AbstractID: 6652 Title: Underestimation Of Low-Dose Radiation in Conventional Treatment Planning of Intensity-Modulated Radiation Therapy

Purpose: In radiation therapy of thoracic cancers (e.g. lung cancers), a high volume of low-dose radiation may lead to severe and fatal pulmonary complications. The purpose of this work is to investigate dosimetric accuracy in low-dose regions from commercial treatment planning systems (TPS) and consequent clinical implications for using IMRT in treating lung and thoracic cancers.

Methods and Materials: We retrospectively reviewed thoracic-cancer patients treated with IMRT at our institution and for whom high-grade lung complications occurred. These IMRT plans were evaluated and were recomputed using a Monte-Carlo-based (MC) treatment planning system (TPS) that explicitly accounts for modeling of the machine head and MLCs. Dose calculations from 2 commercial TPSs (Pinnacle and Corvus systems) were compared with those obtained from the MC system and measurements. Various factors that could contribute to the difference in IMRT dose calculations were analyzed, including tissue heterogeneity effect, MLC modeling, and beam modeling.

Results: Significant dosimetric errors (~25%) were found in the low-dose regions below 5 Gy in the commercial TPSs. Accuracy of dose calculations in the high-dose tumor regions was acceptable (< 5%). In regions < 5 Gy of IMRT plans, MLC transmission, leakage, and scattering were found to be important contributors to the dose. These factors were also spatially variant and field-size dependent. Without explicit modeling of the MLCs, severe underestimation of the low-dose volume could occur in commercial TPS. The degree of low-dose error was particularly greater in IMRT plans with larger target volumes and higher degrees of beam modulation.

Conclusions: Treatment planners should be aware of potentially significant underestimation of low doses in IMRT treatment plans for thoracic and other cancer sites. More accurate modeling of MLCs and low-dose calculation may be achieved by using a Monte-Carlo-based planning system.