

AbstractID: 4539 Title: Optimum Parameters an a Model for Tumor Control Probability Including Interpatient Heterogeneity: Evaluation of the Log-Normal Distribution

Purpose: The heterogeneity of human tumor radiation response to is well known. Researchers have used the normal distribution to describe interpatient tumor radiosensitivity. However, many natural phenomena show a lognormal distribution. Lognormal distributions are common when mean values are low, variances are large and values cannot be negative. These conditions apply to radiosensitivity. The aim of this work was to evaluate the lognormal distribution to predict clinical TCP data and compare the results with the homogeneous (single α value) and normal distributions.

Method and Materials: The clinically-derived TCP data for four tumor types: melanoma, breast, squamous cell carcinoma and nodes were used as the benchmark to fit the TCP models. Three forms of interpatient tumor radiosensitivity were considered: the lognormal, normal and δ -function (homogeneous). The free parameters in the models were the radiosensitivity mean, standard deviation and clonogenic cell density. The evaluation metric was the minimum square difference between the predicted and clinical data.

Results: The normal and lognormal distributions match the clinical data significantly better than the δ -function distribution. The means and standard deviations of the normal and lognormal distributions are similar. Though the clinical data match was slightly better for the lognormal data, the difference was not statistically significant ($p=0.13$). The clonogenic cell density value yielding the best clinical data match (10^1 - 10^5) is much less than the expected tumor cell density (10^7 - 10^9). Three explanations are intratumor radiosensitivity heterogeneity, tumor 'stem' cells and multiple cells required for tumor growth.

Conclusion: The lognormal and normal distribution of interpatient tumor radiosensitivity heterogeneity more closely describe clinical TCP data than a single radiosensitivity value. The lognormal distribution trends towards significance in its ability to match clinical TCP data compared to the normal distribution. The lognormal also has some theoretical and practical advantages over the normal distribution.