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

Working Group on the Future of Medical Physics Research and Academic Training

Robert Jeraj[1] and Thomas Bortfeld[2]

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[2]Massachusets General Hospital, Harvard University, Boston, MA

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University of Wisconsin
SCHOOL OF MEDICINE AND PUBLIC HEALTH

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

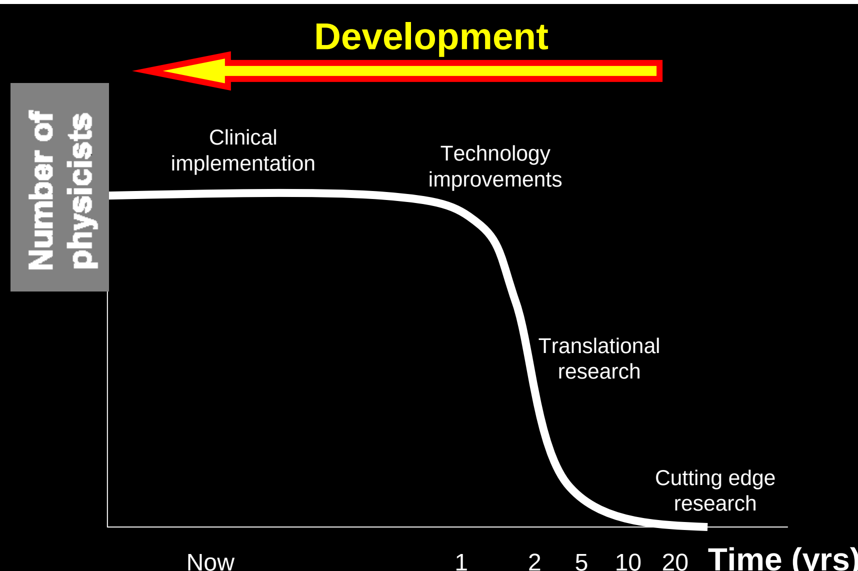
What is medical physics?

Development	Translation	Application
Algorithms	Tools	Clinical

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

THERAPY Dosimetry, Linacs, TPS, IMRT…

Spectrum of medical physics roles



Bortfeld and Jeraj 2011, Br J Rad 84: 485

Optimal medical physics chain

Time [y]	
20	Cutting edge research
10	
5	Translational research
2	Technology improvement
Now	Clinical implementation

Bortfeld and Jeraj 2011, Br J Rad 84: 485

What are we seeing today…

Time [y]	
50	
20	Cutting edge research
10	
5	Translational research
2	Technology improvement
Now	Clinical implementation

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

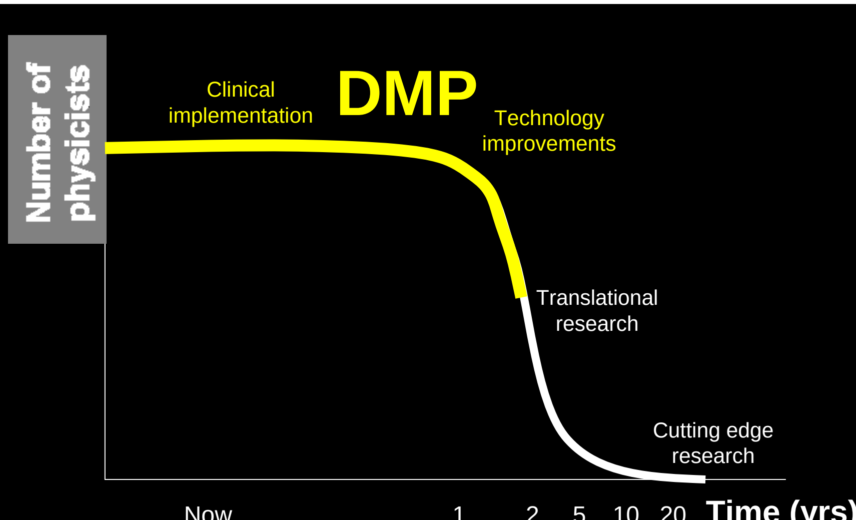
FUTURE activities: Where is future?

- 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



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…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

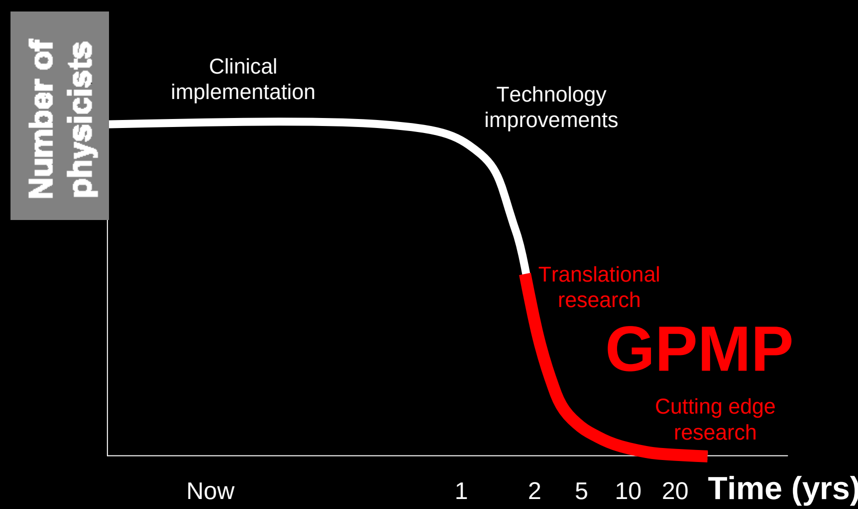
Lessons learned through interviews

- **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



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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)

