

**Physics Summit: Training of Radiologists**  
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## **Introduction by Bill Hendee:**

### Core Tenets of Radiology

- Tradition
- Domain of Expertise
  - Clinical
  - Technological
  - Cost-Effectiveness
- Dedication
  - Quality
  - Safety
  - Patient Care

### Strengths of Radiology

- Clinical Acumen
- Mastery of Technology
- Quality and Safety

### Clinical Acumen

- Radiology attracts best and brightest
- Full-time devotion to imaging procedures
- Image interpretation is a learned skill
- Difficult to quantify
- Subject to challenge

### Technology Mastery

- Challenge of selecting the best technology
- Complexity of data acquisition
- Complexity of image presentation
- Complexity of the acquisition/display interface
- Challenge of storing, retrieving and distributing images

### Quality and Safety

- Displaying optimal images for interpretation
- Minimizing procedural costs
- Reducing risk and assuring safety
- Improving procedures through CQI
- Documenting and demonstrating quality
- Inter-relationship of technology, quality and safety

## Quality Requirements for the Radiologist

- Recognize what's needed
- Program the technology to acquire it
- Manage the technology/patient interface
- Pre- and post- process the information
- Recognize distortions and artifacts
- Interpret images quickly and accurately
- Correlate findings with other information
- Communicate interpretation
- Manage and store information

## Challenges to Radiology

- Clinical demand
- Lowered reimbursements
- Personnel shortages
- Technological complexity
- Dependence on referrals
- Intrusion of other specialties (self referral)

## Bottom Line Conclusion

- Clinical Acumen
- Quality of Images
- Safety of Patients
- Cost Effectiveness of Procedures

CANNOT BE MAINTAINED WITHOUT

- Mastery of Technology

UNDERSTANDING THE UNDERLYING PHYSICS AND USING THIS UNDERSTANDING IN TECHNOLOGY APPLICATIONS

## Indicators of How Well Radiologists Understand Physics

- Resident selection criteria
- Physics learning process during residency
- Attitudes towards physics education (residents, attending, program directors, physicists)
- Performance on certification exams
- General recognition of inadequate understanding of physics

## Reasons for These Indicators

- Discomfort with quantitative sciences
- Demands of clinical services
- Pressure to produce more work
- Fewer persons to do the work
- Expansion of imaging capabilities
- Overwhelming complexity of the technology
- Quality and structure of physics teaching
- Relevance of the certification examination
- Ease of passing the certification examination

## What Must be Examined to Change These Indicators?

- Resident selection criteria
- The learning process for physics during residency
- Active support for the learning process in the department
- What and how physics is taught
- The physics certification process for radiologists
- Incorporation of physics and technology mastery into the MOC process

## This Examination is the Purpose of Today's Meeting

- Think
  - Globally
  - Deeply
  - Thoughtfully
  - Constructively
  - Objectively
- Listen carefully
- Focus on solutions
- Help meet the challenge
  - And capitalize on the opportunity

## Questions and Answers to Hendee's Opening Remarks

Farver: stopped teaching physics about ten years ago, feels the stopping of physics lectures was wrong; have reinstated it and needs help in how to do that and that is the reason why he is here.

Yester: residents coming in learning process are totally different than in the past; self-learning want to memorize function of thinking through things has disappeared; way people have taught has change in the past recent period.

Have noticed a change in Yester's direction: yes

Ritenour: backed off from lectures and try web-based Q&As, it became apparent that performance was dropping and a new program director need to go back to formal lecture the residents came alive; they began to drive Russ; normal mode may have drifted in but when you really engage them in what they are really doing they come back alive.

Hendee: one of the things we want to talk about is if the residents take the physics exam at the start of the 2<sup>nd</sup> may not have had sufficient rotations to take the exams

Gray: why do we want to teach the residents physics; we don't want to make them physicists; pages 8 & 9 to take issues; huge stress on the residents during the 3<sup>rd</sup> year; they were not in the clinic wanted to diffuse things, let them study physics; study for the written and then the clinical; exams changed because the were separated which may have led to the lower scores; residents choose to take it in the 2<sup>nd</sup> year; no physics curriculum no standard mount of items to teach them; should be the main goal of this workshop; meaningful discourse on radiation safety with the patient; don't believe they should have to be able to work the formulas but be able to understand why the if they change settings what happens to the image

Sprawls: indicator slide it would be a good next step if we could wait each of the indicators

Hendee: indicators don't have equal weight

Jamies: recently passed physics exams; every meeting with ABR is dominated with physics; as a resident want to learn physics but need to balance it out; major concerns don't know what to study; we continuously ask for good guideline and everyone has a different opinion; wall don't won't to tell us what is on the exams; want to have a goal and learn to the goals; want to be told what I need to know and how to modify the image and why the artifact is there.

