AbstractID: 6501 Title: Monte Carlo validation of clinical brachytherapy dosimetry under partial scatter conditions for neutron-emitting sources

Purpose: Monte Carlo (MC) models were generated in support of a clinical trial on the effectiveness of neutron-based brachytherapy for a patient treated with a plaque containing Cf-252 sources. Because the AAPM brachytherapy dosimetry formalism does not replicate partial scatter conditions of superficial brachytherapy, MC simulations were performed to evaluate treatment time and dose distributions generated using conventional methods.

Method and Materials: Clinical calculations employed the AAPM dosimetry formalism with modified parameters for the neutron dose component. MC simulations utilized MCNP5 and track length estimator tallies. Computations applied a rectilinear mesh to tabulate neutron transport, including induced photons, and primary photon transport in a 14x14x5 cm^3 volume with 9 mm^3 voxels. Patient surface was simulated using a 20 cm radius hemisphere of water, with a corresponding hemisphere of air. For comparison to the AAPM formalism, the air was replaced with water. An RBE of 6 converted results to cGy-eq for the neutron component. Results were normalized to 0.1 mg Cf-252 source strength.

Results: At the 6 mm prescription depth, calculated dose rates were 186±2 and 205±2 cGy-eq h^{-1} at plaque center and 24 mm offset, respectively. The central 4x4 cm^2 area received 227±32 cGy-eq h^{-1}. For comparison, full-scatter simulations yielded 205±2 cGy-eq h^{-1} at plaque center and 244±32 cGy-eq h^{-1} over a 4x4 cm^2 area; although, computation time increased by a factor of 6.6. Dose ratios of full- (4π) to partial-scatter (2π) environments increased from 1.07 to 1.10 as depth increased from 0.4 to 5 cm. Approximately 90% of the dose-equivalent was due to neutrons, while neutron physical dose was 68% and 57% of the total at 0.6 and 5.0 cm depths, respectively.

Conclusion: Dose can be overestimated upto 10% by assuming full-scatter conditions for Cf-252 plaque brachytherapy. MC simulations are recommended to validate treatment plans generated using conventional methods.