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

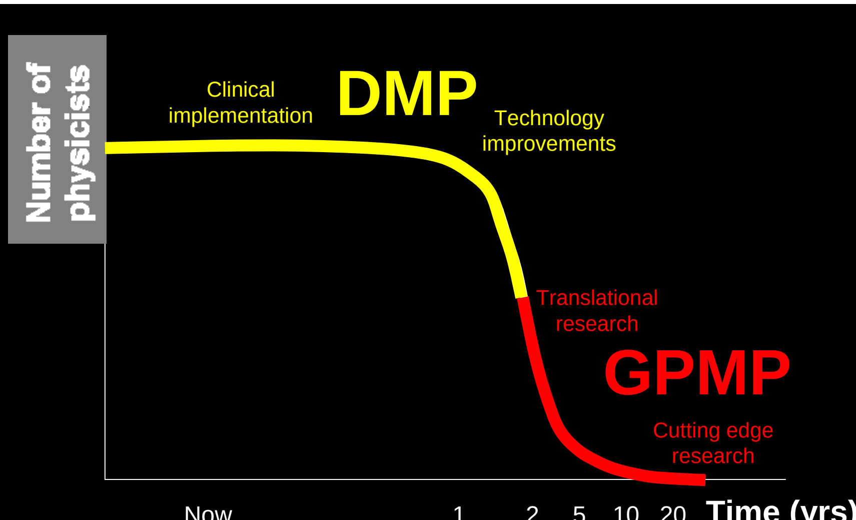
"50% basics" medical physics

- 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



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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?

Development **Translation** **Application**

Algorithms **Tools** **Clinical**

→

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

THERAPY Dosimetry, Linacs, TPS, IMRT…

?

→

Development **Translation** **Application** **Analysis**

Algorithms **Tools** **Clinical and Basic**

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

Waisman 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

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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

Clinical (16)

- Anesthesiology
- Dermatology
- Family Medicine
- Human Oncology (including radiotherapy)
- Medicine
- Neurological Surgery
- Neurology
- Obstetrics & Gynecology
- Ophthalmology & Visual Science
- Orthopedics & Rehabilitation
- Pathology & Lab. Medicine
- Pediatrics
- Psychiatry
- Radiology
- Surgery
- Urology

Basic Science (10)

- Biomolecular Chemistry
- Biostatistics & Med Informatics
- Cell and Regenerative Biology
- Medical Genetics
- Medical History & Bioethics
- Medical Microbiology & Immunology
- **Medical Physics**
- Neurosciences
- Oncology
- Population Health Sciences

Some physicists in Radiotherapy, Radiology, and Psychiatry have joint/affiliate appointments in Medical Physics

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	Classes Offered Spring Semester
463 Radioisotopes in Med & Biol (3 cr)	265 Intro to Med Physics (2 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)	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)
501 Radiological Physics, Dosimetry (3 cr)	566 Physics of Radiotherapy (3 cr)
567 Physics of Diagnostic Radiology (3 cr)	568 Magnetic Resonance Imaging (3 cr)
571 Adv. External Beam Radiotherapy (3 cr)	569 Health Physics (3-4 cr)
573 Image Science: Math Foundations(3cr)	570 Adv. Brachytherapy Physics (3 cr)
577 X-Ray CT Physics (3 cr)	574 Imaging in Medicine: exercises (3 cr)
619 Microscopy of Life (3 cr)	575 Diagnostic Ultrasound Physics (3 cr)
661-666 Rad Labs (1-2 cr)	661-666 Rad Labs (1-2 cr)
679 Radiation Physics Metrology (3 cr)	707 Applications of Digital Imaging (2 cr)
710 Adv. Magnetic Resonance Imaging	775 Advanced Ultrasound
900 Journal Club/Seminar	

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

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    - MP 501 (Radiological Physics and Dosimetry
    - MP 566 (Radiotherapy Physics)
    - MP 569 (Health Physics)
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  - 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 (radiolgical physics and dosimetry),
      - MP 471 (x-ray CT), and
      - MP 463 (Nuclear Medicine and PET).

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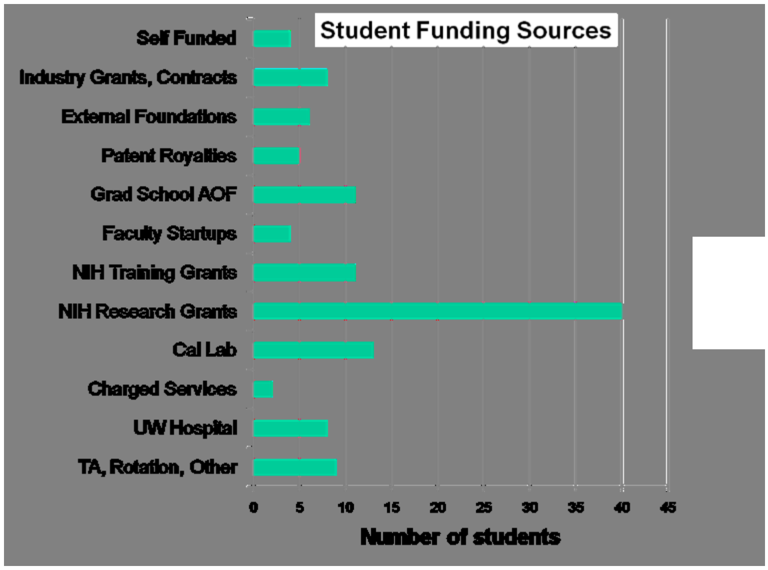
  - Initial emphasis is on physics, mathematics, and clinical examples of medical imaging, anatomy/physiology
  - 5 question qualifier at the end of year 1
    - MP 567, Diagnostic X-ray Physics
    - MP 573, Image Science – conceptual & mathematical
    - MP 574, Image Science: applications,
    - Choice of 2 ?'s from MP 575 (ultrasound), MP 568 (MRI), MP 501 (radiolgical 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)



