AbstractID: 6845 Title: An objective function for TCP/NTCP curve fitting

Purpose:

To propose an objective function for TCP/NTCP curve fitting.

Method and Materials:

One of the widely used objective functions by physicists, when fitting theoretical models to experimental data, is the χ^2 one, where:

$\chi^2 = \Sigma_i((Y^i_{theoretical} - Y^i_{experimental}) / \sigma^i_{experimental})^2$

which is the maximum likelihood function in case of Gaussian random variables. In the case of a binary outcome, as is the nature of clinical or experimental animal radiation outcome data, the random variable has a binomial distribution and the maximum likelihood function for ungrouped data becomes:

$L = \Sigma_{responders} \ln(P_{theor}(par,DVH)) + \Sigma_{non\text{-}responders} \ln(1-(P_{theor}(par,DVH)))$,

where P_{theor} stands for TCP_{theor} or $NTCP_{theor}$. The maximization of L is often used by different authors for the estimation of the TCP/NTCP model parameters.

Results:

However, sometimes χ^2 is used to fit TCP/NTCP functions for different purposes like theoretical comparison between different models. In this case the application of χ^2 becomes inaccurate and inadequate especially when the function values are close to the ends of the interval in which they are defined, namely 0 or 1. This is why we propose the application of the double logarithmic transformation, presuming that the random variable is not normally but log-log-normally distributed.

Conclusion:

Thus the objective function in case of model comparison would become:

$\chi^2 = \Sigma_i((-\ln(-\ln(P^i_{theoretical}) + \ln(-\ln(P^i_{'experimental'}))/\sigma^i_{log\_'experimental'})^2$

where $\sigma^i_{log\_'experimental'} = -\sigma^i_{'experimental'} / (P^i_{'experimental'} \ln(P^i_{'experimental'}))$.

Here $P^i_{theoretical}$ stands for the values of P predicted by one of the models that are being compared and $P^i_{'experimental'}$ stands for the values of P predicted by the other model.

Conflict of Interest (only if applicable):