AbstractID: 3693 Title: On the dose-volume constraints based on radiobiological considerations

Purpose: To apply radiobiological principles in the estimation of dose-volume constraints used in treatment planning. To evaluate NTCP distributions affiliated with certain multiple dose-volume constraints. To estimate the probability $P_{mD\text{-}V}$ that a dose-volume histogram resulting in a given NTCP level also satisfies certain multiple dose-volume constraints.

Method and Materials: The reverse NTCP mapping method[1] is used here to obtain physical dose-volume constraints based on radiobiological indices. A procedure for random integral DVH sampling from the space of monotonously decreasing functions is developed. DVHs are randomly simulated and the ones producing an $NTCP \in \{5 \pm 0.5\%\}$ are selected. An average DVH is produced from the selected DVHs. We propose that any point from the averaged DVH may serve as a physical dose-volume constraint. A Monte-Carlo method is used to estimate the probability $P_{mD\text{-}V}$ for a number of these constraints.

Results: Dose volume constraints for 16 organs selected based on the availability of parameter estimates for the Lyman and the Critical Volume NTCP models[2,3] are obtained. The Emami[4] constraints lay on the "upper boundary" of the DVH sub-space defined by the condition NTCP=5±0.5%. The calculated probabilities $P_{mD\text{-}V}$ are very low, indicating that the physical optimization uses a much smaller subspace of the possible solutions than the biological or the physico-biological optimization.

Conclusion: New dose-volume constraints based on radiobiological considerations are proposed. DVHs passing through a combination of constraints[1] are outside the range of the DVHs producing NTCP=5±0.5%. The physical RT optimization is more restricted in its choice of solutions than the biological one.

1. Stavrev P et al In: Proc. of World Congress on Medical Physics and Biomedical Engineering; 2003, Sydney, Australia; 2. Burman C et al IJROBP 1991; 21 (1):123-35; 3. Stavrev P et al Phys Medica 2001; XVII (2):71-82; 4. Emami B et al IJROBP 1991; 21 (1):109-22