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

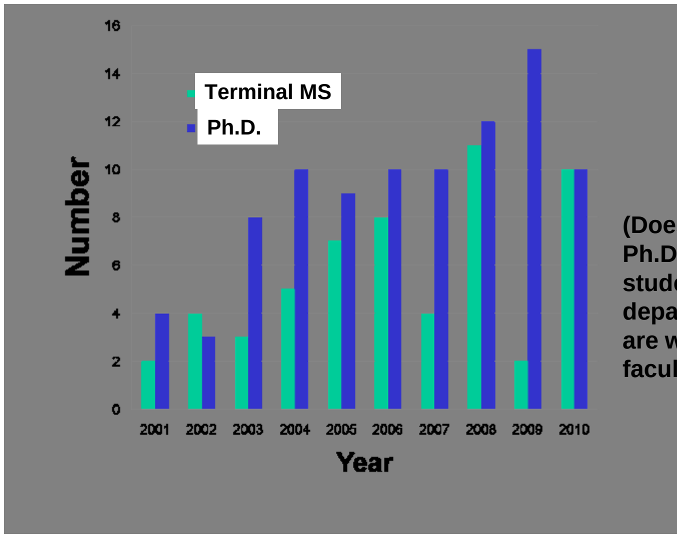
Research Areas of Faculty

- 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

UW Medical Physics Graduates, 2001-2010



(Does not include Ph.D.'s earned by students in other departments who are working with our faculty.)

Simultaneous Fetal Magnetocardiography and pulsed-Doppler Ultrasound

Nana Aba Mensah-Brown

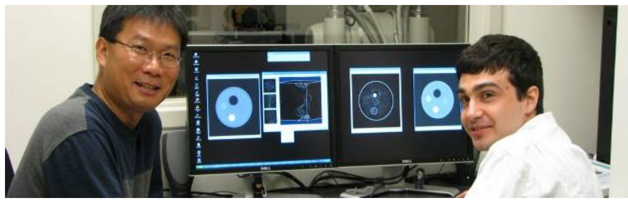
Advisor: Dr Ronald T. Wakai

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

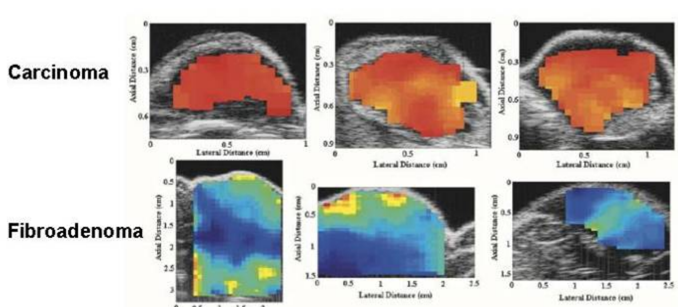
(Assistant Scientist, UW Madison Med Physics
also interested in residency training.)

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

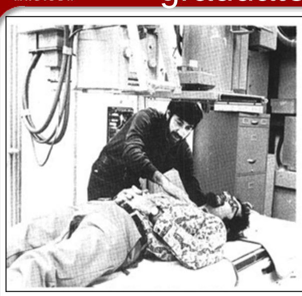
David Westerly

(Assistant Professor in an academic radiation therapy dept.)

Under the supervision of Drs. Rock Mackie andWolfgang 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



A DIGITAL SUBTRACTED IMAGE OF A CARTOID ARTERY

United States Patent [19] — Mistretta et al.

[11] **4,204,226**

[45] **May 20, 1980**

[54] **REAL-TIME DIGITAL X-RAY TIME INTERVAL DIFFERENCE IMAGING**

[75] Inventors: **Charles A. Mistretta; Robert A. Kruger; Theodore L. Houk**, all of Madison, Wis.

[73] Assignee: **Wisconsin Alumni Research Foundation**, Madison, Wis.

Scanning Video Densitometry–Cardiovascular Imaging and Image Processing, SPIE Publication edited by Harrison et al., 1975, pp. 183–194.

Gilbert et al., A Real Time Hardware System for Digital Processing of Wideband Video Images, IEEE Trans. on Computers, vol. C25, #11, Nov. 1976, pp. 1087–1100.

Important inventions have been attributed to graduate students and their research

United States Patent [19] — **[11] 4,277,367**

Madsen et al. — **[45] Jul. 7, 1981**

[54] **PHANTOM MATERIAL AND METHOD**

[75] Inventors: **Ernest L. Madsen; James A. Zagzebski; Richard A. Banjavic; Michele M. Burlew**, all of Madison, Wis.

OTHER PUBLICATIONS

Edmonds et al., "A Human Abdominal Tissue Phantom", pp. 323–326, 1979, NBS Spec. Pub. 525.
Fay, "Studies of Inhomogeneous Substances by Ultrasonic Back-Scattering", Ultrasound in Med. & Biol.,

Important inventions have been attributed to graduate students and their research

(12) **United States Patent** — (10) **Patent No.: US 6,556,856 B1**

Mistretta et al. — (45) **Date of Patent: Apr. 29, 2003**

(54) **DUAL RESOLUTION ACQUISITION OF MAGNETIC RESONANCE ANGIOGRAPHY DATA WITH VESSEL SEGMENTATION**

(75) Inventors: **Charles A. Mistretta**, Madison, WI (US); **Thomas M. Grist**, Madison, WI (US); **Yousef Mazahheri**, Madison, WI (US); **Timothy J. Carroll**, Madison, WI (US); **Jiang Du**, Madison, WI (US); **Walter Block**, Madison, WI (US)

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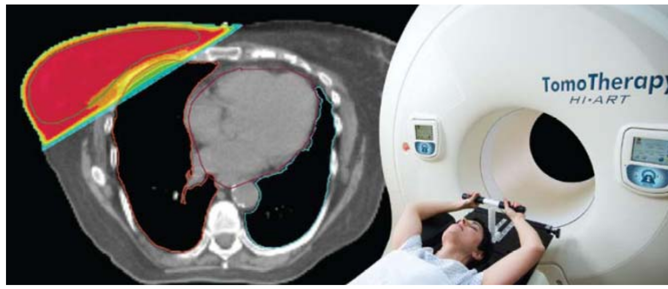
Important inventions have been attributed to graduate students and their research



US005528650A

United States Patent [19]

Swerdloff et al.

