Radiotherapy for lung cancer
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Appendix of Chapter 6

The LQI 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 LQI model and its derivative are continuous at the threshold dose:

$$\lambda d + \delta = ad + \beta d^2 \quad (1)$$

$$\lambda = a + 2\beta d_t \quad (2)$$

Substituting equation 2 into equation 1 yields:

$$\delta = ad_t + \beta d^2_t - ad_t - 2\beta d^2_t = -\beta d^2_t \quad (3)$$

The effect $E_{LQI}$ of the total dose D given in n fractions of dose per fraction d exceeding $d_t$ is thus given by:

$$E_{LQI} = n(\lambda d + \delta) = n[(a + 2\beta d_t)d + \beta d^2_t] = D \alpha + 2\beta d_t - \frac{\beta d^2_t}{d} \quad (4)$$

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 LQI model, i.e., $E_{LQI} = E_{NTD} = NTD(\alpha + 2\beta)$, the NTD can be calculated as:

$$NTD = \frac{E_{LQI}}{\alpha + 2\beta} = D \frac{\alpha + 2\beta d_t - \frac{d^2_t}{d}}{2 + \alpha / \beta} \quad (5)$$