

Alpha-particle emitters are currently being considered for the treatment of metastatic disease. The advantages of using alpha particles are their short range, high LET, and independence of dose rate and oxygen effects. The dosimetry of alpha-particle emitters is a challenge, however, because the stochastic patterns of energy deposition must be taken into account. We propose a model for the tumor control probability (TCP) of alpha-particle emitters which takes into account these stochastic effects. We begin by deriving an expression for cell survival which is a function of the average number of hits to the cell nucleus, the probability of an individual cell surviving, and the single-event specific-hit distribution. This survival equation is multiplied by the number of cells within the tumor cluster, and a Poisson model is used to predict the TCP. Based on this analysis, a number of observations have been made : 1) Similar to the TCP derived for external beam therapy, the alpha-particle TCP depends logarithmically on the number of cells within the tumor. 2) TCP is not only a function of the inherent cell sensitivity, but also a function of the size of the nucleus. Smaller cell nuclei will require more dose to achieve the same level of TCP, relative to larger nuclei, for an identical source-target configuration. 3) TCP is a function of the source-target configuration. Although two different source-target configurations may result in the same average dose to a small tumor, the TCP can be quite different. Examples will be presented.