Hattery: wants to support what the resident said

Now the groups are inviting the board to come every year; residents are not trying to get out of learning the physics; some chairs and directors don't give any weight to physics; don't think we will find a bullet and automatic fix; don't feel the residents want to get out of it; if you carry anything back to the residents is that this group cares;

Howell: Don't think we are devoid of a curriculum there are many good books out there;

Jackson: too many books; physicists are research focused; didn't learn anything that applied to clinical practice; plea is to develop a curriculum; we don't learn clinical physics or radiology to pass an exam;

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Shuman: her residents state they don't care about the didactic aspects of physics but need the practical aspects of physics

### **Richard Massoth's Presentation:**

#### Core Curriculum

- ◆ Intended for Didactic Lectures or Independent Study Modules
- ◆ Learning Objectives are described for each Section in the Curriculum.
- ◆ Each program may develop tests to probe resident knowledge in each section.
- ◆ Laboratory exercises or use of clinical examples should be encouraged to tie materials to radiology practice.
- ◆ Study (by student) may be necessary to understand and retain purely didactic information.

#### Major Sections of the Curriculum **not enough hours for NRC new requirements will require additional units**

- ◆ General Radiology Physics (4 units)
- ◆ Diagnostic Radiology Physics (25.25 units)
- ◆ Nuclear Medicine Physics (6.5 units)
- ◆ Radiation Protection and Regulation (5.5 units)
- ◆ Radiation Biology (3 units)
- ◆ Additional or "special interest" sections or modules may be added as time and interest allow.

Howell: why only 3 units with radiation biology, hottest topic currently should be one fourth of the curriculum

Tarver: it would be nice to have example lectures

Starting place for the person giving the lecture; move them away from the paradigm of didactic and not practical and ties them into the clinic

Hendee: troubling aspect is the things important in imaging is different today than ten years ago; how do we teach the reconstruction of images, image quality; how do you recognize artifacts from what is expected; how far do we drill down into that complexity

Fundamental part of imaging; most physicists (older ones) need to learn this too

Massoth: puts up a cross section of images and identify the artifacts

Tries to drive back from the images; nice simulators have been written

Baumgartner: Clarify the status of the curriculum; information should go to the program directors and not just the physicists

Jackson: is there a link to the AAPM website from their sites AUR, APDR

Kay: if IU doesn't have a clinical physicist then there will be a lot of programs where there is no clinical physicist to do the training

Hendee: it will take a strong program director to defend a basic scientist type of clinical physicist to survive

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Need to link the exam and what's needed with the curriculum

### **Session A Reporting:**

#### **Group A: Table 1: Mark Rzeszotarski:**

Four key points:

1. lack of buy-in by chairman; need to get them to commit to teaching physics;
2. ACGME that didactic physics be measured and enforced
3. needs to be better communication of syllabi at all levels; needs to be distributed to all parties and need to maintain
4. physicists who teach the research physicists have little clinical

#### **Group A: Table 2: Russ Ritenour:**

1. curriculum needs to be linked to exam and this is the approximate distribution of the exam
2. integrate with clinical rotation and part of the rotation ACGME acceptance
3. Groups like RSNA should fund modules for certain subjects in physics, i.e., grants
4. Corporate sponsorships of modules

#### **Group A: Table 3: Richard Massoth:**

1. Is there a core set of information needed before integration in clinic
2. Need better communication.
3. Need to be practical; include physics in clinical exam and continue in MOC.
4. Need to agree on a curriculum on what's needed, but how deep to teach on each topic, then reinforce in clinical.
5. Need to ensure the physics exam questions are relevant to clinical practice.
6. Physics knowledge is value added for new modalities and patient safety.

