AbstractID: 9181 Title: Optimal dose grid and sampling resolution for HDR Interstitial brachytherapy planning

Purpose: Investigating the influence of dose grid resolution on the accuracy and speed of a High Dose Rate (HDR) interstitial brachytherapy isodose plan optimization algorithm.

Method and Materials: Using an adaptive simulated annealing algorithm we have developed a method to optimize dwell times for HDR interstitial brachytherapy planning. The cost function uses a logistic function based on generalized Equivalent Uniform Dose (gEUD) to maximize the target and minimize organs-at-risk (OAR) doses. Simulations for a cervix cancer case were run using up to 75000 iterations. Once the cost function converges towards its minimum value, an upper limit was selected for the iteration number used for subsequent optimizations. The time required for optimization also depends on the dose grid resolution. Optimizations were run using dose point densities ranging from 1-130/cm^3. From optimized plans gEUD values were calculated for target and OARs. The sensitivity of the gEUD values relative to the dose point density was tested using two approaches: i) optimize once and re-sample the space using different grid sizes, ii) re-sample and re-optimize using different grid sizes.

Results: The cost function of the gEUD-based optimization model converges toward its minimum for all grid sizes tested. For 25000 iterations the time required for optimization can reach 4600 seconds for 130 points/cm^3. In general, the uncertainty of gEUD values decreases as the dose point density increases, however the resample-reoptimization scheme results in smaller uncertainties in gEUD calculations. For the dose point density of 40 points/cm^3, corresponding to a grid size of 2.5x2.5x4 mm^3, the optimized gEUD values have uncertainties within 1%.

Conclusion: Dose point density has strong influence on the optimization results and computing speed. Our results show that fewer dose points could speed up the optimization but at least 40 points/cm^3 are needed to ensure optimized gEUD values within 1% uncertainties.