LECTURE 13: TREATMENT PLANNING - ISODOSE DISTRIBUTIONS

Problem Solutions

13.1 Two parallel-opposed $^{60}$Co fields with a separation of 16 cm are used to deliver 60 Gy to a tumor encompassed by the 130% isodose curve. What is the dose delivered to each field at the depth of maximum dose?

In this case the wording is somewhat ambiguous, since the problem does not specify 130% of what, but the most reasonable conclusion is that the reference isodose is the dose to the depth of central axis maximum.

In that case, the dose delivered to the depth of central axis maximum from each field is $6000 \text{ cGy} / 1.30 = 4615 \text{ cGy}$.

13.2 Four coplanar $^{60}$Co fields yield an isodose distribution that encloses a tumor within the 180% isodose curve. For a tumor dose of 60 Gy, what is the dose delivered at $d_{\text{max}}$ to each of the fields?

Again, using the same normalization convention used in the previous problem, the dose delivered to the depth of central axis maximum from each field is $6000 \text{ cGy} / 1.80 = 3333 \text{ cGy}$.

13.3 Four coplanar $^{60}$Co fields yield an isodose distribution that encloses a tumor within the 150% isodose curve when the $d_{\text{max}}$ doses are weighted in the ratio of 100%, 80%, 75%, and 50%. Determine the dose at $d_{\text{max}}$ for each of the fields if the tumor dose is 45 Gy.

For the first beam: dose = $4500 \text{ cGy} \times 1.00 / 1.50 = 3000 \text{ cGy}$
second beam: dose = $4500 \text{ cGy} \times 0.80 / 1.50 = 2400 \text{ cGy}$
third beam: dose = $4500 \text{ cGy} \times 0.75 / 1.50 = 2250 \text{ cGy}$
fourth beam: dose = $4500 \text{ cGy} \times 0.50 / 1.50 = 1500 \text{ cGy}$

13.4 A four-field isocentric treatment configuration is used to deliver 50 Gy to a tumor over a course of 20 fractions, with two fields treated each day. The dose rate at the isocenter is 1.50 Gy/min for a 10 cm x 10 cm field. Output factors are 1.02 (12 cm x 12 cm) and 1.04 (15 cm x 15 cm).

Data for the four fields are:

Field 1: 15 cm x 15 cm, 10 cm depth, TAR = 0.755
Field 2: 15 cm x 15 cm, 12 cm depth, TAR = 0.686
Field 3: 12 cm x 12 cm, 15 cm depth, TAR = 0.564
Field 4: 12 cm x 12 cm, 16 cm depth, TAR = 0.535

What is the treatment time and tumor dose per treatment for each field if the treatment times are equal for all fields?

Calculate dose rates at isocenter:

dose rate at isocenter = dose rate(10x10) x output factor x TAR
Field 1: dose rate = 150 cGy/min × 1.04 × 0.755 = 117.8 cGy/min
Field 2: dose rate = 150 cGy/min × 1.04 × 0.686 = 107.0 cGy/min
Field 3: dose rate = 150 cGy/min × 1.02 × 0.564 = 86.3 cGy/min
Field 4: dose rate = 150 cGy/min × 1.02 × 0.535 = 81.9 cGy/min

Dose delivered = 117.8 t₁ + 107.0 t₂ + 86.3 t₃ + 81.9 t₄

If all times are equal, the dose delivered in 2 fractions is 500 cGy, then

\[ 393.0 \text{ cGy/min} \times t = 500 \text{ cGy} \]

giving \( t = 1.27 \text{ min.} \)

dose from field 1: \( 117.8 \text{ cGy/min} \times 1.27 \text{ min} = 150 \text{ cGy} \)
dose from field 2: \( 107.0 \text{ cGy/min} \times 1.27 \text{ min} = 136 \text{ cGy} \)
dose from field 3: \( 86.3 \text{ cGy/min} \times 1.27 \text{ min} = 110 \text{ cGy} \)
dose from field 4: \( 81.9 \text{ cGy/min} \times 1.27 \text{ min} = 104 \text{ cGy} \)

What is the treatment time for each field if the tumor doses are equal for all fields?

In this case the tumor dose for each field = 125 cGy

\[ t₁ = \frac{125 \text{ cGy}}{117.8 \text{ cGy/min}} = 1.06 \text{ min} \]
\[ t₂ = \frac{125 \text{ cGy}}{107.0 \text{ cGy/min}} = 1.17 \text{ min} \]
\[ t₃ = \frac{125 \text{ cGy}}{86.3 \text{ cGy/min}} = 1.45 \text{ min} \]
\[ t₄ = \frac{125 \text{ cGy}}{81.9 \text{ cGy/min}} = 1.53 \text{ min} \]