#### **Group A: Table 4: Ervin Podgorsak:**

1. defining a body of knowledge that is considered important to the group; don't know which source that is out there is important
2. experience with great teachers in physics but have lost touch with what is clinically relevant and what's on the test
3. disconnect with clinical radiologists with the resident
4. can we make the physics training clinically relevant
5. use of simulators for the resident to experiment with changing the physics setting on the simulator and then take them through the tutorial to increase knowledge
6. looking at the physics learning and teaching as a bit of a hurdle i.e., the exam process; changing the exam perhaps a portion of the exam in each of the four years use of test centers

#### **Group A: Table 5: Tony Seibert:**

1. trying to identify radiologists to help in the teaching to identify the link between basic physics and clinically relevant physics, radiology boot camp
2. developing modules and capabilities with shared modules better conduit for transfer of knowledge for different modalities
3. AAPM curriculum is not too far off but need to set weighting schemes
4. there are physicists that have a disconnect of what they think is relevant and what the radiologist think is relevant

**Group A: Table 6: Herb Mower:**

1. film has to go; do we need to teach film
2. physics of MR, not done in 4 units needs to be
3. those coming in to medical schools may not have science and math backgrounds than in the past; don't have the basics to build on
4. seem to think females have bigger fear of math and science
5. need to make sure we look at curriculum changes and make it relevant to new NRC licensing
6. who should do the teaching and how ready are they to teach; need to train physicists on how to teach radiologists physics
7. need to teach physics as being relevant and not simply a means to pass an exam
8. do the residents want prescriptive information
9. pediatric doses need special attention
10. concern of research physicists in diagnostic radiology

Hendee: Q&As: every program is accredited by ACGME and Residency Review Committee every 5 years

Of the physicists how many have met the review individual during the review to explain the physics?  
Andy once in 20 years; Dan: once

Hendee: if we are going to try and address this with the review process do we need to take action to elevate the physics issues; site visitor has a finite time for the review; visitor could ask the program director;

Simply one question on describe how your program teaches physics;

Kay: When the programs are reviewed not much emphasis on physics

Becker: Need to drill down on what we are going to do to agree on a curriculum and who is going to teach; if we don't have the manpower to teach then need to look at web-based or self-tutorial programs; perhaps look at funding grants

Traver: modules copyrighted by RSNA come from the Saturday sessions for Radiographics publications; are they accessible? If so where?

Lynn: RSNA could arrange for puffs on the RSNA website; need to be reviewed and vetted; need to have RSNA and AAPM look at them



Hattery: how many physicists are item writers for the ABR? And clinical folks writing physics questions

Point is is the writing pool relevant; may be a process problem that needs to be reviewed

**Hendee: issue of relevance, issue of depth, issue of breadth and the linkage between what is taught and what is on the exam. Needs to have radiologists and physicists work together to answer this.**

Bhudatt: in RO it is routinely done between ROs and physicists

Mark: physics tutorial for residents; historically used to produce slide sets that were sold to residents and then went to just publishing in Radiographics and all residents have access

Val: 50% of med students are women but less than 25% radiology residents are women; survey shows that they don't go into it because of the technology knowledge and the physics; it is physics to be embraced and what is relevant to your practice

**Physics is to be embraced to do the right thing**

Bisset: how do we integrate the physics into the point of care concern when working with a resident?

Russ: integration of clinical physics at the time of learning the clinical modality; at the oral physics is not off the table and you may get a question on it.

Yester: needs to have agreement on where the roles are

**Kay: haven't mentioned the MOC process; issue of physics is for everyone and not just the residents;**

Hazle: want to have physics information integrated in the clinical for radiologists

Hattery: ABR would be delighted if AAPM would develop some practical physics

Bisset: questions don't quite look like that; may drill down too far when actually on the exam

Potential solution is three radiologists perhaps need to expand the number of diagnostic outstand rubric but don't quite reflect

Dan: if you look at result of Angoff? Procedure it has been about 2% between what the physicists and radiologists think the resident should do on the exam

Anthony: it is a challenge to identify diagnostic radiologist to sit on the Angoff?  
If we could create a list of names to send out to diagnostic radiologists for exam questions; may solve problem of none clinical relevance

**Session B:**

**Group B: Table 6: Herb Mower:**

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1. dividing the certifications into two parts theoretical and practical separate
2. does it test what we need to now
3. What should there be more of on the exam? MR? CT?
4. think that there are residents that are on previous tests and memorize what is on it in order to get over the hurdle
5. if we split written what would the logistics and costs be
6. more of the physics questions be integrated into the clinical oral exam
7. many residents after they pass the hurdle the learning of physics from that point on is zero
8. relative to the oral each section to have 1 good physics case on it
9. resolve group A and B need better communication
10. Does the exam test competence? Keeps those who are not qualified out
11. annual review of the exam include more radiologists to meet the needs of both sides of the fence