[11] **Patent Number: 5,528,650**

[45] **Date of Patent: Jun. 18, 1996**

[54] **METHOD AND APPARATUS FOR RADIATION THERAPY**

[76] Inventors: **Stuart Swerdloff**, 2309 Upham St., Madison, Wis. 53704; **Thomas R. Mackie**, 2310 Ravenswood Rd., Madison, Wis. 53711; **Timothy Holmes**, 12 Coronado Ct. #2, Madison, Wis. 53705

5,394,452 2/1995 Swerdloff et al. 378/65

OTHER PUBLICATIONS

Calculation and Application of Point Spread Functions For Treatment Planning With High Energy Photon Beams, Ahnesio et al., Acta Oncol. 26:49–56; 1987.

Methods of Image Reconstruction From Projections Applied to Conformation Radiotherapy, Bortfeld et al., Phys. Med. Biol. 35(10), 1423–1434; 1990.

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

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!

Student	GRE Verbal %	GRE Quantitative %	GPA out of 4	Major
1	89	94%	4	Phys
2	84	94%	3.92	Phys
3	99	89%	4	Phys
3	89	94%	3.72	Phys
4	86	89%	3.9	Phys
5	97	94%	3.97	Phys
6	84	92%	4	Phys
7	57	92	3.93	Phys
8	95	94	90/100	Phys
9	99	94	3.96	Phys

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?

Challenges

- Will there be residency slots for those innovative students who wish to practice clinical medical physics?
  - 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

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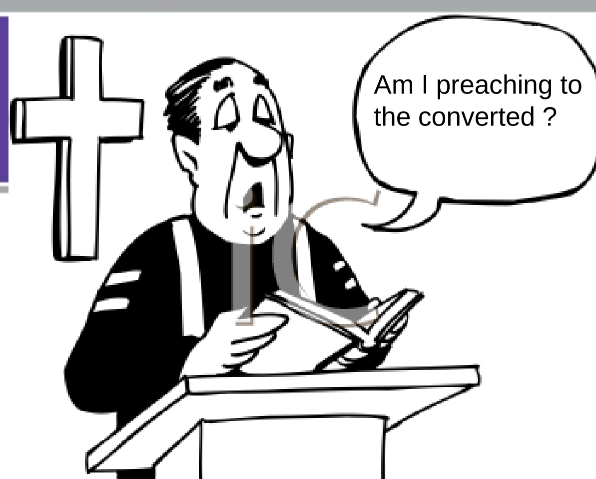

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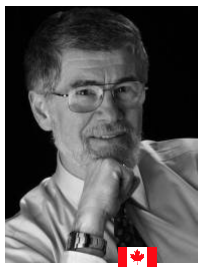
All graduate medical physics programs should have an original research component

David W. O. Rogers[1], Janelle A. Molloy[2], and Colin G. Orton

Med. Phys. 38(5), p 2315-2317



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The British Journal of Radiology, *84* (2011), 485–498

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HOUNSFIELD REVIEW SERIES

The physical basis and future of radiation therapy

[1]T BORTFELD, PhD and [2]R JERAJ, PhD

Fundamental discoveries leading to new treatment and imaging modalities	
1895	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
1896	Discovery of radioactivity (Nobel Prize in physics for Becquerel/Curie in 1903) leading to the first treatment with radioactive isotopes shortly thereafter [3]
1919	Discovery of the proton, leading to the first patient treatments with a proton beam in 1954
1938, 1946	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
Technology inventions in radiation dose delivery	
1951	Cobalt-60 treatment machines become clinically available: use of high-energy gamma rays for better skin sparing
1953	Linear accelerators with higher energies for better skin sparing and improved penumbra [4]
1950s	Cyclotrons for proton therapy (physics Nobel Prize for Lawrence in 1939)
1986	Radiation field shaping with multileaf collimators [5]
1994	Intensity modulated radiation therapy (IMRT)
Technology inventions in treatment planning	
1960s	Use of computers for dose computation
1980s	Development of three-dimensional treatment planning
1987	Inverse treatment planning and plan optimisation techniques
Technology inventions in imaging	
1972	CT (Nobel Prize in Medicine for Cormack and Hounsfield in 1979), which is soon used for radiation treatment planning
1970s	MRI (Nobel Prize in Medicine for Lauterbur and Mansfield in 2003)
2000s	Imaging integrated into treatment machines for image guided radiation therapy

rn

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T Bortfeld and R Jeraj

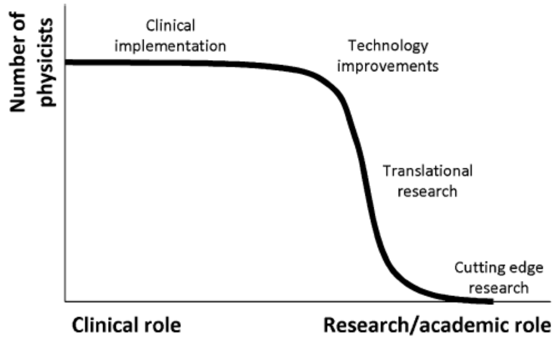

Figure 2. Spectrum of medical physics roles. Each of the four primary roles: cutting-edge research, translational research, technology improvement and clinical implementation, are equally important, even although they are not, and do not need to be, equally represented.

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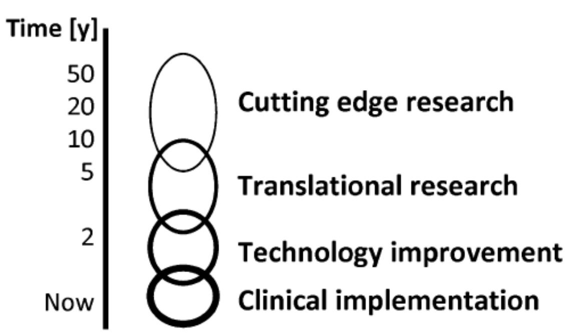

Figure 4. Suboptimal medical physics chain. Currently we are experiencing an increased emphasis on consolidating the clinical part of the medical physics spectrum, leaving the research part behind. This leads to the prolongation of the time between invention and clinical implementation, particularly severe as the relative time scale is not linear.

