MEDICAL PHYSICS EDUCATION
IN A POST-2014 WORLD:
APOCALYPSE OR TRANSFORMATION?

SDAMPP Annual Meeting

Agenda

8:00 8:05 Introduction
Medical Physics Education in a Post 2014 World: Apocalypse or Transformation
Bayouth/Zagzebski

8:05 8:50
Need to Foster Research in Medical Physics Training Programs Report of the Working Group on Future Research and Academic Medical Physics Robert Jeraj

8:50 9:30
Research Training in CAMPEP programs
  8:50 9:10 Example from the US: University of Wisconsin Jim Zagzebski
  9:10 9:30 Example from Canada: University of Western Ontario Jerry Battista

9:30 9:45 Questions & general discussion Audience
Agenda

9:45 10:00 Medical Physics Training in i) professionalism and ethics, ii) patient safety, and iii) failure mode effect analysis Recommendations across professional societies John Bayouth

10:00 10:15 Where should these topics fit in Med Phys training: graduate programs, residency programs, or continuing education during our professional careers? George Starkschall

10:15 10:45 Currently available resources and what’s on the horizon RSNA/AAPM modules Bill Hendee

10:45 11:00 Questions & general discussion Audience
What is medical physics?

- **Research/academic role:**
  - Development of treatment and imaging technologies (in the lab)
  - Translation of treatment and imaging technologies (to the clinics)
  - Application of treatment and imaging technologies (in the clinics)

- **Professional role:**
  - Glue between basic sciences (physics) and clinical sciences
  - Quality Assurance of imaging and treatment technologies
**What is medical physics?**

- **Development**
  - Algorithms

- **Translation**
  - Tools

- **Application**
  - Clinical

**IMAGING**  
CT, MRI, PET, US, Image Analysis…

**THERAPY**  
Dosimetry, Linacs, TPS, IMRT…

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**Spectrum of medical physics roles**

- **Development**  
  - Clinical implementation
  - Technology improvements
  - Translational research
  - Cutting edge research

**Time (yrs)**

Now, 1, 2, 5, 10, 20

Bortfeld and Jeraj 2011, Br J Rad 84: 485
Cutting edge research
Translational research
Technology improvement
Clinical implementation

Optimal medical physics chain

Time [y]
20
10
5
2
Now

What are we seeing today…

Time [y]
50
20
10
5
2
Now

Bortfeld and Jeraj 2011, Br J Rad 84: 485
Why is this happening?

- **Strong professional/clinical component (>80%)**, with typically very limited long-term interests
- **Consolidation of professional training** (e.g., DMP initiatives in the US), neglecting academic training
- **Lack of dedicated academic programs** at graduate and undergraduate level
- **Lack of dedicated research positions** at universities and hospitals
- **Weak links** between academic physics and clinical practice
- **CHANGES IN MEDICINE ARE CALLING FOR CHANGE**

WG FUTURE

- **Charge**: To initiate, coordinate and lead activities to **secure sustainable growth and improvement** in the long-term future environment for **high quality** research and academic training of physicists in medicine

- **Goals**:
  - To prepare a strategic plan and coordinate activities for **improvement of research environment**
  - To prepare a strategic plan and coordinate activities for **improvement of academic training and educational environment**
FUTURE activities: Trends

- Collecting hard evidence on medical physics research and academic trends:
  - Research expenditure trends
    - Within the departments
    - In relation to others
  - Research quality trends
    - Funding trends
    - Publishing trends
  - Academic program trends
    - Research vs clinical component trends
    - Curriculum trends

- Planned activities:
  - Surveys to AAPM membership/programs
  - AAPM member research database
  - Statistics of the journals

FUTURE activities: Where is future?

- Medical physics and clinical sciences:
  - Radiation and Medical Oncology, Neurosciences,…
  - Radiology/Nuclear medicine

- Medical physics and basic sciences:
  - Physics
  - Engineering
  - Other basic sciences (biology, pharmacology)

- Planned activities:
  - Interviews with individuals
  - Meetings with professional societies (ASTRO, RSNA,…)
FUTURE activities: Guidelines

- **Position papers:**
  - Research in medical physics residencies/DMP
  - Research quality
  - ...

- **Guidelines:**
  - Interaction between research and clinics
  - Research academic program curriculum
  - ...

Current push – professional development

Bortfeld and Jeraj 2011, Br J Rad 84: 485
…is this the right direction?

- **A lot of activities** in designing new programs:
  - Main goal to prepare medical physicists for the clinics
  - More clinical training
  - More practical components

- **Very little activities** in designing programs for the future

**What is the future?**

**Where is medicine going?**

"4 P’s of medicine": Individuals respond differently to environmental conditions, according to their genetic endowment and their own behavior. In the future, research will allow us to **predict** how, when, and in whom a disease will develop. We can envision a time when we will be able to precisely target treatment on a **personalized** basis to those who need it, avoiding treatment to those who do not. Ultimately, this individualized approach will allow us to **preempt** disease before it occurs, utilizing the **participation** of individuals, communities, and healthcare providers in a proactive fashion, as early as possible, and throughout the natural cycle of a disease process.

**Elias A. Zerhouni, M.D.**  
Director, National Institutes of Health (NIH), USA, 2008
NIH roadmap

- **New pathways to discovery**: Need to advance our understanding of the daunting complexity of biological systems:
  - Building blocks, biological pathways, and networks
  - Molecular libraries and molecular imaging
  - Structural biology
  - Bioinformatics and computational biology
  - Nanomedicine

NIH roadmap

- **Research teams of the future**: Need that scientists move beyond the confines of their own discipline and explore new organizational models for team science.
  - High-risk research
  - Interdisciplinary research
  - Public-private partnerships
NIH roadmap

- Re-engineering the clinical research enterprise: Need for quick translation of basic research discoveries into drugs, treatments, or methods for prevention.
  - Clinical research networks
  - Clinical research policy analysis and coordination
  - Clinical research workforce training
  - Dynamic assessment of patient-reported chronic disease outcomes
  - Translational research

Lessons learned through interviews

- Anthony Zietman, MD: Medical physics has a unique position:
  - It will always be needed in the clinics (vs. radiation oncology, which might be “swallowed” by other professions)
  - Medical physics should be guiding research in the departments – we (oncologists) don’t really have time, and are not well trained for that
Lessons learned through interviews

- **Kian Ang, MD:** Medical physics is in trouble for two reasons:
  - Medical physics has too much too well educated workforce for what it does in the clinics – this should be resolved with technologists – but that is not in the interest of the professional organizations (AAPM)
  - Medical physics has not delivered what we (oncologists) have been asking for years

Lessons learned through interviews

- **Bruce Chabner, MD:** Medical physics has definitely a role (I don’t really know what), but that role has to be defined better
  - Medical physicists – “fixing blackberry”
  - What has medical physics done to cure cancer?
Lessons learned through interviews

- **Michael Goitein, PhD**: Medical physics training should focus on fundamentals, not specific applications
  - The key in successful training is “rubbing” shoulders with the best people
  - Medical physicists should get broad and deep experience, not shallow training
  - The longer, the harder the training, the better, even if you train in something that is not immediately relevant (e.g., quantum mechanics)