**Group B: Table 5: Tony Seibert:**

1. even though the ABR says they don't they really do decide the content need to have consensus
2. more radiologists writing questions
3. more interaction between the radiologists and physicists to decide what is relevant in both directions
4. goal of test is to define a minimally qualified radiologists
5. different methods on scoring the tests
6. discussion of why the cut score is what it is
7. clinically relevant questions
8. issues of program directors to take a role in defining the ability or capability of getting more physicists and ensuring the residents know what is expected and that it is followed through
9. emphasize physics throughout the residency
10. litmus based questions; can you have an adaptive test

**Group B: Table 4: Ervin Podgorsak:**

1. discussion of percents and distributions of questions
2. after each exam there are always misperception on the distributions of the exam questions
3. seems to be less communication between diagnostic physics and the framework of networking and also with radiologists
4. increase input on the writing and question selection with diagnostic radiologists
5. unified plan to assist AAPM on distributing the information
6. may need to reevaluate the timing of the exam, single, multiple

**Group B: Table 3: Richard Massoth:**

1. Need ABR category breakdown /list on a web site (not analysis).
2. Include technically oriented radiologists into developing the questions, i.e., pre-planning.
3. Risk benefit might be a good topic to be included in the curriculum

4. How deep to drill into each topic – need guidance in curriculum proposals. Relevance and clinical competency milestones by modality.
5. Strong suggestions that the categories are publicly available but not necessarily the percentages.
6. Need some structured learning modules

**Group B: Table 2: Russ Ritenour:**

1. subscribe to the principle that ABR shouldn't be coming up with the curriculum, AAPM should probably establish
2. ABR could link to the AAPM curriculum so residents know that it will be covering
3. ABR could make the historical percentages available
4. important for ABR to do knowledge surveys in certain modalities;
5. like to encourage ABR to have a resident member on the committees one who has passed the board already works for current schedule; or recent fellow

**Group B: Table 1: Mark Rzeszotarski:**

1. to be effective in teaching physics need point of service exponential in teaching; need to engage residents in physics over time
2. discussed moving the test to the 3<sup>rd</sup> year
3. talked about a method of continuous assessment either put physics on all three exams or other mechanism simulators
4. exam changes board exam was physics for physicists 20 years ago; exam has moved away from that towards applied knowledge and problem solving; reason in part is books that have come out; good at memorizing lists residents; struggle when asked how to handle a pregnant patients for example with different modalities
5. was exam fair and did they ask items clinically important; for the last ten years answered yes with a caveat; all these questions on PET; but when we looked at the questions they were different concept questions but using FDG not directly PET

Hattery: ABR is talking about computer adaptive testing, asked domain questions of exam questioners; trustees and item writers have helped ask perception is that exam has changed dramatically

Liked Tony's idea for litmus type questions, we are testing minimal competence  
When you establish a cut score on a minimally competent test; why do we have to establish a cut score?

Tony: litmus type question could be weighted differently

Hendee: how many think we should look at physics written exam; are fundamental and we should weight them more; it might count more; drive performance to a lower level?

Gray: communication with the residents and program directors; perceived as such a big hit because it wasn't discussed ahead of time

190 residencies programs for diagnostic radiology

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Val: cut score change is no excuse for the terrible performance that people have been getting away with

Hendee: where is this going by changing the cut score is this progressing?

What should we do about contacting directors etc?

Russ: discussed the Angoff procedure where a minimally competence person on should perform; how far below the Angoff is the existing cut off score?

Anthony: there is discrepancy between what the Angoff is telling us and where the cut off was.

Clarke: concerned about what he's hearing; ABR is setting the information, no communication between the ABR and those teaching; ABR is changing the psychometrics and ABR is changing the cut scores. It's a danger if there is no standardization; big problem is that there needs to be communication between the program directors, scientific organization setting the curriculum and the ABR.

