Sunday, January 22, 2006

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Opening Presentation

Eric Klein:

2001 Question of What Drives What?

- Driving Forces:
  - Physician Career Needs Should Obviously Mandate Curriculum, ……but
  - Residents Need to Pass ABR Writtens
  - Facilities Use the ACR In-Training Exam as a Gauge of Success for the Early Resident
- What Completes the Cycle?
  - Is the ABR Exam Current for Current Career Subjects?
  - Is the ACR Exam Geared for Career Needs or the ABR Exam?
  - Is Raphex the Go-Between?

What was happening in the late 90s?

- AAPM's Training of Radiologists Committee of the Education Council Conducted Survey of Training Programs (Klein et al, IJORBP, 1996)
- Most taught exclusively to PGY2. Some taught different subjects (or levels) to different year residents.
- Radiation dosimetry, treatment planning, and brachytherapy constituted ~ half of the teaching hours.
- On average total classroom time was 61.4 hours/year with a range of 24-118 hours.
- Khan's textbook was the most prevalent resource for most subjects.
- The survey results reveal enormous differences in national teaching efforts.

Goal of ASTRO's Core Physics Curriculum for Radiation Oncology Residents

- Make Recommendation to, *first and foremost*, Teaching Programs as to Curriculum Based on Career Needs
- In addition, ABR and ACR to use Recommendations to Update Exams
- Further Recommendations as to Teaching Modalities: Move to Web-based Aids

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 (now replaced by Bhudatt Paliwal)
- Bruce J. Gerbi, Ph.D. - University of Minnesota
- Lesley Hughes, M.D. - Drexel University

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.

See table on slides

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).

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 techniques2) 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

SUMMARY
- 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 hasn't commit on references or specifics on when to teach (1st vs. 2nd vs. 3rd vs. 4th) or frequency (i.e. 1st and 3rd vs. 2nd and 4th)
- 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.

New Curriculum
- Reduced some classical courses (Atomic Structure, Electrons, General Brachy

- Increase in IMRT (2 to 4), Radiopharm (2)

Challenges to Training

- Preparation for new technologies.
- IMRT should be a staple with dedicated hours to cover all applications. Technologies of IGRT should be introduced in the curriculum
- Radiology/radiation oncology residents must become more adept in all imaging modalities.
- Rather than this taking place in a diagnostic imaging rotation, there must again be enhancement of training within radiation oncology for imaging modalities such as ultrasound, kilovoltage imaging, CT, MR, PET, MR spect, etc.

New Modules for Training

For expansion of education beyond the classroom, the modules would be:

- A) classroom education to include the new technologies we just discussed.
- B) Web-based training to supplement anything that cannot be delivered in a classroom or for self-studies, or perhaps more advanced self-study by a resident.
- C) Hands on clinical training as supervised by physics. These were historically dedicated rotations within academic departments, but many departments now are eliminating these or filtering them into other clinical rotations as there has been an increase in research time for residents, for example the Holman pathway. Therefore, a reduction or contraction of clinical rotations of other areas such as pathology, oncology, diagnostic imaging, and physics has occurred.

ACGME (Reviews Programs)

It is imperative that we work with ACGME to ensure that requirements for accreditation of training programs be updated routinely to include these new technologies and perhaps to forgo some of the more historical subjects, or subjects outside of routine and future clinical practice such as hyperthermia and total skin electrons.

DISCUSSION:

RRC reviewer had a check list

Gerbi: What is the link in the link in the chain for developing the components of what individuals should know?

RRC sets the essentials of training.

Who's driving the bus?

ASTRO committee developing the curriculum, ACGME, RRC and the Board are all developing pieces of the training necessary for radiation oncologists.

Donaldson: opinion on who should be driving the bus: as program directors we care about meeting the requirements of the ABR so that their residents can pass the certification exams.

See Massoth's slides

Group A: Table 1:

1. ACGME has moved slowly to revise their training requirement.
2. ABR has considerable challenges in dealing with the NRC training requirements.
3. Challenge: Are we providing sufficient training for a radiation oncologist to be an RSO and should we?
4. The curriculum is very good. The ABR is doing a good job of sampling the curriculum.
5. Developing simulators - interactive teaching aids, web-based learning - similar to the needs of the diagnostic residents.
6. Challenges of getting residents to attend physics rotations - Need buy-in from the Chairman/Program Director.
7. Education is always at the lowest priority on the list of research, clinical service and education.
8. Imaging training is one of the biggest education challenges.
9. Canada: one month of intensive hands-on physics training. Works very well. The practical element is extremely valuable.
10. Canada: Graduate students are paired up with rad onc residents to work on projects. Provides excellent experiential learning.
11. Resident assigned physics projects are also very helpful.