Lessons learned through interviews

- **Andrzej Niemierko, PhD**: Medical physics should look well beyond current applications in radiation therapy and imaging
  - There is so much to do for medical physicists in clinical trials – from data analysis to modeling
  - Medical physicists have unique skills that can help in other fields, e.g., systems biology
  - Having basic medical physics training and exposure to clinics helps to better understand clinical problems
Lessons learned through interviews

- **Søren Bentzen, PhD**: If medical physics does not reinvent itself, it risks of being extinct
  - Medical physics has put too much emphasis on development and translation of technology, but not enough on application of it
  - Medical physics should exploit unique “multi-level” modeling expertise (combining heuristic data-based and analytical model based approaches)
  - Medical physics should be trans-disciplinary (connecting) not inter-disciplinary (between)

Lessons learned through interviews

- **Bert van der Kogel, PhD**: The key to the future is to find out what the current problems are
  - Medical physicists have a lot to contribute to biology with their unique modeling skills and their unique approach to solving problems
  - Radiobiology made a big mistake by not responding to the new reality (molecular biology), which made radiobiology practically disappear – the same can happen to med phys
  - Training should present interdisciplinary problems as attractive, not something for people who can not do anything better
Research-oriented academic programs

**Programs of the future**

- **Need to enable the future** - grooming future leaders in medical physics research and leading evolution of the medical physics field
- **Focus on medical physics research** – be a complement to DMP programs with the main objective of clinical support role of medical physics
- **Focus on translational research** – strong interaction with clinical sciences, and relating with physics and other basic sciences
- **Building on the outstanding strengths** of the medical research and technologies in each environment
- **Reaching beyond the traditional medical physics areas** (radiology and radiation oncology)

*Bortfeld and Jeraj 2011, Br J Rad 84: 485*
Who to attract?

- **Top physicists** (and other scientists) with a clear goal of pursuing research/academic career in medical physics
- Having unique **truly trans-disciplinary** (more focus on integration with clinical research, and research in other disciplines), **translational** (connection between basic and clinical sciences) and **research-focused** training in medical physics
- At the same time providing training for **top professional careers** (e.g., heads of clinical physics departments), by providing a hybrid research/professional track (like DMP/PhD)

Curriculum structure

- **50/50% model** (securing highest level of innovation, while providing basic training)
  - “**50% fundamental**” medical physics training
    - Fundamentals of therapy and imaging sciences
    - Fundamentals of related basic and clinical sciences
  - “**50% blue sky**” medical physics training
    - Selection of elective (non-tradiational med phys) courses from basic and clinical sciences
- **Possibility of a joint GPMP/MP residency program** (enabling dual training)
Training foundations

- **Rotations** through clinical/basic sciences (e.g., semester spent in RadOnc/Radiology/Basic labs)
- Focus on **real-world problems** originating from the clinics
- Focus on **developments in basic labs** and translating them to the clinics
- **MD co-advisors** from clinical departments
- **PhD co-advisors** from basic labs
- Deliverables are **clinically-relevant** and **basic science-relevant** products

“50% basics” medical physics

- Radiation physics
- Physics of radiotherapy
- Physics of imaging
- Health physics
- Anatomy/physiology
- Basics of basic sciences research
- Basics of clinical research
- Clinical/basic lab rotation
- PhD thesis
“50% blue sky” medical physics (Sample)

- Biomedical Engineering
- Biomedical Computing
- Systems Biology
- Systems Physiology
- Oncology
- Neurophysiology
- Clinical Trials in Biomedical Enterprise

Summary

Bortfeld and Jeraj 2011, Br J Rad 84: 485
Summary

- Strengthening medical physics professional component (bread and butter) is great, but we also need to take care of our research/academic component (future).

- Trans-disciplinarity (bridge between basic and clinical sciences) is our unique strength, which we need to brand better.

- If we do not modernize AND expand medical physics research and academic training we risk extinction.

What is medical physics - FUTURE?

<table>
<thead>
<tr>
<th>Development</th>
<th>Translation</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithms</td>
<td>Tools</td>
<td>Clinical</td>
</tr>
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</table>

**IMAGING**
- CT, MRI, PET, US, Image Analysis…

**THERAPY**
- Dosimetry, Linacs, TPS, IMRT…

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<th>Development</th>
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<th>Analysis</th>
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<tr>
<td>Algorithms</td>
<td>Tools</td>
<td>Clinical and Basic</td>
<td>?</td>
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</table>
Research Training in CAMPEP programs: Example from the US

James A. Zagzebski
Department of Medical Physics
University of Wisconsin – Madison WI

Medical Physics, University of Wisconsin

- Located in the Wisconsin Institutes for Medical Research (WIMR), floors B1 and L1 (fall, 2008)
- Physically connected to UW Hospitals, Medical School

L1 shared with Radiology Research

B1 shared with Radiation Therapy Physics, PET, Cal-Lab

Other locations for faculty and students: UW Cancer Center, 7th floor of WIMR

Waismann Center for Brain Imaging, just across the street
Program Evolution & History

• John Cameron took an appointment in Physics and Radiology in 1958. Began working in "medical physics."

• Medical Physics Graduate Program, "Radiological Sciences" was housed in the Radiology Department; all faculty were Radiology faculty

• 1972, formation of the Comprehensive Cancer Center and Department of Human Oncology
  ➢ Radiation therapy became part of Human Oncology
  ➢ Medical Physics faculty located in DHO and Radiology

• 1981, Medical Physics Department was formed
Program Evolution & History

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• Medical Physics Graduate Program, "Radiological Sciences" was housed in the Radiology Department; all faculty were Radiology faculty
• 1972, formation of the Comprehensive Cancer Center and Department of Human Oncology
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• 1981, Medical Physics Department was formed. Graduate program now housed in the department. Faculty have joint appointments in clinical departments.

Program Structure and Governance

UW Medical School

<table>
<thead>
<tr>
<th>Clinical (16)</th>
<th>Basic Science (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesiology</td>
<td>Biomolecular Chemistry</td>
</tr>
<tr>
<td>Dermatology</td>
<td>Biostatistics &amp; Med Informatics</td>
</tr>
<tr>
<td>Family Medicine</td>
<td>Cell and Regenerative Biology</td>
</tr>
<tr>
<td>Human Oncology (including radiotherapy)</td>
<td>Medical Genetics</td>
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<tr>
<td>Medicine</td>
<td>Medical History &amp; Bioethics</td>
</tr>
<tr>
<td>Neurological Surgery</td>
<td>Medical Microbiology &amp; Immunology</td>
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<tr>
<td>Neurology</td>
<td>Medical Physics</td>
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<tr>
<td>Obstetrics &amp; Gynecology</td>
<td>Neurosciences</td>
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<tr>
<td>Ophthalmology &amp; Visual Science</td>
<td>Oncology</td>
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<tr>
<td>Orthopedics &amp; Rehabilitation</td>
<td>Population Health Sciences</td>
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<tr>
<td>Pathology &amp; Lab. Medicine</td>
<td>Pediatrics</td>
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<td>Pediatrics</td>
<td>Psychiatry</td>
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<td>Psychiatry</td>
<td>Radiology</td>
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<td>Radiology</td>
<td>Surgery</td>
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<td>Surgery</td>
<td>Urology</td>
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<tr>
<td>Urology</td>
<td>Some physicists in Radiotherapy, Radiology, and Psychiatry have joint/affiliate appointments in Medical Physics</td>
</tr>
</tbody>
</table>
Department Administration

