- A 3D-image-based treatment planning study compared Co-60 and Ir-192 dose distributions, IRD Report 36 (1994), reference points and GEC-ESTRO Working Group (2005) reporting parameters for 15 different anatomical cases for Co-60 and Ir-192 sources. Dose rates were prescribed to the isocentre and compared at 2 cm depths.
- A further 15 clinical cases were treated using Co-60 and Ir-192 dose rates to the isodose levels.

Results

Treatment Planning

Table 1 provides the difference in dosimetric quality indices for Co-60 compared to Ir-192, based on GEC-ESTRO (2005) and GEC-ESTRO (2002) scoring parameters. In a conventional treatment plan, prescribing to Point A, the GEC-ESTRO scoring difference for Co-60 is higher than that of Ir-192.

<table>
<thead>
<tr>
<th>Source</th>
<th>HR-CTV Coverage (Over 10% V100)</th>
<th>Rectal D2cm</th>
<th>Bladder D2cm</th>
<th>Sigmoid D2cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-60</td>
<td>-1.4</td>
<td>0.0</td>
<td>0.3</td>
<td>-0.1</td>
</tr>
<tr>
<td>Ir-192</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.4</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Physical Properties

The dose delivered is proportional to source strength, dose rate constant, air kerma rate constant and dwell time, while the geometric factor, radial dose function and anisotropy function determine the dose distribution around the source.

Table 2 provides a comparison of the 2 cm dose delivered at 2 cm depth for Co-60 and Ir-192 sources. Of the two sources, Co-60 delivers a higher dose at 12 cm, while Ir-192 delivers a dose at 5 cm.

<table>
<thead>
<tr>
<th>Source</th>
<th>2 cm Dose (cGy)</th>
<th>5 cm Dose (cGy)</th>
<th>12 cm Dose (cGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-60</td>
<td>10.3</td>
<td>4.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Ir-192</td>
<td>9.2</td>
<td>4.5</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Economics

Figures 3 and 4 show the cumulative costs of Co-60 and Ir-192 sources over a 10-year period. The total cost is less with Co-60 after 10 months, assuming source replacement at the maximum length of clinical use of 4 months for Ir-192 and 5 years for Co-60. The cumulative costs for a treatment room with increased radiation safety for Co-60 compared to Ir-192 may offset some of the cost savings of Co-60 sources.

Conclusion

While there are small physical differences in the dose distribution around the IBt-Bebig Co-60 and Ir-192 sources, most notably along the axis of the source, the treatment planning comparison showed clinically insignificant changes in target coverage or OAR doses, particularly for the 3D-image-based treatment planning study.

Significant cost savings may be achieved with Co-60 sources, especially for HDR Brachytherapy units, but the capital costs of Co-60 sources are significantly higher than those of Ir-192 sources.

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Figures and Tables

- Fig 1: Percentage difference in dose distribution between Co-60 and Ir-192 sources with the IBt-Bebig HDR MultiSource®Brachytherapy unit at various source strengths.
- Table 1: Percentage difference in dosimetric quality indices between Co-60 and Ir-192 sources.
- Table 2: Comparison of 2 cm dose delivered at 2 cm depth for Co-60 and Ir-192 sources.
- Figure 3: Cumulative costs of Co-60 and Ir-192 sources over a 10-year period.