Radiobiological rationale for accuracy considerations in RT

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Comparing radiation dose deliveries

Dosimetric precision in vivo

The normalized dose-response gradient

Steepness of DR curves for HNSCC
**Steepness of normal-tissue dose-response curves**

- Laryngeal oesophagus
- Buccal mucosa
- Thyroid
- Lingual
- Maxillary
- Mandibular
- Recto-sigmoid
- Lung, early
- Lung, late
- Subcutaneous fibrosis
- Telangiectasia
- Telangiectasia
- Laryngeal edema

**γ50 vs. local γ-value**

- γ varies with position on the dose-response curve, i.e., with the response level.
- The curve is still parameterized in terms of D50 and γ50.
- However, in most situations the local γ-value should be applied.

**Uncertainty components**

The delivered dose can be decomposed as:

\[ D = D_p + b + c \]

where \( D_p \) is the planned (intended or acceptable to the physician) dose, \( b \) is the bias, and \( c \) is a random error.

**Second derivative of dose-response function**

- Logistic dose-response curve: \( D_{50} = 60 \text{ Gy}, \gamma_{50} = 1.8 \)

\[ P''(D) = \text{MAXIMUM INCREASE IN NTCP} \]

\[ -P''(D) = \text{MAXIMUM LOSS OF TCP} = \text{MAXIMUM LOSS OF TCP} \]
So, what’s the accuracy target then?

Tumor control
- GOAL: lack of accuracy results in <5% loss of tumor control probability
- ASSUMPTION: $\gamma_{50}=3$
- What is $\gamma$ at the 80% level where the precision requirement is tightest?

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- What is $\gamma$ at the 80% level where the precision requirement is tightest?
- Answer: $\gamma_{80}=2.1$
- Accepting a maximum loss due to bias of 3% $\implies$ bias $\leq 1.5$
- This caps the loss due to imprecision at 2%

Inflation of sample size needed in RCT

EPILOGUE: Accuracy in a (humbling) perspective

% of patients who lost >3 Gy due to poor compliance
Variation in Mean Equivalent Lung Dose

- 18 patients with NSCLC receiving chemo-RT
- Average MELD = 10.2 Gy
- $CV_{MELD} = 42\%$