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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

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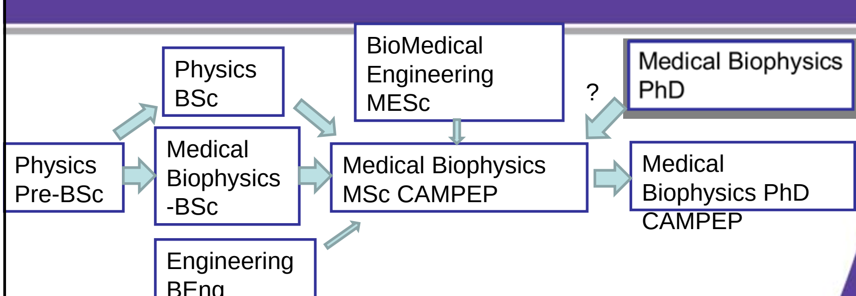
Pathways



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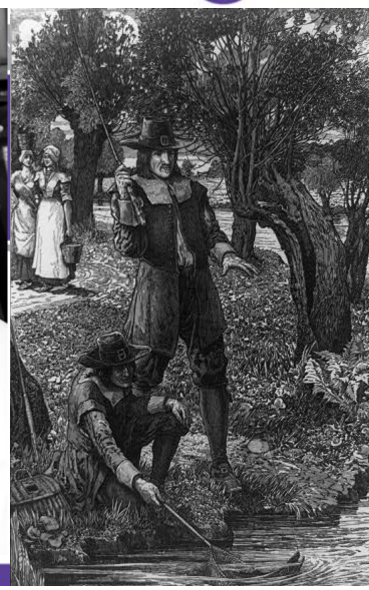
"It's not the roads we take...

it's what we make of them"



The Compleat Angler by **Izaak Walton** (1593 – 168

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

Actual 153
CAMPEP 75

Population : 34 Million

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

Clinical Physics Residency 48 slots

Actual 45
CAMPEP 30

Residents 24/yr

Clinical Physicist

Ontario Residency Program

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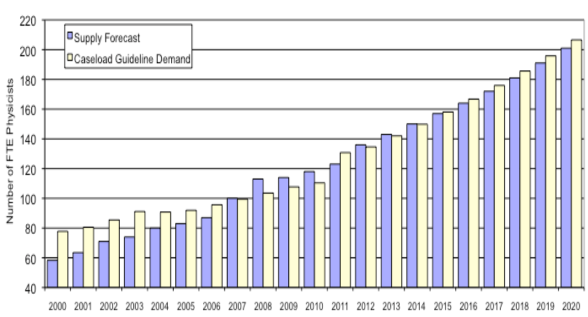
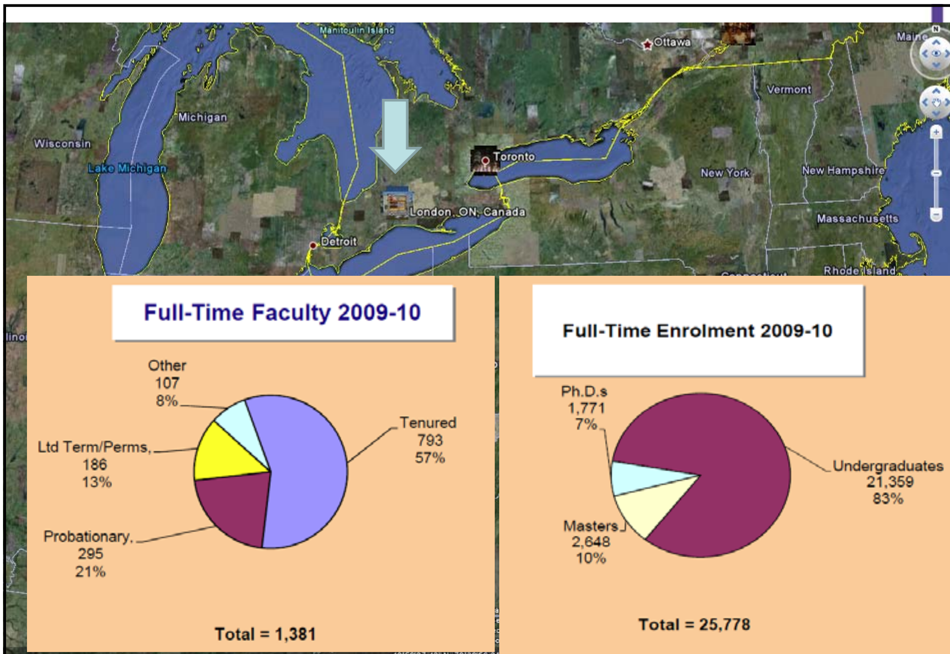


Coordinated Provincial Program 24 FTE positions (max 12 grads/year)
Stipend $54 k/yr x 2 years
Has been in formal operation since 2000
Larger Centres are now CAMPEP accredited
Smaller Centres seeking Affiliate status with larger Centres
20 % Research Weight
Accounts for > 70% of current medical physicists on staff !



