AbstractID: 11993 Title: Biological/Clinical outcomes models in Radiation Therapy Planning

Radiation therapy must strike a balance between clinically acceptable tumor control probability (TCP) and normal tissue complication probability (NTCP). Typical treatments expose several normal organs to incidental dose with an associated risk of a variety of radiation-induced complications, each of which may depend differently on the spatial and temporal dose distribution. Dose/volume effects, wherein the 'iso-complication dose' increases if the irradiated volume fraction decreases, are particularly important in designing and evaluating treatment plans. These effects are pronounced for some complications and weak for others. The classic "Emami" paper of 1991 summarized guidelines based on decades of clinical experience derived from the simple beam arrangements of the 2-dimensional planning era when discrete parts of normal tissues typically received uniform doses at conventional fractionation schedules (partial organ irradiation). More recently, 3-dimensional planning (including IMRT) has led to more conformal distributions with superior patient-specific dosimetric information. Three-dimensionl techniques have also encouraged treatment to higher doses and exposed normal tissues to a more variable and inhomogeneous range of dose distributions and fraction sizes. These complex relationships are often summarized in dose-volume histograms (DVH).

Depending on the suspected volume effect, treatment planners use various DVH-based metrics to estimate complication risks. These include single DVH points (e.g. maximum dose or percent or absolute volume above a dose cut-point), combinations of such points, generalized equivalent uniform dose (including mean dose) and models (e.g. Lyman model). Co-morbidities, chemotherapies and other medical factors may also need to be considered. We will describe commonly used evaluation metrics, some of which date back to the early 1990's and others from more recent publications or in-house experience.

The current metrics used to evaluate normal tissue DVHs are sub-optimal. Under the QUANTEC (Quantitative Analysis of Normal Tissue Effects in the Clinic) initiative, a project that is jointly funded by AAPM and ASTRO, approximately 60 physicists and physicians have critically surveyed the NTCP literature. Their updated consensus guidelines will be published in the near future. Some of their preliminary findings will be discussed here (check the proffered sessions for other presentations).

Learning Objectives:

1. Understand the general features of the volume effect as applied to NTCP.
2. Be familiar with the dose/volume metrics commonly used for complications risk estimation in treatment planning.
3. Understand some of the difficulties in determining reliable dosimetric predictors of normal tissue complications.