

Biological treatment planning involving biological images and/or different RT modalities requires the characterization of dose and biological response on voxel-by-voxel basis. There have been a variety of indices introduced to measure biological effectiveness of a treatment design. The equivalent uniform dose (EUD) is one of the most commonly used indices. The EUD is particularly useful for designing and ranking treatment plans because it is less sensitive to the underlying biological model and parameters than other indices. However, the EUD is a space-averaged quantity. The voxel-based information (e.g., hot and cold spots, residual variation in radiosensitivity) cannot be easily identified using the EUD concept. In this work, we introduce a new concept, termed the voxel equivalent dose (VED), to characterize dose and biological response on voxel by voxel basis. The VED is defined as the equivalent dose to a voxel, if delivered using a specified reference modality (such as the conventional external beam RT), that will produce the same biological effect in that voxel as the radiation delivery of interest. The calculation of VED is similar to that for EUD, except it is done for small tissue regions (i.e., voxels). The VED has all the advantages of EUD. The VED is found to be useful and advantageous as demonstrated using two clinical examples: (1) combining IMRT with brachytherapy dose distribution, and (2) design of IMRT simultaneous integrated boost. Details of using the VED concept in biologically based treatment planning are presenting.