Medical Biophysics

University of Western Ontario

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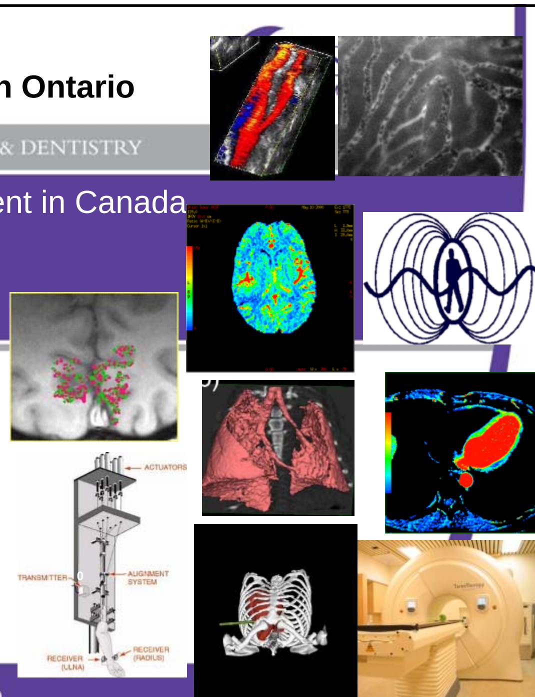
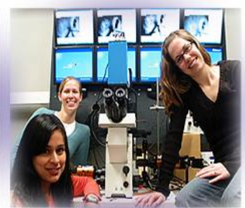
- First Biophysics Department in Canada
  - Founded by Dr. A.C. Burton
  - M.Sc./Ph.D. Degrees (1947)
  - B.Sc. / B.MSc. (1966)
  - CAMPEP Approval (2010)
- Composition
  - 10 core members
  - > 70 Appointees
  - 90+ Grad Students
  - 10 CAMPEP Students (Y1)
- City-wide partnerships with hospitals and research institutes





Learning Through Research

New CAMPEP MSc-PhD

SCHULICH SCHOOL OF MEDICINE & DENTISTRY

- 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) – <u>same</u> research + courses
  - 6.0 full course credits required
  - Clinically-oriented training and exam material
  - CCPM-certified Physicists have a role

COURSE WEIGHT	COURSE NAME (Number) * indicates course in preparation	FACULTY
	ALL SUBSPECIALTIES – COMPULSORY CORE (weight of 4.0)	
N/A	Radiation and Lab Safety Orientation	University, Hospitals, Institutes
0.5	Radiological Physics and Dosimetry (P9655A)	Eugene Wong FCCPM
0.5	Radiation Biology (9567B)	Jerry Battista FCCPM
0.5	Basic Anatomy (e.g. ACB 3319)	External
0.5	Basic Physiology (e.g. Phys 2130)	External
0.5	Inferencing from Data Analysis (9522)	Yves Bureau
0.5	Research Ethics & Biostatistics (Web course)	External (J Williams)
0.5	Medical Imaging Biophysics (9515A)	Maria Drangova
0.5	Scientific Communication (9513Y)	Terry Thompson
	IMAGING SCIENCES – COMPULSORY ELECTIVES (weight of 2.0)	
0.5	Introductory Medical Imaging (9503)	Jim Lacefield, David Holdsworth, Paula Foster, Greg Marsh
0.5	Practical Medical Physics Lab (9520Y)	David Holdsworth
0.5	Imaging Principles (9516Y)	Ian Cunningham FCCPM &
0.5	MRI Physics 9663	Robert Bartha
0.5	Conceptual MRI 9650	Charles McKenzie
0.5	Nuclear Magnetic Resonance 9662	Blaine Chronik
0.5	Advanced MRI Physics 9665*	Jean Theberge MCCPM
1.0	Practical Nuclear Medicine Physics (9570/80*)	Robert Stodilka MCCPM
	RADIATION THERAPY – COMPULSORY ELECTIVES (weight of 2.0)	
1.0	Practical Radiotherapy Physics (9570/80*)	LRCP clinical physicists F/MCCPM
1.0	To be chosen from Imaging Sciences Electives (above)	

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
- …

2011 Joint AAPM/COMP Meeting — Program

Please note: If you are seeing small squares on your abstract document, you need to update to the latest version of Adobe Acrobat Reader.

amos v.2

Session Information | Meeting Home

Innovations in Medical Physics Educatiion

Innovations in Medical Physics Education		You must log into the abstracts system to use the meeting planner
Innovations in Medical Physics Education		
Wednesday	4:30:00 PM - 6:00:00 PM	Room: Ballroom C

AAPM Technical Exhibit # 936
Modus Medical Devices

DESKCAT

http://www.deskcat.com/

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Sample Curriculum – Radiotherapy MSc-PhD (CAMPEP)

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Year 1	•Radiation and Lab Safety Orientation •Radiological Physics and Dosimetry (P9655A) •Radiobiology (9567B) •Basic Anatomy (e.g. ACB 3319) •Basic Physiology (e.g. PHYSIOLOGY 2130) •Inferencing from Data Analysis (9522) •Research Ethics & Biostatistics (Web course) •Medical Imaging Biophysics (9515A) •Scientific Communication (9513Y)
Year 2	•Physics of Radiation Oncology (9570/80) •Electives (1.0 credit) from other subspecialties •Thesis Advisory Committee Meeting #1 (thesis proposal) •Low-Level Comprehensive Examination
Year 3, 4	•Thesis Advisory Committee Meeting #2 •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. •Mid-Level Comprehensive Examination
Year 5	•Thesis Advisory Committee Meeting #3 •Thesis Defense (PhD **typically 3 peer-reviewed publications**) •Clinical Comprehensive Exam (a mock CCPM-like/Ontario A-Review oral exam) • Well prepared for a Residency Program (possibly abbreviated by 6 months)

?CAMPEP Non-Thesis MSc?

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- 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)

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Conclusion

Schulich MEDICINE & DENTISTRY

SCHULICH SCHOOL OF MEDICINE & DENTISTRY

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

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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

Improving patient safety in radiation oncology

William R. Hendee PhD[a], Michael G. Herman PhD[b,*] Practical Radiation Oncology (2011) **1**, 16–21

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

ARTICLE IN PRESS

Int. J. Radiation Oncology Biol. Phys., Vol. ■, No. ■, pp. 1–7, 2011

0360-3016/$ - see front matter

ELSEVIER

doi:10.1016/j.ijrobp.2011.05.010

PHYSICS CONTRIBUTION

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

Mario Ciocca, M.S.,[*] Marie-Claire Cantone, Ph.D.,[†‡] Ivan Veronese, Ph.D.,[†‡] Federica Cattani, M.S.,[§] Guido Pedroli, M.S.,[§] Silvia Molinelli, M.S.,[*] Viviana Vitolo, M.D.,[||] and Roberto Orecchia, M.D.[¶**††]