Key is increased communication

Problem is those teaching the residents don't know what the boards are requiring; boards need to be more diligent on what is relevant

Kay: resident member on the exam committee; experience in RRC having a resident member has added a different perspective and they have been terrific; it has only been a positive benefit;

Mower's Presentation:

Challenges to Education

- Challenges to Implementing the AAPM Proposed Program
- What are the Time Challenges to Physics Education in Diagnostic Radiology Residency Programs?
- What are the Cultural Challenges to Physics Education?
- What are the Resource Challenges to Physics Education?
- Are there Challenges Related to the Dedication and Ability of Physicists to Teach?
- Can Physicists Teach Radiology Residents?
- What Other Challenges Handicap Physics Education in Radiology Residency Programs?

Fallone: programs are institution based; very similar problems in Canada

**Session C:**

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**Group C: Table 4: Ervin Podgorsak:**

1. availability of adequate physic educators; on-line and self-directed learning
2. buy-in from the residents identify what is being tested and modeling by attending and senior resident
3. identify level of detail of the curriculum; is there agreement on how deep we need to go
4. resources money and people to achieve these goals identified
5. timing of the exam; 2<sup>nd</sup> or 3<sup>rd</sup> year would be ok, having flexibility a good thing and adding some physics to oral or virtual physics incentive for them to maintain interest in physics

**Group C: Table 5: Tony Seibert:**

1. time challenge; when should it occur; didactic is ok but should merge into clinical; teach at noon displace clinical for one month; get program director buy-in and department
2. need finances; need to interact from the hospital quality control and support for training
3. requiring attendance for didactic training; incentives
4. generalized resource of teaching materials so they can be accomplished outside the box
5. cultural issues not a major problem in terms of language except for perhaps pregnancy
6. more exciting way of teaching; teach from the image and work backwards

**Group C: Table 6: Herb Mower:**

1. Timing issue what is a good time for the residents, staff time of day? Noon better than early morning or last thing in the evening; does it bring a different perception to the resident
2. cultural faculty physicians who might say, you can go talk to the physicist vs. a formal course
3. advantages to a teleconference or web-based for multiple sites with interaction
4. developing clinical interlink, bring up a physics piece
5. capture resident symposium for the RSNA
6. What is the ability of the physicist of the individual teaching? Do they have the knowledge and/or the ability to share
7. is teaching of physics considered a burden
8. for those in research, may not be as interested in teaching
9. can we utilize the physicians to do some of the physics teaching and how do we keep them up to date
10. availability of physicists in general and then how we researching out to lure students into the field

**Group C: Table 3: Richard Massoth:**

1. Challenge of time to develop a modular training program, should we go for a vendor support for simulator or atomized module?
2. some discussion on labs especially with NRC going back to classroom and laboratory training
3. cultural challenges both the culture of the department and motivation of the individual training and the cultural change for the residents to perceive physics as more than a hurdle and important to their practice
4. specialist vs. generalist one may drill down too deeply and one may not have sufficient knowledge to focus

5. tag team approach might be a challenging way of handling certain sessions

**Group C: Table 2: Russ Ritenour:**

1. culture, time and money;
2. physics is perceived as a single time learning vs. life long
3. learning files might result in problem based teaching increase
4. lack of physics teachers might not be the problem but lack of clinically teaching might be the problem; how do we get them to come in to physics training for MOC
5. who will pay for and implement interactive modules for training of physics?; developing for their own use or everyone

**Group C: Table 1: Mark Rzeszotarski:**

1. need for guidance on directed readings which books are good and which should be avoided
2. need information on physicist job market
3. challenges in profession development; lack of expertise in new modalities
4. problems with teaching skills, how to teach to different types of learners
5. recognition of learning style differences; don't like formulas,
6. financial challenges for small programs in particular;
7. lack of physics mentors for the new physicists
8. when to teach, make it front and center make if the noon conference

Spencer Gray: Need to develop questions for each of the oral examiners; is this something that the examiners could do or would you need physics input

Val: in the clinical written exam instructions for the examiner you should ask one question on the physics, radiation dose, and protection issue on the oral

Becker: incorporation of more physics in each of the content areas and the other is more physics questions

Greenspan: one case in nuclear medicine devoted to physics

Val: in making up the exam, should be easy to include one physics-based case and then it would be standardized

Hattery: need to tell people what you are going to do and when you are going to start; need lot of help from all areas as to the reason

Sprawls: using the term physics; but as we move towards need to consider the principles of imaging "x" clinically move away from the term "physics"

