AbstractID: 6682 Title: Influence of Monte Carlo beamlet smoothness on plan metric accuracy

Purpose: Monte Carlo (MC) may be advantageous as a basis for IMRT dose calculations as it provides for reliable heterogeneity corrections even in complex media. However, the upper-limit of noise in pre-computed beamlets has not been previously investigated.

Method: We investigated convergence in plan metrics for optimized IMRT treatment plans as a function of MC noise in the input pre-computed beamlet influence matrices. We analyzed seven individual patient cases of head and neck cancer. Each radiotherapy dose calculation involved nine 6 MV beams divided into beamlets of 1cm × 1cm cross-section. The VMC++ Monte Carlo dose calculation engine was used as a basis for the calculations. A prioritized prescription optimization process was utilized to produce the final plan. As a function of beamlet noise levels, we monitored minimum combined-PTV dose, D95 (minimum dose to hottest 95% of the combined PTVs), maximum dose to the brain stem, and mean dose to the parotid glands. For all metrics, we took a convergence within 1% of the low-noise limit as being adequate.

Results: For D95, 1% accuracy was typically achieved with an individual beamlet noise level of 2.4% (std. error); minimum target dose was accurate only when very noise levels were reached (< 0.5%); maximum dose to brain stem was accurate when beamlet noise was typically less than approximately 2%; mean dose to the parotid glands was accurate even at relatively noise beamlet levels (5%).

Conclusions: Adequate MC beamlet smoothness depends critically on the plan review metrics. Metrics which partially or fully average over voxels (D95 of targets, or mean doses to organs) converge rather quickly compared to metrics which are sensitive to single-voxel excursions (e.g., maximum organ dose or minimum target volume dose).

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