AbstractID: 5313 Title: Margin-less prostate IMRT plans, directly optimized for TCP and NTCP including geometric uncertainties

Purpose: To account for geometric uncertainties without the use of margins during IMRT planning such that optimal values are obtained for the population averaged TCP and NTCP functions.

Methods and materials: A new method of computing cost functions was implemented within the IMRT planning tool Hyperion. Population-averaged values of biologic score functions (TCP_{pop} and $NTCP_{pop}$) are optimized, simulating random errors by blurring the dose, and systematic errors by displacing target and OARs relative to the dose distribution.

For 19 prostate (and seminal vesicle) patients, treatment plans for a five beam setup were created, optimising TCP_{pop} while constraining rectum $NTCP_{pop}$ and the maximum dose to the target. Gaussian distributions were used for the systematic and random errors (translations only, no attempt was made to model rotations or deformations). Since geometric uncertainties were accounted for within the cost functions, no CTV to PTV margin was used. For comparison, conventional plans were created using a CTV-to-PTV margin ($M=2.5\Sigma+0.7\sigma$) and a Simultaneous Integrated Boost (SIB) technique (68Gy to the above PTV, 78Gy to PTV_{boost} with 5mm margin, 0mm towards rectum). The resulting plans were evaluated using an independent tool that simulates the effects of geometric uncertainties.

Results: Compared to conventional plans, our new technique reduced the planned dose to the rectum, while increasing the volume receiving 78Gy. We ensured that TCP_{pop} of the new technique was not smaller than for conventional techniques. The average rectum $NTCP_{pop}$ values were 14% (margin recipe), 8% (SIB), and 4% (new technique), for average TCP_{pop} values of 69%, 70%, and 71%.

Conclusions: The computation of TCP and NTCP including knowledge of geometric uncertainties within the inverse IMRT optimization loop is feasible (less than 1 hour optimization time), and results in robust prostate treatment plans with an improved balance between local control and rectum toxicity.