AbstractID: 4653 Title: Conservation of Integrated Reference Air Kerma

Purpose:

To demonstrate the conservation rule of the integrated reference air kerma (IRAK).

Method and Materials:

For a brachytherapy photon source whose radial dose functions is flat over the clinical distance range, the dose falls off with the inverse square of distance. If we assume further that the photon spectrum does not change with distance in tissue and the kerma in tissue can be substituted for radiation dose, it follows that both the photon particle and energy fluences obey the inverse square law. Under these assumptions, the photon fluence integrated over any arbitrary isodose surface, which is proportional to the integrated reference air kerma (IRAK), is conserved as long as the isodose surface contains all the brachytherapy sources, regardless of the distribution of the activity or equivalently the shape of the isodose surface.

Results:

One application of this conservation law is that the total dwell time (proportional to IRAK) of a plane implant is proportional to the total area of the prescription dose isodose surface. A quick second check QA program is established based on this relation for our intra-op HDR using HAM applicator.

Another application is to calculate the area of the absolute isodose surface assuming all the distributed activity is placed on one single point. The total area of spherical isodose surface is simply AREA = $4\pi r_0^2\Lambda ST/D$, where r_0 is the reference radial distance of 1 cm, Λ the dose rate constant, S the source activity, T the total dwell time, and D prescription dose. This area should equal the isodose surface area for an plan with optimized dose distribution achieved by redistributing the same amount of activity within tissue. Two examples, one HDR planar implant and the other Patterson-Parker nomogram, are given in the supporting material.

Conclusion:

The IRAK conservation rule has both theoretical and practical values.