AbstractID: 13757 Title: A novel approach to HDR brachytherapy dose planning using Integer Programming with direct dosimetric-index-based objectives

Purpose: Develop and test Inverse Planning Integer Program (IP2), an optimization model for computing high dose rate (HDR) brachytherapy dose plans. Unlike current models of dose planning, structure dosimetric criteria can be specified directly into IP2. Therefore, the optimal solution will necessarily comply with all dosimetric specifications.

Materials and Methods: We derive the IP2 model as well as two heuristic algorithms to compute near-optimal solutions for it: the Capping and Hard Cut heuristic. We generated plans for 20 prostate patient datasets from both heuristics, and compared them with the clinical dose distributions generated by Inverse Planning Simulated Annealing (IPSA). Runtime, dosimetric indices, and DVH were evaluated.

Results: The average run time of the Capping and Hard Cut heuristics were 23 and 900 s, and the maximum run times were 62 and 3060 s respectively. The average run time for IPSA was 5 seconds with a maximum run time of 9 seconds. The Capping heuristic met all specified dosimetric criteria for 19/20 cases, the Hard Cut Algorithm 20/20 cases. IPSA did not satisfy the criteria at the first iteration and would require dose objective parameter adjustment to fulfill them. Both IP2 heuristics produced prostate coverage within 2% of IPSA for 19/20, the one exception being 4% higher coverage than IPSA.

Conclusion: We have formulated a new model for optimizing HDR brachytherapy dose plans based on dosimetric index objectives using heuristics that achieve: (1) converge to a solution, (2) guarantee compliance with all OAR constraints, and (3) cover of the target comparably to state of the art planning models.