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ABR Radiation Oncology Initial Certification Qualifying (Computer-Based) Examination: Study Guide for Medical Physics for Radiation Oncology

This exam tests your knowledge of the principles of physics underlying the practice of radiation oncology and radiation safety. Included are questions on the following topics:

- Basic physics
- Instruments and measurements
- Dosimetry
- Radioactivity
- Protection and safety

Categories for Medical Physics for Radiation Oncology

I. Atomic and nuclear structure

1. Bohr model of the atom, electron transitions, and characteristic radiation
2. Nuclear structure, nuclear forces, and mass/energy relationships
3. Factors affecting nuclear stability
4. Nuclear nomenclature

II. Radioactivity

1. Modes of radioactive decay
2. Decay schemes and properties for therapeutic isotopes
3. Mathematics of radioactive decay
4. Naturally occurring radioisotopes
5. Nuclear activation, fusion, fission

III. Particle interactions and production of radiation

1. Mass, energy, and charge relationships
2. Electromagnetic radiation
3. Production of radiation
4. Interactions of particulate radiation with matter

IV. Treatment machines

1. Linear accelerators
2. Other particle accelerators
3. Cobalt units

4. Low energy therapeutic x-rays (< 300 kV)
5. Treatment machine quality assurance

V. Photon interactions

1. Coherent scatter
2. Photoelectric effect
3. Compton effect
4. Pair production
5. Photonuclear disintegration
6. Relative dependence on Z, E, and density

VI. Radiation measurement and calibration

1. Exposure (air kerma)
2. Absorbed dose and kerma
3. Dose equivalent / effective dose equivalent (radiation quality and tissue weighting factors)
4. Calculation of absorbed dose from exposure (e.g., f-factor)
5. Bragg-Gray cavity theory
6. Ionization chambers
7. Calibration of photon and electron beams (e.g., TG-51)
8. Other dosimetry techniques (thermoluminescent dosimetry/optically stimulated luminescence dosimetry, film, solid-state diodes, other gas-filled detectors, scintillation detectors, chemical dosimetry, calorimetry)
9. Measurement techniques

VII. Radiation beam quality

1. Mathematics of exponential attenuation
2. Beam quality for heteroenergetic beams

VIII. Dosimetry of photon beams in a homogeneous water phantom

1. Dose distributions
2. Flattening filters and flattening-filter free beams
3. Dose distributions for multiple unshaped beams
4. Tissue-air ratio (TAR), tissue-maximum ratio (TMR), and tissue-phantom ratio (TPR)
5. Relationships between PDD, TAR, TMR, and TPR
6. Point-dose and treatment-time calculation methods for single unshaped fields
7. Point-dose and treatment-time calculations for single-shaped fields
8. Isodose distributions for multiple fields, including arc therapy

IX. Dosimetry of photon beams in a patient

1. Corrections for patient contour
2. Corrections for tissue inhomogeneities
3. Dose within and around an inhomogeneity
4. Matching of adjacent fields
5. Wedges
6. Parallel-opposed beams

7. Entrance dose and exit dose, including beam-modifying devices
8. Isodose distributions for multiple beams, including mixed modality and arc therapy
9. Compensators for photon beams
10. Off-axis factors

X. Electron beam characteristics and dosimetry

1. Dose distributions
2. Factors affecting dose distributions
3. Energy specification
4. Choice of energy and field size
5. Air gaps and oblique incidence
6. Tissue inhomogeneities
7. Bolus, absorbers, and spoilers
8. Matching adjacent fields
9. Point-dose and treatment-time calculations
10. Field-shaping techniques
11. Electron arc
12. Total skin electron therapy

XI. Imaging for radiation oncology

1. Plane radiography and fluoroscopy for simulation
2. Portal imaging
3. Imaging for radiation therapy planning
4. Isotope imaging
5. Image processing, digitally reconstructed radiographs (DRRs), and volume rendering
6. Image registration

XII. Treatment planning, ICRU, and beam-related biology

1. 3D treatment planning, non-coplanar beams
2. ICRU concepts
3. Virtual simulation, including beam's eye view (BEV) techniques
4. Treatment planning systems
5. Plan evaluation (DVH, normal tissue complication probability [NTCP], tumor control probability [TCP], etc.)
6. Radiosurgery/stereotactic body radiotherapy (SBRT)
7. Total body irradiation

XIII. IMRT, conformal arc, and volumetric modulated arc therapy (VMAT)

1. IMRT delivery systems
2. Dose prescriptions and inverse planning
3. IMRT quality assurance

XIV. Assessment of patient setup and verification

1. Positioning and immobilization methods and devices
2. Treatment verification
3. Imaging for treatment delivery/image-guided radiation therapy (IGRT)
4. Respiratory motion management

XV. Brachytherapy

1. Calculation of dose from a point source
2. Calculation of dose from a line source
3. Physical and dosimetric properties of commercial sealed sources and applicators
4. Implant instrumentation and techniques for low dose-rate
5. Implant instrumentation and techniques for high dose-rate, including PDR
6. Biological implications of dose, dose rate, and fractionation
7. Calibration and specification of sources
8. Disseminated (unsealed) sources/total body and organ dosimetry
9. Acceptance testing and quality assurance
10. Dose specification, implantation, dosimetry, and dosimetry systems

XVI. Radiation protection

1. Principles, biological effect models, personnel dose limits, rules, and regulations
2. Structural shielding design for external beam therapy
3. Radiation protection for brachytherapy procedures
4. Leak testing of sealed sources
5. Routine radiation surveys
6. Personnel monitoring
7. Protection against nonionizing radiation

XVII. Informatics

1. DICOM
2. PACS
3. Networks, storage, and archives

XVIII. Particle beam therapy

1. Heavy charged particles
2. Light charged particles, protons
3. Neutrons
4. Relative biological effectiveness (RBE) and RBE-weighted dose
5. Physical and biological implications of particle therapy

Additional core study literature

a. Burmeister, J., Chen, Z., Chetty, I.J., et al., The American Society for Radiation Oncology's 2015 Core Physics Curriculum for Radiation Oncology Residents. Int. J. Radiat Oncol Biol. Phys. 95, 1298-1303 (2016)