- Chair, appointed by the Dean of the School of Medicine and Public Health, advised by a faculty “preferential ballot”
- Vice chairs
  - Vice chair for faculty
  - Vice chair for research
- Committees (graduate committee; admissions; space; computer; ad hoc prelim exam; etc)
- Office staff

Faculty

- 26 partial or full appointees (20% - 100%) in the tenure track (5 assistant professors; 8 associate professors; 13 professors)
  - 18.2 FTE’s
- 5 FTE’s in non-tenure track positions (CHS professor; CHS associate professor; clinical assistant professor)
- Many affiliates (0%) who play active roles in training
  - They are from Radiology, Human Oncology, Engineering AND centers throughout the US and the world
Department Mission

• Apply our knowledge of physics and physics principles to solve important medical problems that benefit patients
• Train the future leaders in medical physics.
  ➢ Courses in all areas of diagnostic and therapeutic medical physics
  ➢ Research
  ➢ Medical physics service

Students

• Faculty Currently working with 163 students
  ➢ 127 in Medical Physics Department
  ➢ 36 from other departments
    • 19 in BME    7 in EE
    • 5 Neurosciences    5 other

• Degrees
  ➢ M.S. (Approximately 2 years of course work, 29-32 credits, including anatomy/physiology or equivalent; radlabs (3))
  ➢ Ph.D. (Approximately 4 ½ years, last 2 ½ mostly research; all MS requirements; 54 credits, including minor)
  ➢ Typical load is 9 didactic credits plus seminar
### Classes Offered

#### Fall Semester

- 463 Radioisotopes in Med & Biol (3 cr)
- 471 Special Topics (1-3 cr)
  - Radiation Treatment Planning (3 cr)
  - Math Modeling in Rad Therapy (2 cr)
  - Molecular Imaging (3 cr)
  - Optical Imaging (3 cr)
  - Medical Image Management (2 cr)
- 501 Radiological Physics, Dosimetry (3 cr)
- 567 Physics of Diagnostic Radiology (3 cr)
- 571 Adv. External Beam Radiotherapy (3 cr)
- 573 Image Science: Math Foundations (3 cr)
- 577 X-Ray CT Physics (3 cr)
- 619 Microscopy of Life (3 cr)
- 661-666 Rad Labs (1-2 cr)
- 679 Radiation Physics Metrology (3 cr)
- 710 Adv. Magnetic Resonance Imaging
- 900 Journal Club/Seminar

#### Spring Semester

- 265 Intro to Med Physics (2 cr)
- 401 Intermed Physics for Med, Biol (3 cr)
- 410 Radiobiology (2 cr)
- 471 Special Topics (1-3 cr)
- 530 Medical Imaging Systems (3 cr)
- 559 Patient Safety and Error Reduc. (3 cr)
- 566 Physics of Radiotherapy (3 cr)
- 567 Physics of Diagnostic Radiology (3 cr)
- 569 Health Physics (3-4 cr)
- 570 Adv. Brachytherapy Physics (3 cr)
- 574 Imaging in Medicine: exercises (3 cr)
- 575 Diagnostic Ultrasound Physics (3 cr)
- 661-666 Rad Labs (1-2 cr)
- 707 Applications of Digital Imaging (2 cr)
- 775 Advanced Ultrasound

### Academic Tracks in Medical Physics

- **General Medical Physics Track**
  - Emphasis is on radiological sciences, radiation therapy physics
- **Image Science Track**
  - Emphasis is on image science courses, starting with mathematical concepts, proceeding to specialized classes
- **Health Physics Track**
  - Emphasis is on radiological sciences, nuclear physics, radiation metrology, etc.
- **Tracks allow students to emphasize courses needed during the first year in order to make progress in their research.**
Academic Tracks in Medical Physics

• General Medical Physics Track
  ➢ Emphasis is on radiological sciences, radiation therapy physics, anatomy/physiology
  ➢ Qualifier at the end of year 1
    • MP 567 (Diagnostic Physics)
    • MP463 (Nuclear Medicine & PET)
    • MP 501 (Radiological Physics and Dosimetry)
    • MP 566 (Radiotherapy Physics)
    • MP 569 (Health Physics)
  ➢ Courses closely aligned with AAPM Report 197

• General Medical Physics Track
  ➢ Emphasis is on radiological sciences, radiation therapy physics, anatomy/physiology
  ➢ Qualifier at the end of year 1
    • MP 567 (Diagnostic Physics)
    • MP463 (Nuclear Medicine & PET)
    • MP 501 (Radiological Physics and Dosimetry)
    • MP 566 (Radiotherapy Physics)
    • MP 569 (Health Physics)
  ➢ Courses closely aligned with AAPM Report 197

• 2nd year:
  • image science; brachytherapy; advanced radiation therapy; radiation treatment planning; radiobiology;
  • many electives from imaging (MRI, US, CT, etc.)
Academic Tracks in Medical Physics

**Image Science Track**
- Initial emphasis is on physics, mathematics, and clinical examples of medical imaging, anatomy/physiology
- 5-question qualifier at the end of year 1
  - MP 567, Diagnostic X-ray Physics
  - MP 573, Image Science – conceptual & mathematical
  - MP 574, Image Science: applications,
  - Choice of 2 questions from
    - MP 575 (ultrasound),
    - MP 568 (MRI),
    - MP 501 (radiological physics and dosimetry),
    - MP 471 (x-ray CT), and
    - MP 463 (Nuclear Medicine and PET).
- Many students take radiation physics and radiotherapy physics classes years 2 and 3
Med Physics Student Support (July 2011)

- ~250 Ph.D. degrees since the department’s inception.
- ~125 terminal MS degrees (no thesis required)
- 50-75 post docs who went on to other opportunities after training in the department

Research results of MP students throughout the US and beyond are where the future of our profession lies.

