Research Article

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Appendix C

Appendix C. Fitting of survival curves using the least squares method

Survival rates are plotted on log-linear scales, so square errors were calculated as follows;

$$E^2 = \left(\ln S(x) - \ln Sm(x)\right)^2 \quad \text{(C-1)}$$

S(x): cell survival rate in "1-Target 1-Hit" model with a radiation dose of x-Hits/Target.

Sm(x): measured (actual) cell survival rate.

E: error between estimated survival rate and measured survival rate.

$$f(x) = \sum_{i=1}^{j} E^2 = \sum_{i=1}^{j} \left(\ln S(x) - \ln Sm(x)\right)^2$$

$$= \sum_{i=1}^{j} \left\{ \left(\ln S(x)\right)^2 - 2 * \ln S(x) * \ln Sm(x) + \left(\ln S(x)\right)^2 \right\} \quad \text{(C-2)}$$

Coefficient of (lnS(x)) is positive, so the equation (C-2) is a positive quadratic function of "x"

$$\therefore f(x) = \sum_{i=1}^{j} E^2 \qquad \text{becomes minimum when} \quad f'(x) = 0$$

i) In the "multi-Target 1-Hit" model, sum of square errors is represented as follows;

$$g(x)\sum_{i=1}^{j} ETi^2 = \sum_{i=1}^{j} \left(\ln ST(x) - \ln Sm(i)\right)^2 = \sum_{i=1}^{j} \left\{ \ln\left(1 - \left(1 - e^{-kx}\right)^n\right) - \ln Sm(i) \right\}^2$$

ii) In the "1-Target multi-Hit" model, sum of square errors is represented as follows;

$$h(x)\sum_{i=1}^{j} EHi^2 = \sum_{i=1}^{j} \left(\ln SH(x) - \ln Sm(i)\right)^2 = \sum_{i=1}^{j} \left\{ \ln\left(\frac{kx^i . e^{-kx}}{i!}\right) - \ln Sm(i) \right\}^2$$

ST(x): estimated survival rate with a dose inducing x-Hit/Target in the "multi-Target 1-Hit" model.

SH(x): estimated survival rate with a dose inducing x-Hit/Target in the "1-Target multi-Hit" model.

Sm(x): measured cell survival rate.

ET: Error between estimated survival rate and measured survival rate in the "multi-Target 1-Hit" model.

EH: Error between estimated survival rate and measured survival rate in the "1-Target multi-Hit" model.