[*]Unit of Medical Physics, Centro Nazionale di Adroterapia Oncologica (CNAO) Foundation, via Campeggi, 27100 Pavia, Italy; [†]Department of Physics, Università degli Studi di Milano, via Celoria 16, 20133 Milano, Italy; [‡]Istituto Nazionale di Fisica Nucleare, INFN Milano, via Celoria 16, 20133 Milano, Italy; [§]Unit of Medical Physics, European Institute of Oncology, via Ripamonti 435, 20141 Milano, Italy; [||]Unit of Radiotherapy, Centro Nazionale di Adroterapia Oncologica (CNAO) Foundation, via Campeggi, 27100 Pavia, Italy; [¶]Division of Radiation Oncology, European Institute of Oncology, via Ripamonti 435, 20141 Milano, Italy; [**]Scientific Direction, Centro Nazionale di Adroterapia Oncologica (CNAO) Foundation, via Campeggi, 27100 Pavia, Italy; and [††]Faculty of Medicine, Università degli Studi di Milano, via Ripamonti 435, 20141 Milano, Italy

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 (IORT) delivered using mobile linear accelerators, aiming at preventing accidental exposures to the patient.
Methods and Materials: FMEA was applied to the IORT 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

Int. J. Radiation Oncology Biol. Phys., Vol. 74, No. 3, pp. 852–858, 2009

0360-3016/09/$–see front matter

ELSEVIER

doi:10.1016/j.ijrobp.2008.10.038

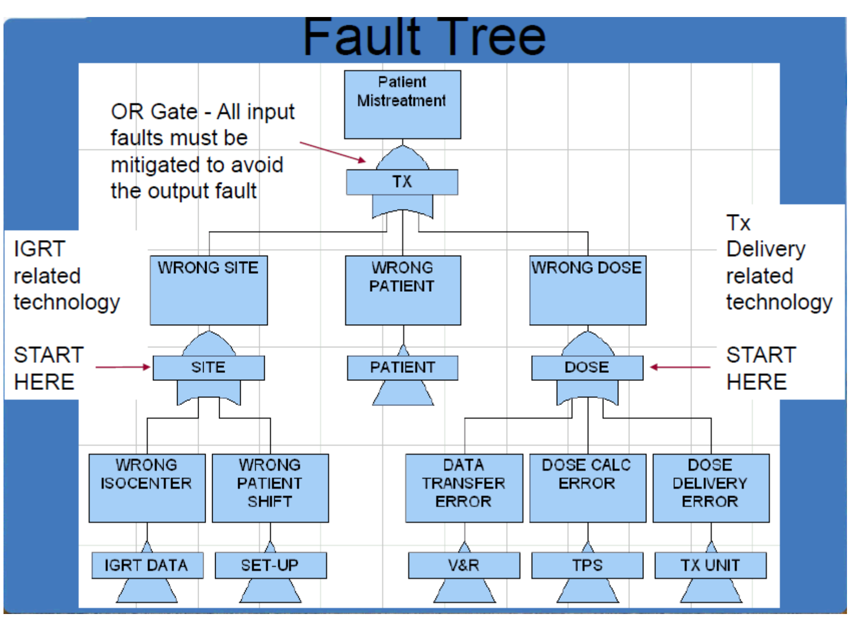
CLINICAL INVESTIGATION **Quality Improvement**

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

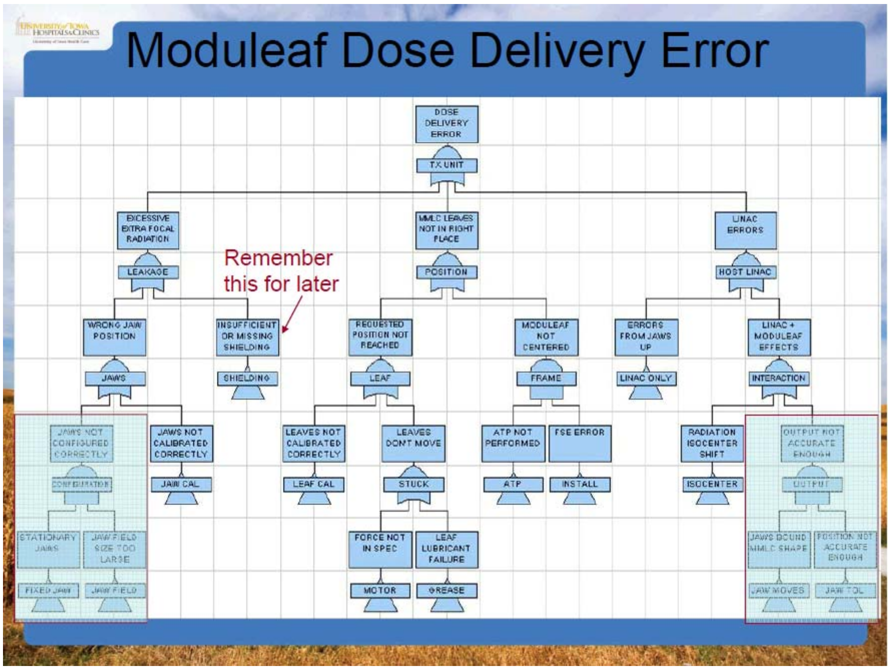
Eric C. Ford, Ph.D.,* Ray Gaudette, M.S.,* Lee Myers, Ph.D.,* Bruce Vanderver, M.D.,† Lilly Engineer, Dr.P.H., M.D., M.H.A.,† Richard Zellars, M.D.,* Danny Y. Song, M.D.,* John Wong, Ph.D.,* and Theodore L. DeWeese, M.D.*

*Department of Radiation Oncology and Molecular Radiation Sciences and †Center 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 reliability. We report our experiences 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.



