Planning for liver SBRT cases following where

The Equation 2 is a simplified form of the NTCP formula such that it can be expressed using an Error function:

\[ \text{NTCP} = \frac{1}{2} \left( \text{Erf} \left( \frac{t}{\sqrt{2}} \right) + 1 \right) \]

\[ t = \left( \frac{\text{NTD2,max} - \text{TD50}(\text{veff})}{\text{TD50}(\text{veff})} \right) \]

\[ \text{TD50}(\text{veff}) = \text{TD50}(1) \times \text{veff}^{-0.5} \]

\[ \text{NTD2,max} = \text{D}_{\text{max}} \times \left( \frac{\text{D}_{\text{max}} + \alpha/\beta}{2 + \alpha/\beta} \right) \]

Equation 2 is a simplified form of the NTCP formula such that it can be expressed using an Error function, which is easy for the script to calculate using the Math.Net Numerics package.

Equations 3-5 break down the variable \( t \), the argument of the Error function.

TD50(veff) is the liver tolerance dose at 2 Gy/Fx to a fraction of the whole organ leading to 50% complication probability in 5 years; TD50(1) is the same parameter but for the whole organ.

NTD2,max is the nominal standard dose in 2 Gy/Fx corresponding to Dmax.

Results

The script is a binary plug-in script, meaning it can only be run from within Eclipse and with a specific patient open.

It runs on a per-patient basis, and can only access the information of one patient at a time.

The user interface prompts to select the specific plan for the patient, and if the plan is hepatocellular carcinoma or metastatic.

The NTCP Calculator script is easy to use and runs quickly, displaying in the user interface the \( \text{V}_{\text{eff}} \) and NTCP as percentages (see Figure 1).

Figure 1 – The NTCP Calculator script, as it appears in Eclipse

The \( \text{V}_{\text{eff}} \) and NTCP values generated by the script were compared with the values obtained by hand calculation for 10 mixed cases of Hepatocellular Carcinoma and Liver metastases and with different prescribed doses in order to evaluate the accuracy of the script’s calculations, showing excellent agreement.

Based on these results the script was released for clinical use.

Conclusion

The NTCP Calculator has proven to be useful in expediting the liver SBRT planning process.

Prior to having the script, the dosimetrists had to wait for a medical physicist to manually calculate the \( \text{V}_{\text{eff}} \) and NTCP outside of Eclipse.

Using the script, the dosimetrists can assess the \( \text{V}_{\text{eff}} \) and NTCP of a plan themselves in real-time, providing crucial information for the plan optimization process.

Because the script runs quickly, the dosimetrists can use it iteratively to evaluate \( \text{V}_{\text{eff}} \)/NTCP at various stages of plan optimization.

References


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