“A Unified Model of Tissue Response to Radiation”.

We propose a generalized unified model of tissue response to radiation based on two fundamental assumptions. 1) A structure of interest (tumor or normal tissue) exhibits a specific end-point (local control for tumors or complication for normal tissues) if tolerance of the structure for this end-point is exceeded. 2) The Equivalent Uniform Dose (EUD) is an index associated with tolerance. If tolerance is log-normally distributed in a population than the probability of a specific end-point for a given case characterized by EUD is $p = \Phi\left(\frac{\ln EUD - \ln D_{50}}{s}\right)$ where Φ is the standard normal distribution function, s is the standard deviation of log-tolerance in a population, and D_{50} is the median “tolerance dose”. The formula can be rewritten using slope γ_{50}: $p = \Phi\left[\gamma_{50} \quad 2p\left(\ln EUD - \ln D_{50}\right)\right]$. The EUD for any structure of interest (tumor or normal tissue) is estimated as $EUD = \left(\sum_{i=1}^{N} n_i D_i^a\right)^{\frac{1}{a}}$, where $\{v_i, D_i\}$ are bins of a histogram and “a” is a tissue-specific parameter. The parameter “a” is negative for tumors and it is positive for normal structures. The model has only three parameters (a, D_{50}, γ_{50}). We fitted the model to several tumor and normal tissue data sets. The fit was better or at least as good as fits of other more complicated models proposed in the literature. We attribute this to the fact that the model captures the fundamental dose-volume-response relationship in the most flexible form. We will discuss the rationale of the model and we will present the results of fitting the model to tumor and normal tissue data.