R. Alfredo Siochi, PhD



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

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center
Making Cancer History®

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

Graduate curriculum

AAPM REPORT NO. 197
(Revision of AAPM Report No. 79)

Academic Program Recommendations for Graduate Degrees in Medical Physics

3.1.6.2 *Professional Ethics/Conflict of Interest/Scientific Misconduct*

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

3.1.6.2 *Professional Ethics/Conflict of Interest/Scientific Misconduct*

2. Publications and Presentations

(a) Authorship

(b) Copyright

(c) Peer review, confidentiality, and conflicts of interest

(d) Plagiarism

3.1.6.2 *Professional Ethics/Conflict of Interest/Scientific Misconduct*

3. General Professional Conduct

(a) Interaction with colleagues

(b) Fair competition for employment

(c) Consulting and conflict of interest

(d) “Whistle-blowing”

3.1.6.2 *Professional Ethics/Conflict of Interest/Scientific Misconduct*

4. Medical Malpractice

- (a) Standard of care
- (b) Testimony as an expert witness
- (c) Rights and responsibility in communicating with patients and physicians

3.1.6.2 *Professional Ethics/Conflict of Interest/Scientific Misconduct*

5. Research

- (a) Human subjects
- (b) Informed consent
- (c) Environmental health and safety
- (d) Dissemination of research results
- (e) Attribution
- (f) Conflict of interest

TG 159 Report

- Serago et al, "Recommended ethics curriculum for medical physics graduate and residency programs: Report of Task Group 159," Med Phys 37(8) 4495-4500 (2010)

TG 159 Report

TABLE I. Recommended ethics subjects for medical physics graduate and residency programs.

Ethical principles
Historical perspective
Ethical encounters or dilemmas
Basic ethical values
Relationships
Clinical conflicts
Continuing education
Public responsibility
Employer/employee relationships
Conflict of Interest
Human research principles
Scientific principles
Scientific misconduct
Publication practices
Animal research
Teacher education ethical issues
Student education ethical issues

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."

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."

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

Do our programs address these issues?

- Ethics:
  - Other program don’t address ethics

Typical Program for Master of Science Degree in Medical Physics (General Medical Physics Option)

1st Semester (Fall)

- Med. Phys. 463 Radioisotopes in Medicine and Biology (3 cr.)
- Med. Phys. 501 Radiological Physics and Dosimetry (3 cr.)
- Med. Phys. 567 The Physics of Diagnostic Radiology (3 cr.)
- Med. Phys. 900 Journal Club and Seminar (1 cr.)

2nd Semester (Spring)

- Med. Phys. 410** Radiobiology (2 cr.)
- Med. Phys. 566 Physics of Radiotherapy (3 cr.)
- Med. Phys. 569 Health Physics (4 cr.)
- *Electives: Choose From:
  - Med. Phys. 401 Intermediate Physics for Medicine and Biology (3 cr.)
  - Med. Phys. 530 Medical Imaging Systems (3 cr.)
  - Med. Phys. 568 Magnetic Resonance Imaging (MRI) (3 cr.)
  - Med. Phys. 570*** Advanced Brachytherapy Physics (3 cr.)
  - Med. Phys. 575 Diagnostic Ultrasound Physics (3 cr.)
  - Med. Phys. 707 Applications of Digital Imaging: DSA, CT, MRI (2 cr.)
- Med. Phys. 900 Journal Club and Seminar (1 cr.)

Medical Physics Qualifier

3rd Semester (Fall)

- Med. Phys. 661 to 666 Rad Lab in Radiological Physics (1-3 cr.)
- *Electives: Choose From:
  - Med. Phys. 573 Medical Image Science: Deterministic Aspects (3 cr.)
  - Med. Phys. 571**** Advanced External Beam Radiotherapy (3 cr.)
  - Med. Phys. 577 Principle of X-ray Computed Tomography (3 cr.)
  - Med. Phys. 710 Advances in Medical Magnetic Resonance (2 cr.)
  - Med. Phys. 812 Radiation Medicine Physics Clerkship (2 cr.)
  - Biological Science (i.e. Physiology 335, Oncology 401, Anatomy 637)
- Med. Phys. 900 Journal Club and Seminar

4th Semester (Spring)

- Med. Phys. 661 to 666 Rad Lab in Radiological Physics (1-3 cr.)
- Med. Phys. 410** Radiobiology (2 cr.)
- *Electives: Choose From:
  - Med. Phys. 401 Intermediate Physics for Medicine and Biology (3 cr.)
  - Med. Phys. 530 Medical Imaging Systems (3 cr.)
  - Med. Phys. 568 Magnetic Resonance Imaging (MRI) (3 cr.)
  - Med. Phys. 570*** Advanced Brachytherapy Physics (3 cr.)
  - Med. Phys. 574 Medical Image Science: Stochastic Aspects (3 cr.)
  - Med. Phys. 575 Diagnostic Ultrasound Physics (3 cr.)
  - Med. Phys. 707 Applications of Digital Imaging: DSA, CT, MRI (2 cr.)
  - Med. Phys. 812 Radiation Medicine Physics Clerkship (2 cr.)
  - Biological Science (i.e. Anatomy 328, Neuroscience 524, Physiology 335)
- Med. Phys. 900 Journal Club and Seminar

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?

Comments and Discussion


Thank you

Effective Use of Web-Based Instructional Modules

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Distinguished Professor
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Medical College of Wisconsin

Professor of Biomedical Engineering
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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)
Medical College of Wisconsin

George Bisset MD
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Robert Dixon MD
University of North Carolina

Mitch Goodsitt, PD
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Mark Rzeszotarski PhD
Case-Western University

Ehsan Samei PhD
Duke University

Phase I Physics Modules

Radiography/Fluoroscopy	7 modules
Computed Tomography	3 modules
Nuclear Medicine	6 modules
Magnetic Resonance	9 modules
Ultrasound	3 modules
Radiation Biology/Protection	3 modules

Phase II Physics Modules

Properties of Atoms/Radiation	4 modules
Image Properties	4 modules
Image Perception/Display/PACS	2 modules
Radiation Protection	1 module
Digital Imaging	1 module
Ultrasound	1 module
MRI	2 modules
Image Gently	1 module

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

ABRF	ABR	RSNA
AAPM	ACR	ASTRO
ARS		

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

ABRF Web-Based Modules on Ethics and Professionalism

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