Group A; Table 2:

1. who's in charge; perception is Board should respond to changing needs of the profession; should be coordinated better, board should change blueprint to match syllabus
2. ideally writers or exam and syllabus should be better connected
3. ACR in-service exam disconnected with ABR exam
4. perception by residents that you are tested on what you are taught, amount of material you have to learn and what can be covered on the exam; learning physics to aid in how to be a better RO, not simply to pass the exam
5. two curriculum ASTRO and AAPM, perhaps committees should be merged
6. NRC regulations; very confusing requirements misconstrued; better communication between NRC folks and exam writes
7. no serious concerns on quantity and quality of physics teaching

Group A: Table 3:

1. ASTRO/AAPM/ABR monitoring of the NRC, ACMUI advisory committee, CRCPD (and OAS) activities and issues through liaisons reports and/or personal

attendance. Have Associate Executive Director of ABR act as coordinator and conduit through ABR to ASTRO, AAPM, and ACR? Unified front is needed.
2. AAPM approval of syllabus, even if authored by ASTRO is not lost/wasted – it adds weight and provides unified front.
3. Why are hyperthermia a d proton and neutron therapy at equal weight? The "checklist" evaluation keeps low-usage areas in the curriculum through RRC enforcement. Why not no hypothermia and more proton therapy? Would you do a Grenz-Ray therapy?
4. when developing curricula need to assess if the residents are really learning the curricula;
5. ACR in-training exam as resident competency assessment tool instead of self assessment?

Exams are given throughout the year of physics training, residents are required to pass before the can move forward. Use RAPHEX (RAMPS generated); as one of the exams.

Fiveash: Is one of the recommendations that RO physics programs should be exams and if not pass they can't move forward in the residents. ACGME – exams may only be one part of the process; will have to have a resident portfolio on; may need more for the future due to ACGME reviews.

Mark: it is based on outcome basis and measure competence of physician; now doing portfolios for diagnostic and 360 evaluations for professionalism and inter-personal skills. Quality improvement – many programs do not train residents in quality improvement methodologies, there is an ACGME requirement that we use quality improvement tools to assess the program; meaningful for a physicists to teach.

Davis: competencies have been in placed since the inception of the program but are a collective competency of how you practice;

See Bhudatt's slides

Massoth: AAPM adopted the ASTRO curriculum with few additions; AAPM report 64 with ARRO and A3CR2; survey residency programs 1999; 35.300 700 hours AU; 700 hrs RSO

Klien is leader in curriculum for RO residents. His 2004 curriculum has been approved by AAPM with extension and modifications.

How well do the ROs do in physics: has been very stable in Angoff over a number or years in their performance

Anthony: generally around 70%

Mark: there is not a physicist working side-by-side everyday in radiology

Harris: Can't have an accredited RO program without a physics course or physicist on staff

Hendee: In diagnostic radiology: book of questions Buda; old exam questions;

Mark: want book of facts not applied knowledge and problem solving

Hendee: what other things make physics successful?
Physicist in department and closer working relationship; relevance of physics education; requirement by ACGME for accreditation to have a physicist;

Tony: importance of physics in patient safety;

Donaldson: how is physics viewed by heads of departments and chairmen; ROs recognize we can't practice their discipline without a keen understanding of physics and cross-sectional imaging; need to be in bed with medical physicist and diagnostic radiology?

How can she be better as an RO for her residents; how she can fuse images, how to approve an IMRT plan;

Bhudatt: diagnostic radiologists are isolated for the most part; need to interact better

Eugene: a lot of criticism for board exam for physics in diagnostic radiology, can you critique from what he's heard it sounds pretty fair, main criticism on heavy particles; it tests what they expected and what they should learn

Feavish: things he would like to see more on the test is newer modalities focused in educating but not necessarily on the test; especially things that are more clinically relevant.

Davis: some programs don't do IMRT; disconnect is coming on imaging piece; needs to be push into teaching

Harris: try very hard to have course in diagnostic radiology and that they could interpret and how the modalities work; the way radiology is organized is not RO friendly; residents felt experience in radiology was not important; get it more through tumor boards;

Bhudatt: have a radiologists come to RO every afternoon;

Massoth: CT sim, don't care about the technique since not using real patient;

Davis: CT and other have become so automatic in RO and people do need to be trained; they are not thinking about it, it just happens but needs to know the principles behind the pushing of the buttons;

Harris: makes more sense to incorporate in RO program;

Klein: residents may loose out because things are so automated;

Donaldson: how do your residents get this information; it is a gradual rotation; you learn it through each rotation; not very well defined necessarily;

Hendee: could it be integrated in the physics training?

Gerbi: train both the residents and staff moved it out of the didactic lecture series and into the Tuesday night conference; what do you see as the physics aspects of these new modalities; that's the didactic practice; then the clinical practical aspects; through the conferences etc.