Research Training is at the heart of our Graduate Program

- ~250 Ph.D. degrees since the department’s inception.
- ~125 terminal MS degrees (no thesis required)
- 50-75 post docs who went on to other opportunities after training in the department

- Research results of MP students throughout the US and beyond are where the future of our profession lies
Research Areas of Faculty

- Advanced Radiation treatment systems
  - Proton therapy
  - Robotic brachytherapy
- Biomagnetism
- PET, CT, MRI Treatment Assessment
- X-Ray CT
- Diagnostic X-Ray Imaging
- Magnetic Resonance Imaging (MRI)
- Medical Instrumentation
- PET and PET tracer development
- Optical Imaging
- Radiation Metrology/calibrations
- Ultrasound and ultrasound based elastography

Student Progression

- The majority of students admitted say their goal is the Ph.D.
- Students generally take 5 years to complete the degree
  - Year 1: mostly class work, qualifier
  - Year 2: additional course work, work on Ph.D. prospectus
  - Year 3: Ph.D. prospectus; dissertator status
    - Prospectus is written as a RO1 grant application
    - Prelim consists of 45 minute presentation, followed by 45 minutes of questions. This is followed by a period of questions on related topics, not necessarily involving the thesis.
  - Year 5: completion of dissertation
    - Defense is a 45 minute presentation, followed by questions from the audience, then focused questions by committee
Simultaneous Fetal Magnetocardiography and pulsed-Doppler Ultrasound

Nana Aba Mensah-Brown  
Advisor: Dr Ronald T. Wakai  
Co-Advisor: Dr. Janette Strasburger  
(Medical Physics Residency in Radiation Therapy.)

- Assessing severity of fetal heart disease is important since interventions are now available, fetal demise rates are high, and cost of neo-natal care for some conditions is very high.
- Arrhythmias are difficult to diagnose because SNR of ECG’s is low (vernix caseosa inhibits signal)
- Use Biomagnetism: record a fetal magnetocardiogram using a 37 channel SQUID in a magnetically shielded room.
- Several years of success with this program
Design and Characterization of a Phase Contrast X-ray CT System

Joseph Zambelli
Under the supervision of Dr. Guang-Hong Chen
(Assistant Scientist, UW Madison Med Physics also interested in residency training.)

Effective scatterer size estimation of in-vivo breast tumors using attenuation corrected Ultrasound RF signals
Kibo Nam
(will be a post doctoral associate in an academic acoustics lab)
Under the supervision of Drs. Tim Hall and James Zagzebski
Strategies for Improved Accuracy and Efficiency with Advanced Intensity Modulated Radiation Therapy Techniques

David Westerly

(Assistant Professor in an academic radiation therapy dept.)

Under the supervision of Drs. Rock Mackie and Wolfgang Tome

The aim of this work is to investigate strategies designed to improve the accuracy and efficiency of 2 advanced forms of IMRT: helical tomotherapy and intensity modulated proton therapy.

Important inventions have been attributed to graduate students and their research

United States Patent

Mistretta et al. [10] 4,204,226

Inventors: Charles A. Mistretta; Robert A. Kruger; Theodore L. Hous; all of Madison, Wis.

Assignee: Wisconsin Alumni Research Foundation, Madison, Wis.


Important inventions have been attributed to graduate students and their research

**United States Patent**

Madsen et al.

![Image of invention]

**Inventors:**
- Ernest I. Madsen
- James A. Zagzebski
- Richard A. Basletic
- Michele M. Harlow, all of Madison, Wis.

**Patent No.:** US 4,277,367
**Date of Patent:** Jul. 7, 1981

**Other Publications**

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**United States Patent**

Mistretta et al.

![Image of invention]

**Inventors:**
- Charles A. Mistretta, Madison, WI
- Thomas M. Griswold, Madison, WI
- Youssef Mazhari, Madison, WI
- Timothy J. Carroll, Madison, WI
- Jiayi Duan, Madison, WI (US)
- Walter Block, Madison, WI (US)

**Patent No.:** US 6,556,856 B1
**Date of Patent:** Apr. 29, 2003

**References Cited**

<table>
<thead>
<tr>
<th>U.S. Patent Documents</th>
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<tr>
<td>5,792,596 A * 9/1998</td>
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<td>5,933,540 A * 8/1999</td>
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<td>6,073,042 A * 6/2000</td>
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</table>
Important inventions have been attributed to graduate students and their research.

**United States Patent**

**Swerdlow et al.**

**Method and Apparatus for Radiation Therapy**

Inventors: **Swerdlow, Smart**, 2309 Upham St., Madison, Wis. 53704; **Thomas R. Mackle**, 2310 Kinnickinnic Rd., Madison, Wis. 53711; **Hinotoy Hotma**, 12 Coronado Ct., #2, Madison, Wis. 53710

**Patent Number:** 5,528,650

**Date of Patent:** Jun. 18, 1996

**Other Publications**


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**Partial Snapshot of qualifications of a recent class of students entering our program**

<table>
<thead>
<tr>
<th>Student</th>
<th>GRE Verbal %</th>
<th>GRE Quantitative %</th>
<th>GPA out of 4</th>
<th>Major</th>
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<tr>
<td>1</td>
<td>89</td>
<td>94%</td>
<td>4</td>
<td>Phys</td>
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<td>2</td>
<td>84</td>
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<td>9</td>
<td>99</td>
<td>94%</td>
<td>3.96</td>
<td>Phys</td>
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Medical Physics programs now attract some of the brightest students from the highest ranked undergraduate programs. In their application materials most see research AND clinical service as part of their future!
Challenges

• Will there be residency slots for those innovative students who wish to practice clinical medical physics?
• Will federal funding continue to be available to support innovative research in medical physics?
• As state budgets become more competitive (and contentious) will programs that also rely on a base budget have to cut back somewhat?

Student and post-doctoral (supervised) research is an important driver in medical physics innovation.

Nevertheless, many students see their professional (post Ph.D.) role aligned with clinical practice of medical physics.

• Currently many take clinical positions and junior physicist positions directly out of graduate school
• Many imaging Ph.D.’s go into residencies to gain further clinical background

My belief is that there will not be enough residency positions to accommodate all capable Ph.D.’s after the “2014” rule is in effect.

• Medical physics may become a less desirable field for bright physics students to enter than it currently is.

Will federal funding continue to be available to support innovative research in medical physics?
Summary

Innovation will continue to drive the future of our field.

- Medical Physics owes its present status in large part to the outstanding research done by physicists in clinical and educational facilities.
- It is important that graduate programs continue to foster and support research and development that will lead to tomorrow’s clinical medical physics work.
- It is equally important that professional associations, such as AAPM and SDAMPP do whatever is in their capacity to nourish research and development in our field!
  - This means our future leaders MUST be trained to do research that applies physics and engineering principles that will benefit our patients.

Medical Physics, University of Wisconsin

Thank You!
Research Training in CAMPEP Programs: A Canadian Example

J. Battista, Ph.D.
Chair
Department of Medical Biophysics

Am I preaching to the converted?
All graduate medical physics programs should have an original research component
David W. O. Rogers¹, Janelle A. Molloy², and Colin G. Orton

The physical basis and future of radiation therapy
T Bortfeld, PhD and R Jeraj, PhD

 Fundamental discoveries leading to new treatment and imaging modalities

<table>
<thead>
<tr>
<th>Year</th>
<th>Discovery/Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1895</td>
<td>Discovery of X-rays (Nobel Prize in physics for Röntgen in 1901) leading to X-ray (CT) imaging and first radiation treatment of cancer with X-rays only 1 year later</td>
</tr>
<tr>
<td>1896</td>
<td>Discovery of radioactivity (Nobel Prize in physics for Becquerel/Curie in 1903) leading to the first treatment with radioactive isotopes shortly thereafter</td>
</tr>
<tr>
<td>1919</td>
<td>Discovery of the proton, leading to the first patient treatments with a proton beam in 1954</td>
</tr>
<tr>
<td>1938, 1946</td>
<td>Discovery of nuclear magnetic resonance (Nobel Prize in physics for Rabi in 1944 and Bloch and Purcell in 1952), leading to MRI in the 1970s</td>
</tr>
</tbody>
</table>

 Technology inventions in radiation dose delivery

<table>
<thead>
<tr>
<th>Year</th>
<th>Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>Cobalt 60 treatment machines become clinically available: use of high-energy gamma rays for better skin sparing</td>
</tr>
<tr>
<td>1953</td>
<td>Linear accelerators with higher energies for better skin sparing and improved penumbra</td>
</tr>
<tr>
<td>1950s</td>
<td>Cyclotrons for proton therapy (physics Nobel Prize for Lawrence in 1939)</td>
</tr>
<tr>
<td>1980s</td>
<td>Radiation field shaping with multileaf collimators</td>
</tr>
<tr>
<td>1994</td>
<td>Intensity modulated radiation therapy (IMRT)</td>
</tr>
</tbody>
</table>

 Technology inventions in treatment planning

<table>
<thead>
<tr>
<th>Year</th>
<th>Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s</td>
<td>Use of computers for dose computation</td>
</tr>
<tr>
<td>1980s</td>
<td>Development of three-dimensional treatment planning</td>
</tr>
<tr>
<td>1987</td>
<td>Inverse treatment planning and plan optimisation techniques</td>
</tr>
</tbody>
</table>

 Technology inventions in imaging

<table>
<thead>
<tr>
<th>Year</th>
<th>Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>CT (Nobel Prize in Medicine for Cormack and Hounsfield in 1979), which is soon used for radiation treatment planning</td>
</tr>
<tr>
<td>1970s</td>
<td>MRI (Nobel Prize in Medicine for Lauterbur and Mansfield in 2003)</td>
</tr>
<tr>
<td>2000s</td>
<td>Imaging integrated into treatment machines for image guided radiation therapy</td>
</tr>
</tbody>
</table>
Figure 2. Spectrum of medical physics roles. Each of the four primary roles: cutting-edge research, translational research, technology improvement and clinical implementation, are equally important, even although they are not, and do not need to be, equally represented.

Figure 4. Suboptimal medical physics chain. Currently we are experiencing an increased emphasis on consolidating the clinical part of the medical physics spectrum, leaving the research part behind. This leads to the prolongation of the time between invention and clinical implementation, particularly severe as the relative time scale is not linear.
We believe that a professional Medical Physics career requires an “R&D” attitude (normally PhD), in addition to core clinical competencies (courses, practicum)

**Cons**
- Requires long training period (10 years, BSc to Ph.D.)
- Is it over-training for typical clinical duties?
- Does it lead to less direct patient care?
- Is a researcher “clinically safer” for patients?

**Pros of Research within CAMPEP Program**
- Drives Translational Research in Radiation Oncology
- Access to University faculty, facilities, and future positions
- “Respect” from clinical colleagues and regulatory bodies
- Career Advancement and Flexibility

---

**Pathways**

- Physics BSc
- Medical Biophysics Pre-BSc
- Medical Biophysics -BSc
- Medical Biophysics MSc CAMPEP
- BioMedical Engineering MESc
- Engineering BEng
- Medical Biophysics PhD CAMPEP
- Medical Biophysics PhD

---

*The University of Western Ontario*
“It’s not the roads we take... it’s what we make of them.”

CAMPEP Programs in Canada

**GRADUATE PROGRAMS**
- Carleton University (PhD)
- McGill University
- University of Alberta – Cross Cancer Institute
- University of British Columbia
- University of Calgary – Tom Baker Cancer Cent
- University of Victoria – BC Cancer Agency
- University of Western Ontario (2010)

**RESIDENCIES – RADIATION ONCOLOGY**
- Cancer Care Manitoba
- University of Alberta – Cross Cancer Institute
- London Regional Cancer Program (2006)
- McGill University
- The Ottawa Hospital Cancer Centre
- Tom Baker Cancer Centre
- University of Toronto

**RESIDENCIES – IMAGING**
- University of Alberta – Cross Cancer Institute
**Radiation Oncology Demand (2010)**

- B.Sc 96 slots
- M.Sc. 48 slots
- Ph.D. 72 slots
- Clinical Physics Residency 48 slots

**Population:** 34 Million

- Incidence: 178,000/yr
- RT cases: 75,000/yr
- Physicists: 300 FTEs

**Ontario Residency Program**

- Coordinated Provincial Program 24 FTE positions (max 12 grads/year)
- Stipend $54 k/yr x 2 years
- Has been in formal operation since 2000
- Larger Centres are now CAMPEP accredited
- Smaller Centres seeking Affiliate status with larger Centres
- 20% Research Weight
- Accounts for > 70% of current medical physicists on staff!
• First Biophysics Department in Canada
  – Founded by Dr. A.C. Burton
  – M.Sc./Ph.D. Degrees (1947)
  – B.Sc. / B.MSc. (1966)
  – CAMPEP Approval (2010)

• Composition
  – 10 core members
  – > 70 Appointees
  – >90* Grad Students
  – 10 CAMPEP Students (Y1)

• City-wide partnerships
  with hospitals and
  research institutes
Admission Requirements
– More strict than pure Research Option
– “Minor in Physics” (minimum)

Research PhD (Non-CAMPEP)
– Scientific Communications: 0.5 credit (mandatory)
– Students typically take 1-4 additional half-courses (optional)
– Expect 4 Peer-Reviewed Publications, >4 presentations

Research PhD (CAMPEP) – same research + courses
– 6.0 full course credits required
– Clinically-oriented training and exam material
– CCPM-certified Physicists have a role

New CAMPEP MSc-PhD
Imaging Education

SCHULICH SCHOOL OF MEDICINE & DENTISTRY

Lab Kit includes:
- Scanner
- Starter Phantoms
- Instructor's Guide
- Student's Guide

- Radiography (2D) and CT (3D)
- 3D Localization
- Image Uniformity and Linearity
- Spatial Resolution
- Contrast Resolution
- ...

The University of Western Ontario
<table>
<thead>
<tr>
<th>Year 1</th>
<th>Radiation and Lab Safety Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>•Radiological Physics and Dosimetry (P9655A)</td>
</tr>
<tr>
<td></td>
<td>•Radiobiology (9567B)</td>
</tr>
<tr>
<td></td>
<td>•Basic Anatomy (e.g. ACB 3319)</td>
</tr>
<tr>
<td></td>
<td>•Basic Physiology (e.g. PHYSIOLOGY 2130)</td>
</tr>
<tr>
<td></td>
<td>•Inferencing from Data Analysis (9522)</td>
</tr>
<tr>
<td></td>
<td>•Research Ethics &amp; Biostatistics (Web course)</td>
</tr>
<tr>
<td></td>
<td>•Medical Imaging Biophysics (9515A)</td>
</tr>
<tr>
<td></td>
<td>•Scientific Communication (9513Y)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Physics of Radiation Oncology (9570/80)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>•Electives (1.0 credit) from other subspecialties</td>
</tr>
<tr>
<td></td>
<td>•Thesis Advisory Committee Meeting #1 (thesis proposal)</td>
</tr>
<tr>
<td></td>
<td>•Low-Level Comprehensive Examination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 3, 4</th>
<th>Thesis Advisory Committee Meeting #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>•Additional Clinical Exposure: the student will shadow a medical physicist or Year-2 resident for special topics such as acceptance testing, QC, site planning, treatment planning. Duration: 2 hours/session x 5 sessions.</td>
</tr>
<tr>
<td></td>
<td>•Mid-Level Comprehensive Examination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 5</th>
<th>Thesis Advisory Committee Meeting #3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>•Thesis Defense (PhD typically 3 peer-reviewed publications)</td>
</tr>
<tr>
<td></td>
<td>•Clinical Comprehensive Exam (a mock CCPM-like/Ontario A-Review oral exam)</td>
</tr>
<tr>
<td></td>
<td>•Well prepared for a Residency Program (possibly abbreviated by 6 months)</td>
</tr>
</tbody>
</table>
?CAMPEP Non-Thesis MSc?

- CAMPEP courses (only) MSc degree
- Access To/From Research PhD degree

- Re-Opens door to Board Exams
- Could generate University revenue!
- Require more CCPM Faculty if it becomes popular with ‘external’ PhD’s (latecomers)

Conclusion

- Experienced with CAMPEP Residency Programs
- New at CAMPEP Graduate Program
- Embed research into our CAMPEP Programs
- Value diversity of disciplines (beyond minimum Physics)
- Allow some flexibility in the pathways

http://www.uwo.ca/biophysics

j2b@uwo.ca
Medical Physics Training in professionalism and ethics, patient safety, and failure mode effect analysis

Recommendations Across Professional Societies

John Bayouth, PhD
University of Iowa

Introduction

• Supplemental Training in Medical Physics
  – Professionalism & Ethics
  – Patient Safety
  – Failure Mode Effect Analysis
• Review recommendations across professional societies
Professionalism & Ethics

AAPM
• Report 79 recommends inclusion in graduate program.
• TG 159 recommended inclusion in residencies covering topics in nine major areas.
  – 15-30 h with program flexibility

Professionalism & Ethics

ABR Foundation (ABRF)
• Sponsored by:
  – ARS, ASTRO, RSNA
• To be discussed further by Dr. Hendee
Professionalism & Ethics

ABR
• MOC: Components of Professionalism
• Part I: Professional Standing – State board license requirements & actions
• Part II: Lifelong Learning & Self Assessment – SAMs content on professionalism
• Part III: Cognitive Expertise – General questions about ethics and charter on professionalism
• Part IV: Practice Performance – Practice Guidelines, Referring Physician Survey

Professionalism & Ethics

ACGME
• Accreditation Council for Graduate Medical Education – Residencies must demonstrate each resident is competent to the level expected of a new practitioner in the core competency of Professionalism which includes ethical principals.
• Programs must provide educational experiences and assess performance in order for residents to demonstrate competency.
Patient Safety

AAPM / ASTRO / RSNA
• strongly supports the CARE bill, which stands for Consistency, Accuracy, Responsibility and Excellence in Medical Imaging and Radiation Therapy, as a method to improve patient safety.

Patient Safety

ACR
• working with AAPM to develop a credentialing program for nonradiologist physicians who use fluoroscopy.
• Intends implement a periodic review and update of its primer on radiation risk
Patient Safety

ASTRO
• issued Target Safely in 2010
  – patient safety, first and foremost.
• 6-point action plan includes expand education and training programs to include quality & safety.

Patient Safety: A Call to Action

• co-hosted by 14 organizations in the United States and Canada
• 20 recommendations to reducing errors & improve patient safety
  – 11. A covenant and commitment to safety should be expected of the treatment team.
  – 17. Patient safety should be a competency.
  – 9. Radiation therapy facilities should use techniques for failure mode effects analysis to identify potential sources of error and root cause analysis to identify and correct errors when they occur.
Failure Mode Effect Analysis - FMEA

- Courses offered in Industrial Engineering
  - Engineering Distance Program @ Oklahoma State U
  - Online course @ University of Illinois
- Commonly used in aviation, nuclear power, aerospace, chemical process & automotive
- AAPM TG 100
- US Department of Veteran Affairs
- JCAHO Standard LD.5.2
  - Leaders ensure that an ongoing, proactive program for identifying risks to patient safety and reducing medical/health care errors is defined and implemented

Examples of FMEA in Medical Physics

APPLICATION OF FAILURE MODE AND EFFECTS ANALYSIS TO INTRAOPERATIVE RADIATION THERAPY USING MOBILE ELECTRON LINEAR ACCELERATORS

Mario Ciccia, M.S., Marie-Claire Cantone, Ph.D., Ivan Veronise, Ph.D., Federica Cattani, M.S., Guido Pedrelli, M.S., Silvia Molinelli, M.S., Viviana Veroli, M.D., and Roberto Orsucci, M.D.

Purpose: Failure mode and effects analysis (FMEA) represents a prospective approach for risk assessment. A multidisciplinary working group of the Italian Association for Medical Physics applied FMEA to electron beam intraoperative radiation therapy (EB-IBRT) delivered using mobile linear accelerators, aiming at preventing accidental exposures to the patient.

Methods and Materials: FMEA was applied to the IBRT process, for the stages of the treatment delivery and verification, and consisted of three steps: 1) identification of the involved subprocesses; 2) identification and ranking of
Examples of FMEA in Medical Physics

EVALUATION OF SAFETY IN A RADIATION ONCOLOGY SETTING USING FAILURE MODE AND EFFECTS ANALYSIS

Eric C. Ford, PhD, Ray Gauthier, M.S, Lee Myers, PhD, Bruce Vanderwek, M.D., Lily Enginir, Dr.P.H., M.D., M.H.A, Richard Zellars, M.D., Danny Y. Song, M.D., John Wong, PhD, and Theodore L. DeWeese, M.D.

*Department of Radiation Oncology and Molecular Radiation Sciences and 1Center for Innovation in Quality Patient Care, Johns Hopkins University, Baltimore, MD

Purpose: Failure mode and effects analysis (FMEA) is a widely used tool for prospectively evaluating safety and performance. It reports on our experience in applying FMEA in the setting of radiation oncology.

Methods and Materials: We performed an FMEA analysis for our external beam radiation therapy service, which consisted of the following tasks: (1) create a visual map of the process, (2) identify possible failure modes; assign risk probability numbers (RPN) to each failure mode based on tabulated scores for the severity, frequency of occurrence, and detectability, each on a scale of 1 to 10; and (3) identify improvements that are both feasible and effective. The RPN scores can span a range of 1 to 1000, with higher scores indicating the relative importance of a given failure mode.

Fault Tree

OR Gate - All input faults must be mitigated to avoid the output fault

Tx Delivery related technology

START HERE

IGRT related technology

START HERE

Patient Mis-treatment

Tx

Wrong Site

Wrong Patient

Wrong DOSE

Site

Patient

Dose

Wrong Isocenter

Wrong Patient SHPT

Data Transfer Error

Dose Calc Error

Dose Delivery Error

IGRT Data

Set-Up

Var

TPS

Tx Unit

R. Alfredo Siochi, PhD
AAPM Strategic Plan

Goal 1, Objective 2, Strategy 2:

• Cooperatively develop industry standard Quality and Safety improvements ... publish position statements in support of IHE, IHERO, CARE Bill, and other proactive safety measures.
AAPM Strategic Plan

Goal 4, Objective 1, Strategy 2:
• Expand AAPM graduate/residency recommendations to cover safety culture, ethical, professional, management and communications issues; and critical thinking/problem solving, so that CAMPEP and ABR can ensure compliance.

AAPM Strategic Plan

Goal 4, Objective 2, Strategy 2:
• Provide continuing education in ethical, professional, leadership, management, safety culture and communications knowledge and skills.
AAPM Strategic Plan

Goal 5, Objective 3, Strategy 1:
• Provide radiation physics and radiation safety education for other medical professions (e.g. pain management, neurosurgeons, vascular surgeons, breast surgeons, etc)

Conclusions

• Clear demand for training in:
  – Professionalism & Ethics
  – Patient Safety
  – Failure Mode Effect Analysis

• Where should this fit in Med Phys training?
• What resources are available?
Including ethics, safety, and FMEA in a medical physics educational program

George Starkschall, PhD
Chair, AAPM Education Council

Objective

Where should education in professionalism and ethics, patient safety, and failure mode effect analysis (FMEA) fit into medical physics training: graduate programs, residency programs, or continuing education?
Objective

Where should education in professionalism and ethics, patient safety, and failure mode effect analysis (FMEA) fit into medical physics training: graduate programs, residency programs, or continuing education?

Yes

Objective

How should education in professionalism and ethics, patient safety, and failure mode effect analysis (FMEA) fit into medical physics training?
Outline

• What is recommended – AAPM Reports
• What is reviewed – CAMPEP Guidelines
• What actually exists
• Discussion

What is recommended

• Professional Ethics
  – AAPM Report 197 – graduate programs
  – AAPM Report 159 – ethics
  – AAPM Report 90 – residency programs
• Patient Safety
  – AAPM Report 197
• FMEA
1. Data, Patient Records, Measurement Results, and Reports
   (a) Privacy and ownership
   (b) Fair use issues
   (c) Patent rights/HIPAA
   (d) Archiving and record keeping
   (e) Falsification of data
2. Publications and Presentations
   (a) Authorship
   (b) Copyright
   (c) Peer review, confidentiality, and conflicts of interest
   (d) Plagiarism

3. General Professional Conduct
   (a) Interaction with colleagues
   (b) Fair competition for employment
   (c) Consulting and conflict of interest
   (d) “Whistle-blowing”
4. Medical Malpractice
   (a) Standard of care
   (b) Testimony as an expert witness
   (c) Rights and responsibility in communicating with patients and physicians

5. Research
   (a) Human subjects
   (b) Informed consent
   (c) Environmental health and safety
   (d) Dissemination of research results
   (e) Attribution
   (f) Conflict of interest
Patient Safety (Report 197)

3.1.2 Radiation Protection and Radiation Safety
1. Introduction and Historical Perspective
2. Interaction Physics as Applied to Radiation Protection
3. Operational Dosimetry
4. Radiation Detection Instrumentation
5. Shielding: Properties and Design
6. Statistics
7. Radiation Monitoring of Personnel
8. Internal Exposure
9. Environmental Dispersion
10. Biological Effects
11. Regulations
12. High/Low Level Waste Disposal

Patient Safety (Report 197)

3.1.6.4 Safety: Electrical/Chemical/Biological/Elementary Radiation
1. Electrical Safety
2. Hazard Communication Standards
3. Hazardous Materials
4. Material Safety Data Sheets
5. Environmental and Emergency Procedures
6. Radiation Safety
Patient Safety (Report 197)

3.3.8 Radiation Protection in Radiotherapy

1. Operational Safety Guidelines
   (a) Regulatory agencies and regulatory requirements
   (b) Radiation surveys: Measurement techniques and equipment
   (c) Area personnel monitoring
   (d) External beam radiation sources
   (e) Brachytherapy sources

2. Structural Shielding of Treatment Installations
   (a) Definition of workload, occupancy factor, use factor, etc.
   (b) Definition of primary, scatter, and leakage barriers
   (c) Structural shielding design

Patient Safety

Note that the word “patient” does not appear in the syllabus!
FMEA

• What’s that?

Residency curriculum

AAPM REPORT NO. 90
(Revision of AAPM Report No. 36)

Essentials and Guidelines for Hospital-Based Medical Physics Residency Training Programs
Ethics

• 1.4.6 Training Evaluation:
  – “It is the program director’s responsibility to counsel, to censure, and, after due process, to dismiss residents who fail to demonstrate appropriate industry, competence, responsibility, learning abilities, and ethical behavior.”

• Repeated in 2.4.6 Training Evaluation
• Repeated in 3.4.6 Training Evaluation

Ethics

• We expect the resident to exhibit ethical behavior, but we don’t tell them what that behavior is
Patient Safety

• Finally – Section 3.5.4 Patient Treatment

G. Patient safety

1. Mechanical
   a. Blocks and trays
   b. Patient couch
   c. Gantry–patient collision
   d. Accessories

2. Electrical

3. Ozone

4. Cerrobend

FMEA

• No mention
FMEA

• No mention
  – You would think FMEA was the organization that messed up the response to Hurricane Katrina

Conclusion

• Our curricula address professional ethics, but say almost nothing about patient safety, and nothing at all about FMEA.
What is reviewed

• CAMPEP Guidelines
  – Professional Ethics
  • Graduate Programs
    – “the students shall ... have an understanding of patient privacy issues, ethics, etc., and receive training in regulations appropriate to clinical activities and research consistent with the recommendations in AAPM Report 159, ‘Recommended ethics curriculum for medical physics graduate and residency programs’.”

What is reviewed

• CAMPEP Guidelines
  – Professional Ethics
  • Residency Programs
    – “Education on the professional aspects of the medical physics profession should take place. Professional subjects include: medical-legal considerations, ethics, the various societies associated with medical physics and their roles (AAPM, CAMPEP, ASTRO, RSNA, etc), and interactions between medical physicists and state/provincial and federal government agencies. “
What is reviewed

• CAMPEP Guidelines
  – Patient Safety
  • Graduate Programs
    – “The program shall provide introductory safety training regarding the potential dangers that students may encounter and measures to prevent damage to expensive equipment. The program shall have a published set of guidelines and restrictions addressing the relevant safety programs.”

