Comparison of Radiation Shielding Requirements for $^{192}\text{Ir}$, $^{60}\text{Co}$ and $^{169}\text{Yb}$ HDR Brachytherapy Sources Using Monte Carlo Simulations

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A- Summary
With the aim of comparing the differences in the shielding requirements, the results of this study show that:

- Selection of $^{169}\text{Yb}$ over $^{192}\text{Ir}$ and $^{60}\text{Co}$ sources would afford significantly less massive direct shielded doors.
- For facilities with a typical maze, the $^{169}\text{Yb}$ source may not afford a significant saving on the shielding thickness requirement for the door.
- Radiation leakage may dominate the dose rate behind the door even when the core lead thickness has been correctly specified.

B- Monte Carlo simulations

- Realistic modelling of brachytherapy radiation sources, placed at the centre of a typical treatment room in air and also at the centre of a water phantom.
- MCNPX version 2.5.0
- Photon Flux Mesh Tally
- Particle Flux Tally - dose function modified
- Cut-off energy 10keV
- Relative errors < 5% (1.s.d.)

C- Results 1: Primary barrier

- For the $^{169}\text{Yb}$ source the lead thickness reduction relative to the $^{192}\text{Ir}$ source was found to be about three HVLs.
- The primary barrier lead thickness required for the $^{60}\text{Co}$ source was found to be about five HVLs higher than that required for the $^{192}\text{Ir}$ source.

D- Results 2: Door shielding

- Dose rate behind the shielded door ($\mu$Sv h$^{-1}$)

<table>
<thead>
<tr>
<th>Source</th>
<th>$^{192}\text{Ir}$</th>
<th>$^{169}\text{Yb}$</th>
<th>$^{60}\text{Co}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mm Pb door No phantom</td>
<td>0.6</td>
<td>0.7</td>
<td>3.0</td>
</tr>
<tr>
<td>6 mm Pb door With water phantom</td>
<td>0.2</td>
<td>0.4</td>
<td>1.6</td>
</tr>
<tr>
<td>9 mm Pb door No phantom</td>
<td>-</td>
<td>-</td>
<td>1.8</td>
</tr>
<tr>
<td>9 mm Pb door With water phantom</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* For typical $^{192}\text{Ir}$ and equivalent $^{169}\text{Yb}$ and $^{60}\text{Co}$ sources set-up at the centre of a treatment room with a maze.

E- Results 3: Leakage through the door & floor gap

- The lead mat solution: