AbstractID: 11994 Title: Biological/Clinical outcomes models in Radiation Therapy Planning - (Equivalent Uniform Dose (EUD) and Tumor Control Probability (TCP))

Designing radiation treatments is a difficult and complex art. Many considerations must be balanced to arrive at a satisfactory plan of treatment. Most of the tools and criteria that have been applied to designing radiation treatment plans involve constraints on the dose delivered to selected regions within the patient. These criteria indeed parallel some of those used by clinicians in evaluating plans. However, on the one hand, dose criteria are at best surrogates for biological considerations and, on the other hand, the criteria used have ignored a number of important considerations employed by therapists - not least of which is the assessment of non-uniform irradiation of organs and tissues.

These considerations have led to an interest in developing quantitative models that attempt to predict the likely biological or clinical response of organs and tissues to any arbitrary pattern of irradiation. The need to assess inhomogeneous dose distributions comes from two sources. First, even if the goal is to achieve uniform irradiation of the target volume, any scheme which is used in an automated procedure must be able to evaluate a non-uniform pattern of irradiation, if only to ensure that, by giving it a low score, a more uniform dose distribution will be preferred. It is also possible that a somewhat non-uniform target volume irradiation may lead to an overall more satisfactory plan than one in which there is an entirely uniform target coverage but which is associated with a higher dose to an adjacent critical organ. The second reason to assess inhomogeneous dose distributions is that these are the norm when it comes to the normal tissues outside the target volume - and there is thought to be a sometimes quite strong volume dependence of normal tissue tolerance of which clinicians wish to take advantage.

It is intuitively logical that, for any inhomogeneous dose distribution delivered to a volume of interest according to a certain fractionation scheme, there exists a unique uniform dose distribution delivered in the same number of fractions, over the same total time, which causes the same radiobiological effect. The important feature of this equivalent dose distribution would be its uniformity, which allows one to use a single number to describe the entire VOI dose distribution. This observation led to developing a concept of Equivalent Uniform Dose (EUD).

Models of EUD and models of tissue response to radiation can be classified into two broad categories. One category includes mechanistic models developed based on our best understanding of the underlying biological processes. The second category includes phenomenological models based on the observed phenomena and general laws governing these phenomena. Although these two categories are based on quite different philosophical approaches, they offer complimentary views. Both categories of models and their applications will be presented during the course.

The objectives of this course are:

1. To discus the importance of biological considerations in treatment planning.

2. To present mechanistic and phenomenological approaches to modeling tissue/organ response to radiotherapy.