Radiotherapy for lung cancer
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Citation for published version (APA):

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Appendix of Chapter 6

The LQ model has a linear-quadratic shaped log-survival curve $ad + \beta d^2$ below a threshold dose $d_T$ and a linear shaped log-survival curve $\lambda d + \delta$ above $d_T$. The LQ model and its derivative are continuous at the threshold dose:

$$\lambda d_T + \delta = ad_T + \beta d_T^2$$  \hspace{1cm} (1)

$$\lambda = a + 2\beta d_T$$  \hspace{1cm} (2)

Substituting equation 2 into equation 1 yields:

$$\delta = ad_T + \beta d_T^2 - ad_T - 2\beta d_T^2 = -\beta d_T^2$$  \hspace{1cm} (3)

The effect $E_{\text{LQ}}$ of the total dose $D$ given in $n$ fractions of dose per fraction $d$ exceeding $d_T$ is thus given by:

$$E_{\text{LQ}} = n(\lambda d + \delta) = n[(a + 2\beta d_T)d - \beta d_T^2] = D\alpha + 2\beta d_T - \frac{\beta d_T^2}{d}$$  \hspace{1cm} (4)

With the NTD [15] defined as the total dose given in 2-Gy fractions having an equivalent effect (as determined by the LQ model) as predicted by the LQ model, i.e., $E_{\text{LQ}} = E_{\text{NTD}} = \text{NTD}(\alpha + 2\beta)$, the NTD can be calculated as:

$$\text{NTD} = \frac{E_{\text{LQ}}}{\alpha + 2\beta} = D\frac{\alpha + 2\beta - \frac{d_T^2}{d}}{2 + \alpha + \beta}$$  \hspace{1cm} (5)