

# Self-Assessment Module

## 2017 ASTRO Annual Meeting

### EDU37-Advancements in Clinical Brachytherapy

Luc Beaulieu, PhD, Adam Cunha, PhD, Michael Ghilezan, MD, PhD

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#### Question 1:

In the case of breast brachytherapy, which of the following leads to the largest differences between model-based dose calculation and the current clinical standard, TG43?

- a) Tissue composition for  $^{192}\text{Ir}$ -based treatments
- b) Scatter condition for  $^{192}\text{Ir}$ -based treatments
- c) Heterogeneities for low-energy (e.g. electronic brachy) based treatments
- d) Scatter condition for low-energy (e.g. electronic brachy) based treatments

Answer : c

#### Feedback:

Soft tissue composition has minimal impact for  $^{192}\text{Ir}$  brachytherapy due to the dominance of Compton scattering. While scatter condition will have an impact of dose distribution in  $^{192}\text{Ir}$  that impact is small compared to effect of tissue heterogeneities for low-energy brachytherapy of the breast (due to photo-electric effect which goes as the effective composition,  $Z_{\text{eff}}^n$ , at a power  $n$  where  $n$  can be between 3 and 4). For low-energy brachytherapy, only a few cm of tissue is enough to ensure full scatter condition due to the small mean free-path of the low energy photons.

#### References:

Rivard, M J, J L M Venselaar, and L. Beaulieu. 2009. "The Evolution of Brachytherapy Treatment Planning." *Medical Physics* 36 (6): 2136–53. doi:10.1118/1.3125136.

White, Shane A, Guillaume Landry, Gabriel Paiva Fonseca, Randy Holt, Thomas Rusch, Luc Beaulieu, Frank Verhaegen, and Brigitte Reniers. 2014. "Comparison of TG-43 and TG-186 in Breast Irradiation Using a Low Energy Electronic Brachytherapy Source.." *Medical Physics* 41 (6): 061701. doi:10.1118/1.4873319.

Beaulieu, Luc, Åsa Carlsson Tedgren, Jean-François Carrier, Stephen D Davis, Firas Mourtada, Mark J Rivard, Rowan M Thomson, Frank Verhaegen, Todd A Wareing, and Jeffrey F Williamson. 2012. "Report of the Task Group 186 on Model-Based Dose Calculation Methods in Brachytherapy Beyond the TG-43 Formalism: Current Status and Recommendations for Clinical Implementation." *Medical Physics* 39 (10): 6208–36. doi:10.1118/1.4747264.

Chiu-Tsao, Sou-Tung, Melvin A Astrahan, Paul T Finger, David S Followill, Ali S Meigooni, Christopher S Melhus, Firas Mourtada, et al. 2012. "Dosimetry of (125)I and (103)Pd COMS Eye Plaques for Intraocular Tumors: Report of Task Group 129 by the AAPM and ABS.." *Medical Physics* 39 (10): 6161–84. doi:10.1118/1.4749933.

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#### Question 2:

In  $^{192}\text{Ir}$  HDR gynecological brachytherapy, one may expect the most significant dosimetric difference from the TG-43 calculation when using a Model-Based Dose Calculation Algorithms in Brachytherapy (MBDCA) when:

- a) The patient is very thin.
- b) There is a variety of different tissues present in the calculation region.
- c) There is air in the rectum.
- d) The applicators include the use of shielding.

**Answer :** d

#### Feedback:

All soft tissues for  $^{192}\text{Ir}$  brachytherapy could be approximated as water-equivalent for dose calculation purposes. The presence of air or lack of full scatter condition will have an impact on some dosimetric parameters but tend to be limited compare to the effect of placing a massive structure such as an applicator with high-Z materials for shielding e.g. stainless-steel or tungsten.

#### References:

Mikell, Justin K, Ann H. Klopp, Michael Price, and Firas Mourtada. 2013. "Commissioning of a Grid-Based Boltzmann Solver for Cervical Cancer Brachytherapy Treatment Planning with Shielded Colpostats." *Brachytherapy* 12 (6): 645–53.