Hendee: in RO the technology is becoming more complex but the superficial use of becoming simplistic and the underlying concern is how much and how does the RO resident know what he needs to know to be the best physician.

Group B:

Group B: Table 2:

1. Teaching in preparation for the exam; general consensus is that they are generally satisfied with the physics course
2. RO residents understand the relevance and importance of physics
3. quality of teaching varies; agreed that it should be a physicist who teaches and not a medical colleague but may be useful to supplement the teaching with other medical experts
4. teaching should be exciting and not boring for the resident
5. closer the relationship between the program director and the residents the better for teaching success
6. importance of a physics rotation; involved in teaching the practical aspects of the physics; not necessarily easy to organize would benefit the residents but they need to take initiative to do this to; it is useful for the residents to understand the physics behind the practice and modalities
7. how can ABR test the knowledge and practicum
8. examiners should be involved with the residencies programs, strong sentiment for doing this
9. issues important to physicist but need to be understand by the RO; for example purchasing equipment and writing RFP or purchase orders

Group B: Table 1 Session 3B
Certification Expectations

1. Challenge: Political issues with nuclear medicine isotope training as well as with sealed sources.
2. Faculty evaluations are used to improve teaching skills of physicists.
3. We examined cultural and diversity issues. Approximately 30% of the residents are female. There are no differences between males and females on board and training performance. More female residents should be encouraged to enter the field. Physics training is a concern, but the on-site presence of physicists should allay these fears.
4. Much of what is taught to diagnostic radiology residents is appropriate for teaching rad onc residents. Need to share resource lists. Create an AAPM teaching resources for rad onc residents. Example: AAPM/RSNA Physics Tutorial for Residents articles in Radiographics.
5. Resident lectures are mandatory and are generally well attended. Duty hours are not an issue with education.
6. Protected time for physicists as teachers can be problematic. Classroom time is okay, but the time to prepare lectures is limited.
7. Radiation biology training - used to be taught by rad bio specialists. Boards have been slow to move forward to new rad bio concepts. Some programs have both rad bio and cancer biologists.
8. Rad bio is more variable that physics with respect to content. Hall is not adequate. There is not single great text.
9. Lack of program director communication: ADROP web site may move forward now due to recent changes in the leadership. 82 training programs.
10. Create a chat room for discussion.

Group B: Table 3:

1. consensus we have entered the "push button" era much too quickly for rapidly evolving therapy modalities
2. Need diagnostic physics input into RO residency programs and therapy imaging protocols for Sim (at least)
3. Wide range of assessment methods exists – study/analysis of the level and difficulty of in-training and practice questions is needed.
4. Need sharing of how RO residency programs teach physics and assess resident competency
5. In instructional terms, therapy planning (especially for IMRT) is most antiquated and a good candidate for on-line learning and testing
6. Protocol optimization for Sim, Image fusion for therapy planning, IMRT, IGRT, etc. (new therapy modality) needs to be taught at higher level.

Mark Rzeszotarski - Table 1 Session 3C
Implementation Challenges

1. Time challenges - resident perspective: Teach it at the beginning. Not common but very good. Some do a two week orientation. Orientation is essential, but there is value to teach through repetition. Experiential learning is most effective.

2. Radiation oncology imaging education - deficiencies in both diagnostic and rad onc training programs.
3. Inertia in organizations, meeting frequencies, representation of all members in an organization, timing with respect to board meetings. One group should have taken the lead. ASTRO takes the lead, AAPM is the responder. List server with a contact person for each organization responsible for disseminating information to all members. Suggest an update from the AAPM column in the ASTRO newsletter and vice versa RSNA newsletter, ACR bulletin and others would also be good vehicles for communication.
4. Create a chat room and/or net meeting to facilitate the discussion of high interest and/or politically sensitive issues. It would improve the communication between affected parties.

Group C: Table 2:

1. ASTRO vs. AAPM syllabus; concerned about confusion between the various syllabi, not clear on which syllabi is official, ABR should charge one body to set the syllabi with contribution of those currently involved; residents are concerned about it; physics is still a bit of a scary subject for this issue
2. NRC/ABR heard a lot about external forces on us, such as NRC, ACGME and ABR and how it should be included in the examination and the requirements should be communicated clearly to membership and residents
3. quality of teaching; availability of teaching materials AAPM could assist in this; what's important is the discipline; need to hold to schedule announced so that courses aren't canceled, medical physicists teaching needs to be given proper credit and respect for those delivering the course need to e recognized as a major component of the field
4. no short cuts to learning; learning means hard work
5. teaching has to be inspired and interesting especially for physicians
6. in house exams are good means to ensure that physics is taken seriously
7. commitment from program director is very important; they need to enforce the rules; one on one evaluation is very important

Group C: Table 3:

