Abstract ID: 16574 Title: Model for time-dependent radiation-induced lung disease risk based on systematic image-based scoring and Monte-Carlo dose calculations

Purpose: To construct an analytical model for radiation-induced lung injury (RILD) risk using computed tomography (CT) image analysis correlated to Monte Carlo (MC) dose calculations along with investigation of the model's post-RT dependency.

Methods: The extent of RILD was segmented on the difference CT image between a planning CT image and registered post-RT diagnostic CT image. Radiation dose was calculated using the anisotropic analytical algorithm (AAA) and MC methods. The segmented RILD was spatially correlated with the dose distribution to generate a dose-response curve for each of 39 follow-up studies from 12 subjects. The response curves were grouped into 6 follow-up periods with 3 months intervals according to the time elapsed since the completion of RT. For each period, a probit function derived from the Lyman-Kutcher-Burman (LKB) model was fit to the patient data with the two adjustable parameters: TD50 (dose at 50% chances of complication) and m (steepness of the curve).

Results: TD50 demonstrated a monotonic increase from its initial level (73 Gy/77 Gy for AAA/MC dose) to its peak (130 Gy/116 Gy) at 9~12 months post-RT after which it fell to 85 Gy/80 Gy beyond 15 months post-RT. The change in TD50 occurred coincidently with the decrease in the proportion of injured lung volume, demonstrating the association between TD50 and the severity of RILD. The value of m significantly decreased in time from its initial values (0.51/0.55) to 0.24/0.25 beyond 15 months post-RT. This suggests a transition in the dose-response from a linear-no-threshold to nonlinear-threshold type behavior. Replacement of AAA calculation by MC did not yield a significant difference in the fitting parameters.

Conclusions: Time-dependent results from the analytical modeling of RILD dose response indicates the transition from early to late radiation effects and the necessity to incorporate a temporal factor into the current time-static RILD risk models.