AbstractID: 9869 Title: Outcome-driven automated treatment planning

Rapid advances in functional and biological imaging, predictive assays and our understanding of the treatment responses herald the coming of the long-sought goal of implementing biologically based radiation therapy in the clinic. Until now, the practice of RT has been based on the premise that effective treatments require the delivery of uniform radiation doses to all target volumes. However, the uniform-dose approach only yields the best possible tumor control for the implausible situation in which all regions of the tumor have exactly the same biological characteristics and sensitivities to radiation. Theoretical studies and the accumulated clinical data strongly suggest that the treatment plans designed to exploit patient- and tumor-specific biological features will substantially improve treatment outcomes.

Biologically based treatment planning (BBTP) use dose response models to estimate biological responses for a dose distribution and/or a fractionation schedule. There have been at least two commercial BBTP systems available for clinical use. A variety of dose response models and quantities (e.g., the generalized equivalent uniform dose (gEUD), Poisson cell killing, serial and parallel complication models, and Lyman-Kutcher-Burman model) along with a series of organ-specific model parameters are included in these systems to calculate TCP, NTCP and EUD. Experience with these commercial and non-commercial planning systems has shown that the appropriate use of biological-model based cost functions can generate plans with similar target coverage but with better normal tissue sparing or equivalent plans but with much smaller number of iterations, as compared to the use of physical (dose-based) cost functions. Because of these and other anticipated benefits, we believe that the use of biological models in treatment planning process will become popular in the near future.

However, it is also evident that, due to various limitations, such as the limitations of models and available model parameters, the incomplete understanding of dose responses, and the inadequate clinical data, the use of biologically models for treatment planning can be potentially dangerous. In addition, the models can also be used simply to evaluate treatment plans. Some aspects of the models may be unintuitive and their correct interpretation and use as planning indices may not be straightforward. Biologically based planning represents a paradigm shift. There will be a steep learning curve for most clinical physicists/planners to understand how, when and why biological models do and/or do not work. To address these issues, AAPM has recently established a task group (TG166).

This talk will provide an overview for the development of biologically-based treatment planning. Initial experience of using a commercial BBTP system will be discussed.

Educational Objectives:

- Understand the basic and limitations of using dose-response models in treatment planning
- Understand dosimetrical differences between biologically based and physical dose based treatment plan optimization and evaluation.