1. Lack of knowledge (in various organizations) with tools/resources for physics instruction and with roles and responsibilities
2. Poor coordination and communication between the fractionates organizations
    a. Liaisons who don't
    b. Minutes of meetings not shared
    c. "dropped" resident liaison referrals to appropriate committees
3. Have we 'discovered" all of the functional "fractions" organizations?
    a. ARRS
    b. ACR resident section
    c. ACROP
    d. APCR

    e. SCAROB
    f. SCARD
4. Continuing resident liaison support is needed
5. Need a liaison conference call perhaps on quarterly basis

Hendee: issues for impediments

1. how often do you teach the same material and repetitively
2. list serve concerns
3. syllabi concerns need one official syllabi; AAPM started with ASTRO's syllabus adopted and expanded it
4. no shortcut to teaching or learning

What do you want to recommend as a strategy for going forward from this point forward? How can we make it better and how can RO be used for example?

Group D: Overcoming the Challenges

Group D: Table 3: three tools suggested written tests, evaluations of rotations; 360 degree evaluations;

1. How best to evaluate programs? A validated version of the ACR in-training exam with input by physicists
2. on-line example

Group D: Table 2:

1. don't see many serious problems in physics teaching of ROs, too many organizations involved
2. Teaching evaluations; standard evaluations of teachers by residents is very important, the program directors should ensure that this is done.
3. Maybe ask ASTRO to poll new members on what type of teaching they are receiving? Questionnaire could focus on institution and they could be given the feedback
4. in-service exam is important and perhaps AAPM should get more involved in questions and input; ?how much do the ACR physicists involve in the in-service questions bank
5. Written ABR exam should include more clinical questions
6. Integration of ASTRO and AAPM syllabi; AAPM took ASTRO syllabus and added pieces and qualifiers; AAPM can give guidance on how to implement the syllabi, tools and web-base some of it. Not conflicting products. Bhudatt's slides don't look like the syllabus; perhaps needs to be redone to reflect how the ABR is representing the syllabi.

Group D: Table 1 Session 3D

1. Teaching Skills:
    a. potential for disconnect between basic science and clinical applications
    b. just provide clinical relevance to the basic science

c. level of math being taught is appropriate and is recognized by the physicist
d. 4 step teaching process: introduce, explain, interpret, summarize and relate it clinically
e. interaction with the residents - active participation
f. there is considerable value to interactive teaching materials
g. 20 minute rule - short term memory reserves are exhausted after that

2. Effective Learning
    a. self-study is very important
    b. self-directed learning
    c. difficult to study at the computer
3. There are lots of teaching resources. Which of these are useful? Can AAPM or other societies provide guidance? What on-line is useful? What are the key materials? Will MOC help?

Bill Hendee's Summary Comments:

1. Physics education in Radiation Oncology is quite good → but it can be improved.

2. Klein pointed out 3 forces driving physics learning in Radiation Oncology. But we would agree the ABR exam is the stronger. How can this be changed so the mastery of core knowledge in physics to satisfy career needs is strongest?

3. Increase clinical commitments and changing priorities (e.g., research) are decrease time for physics education. How can this be accommodated?
    1. Emphasize importance of physics – Teaching must take precedence and must be taken seriously
    2. More physicist – resident interaction
    3. Ancillary on-demand teaching aids (e.g. SAMS)

4. Communication needs to be improved
    1. ASTRO-AAPM – joint curriculum committee – ASTRO in the lead.
    2. Committee in (1) with ABR – therapy physics trustee on committee (to correlate course syllabus and exam blue print)
    3. ABR Assoc. Executive Director with NRC/CRCPD/ACMUI/OAS, etc. – with organization governmental liaisons.
    4. Communicate with ACGME/RRC regarding importance and unimportant topics in check list.

5. Tag-team physicist/physician teaching of complex technology topics should be explored (principles and applications). Also, physics rotation where possible.

6. A major challenge is to identify the correct depth for teaching the physics underlying the increasingly push button technologies of radiation oncology.

7. Physics instruction should be molded to the needs of Radiation Oncologist not sending Radiation Oncology residents to other sites for learning

8. A website for sharing "how I teach physics" should be created by AAPM. In addition, a list serve with organizational representative (AAPM, ASTRO, ARRS, ACR Residents section, ACROP, APCR, SCAROB, and SCARD) to improve communication.

9. A major need is for assessment methods to evaluate and act on the effectiveness of physics instructions and the assessment of physics learning.

10. Input into the certification process for persons who have recently taken the ABR/physics/certification examination should be encouraged.

Rough notes will be posted on AAPM meeting website.
Summary document distributed to everyone.

Not sure we have basis for a white paper.

Massoth: if you have suggestions for this send him an email.
Malinkrodt has a tool for collecting interesting DICOM; can look at using for sharing common cases for potential on-line use if release for on-line images could be obtained by the patient.