Hattery: challenge is getting bigger

Becker: on the general content SAMs we were sensitive to the word "physics" called RFP principles

ACGME requires a statement of competence

Mark: in terms of phase in with something like this we have had communications problems; molecular imaging inclusion has this been conveyed to program directors; in terms of including it on orals; we can't tell them that until we start; but we could include it now and assess the current state of physics at the time of orals

Hattery: not sure ABR has all current program directors not necessarily program coordinators

ABR: APCR, APDR, RSNA, ACR

Solvable Problem: communicating what the board expects for the upcoming exams

Hendee to Seibert: can we start with images and work back to teaching physics; Hendee thinks it would challenge most physicists;

Geoff: "MRI from picture to proton" McRobbie; or Val Rung's textbook

Seibert: less is more; be careful of including too much

### **Session D:**

#### **Group D: Table 2: Russ Ritenour:**

1. low budget solutions- AAPM/RSNA physics tutorial for residents set up as a list of all the tutorials and linked from other sites
2. ACR radiology case of day with physics orientation
3. double duty teaching the teachers, have faculty come to physics lectures
4. SAMs will be developed for radiologists and some will be physics oriented
5. high budget: developing interactive-based modules for CT and MR for example
6. RSNA funding source, Congress perhaps; no funding for physicists teaching radiologists
7. in a department level needs to top down and bottom up; the chairmen need buy-in

#### **Group D: Table 5: Tony Seibert:**

1. textbooks to develop paradigm shift to figure out in an efficient manner
2. common repository of syllabi
3. funding to develop syllabi
4. potential sponsoring of workshop training workshop to develop knowledge base radiologist to give ideas and physicists to fill in
5. re-engineering physics curriculum noting institutions responsibility and the organizations/associations would provide the framework
6. take the curriculum over a year and then monthly self-exams
7. NRC requirements 200 hours defines specific training and how do we mesh what we have and determine how we can get to the meet the requirements
8. need to be sensitive the issues of how the residents can meet the requirements to be RSO

#### **Group D: Table 4: Ervin Podgorsak:**

1. discussed financial, cultural and practical aspects

2. funding for teaching in radiology should be addressed; teaching is done on an ad hoc basis in many places
3. need adequate support to obtain good teaching
4. accreditation of resident programs, could evaluate the physics quality of teaching is not stressed in accreditation should also look at course evaluation of the students and the success of the residents in passing the exam
5. question of syllabus and level of knowledge of the physics expected; the AAPM curriculum is a good start but radiologists should get involved
6. idea of getting into a program of starting with an image going back is a much longer time frame initiative
7. cultural a mutual respect between the teachers and residents
8. relevance of physics to radiology needs to be stressed by management the chair and program director, not simply studying physics to pass the exam but to be the best they can
9. as far as the exam is concerned, adequacy of giving it in the 2<sup>nd</sup> year; perhaps change for only on basic aspects and the more complex aspects be moved to written and oral clinical exams

**Group D: Table 1: Mark Rzeszotarski:**

1. need for the syllabus to extend down one or more layers in some areas and the need for more societies to be involved in maintenance of syllabus
2. list serve or other mechanism for disseminating information from this meeting; review and input summary document reviewing what was done today and then a consensus document

**Group D: Table 3: Richard Massoth:**

1. how to provide radiologist input into the physics questions pool not just physics but also clinical
2. add more images and moving to computer based test
3. better defined clinical relevance may
4. teaching from images should be an emphasis
5. recommended that a survey of textbooks and how they tie into the curriculum and clinical examples
6. at which depth and which type of text should be used perhaps a survey done by AAPM and publish results

**Group D: Table 6: Tim Solberg:**

1. need for an attitude adjustment towards physics training

Massoth: can go negatively fast, any physicists can teach

Hattery: bottom makes sense good place to start, need to bring the professionals together;

Additional Suggestions:

Hendee: Is it feasible to come out with a summary document and then a consensus document?

Hattery: feel we have taken a step in that direction



Tarver: need to get to the middle of Becker's chart; why can't we say have a medical physicist teaching physics

Bhudatt: weakest link is the physics faculty support from the academic institutions; fundamental issue is support to maintain physics teaching in support of diagnostic radiology

Sprawls: roles of different organizations and institutions; educating residents is the institutions responsibility; need a model curriculum; not all program are equal for effective of teaching physics; need to make resources available for some to enhance their capability

Hendee: we can these organizations to work together?