Where is the patient?
What is recommended

- CAMPEP Guidelines
  - Patient Safety
  - Residency Programs
    - “The program should have introductory safety training in radiation protection and should provide the resident with his/her own radiation exposure monitor in compliance with state and federal regulations. It should also provide introductory training in the dangers of high voltage.”

Where is the patient?
Conclusion

- CAMPEP is moving toward requiring graduate programs to include professional ethics, but there are no requirements for education in patient safety and FMEA.

Do our programs address these issues?

- Ethics:
  - Some programs offer ethics courses

GS210051  The Ethical Dimensions of the Biomedical Sciences

Erwin, Cheryl. One semester hour. Fall annually. Prerequisite: none

This course examines the ethical concepts and traditions that undergird biomedical science. It explores such issues as commitment to truth and its breakdown in self-deception and fraud, the ethics of authorship, experimentation with human and animal subjects, responsibilities of scientists to society; science's relationship with industry; and the consequences of technologic advances from scientific learning. The course's aim is to teach students to recognize ethical conflicts and problems in their professional lives and to provide a framework within which to analyze and resolve them. This course is required for graduation from all degree programs at GSBS.
Do our programs address these issues?

- Ethics:
  - Some programs offer ethics courses
  - But course is research ethics, not professional ethics

- Other programs don’t address ethics
Do our programs address these issues?

• Patient Safety:
  – Most programs require course in radiation safety
  – Few offer studies in patient safety

Do our programs address these issues?

• FMEA:
Do our programs address these issues?

• FMEA:

Problem in teaching FMEA

• Most of us don’t even know what it is
• Should students take the time to learn the process?
• Should a medical physicist even be able to do an FMEA study?
  – We’re the ones responsible for ensuring patient safety
Discussion

• Should a course in professional (as opposed to research) ethics be made mandatory for graduate students?
• What is the best approach to teach residents professional ethics?
  – A didactic course
  – Brown bag lunch discussions
  – Formal seminar series
  – Learn from mentor
  – Case studies

Discussion

• Should the radiation safety course in graduate school be expanded to include patient safety?
• What is the best approach to teach grad students and residents patient safety?
  – A didactic course
  – Brown bag lunch discussions
  – Formal seminar series
  – Learn from mentor
  – Online instruction, e.g., IAEA slides
Discussion

• If we spend more time teaching professional ethics, patient safety, FMEA, what should we leave out of the existing curriculum?
Effective Use of Web-Based Instructional Modules

William R. Hendee, PhD
Distinguished Professor
Radiology, Radiation Oncology, Biophysics, Population Health
Medical College of Wisconsin

Professor of Biomedical Engineering
Marquette University

Adjunct Professor
Electrical Engineering
University of Wisconsin-Milwaukee

Adjunct Professor of Radiology
University of New Mexico

Adjunct Professor of Radiology
University of Colorado

Events Leading to the Web-Based Modules

- January 2006: AAPM Educational Summit – Atlanta
- February 2007: RSNA Educational Summit – Dallas
- Several articles in Radiology and the JACR
Recommendations of the Dallas Summit

- Revise the physics curriculum
- Encourage the RRC to include physics in residency accreditation
- Revise the physics portion of ABR certification of radiologists
- Develop web-based physics modules for residents

Task Force Members

William Hendee PhD (Chair)  Mahadevappa Mahesh PhD  
Medical College of Wisconsin  Johns Hopkins University

George Bisset MD  Mary Moore MS  
Duke University  Philadelphia VA

Robert Dixon MD  Mark Rzeszotarski PhD  
University of North Carolina  Case-Western University

Mitch Goodsitt, PD  Ehsan Samei PhD  
University of Michigan  Duke University

Philip Heintz, PhD  
University of New Mexico
## Phase I Physics Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiography/Fluoroscopy</td>
<td>7</td>
</tr>
<tr>
<td>Computed Tomography</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Medicine</td>
<td>6</td>
</tr>
<tr>
<td>Magnetic Resonance</td>
<td>9</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>3</td>
</tr>
<tr>
<td>Radiation Biology/Protection</td>
<td>3</td>
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</tbody>
</table>

## Phase II Physics Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties of Atoms/Radiation</td>
<td>4</td>
</tr>
<tr>
<td>Image Properties</td>
<td>4</td>
</tr>
<tr>
<td>Image Perception/Display/PACS</td>
<td>2</td>
</tr>
<tr>
<td>Radiation Protection</td>
<td>1</td>
</tr>
<tr>
<td>Digital Imaging</td>
<td>1</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>1</td>
</tr>
<tr>
<td>MRI</td>
<td>2</td>
</tr>
<tr>
<td>Image Gently</td>
<td>1</td>
</tr>
</tbody>
</table>
Properties of Modules

- No charge for RSNA/AAPM members (students and residents)
- Approximately 1 hour each
- Always available
- Available when/where needed
- Contain special features (animations, pop-ups, video, etc.)
- Self-paced learning
- Can be repeated
- Pop-up questions and self test
- Certificate of successful completion

Using the Modules

- Focusing on images
- Completing modules during rotations
- Requiring successful completion
- Reviewing before examinations
- Stimulating questions/discussion
- Getting faculty involved with residents
- Serving as learning guide rather than lecturer
- Incorporating into graduate student education
- Facilitating faculty self-learning
- Using educational medium students are familiar with
Conclusions

- Scheduled lectures are difficult to accomplish
- Self-learning is more effective than lecturing
- Web-based modules promote self-learning
- Modules should be considered by every teacher
  - Residents
  - Graduate Students
  - Technologists

ABRF Web-Based Modules on Ethics and Professionalism

SPONSORS

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ABRF Web-Based Modules on Ethics and Professionalism

TOPICS

- Attributes of Professions and Professionalism
  Becker, J. Bosma, et al
- Physician/Patient/Colleague Relationships
  N. Sundaram, et al
- Personal Behavior and Employee Relationships
  P. Halvorsen, et al

TOPICS (continued)

- Conflicts of Interest
  F. Chew, et al
- Ethics of Research
  W. Hendee, et al
- Human Subjects Research
  D. Eisenberg et al
- Research with Animals
  K. Zeitzer, et al
ABRF Web-Based Modules on Ethics and Professionalism

TOPICS (continued)
- Relationships with Vendors
  S. Seltzer, et al
- Publication Ethics
  E. Gould, et al
- Ethics of Education
  K. Hogstrom, et al

Web Modules on Patient Safety (Proposed)
- Safety modules in imaging and radiation oncology
- Define what radiologists/radiation oncologists/medical physicists should know
- Designed for residents, practicing physicians and physicists
- CE and SAMS credit
- Good fit to Practice-Quality Improvement Initiative (PQI)
Modules for Radiation Oncologists (proposed)

- Similar to radiology modules
- Reflect approved curriculum
- ASTRO/AAPM collaboration
- Learning platform unresolved
- Authorship unresolved
- Funding unresolved

Modules for Medical Physicists (proposed)

- Similar to radiology modules
- Based on TG Report 197S
- Designed for graduate and certificate programs
- AAPM possibly working with RSNA
- Authorship unresolved
- Possible industry support

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