Rivard, M J, J L M Venselaar, and L. Beaulieu. 2009. "The Evolution of Brachytherapy Treatment Planning." *Medical Physics* 36 (6): 2136–53. doi:10.1118/1.3125136.

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**Question 3:**

Which of the following is within 2% of TG43 when using model-based dose calculation algorithms?

- a) Dose to the skin in  $^{192}\text{Ir}$  interstitial breast
- b) Dose distribution in  $^{192}\text{Ir}$  interstitial prostate HDR brachytherapy
- c) Dose to the tip of the applicator in GYN cylinder-based brachytherapy
- d) Dose to the prostate in permanent seed implants

Answer : b

**Feedback:**

An interstitial HDR prostate brachytherapy, in particular using plastic catheter, possesses most of the characteristic related to the TG43 geometry due to the location (many cm of tissues in most direction, no high Z material as well as no significant amount of low-density tissues close-by), the fact that there is no inter-seed attenuation (only one source at any given time is present) and that for  $^{192}\text{Ir}$  soft tissues can be approximated as water-equivalent.

**References:**

Ma, Yunzhi, Frédéric Lacroix, Marie-Claude Lavallée, and Luc Beaulieu. 2015. "Validation of the Oncentra Brachy Advanced Collapsed Cone Engine for a Commercial ( $^{192}\text{Ir}$ ) Source Using Heterogeneous Geometries.." *Brachytherapy* 14 (6): 939–52. doi:10.1016/j.brachy.2015.08.003.

Rivard, M J, J L M Venselaar, and L. Beaulieu. 2009. "The Evolution of Brachytherapy Treatment Planning." *Medical Physics* 36 (6): 2136–53. doi:10.1118/1.3125136.

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#### Question 4:

Based on the GEC-ESTRO randomized controlled trial evaluating APBI vs WBI which of the following statements is correct:

- a) Acute grade 3 and 4 skin toxicities were higher with APBI but late skin 3 and 4 toxicity were similar between APBI and WBI
- b) Acute grade 2 and 3 skin toxicities were higher with APBI but late skin 2 and 3 toxicity were similar between APBI and WBI.
- c) Acute grade 2 and 3 skin toxicities were lower with APBI but late skin 2 and 3 toxicity were similar between APBI and WBI.
- d) Acute and chronic grade 2 and 3 skin toxicities were higher with APBI compared to WBI.
- e) Acute and chronic grade 2 and 3 skin toxicities were lower with APBI compared to WBI.

Correct answer is "e"

#### Feedback:

Acute skin toxicity grade 3 was 7% with WBI and 0.2% with APBI, whereas grade 1 and 2 toxicities were 86% vs 21% respectively. There was no grade 4 acute toxicity observed. (Ott et al, Radiother Oncol, 2016, vol 120 (1) pp 119-123).

The 5 year cumulative incidence of chronic skin toxicity grade 2 and 3 was 10.7% for WBI and 6.9% for APBI ( $p=0.02$ ).

#### References :

Polgar et al, Lancet Oncology, 2017 vol 18 (2) pp 259-268.

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#### Question 5:

In the ASCENDE-RT randomized trial comparing EBRT vs EBRT+LDR brachytherapy in intermediate and high-risk Pca patients there was a significant increase in 9-year bNED for all patients favoring the brachytherapy-combined treatment arm of about:

- a) 20% for IR patients and 10% for HR patients
- b) 30% for IR patients and 10% for HR patients
- c) 10% for IR patients and HR patients
- d) 30% for IR patients and 20% for HR patients
- e) 20% for IR patients but none for HR patients

Correct answer is "d"

#### Feedback:

The 9 year bNED for EBRT patients was 60% for IR patients and 58% for HR patients compared to 92% for IR patients and 78 for HR patients in the LDR+EBRT arm which is 32% 9-year nNED benefit in IR patients and 20% in HR patients.

#### Reference :

Morris et al, Red Journal 2017

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