Bisset: do we need the exam? Are goal is not tot test people but to provide an education in radiologic physics to help them throughout their career; will it be taught during the month before the test or lifelong?

Hendee: if we looked at physics as part of the accreditation; wouldn't need a physics exam because you have quality control to ensure that the proper level of physics knowledge was there;

Jaimes: could get there if you had to complete on-line set of question before you could progress into something else; reservation on saying we don't need the exam at all because we need to learn so much else, we will bury it; accomplishing a detailed consensus curriculum that is standardized and each program will teach it differently will cause residents to select programs based on how it is taught; need to be able to test in some way

### **Bill Hendee's Summary:**

What have we learned today?

1. Time of opportunity
  - a. Help radiologists learn and sustain physics knowledge in order to master technology essential to
    - i. Clinical acumen
    - ii. Ensure quality and safety
    - iii. Cost-effectiveness
2. What are the major challenges
  - a. Identify breadth and depth needed
    - i. Core knowledge
    - ii. Protection, detection, quality, dose
  - b. Teach what is needed in a clinically relevant manner
  - c. Examine on what we teach
    - i. Physicists and radiologists work together – standard curriculum
    - ii. Tie certification (ABR) and curriculum (AAPM) together
    - iii. Communication is key - what will we do, why and when
    - iv. NRC tracking
  - d. Reflect changing technology in MOC
3. Make certification process more transparent
  - a. Examination blueprint
  - b. Increase communication re: expectations/changes electronic
  - c. Resident on committees

- d. Make certification clinically relevant
- e. Input radiology in physics exam or maybe area, nor questions
- f. Exam schedule - foundation
- g. Physics questions in written and oral clinical exams or divide exam
4. Website summary consensus
5. ACGME/RRC emphasis on physics
6. Teaching modules (SAMs) and simulators – point of care teaching
7. Already good materials – Radiographics – more accessible; ACR question of the day/RSNA physics tutorials
8. Women in radiology
9. Computer adaptive exams
10. Challenge to physicists
  - a. too few good teaching physicists
    - i. do they have the knowledge
    - ii. can they teach
    - iii. do they have the time and incentive
    - iv. should we be teaching how to teach – teachable moment and point of care/when to teach
  - b. develop modules and simulators and evaluation process included/could be on line
    - i. who pays – not hospital or medical school
  - c. tag team teaching – relative sensitivities; item writing and workshops
  - d. challenge of teaching or testing from images
  - e. support of chair/senior faculty

### **Closing Remarks:**

Hendee very productive day, and thanks for participating  
 Need to do a lot to help radiologists learn the physics necessary to maintain the acumen,

### Major challenges:

- Need to identify the breadth and depth of core knowledge necessary to practice in their discipline
- Need to respond to organizations like the NRC and have tracking mechanism in place to recognize qualifications of radiologists
- Need to examine to what we teach
- Physicists and radiologists need to work together on the consensus curriculum and then examine on it
- Communication is key; need to be able to say what we intend to do, why and when we are going to do it;
- Need to make the certification process more transparent to those taking it
- Need to improve communication process to candidates
- Need to involve young residents and radiologists in the examination process using RRC model
- Certification needs to be clinically relevant
- Need to integrate radiologists in helping write the questions or the areas of what they should address?
- Examination schedule? Change it or change the exam to concentrate on fundamentals
- Can we ask clinically relevant physics questions on written and oral exams

- Challenges to physicists: too few teaching physicist; does that person have the knowledge to radiologist, can they teach it even if they have knowledge, do they have the time and interest; are there ways to teach at the point of care, when and how should physics be taught; if foundation materials are available can we move to a different model? Should we teach physics students how to teach
- Need to build evaluation measures on how effective use of simulators is in teaching; who pays for the cost of preparing the materials? Maybe medical schools? However they don't consider residency as part of their charge; perhaps our organizations need to foot the bill talk with vendors perhaps?
- Tag team teaching, physics of CT bring in whole body imager with the physicist
- Suggestion of boot camps for writers of questions
- Challenge of teaching physics from images
- Need buy-in on the importance of physics from the radiologist from top to bottom and bottom up and from the physicists

Hendee: will put the summary report

Will post rough notes

Then move to a consensus paper for a strategy going forward and will require the input from everyone

Proposed curriculum and presentation