Training Radiation Oncology Residents and Dosimetrists

The ASTRO Physics Curriculum –
Eric E. Klein, Washington University, Saint Louis, MO

ABR Perspective On the ABR Written Exam -
Edward Chaney, Univ North Carolina, Chapel Hill,NC

MDCB Perspective On "Teaching Physics to Dosimetrists" - **Indra Das,** Univ Pennsylvania, Philadelphia, PA

The Dosimetry Training Tool (DTT) Project -
Art Boyer, Stanford Univ School of Med, Stanford, CA

ASTRO's Core Physics Curriculum for Radiation Oncology Residents

ASTRO Ad-hoc Committee

- **Eric E. Klein, M.S., Chair - Washington University**
- **James M. Balter, Ph.D. - University of Michigan,**
- **Edward L. Chaney, Ph.D. - University of North Carolina**
- **Bruce J. Gerbi, Ph.D. - University of Minnesota**
- **Lesley Hughes, M.D. - Drexel University**

The ASTRO Physics Curriculum: BACKGROUND

- In 2002, the American Society of Therapeutic Radiology and Oncology (ASTRO)'s Radiation Physics Committee appointed an Ad-hoc Committee on Physics Teaching To Medical Residents.
- The main initiative of the committee was to develop a core curriculum for physics education.

RESULTING DOCUMENT

- **The document resulted in a recommended 54-hour course.**
- **Some of the subjects were based on American College of Graduate Medical Education (ACGME) requirements (particles, hyperthermia),**
- **Majority of the subjects along with the appropriated hours per subject were devised and agree upon by the committee.**

Subject Matter (*Indicates Subject Matter that should be Complemented During a Physics Rotation.)	Teaching Hours /Subject
Atomic and Nuclear Structure (including decay and Radioactivity)	3
Production of X-rays, photons and electrons	2
Radiation Interactions	3
Treatment Machines and Generators; Simulators (incl. CT)	3
Radiation Beam Quality and Dose	2
Radiation Measurement and Calibration	4*
Photons (incl. concepts, isodoses, MU, heterogeneities, field shaping, compensation, field matching, etc.)	7*
Electrons (incl. concepts, isodoses, MU, heterogeneities, field shaping, field matching, etc.)	3*
External Beam Quality Assurance	2*

Radiation Protection and Shielding	2
Imaging for Radiation Oncology	4
3DCRT including ICRU concepts and beam related biology	3*
Assessment of Patient Setup and Treatment (incl. EPID, Immobilization, etc.)	2*
IMRT	2*
Special Procedures (incl. Radiosurgery, TBI, etc.)	3*
Brachytherapy (incl. Intracavitary, Interstitial, HDR, etc.)	7*
Hyperthermia	1
Particle Therapy	1
Total	**54**

RESULTING DOCUMENT

- For each subject there are learning objectives and for each hour there is a detailed outline of material to be covered.
- Some of the required subjects/hours are being taught in most institutions (i.e. Radiation Measurement and Calibration for 4 hours), while some may be new subjects (4 hours of Imaging for Radiation Oncology).

4. **Treatment Machines and Generators; Simulators (3 Lectures)**

Learning Objectives

The resident should learn about:

1) the mechanics and delivery of radiation with respect to wave guides, magnetron v. klystron for production
2) the production and delivery of electrons by the electron gun, buncher, and scattering foil v. scanning
3) the use in photon and electron delivery
4) benefits and limitations of MLC collimators and cerrobend and hand-block
5) the production and collimation of superficial photons
6) the production of low energy x-rays for imaging
7) the differences in film and other imaging modalities for simulation, the DRR (digitally reconstructed radiograph) production and use

3 LECTURES FOR Treatment Machines and Simulators

A. Linear accelerators
- Operational theory of wave guides
- Bending magnet systems
- Photon beam Delivery
- Electron beam delivery
- Beam energy
- Monitor chamber

B. Linac Collimation systems and other Teletherapy
- Primary and secondary collimators
- Multileaf collimators
- Other collimation systems
- Radiation and light fields (including field size definition)
- Cobalt units
- Therapeutic x-ray (<300 kVp)

C. Simulators
- Mechanical and Radiographic Operation
- Fluoroscopy and Intensifiers
- CT Simulation Machinery and Operation

Imaging for Radiation Oncology

Learning Objectives - The resident should learn:

1) the physical principles associated with good diagnostic imaging techniques
2) the rational behind taking port films, how port films are used in the clinic, and the response characteristics of common films used in the radiation therapy department.
3) the types of portal imaging devices that are available in radiation therapy, the operating characteristics of these various devices, and the clinical application of this technology in daily practice.
4) the physical principles of ultrasound, its utility and limitations as an imaging device, and its application to diagnosis and patient positioning.
5) the physical principles behind CT, MR, and PET scanning, how these modalities are applied to treatment planning, and their limitations.
6) the advantages of one imaging modality over another for various disease and body sites.
7) image fusion, its advantage in treatment planning, the difficulties and limitations associated with image fusion, and how image fusion can be accomplished.

4 Lectures for Imaging for Radiation Oncology

A. Routine Imaging
- Diagnostic Imaging Physical principles
- Port Films
- XV-2 film, EDR-2 film characteristics
- Processors

B. Other Imaging
1. Electronic Portal Imaging
   - Overview of electronic portal imaging devices
   - Types of portal imaging devices
   - Clinical applications of EPID technology in daily practice
2. Ultrasound
   - Physical principles
   - Utility in diagnosis and patient positioning

4 Lectures for Imaging for Radiation Oncology (cont.)

C. Image Based Treatment Planning
1. CT scans
   - Physical principles
   - Hounsfield Units, CT numbers, inhomogeneity corrections based on CT scan images
2. MRI Scanning
   - Physical principles
   - T1, T2, TE, TR imaging characteristics
   - Advantages & limitations of MRI images for diagnosis and computerized treatment planning

D. PET Imaging
1. Physical principles
2. Utility for Radiation Therapy
3. Image Fusion
   - Advantages, Challenges, Techniques, Limitations

- To ensure that the subject matter and emphasis remain current and relevant, the curriculum will be updated every two years.
  - For example, specific IGRT courses may replace some classical physics
- Committee is looking at recommendations for on-line supplemental learning
- Committee has not commit on references or specifics on when to teach (1st vs. 2nd vs. 3rd vs. 4th) or how frequent (I.e. 1st and 3rd vs. 2nd and 4th, etc.)
- Reference: Klein EE, Balter JM, Chaney EL, Gerbi BJ, Hughes L. ASTRO's Core Physics Curriculum for Radiation Oncology Residents. Int J Radiat Oncol Biol Phys. 2004 Nov 1;60(3):697-705.