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# Outline • Basic terminology • Curved contour surface correction (bolus, compensators, wedges) • Oblique beam incidence • Correction for tissue inhomogeneities

# Patient dose calculation The aim of treatment planning is to find the beam arrangement that provides the adequate radiation dose to the tumor while sparing surrounding normal tissues Terms used in treatment planning: Reference dose (normalization point, calculation point) Tumor dose

- Skin (entrance) dose, exit dose

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#### Wedge filter implementations

- Hard wedge: set of fixed wedge angles
- Motorized (universal) wedge: physical wedge of the largest wedge angle (steepest gradient) combined with open beam to produce the required isodose tilt
- Dynamic or Virtual wedge: fluence gradient across the beam is produced by progressively moving one of the collimator jaws across the treatment field during the exposure. The amount of MU's can also be varied during the treatment

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### Example 3

- Modern linacs can be equipped with either a "universal wedge" (i.e., a "hard" 60° wedge in the head of the linac that can be remotely moved in or out of the beam) or a "dynamic wedge" (i.e., programmable collimator jaw to simulate a hard physical wedge). For the same nominal beam energy:
  - A. The dynamic wedge will have a more penetrating depth dose
  - B. The dynamic wedge will require fewer monitor units for the same central axis dose
  - C. There will be more scatter dose outside the field edge for a universal or dynamic wedge than for a "hard" wedge
  - D. The effective "wedge transmission factor" varies with field size ONLY for the dynamic wedge

Both the universal and dynamic wedges are physically higher in linac head, producing less scatter. The universal wedge attenuates the beam along the central axis  $\sim$  more MU's to deliver the same dose

Example 4

- A field with an effective wedge angle of 30 degrees could be achieved by all of the following except:
  - A. Combining open and 60-degree wedged fields for equal doses at the isocenter
  - B Combining open and 60-degree wedged fields for equal MUs
  - C. A Universal wedge, combining wedged and open fields
  - D. A dynamic wedge
  - E. A custom compensator

Doses should be equal, MU's in a wedge field will be higher compared to the open field



**Dose corrections for inhomogeneities** • Use methods similar to correction for curved surfaces • In *TAR correction method* introduce dose correction factor for a field size  $r_d$ :  $C = T_a(d', r_d)/T_a(d, r_d)$ • The equivalent thickness  $d' = d_1 + \rho_e d_2 + d_3$ density  $\rho_e$  is relative to water

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#### **Dose corrections for inhomogeneities**

 More accurate correction factor takes into account the proximity of the inhomogeneity (power law method):

$$C = \frac{T_a(d_3, r_d)^{\rho_3 - \rho_2}}{T_a(d_2 + d_3, r_d)^{1 - \rho_2}}$$

 $\rho_3$  is the density of the material in which the point lies

 $\rho_2$  is the density of the overlying material



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#### Dose corrections for inhomogeneities







**Example 5** · If heterogeneity corrections are not done, which of the following is likely to give the greatest discrepancy between calculated and actual dose at a point on the beam axis beyond the heterogeneity? Medium Thickness Photon energy 10 cm A.Lung 6 MV B. Lung 10 cm 18 MV 10 cm 6 MV C. Fat D. Dense bone 5 cm 6 MV E. Dense bone 5 cm 18 MV

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# **Energy imparted**

Integral radiation dose evaluated in prostate cancer treatment plans The prescription was normalized to encompass 95% of the PTV at a dose of 70 Gy for all plans

H. Aoyama, D.C. Westerly, T.R. Mackie, G.H. Olivera, S.M. Bentzen, R.R. Patel, et al., Integral radiation dose to normal structures with conformal external beam radiation, Int J Radiat Oncol Biol Phys, 64 (2006), pp. 962-967

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	Energy imparted								
	3DCRT 6 MV	IMRT 6 MV		3DCRT 20 MV		IMRT 20 MV		Tomo-IMRT	
	ave. (liter- gray)	ave.(lite r-gray)	p.d. (%)	ave.(lite r-gray)	p.d.(%)	ave.(lite r-gray)	p.d.(%)	ave.(lite r-gray)	p.d.(%)
Planning target volume	8.27	8.27	0.0	8.28	0.2	8.27	-0.1	8.26	-0.1
Rectal wall	2.53	2.37	-6.1	2.53	0.0	2.43	-1.8	2.23	-11.9
Penile bulb	0.201	0.196	-2.7	0.211	4.8	0.201	-0.3	0.168	-16.5
Bladder	4.99	4.61	-7.5	4.84	-2.9	4.95	-0.7	4.69	-6.0
Nontum or tissue	122.85	116.66	-5.0	113.38	-7.7	109.06	-11.2	117.89	-4.0

## **Total body irradiation (TBI)**

 Indication: leukemia (cancer of bloodforming tissues, including bone marrow), lymphoma (cancer of lymphocytes), myeloma (cancer of plasma cells), some solid pediatric tumors



· Risks: dose limited by skin, lung

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#### Summary

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