University of Michigan
Department of Radiation Oncology
Division of Radiation Physics

Intensity Modulated Radiation Therapy (IMRT) QA Rotation

Resident: ____________________________________

Rotation staff mentor/ advisor(s): Dale Litzenberg, Kelly Younge, and __Jean Moran (supplemental training)_____

Rotation duration: 2 months
Rotation Dates: _______________________________

A medical physics resident in radiation oncology at the University of Michigan will be expected to demonstrate the following competencies associated with IMRT QA. These are considered the minimum standards.

Contents Outline

Knowledge Factors
- List of reading assignments
- QA Discussion Points
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Practical Factors
- Discussion points
- Training and observation
- Exercises
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Case Participation

Bi-monthly Progress Review

Knowledge Factors – List of reading assignment

1. A Practical Guide To Intensity-Modulated Radiation Therapy, Medical Physics Publishing, 2003, Memorial Sloan-Kettering Cancer Center, Department of Medical Physics.
2. Intensity-Modulated Therapy, The State of the Art, Monograph No. 29, Medical Physics Publishing, 2003
3. The Modern Technology of Radiation Oncology, Volume 2, Editor J. Van Dyk, Medical Physics Publishing, 2005.
4. P.C. Williams, "IMRT: delivery techniques and quality assurance," *The British Journal of Radiology*, 76, 766-776 (2003).
5. Chang, et al, "Relative profile and dose verification of intensity-modulated radiation therapy," *Int. J. Radiation Oncology Biol. Phys.*, Volume 47, No. 1. pp. 231-240, 2000.
6. Bortfeld, et al, "X-ray field compensation with multileaf collimators," *Int. J. Radiation Oncology Biol. Phys.*, Volume 28, No. 3. pp. 723-730, 1994.
7. Spirou and Chui, "Generation of arbitrary intensity profiles by dynamic jaws or multileaf collimators, Med Phys, 21(7), pp 1031-1041, 1994.
8. Graves, et al, "Calibration and quality assurance for rounded leaf-end MLC systems," Med Phys, 28(11), pp 2227-2233, 2001.
9. Low, "A technique for the quantitative evaluation of dose distributions," Med Phys, 25(5), pp656-661, 1998.
10. Moran, et al, "A dose-gradient analysis tool for IMRT QA," JACMP, 6(2), pp62-73, 2005.
11. TG 119: IMRT Commissioning
12. TG 120: IMRT Measurements

Knowledge Factors – QA Discussion Points

Discuss and demonstrate understanding of the following topics:

1. The distinctions between patient-specific QA, equipment QA, and process QA.

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2. Distinctions of different types of IMRT planning and delivery.
   a. Optimization goals and algorithms
   b. Accuracy of dose calculation algorithms for optimization compared to final calculation
   c. Field-in-field compared to beamlet-based

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3. Various IMRT delivery techniques
   a. Physical compensation
   b. Tomotherapy
   c. MLC-based IMRT (SMLC & DMLC delivery types)
      i. Tongue and groove
      ii. Leaf travel limits
      iii. Rounded leaf ends
      iv. Transmission
      v. QA
   d. Static-gantry IMRT vs. VMAT

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4. QA measurements
   a. Composite measurements
   b. Gantry-zero measurements

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5. Detectors for QA Measurements
   a. Detector arrays
   b. Ion chambers
   c. Film, processing and digitization
   d. Commissioning detectors
   e. Strengths and weaknesses of detectors
   f. Absolute vs. relative comparisons

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6. QA for advanced delivery techniques – machine-based
   a. Commissioning of IMRT or VMAT
      i. Appropriate detectors for commissioning
      ii. Frequency, type, spatial resolution, and accuracy considerations
   b. Implementing an IMRT QA program
7. Patient-specific QA process and measurements
   a. Calculations on phantom geometries
   b. Selection of detectors
   c. Ion chamber placement, when used
   d. Plan validation following the transfer process.

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8. QA Analysis, Evaluation and Criteria
   a. What is calced and what is measured?
      Methods of comparison and evaluation (e.g., Gamma, DTA, and Gradient compensation)
   b. Calc and measurement uncertainties
   c. Evaluation criteria
   d. Limitations of measurement-based QA

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9. Trouble Shooting
   a. Modulation
   b. Chamber placement
   c. Verifying shifts
   d. Film, processor and digitization problems
   e. Calibration issues

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Practical Factors – Training and Exercises

Over the course of training, the Resident should be able to perform the procedures below independently:

At least 3 IMRT QA calculations on the ArcCHECK, including any necessary shifts.

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Perform at least 2 IMRT QA calculations and measurements on phantoms containing an ion chamber (one with micro-chamber, one with Farmer-type chamber), including any necessary shifts.

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Perform at least 1 IMRT QA calculations and measurements on phantoms containing film.

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Export all calculation data for analysis.

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Measure four IMRT QA cases using the ArcCHECK.

	Date	Site	# of beams; dose per fraction	Signature
1				
2				
3				
4				

Measure two cases with an ion chamber.

	Date	Site	# of beams; dose per fraction	Signature
1				
2				

Perform MLC QA, analyze and discuss the results.

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Analyze film, ion chamber, and ArcCHECK data.

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Review IMRT QA results for at least 5 cases and determine the pass/fail status.

	Date	Site	# of chambers in high dose, low gradient region	Signature
1				
2				
3				
4				