Abstract ID: 17777 Title: Robustness Evaluation and Robust Optimization of IMPT Plans Based On Per-Voxel Standard Deviation of Dose Distributions

Purpose: Proton dose distributions, IMPT in particular, are highly sensitive to setup and range uncertainties. We report a novel method, based on per-voxel standard deviation (SD) of dose distributions, to evaluate the robustness of proton plans and to robustly optimize IMPT plans to render them less sensitive to uncertainties.

Methods: For each optimization iteration, nine dose distributions are computed - the nominal one, and one each for ± setup uncertainties along x, y and z axes and for ± range uncertainty. SD of dose in each voxel is used to create SD-volume histogram (SVH) for each structure. SVH may be considered a quantitative representation of the robustness of the dose distribution. For optimization, the desired robustness may be specified in terms of an SD-volume (SV) constraint on the CTV and incorporated as a term in the objective function. Results of optimization with and without this constraint were compared in terms of plan optimality and robustness using the so called 'worst case'□ dose distributions; which are obtained by assigning the lowest among the nine doses to each voxel in the clinical target volume (CTV) and the highest to normal tissue voxels outside the CTV. The SVH curve and the area under it for each structure were used as quantitative measures of robustness. Penalty parameter of SV constraint may be varied to control the tradeoff between robustness and plan optimality. We applied these methods to one case each of H&N and lung.

Results: In both cases, we found that imposing SV constraint improved plan robustness but at the cost of normal tissue sparing.

Conclusions: SVH-based optimization and evaluation is an effective tool for robustness evaluation and robust optimization of IMPT plans. Studies need to be conducted to test the methods for larger cohorts of patients and for other sites.

Funding Support, Disclosures, and Conflict of Interest:

This research is supported by National Cancer Institute (NCI) grant P01CA021239, the University Cancer Foundation via the Institutional Research Grant program at the University of Texas MD Anderson Cancer Center, and MD Andersonâ€™s cancer center support grant CA016672.