# Education and Mentoring of New Medical Physicists

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## Outline

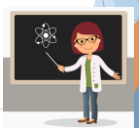
- Graduate education
  - AAPM Report 197
  - CAMPEP
  - Graduate education at UF
- Diagnostic and Nuclear Medicine Residency
  - AAPM Report 249
  - CAMPEP
  - Diagnostic and nuclear medicine physics residency at UF
- This talk will focus on curriculum rather than program structure

## Graduate Programs in Medical Physics

## How to structure a graduate program

- AAPM Report 197: Academic Program Recommendations for Graduate Degrees in Medical Physics
- CAMPEP Standards for Accreditation of Graduate Educational Programs in Medical Physics
- Have strong involvement from clinical physicists who work in and know the field!

C A M P E P



## AAPM Report 197 contents

- Core curriculum that should be common to all medical physics degrees:
  - Radiological Physics and Dosimetry
  - Radiation Protection and Radiation Safety
  - Fundamentals of Imaging in Medicine
  - Radiobiology
  - Anatomy and Physiology
  - Special Topics (Computational Methods, Mathematical Methods, Professional Ethics, Electrical/Chemical/Biological/Radiation Safety, Clinical Research, Scientific Communication)
- More specific guidance for Imaging Physics, Radiation Therapy Physics, and Imaging for Treatment Guidance and Monitoring
- Recommended laboratory training
- Extensive bibliography

## AAPM Report 197 for diagnostic physics

- No clinical introduction or clinical applications for diagnostic topics
- Strange organization for some topics
- Missing topics
- Inconsistent treatment of topics related to QC and regulation
- Some of the topics listed are very specific, while others are very vague
- "Role of a clinical medical physicist" and professional organizations found in the therapy section only
- Only 2 of the 10 committee members were diagnostic physicists
- No nuclear medicine physicists?

**In the Mathematical Methods for Imaging in Medicine section:**

3. Noise Averaging and Filtering

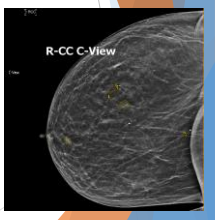
(a) Principles of noise averaging: The covariance concept
(b) Autocovariance and power spectrum concepts [Noise graphs]
(c) Filtering: The inverse, Metz, Wiener, matched, and Wiener-Hellstrom filters [figures]
(d) The propagation of error and the covariance matrix

**In the Digital X-Ray Imaging and Computed Tomography section:**

4. Dose and Dose Reduction Issues

## AAPM Report 197

- Published 10 years ago – is getting dated
  - "Digital imaging" is apart from "conventional planar x-ray imaging" (and lumped in with CT), which does not reflect modern practice, and this section could be expanded
  - Could remove film topics
  - Missing modern technologies such as OSL dosimeters, DBT, CAD, AI
  - Little attention to modern priorities such as dose reduction and accreditation




## What does CAMPEP say?

**Standards for Accreditation of Graduate Educational Programs in Medical Physics**
Revised March 2019

- This document focuses more on program structure, but does have a list of minimum core curriculum requirements
- Not as detailed as AAPM Report 197, but does not suffer from the same problems
  - Seems more up-to-date and the diagnostic section is more comprehensive
  - Ethics, leadership, and professionalism sections also more comprehensive
  - All items *must* be covered by the graduate program
- You explain how you will cover everything in the self-study document

Excerpt from CAMPEP Standards:

**8.1 Radiological physics and dosimetry**
- 8.1.1 Atomic and nuclear structure
- 8.1.2 Classification of radiation
- 8.1.3 Quantities and units to describe radiation fields
- 8.1.4 Quantities and units to describe radiation interactions

Excerpt from UF's self study:

| Topic | Course # |
|---|---|
| 8.1 Radiological physics and dosimetry | |
| 8.1.1 Atomic and nuclear structure | BME 6555, ENU 6659 |
| 8.1.2 Classification of radiation | BME 6555, ENU 6659 |
| 8.1.3 Quantities and units – radiation fields | BME 6555, ENU 6659 |
| 8.1.4 Quantities and units – radiation interactions | BME 6555, ENU 6659 |

## About UF's graduate program

- Founded in 1961 in the Department of Radiology as a joint venture with the Department of Nuclear Engineering Sciences
- The program's home wandered over the years from Nuclear Engineering (in 1972), to Biomedical Engineering (in 2010), and back to Radiology (in 2017)
- Our program has a strong clinical focus!
- Of the medical physics faculty who teach courses or advise students:
  - *12 out of 15* have clinical responsibilities
  - *All 15* are board certified by the ABR, ABSNM, or ABHP (or in the process of certification)

UF | Medical Physics Graduate Program
College of Medicine

Program Director
Manuel Arreola

## Mentoring students

- All students meet individually with the Program Director each semester
- PhD students are evaluated by their advisor each semester, with goals for the following semester explained and agreed upon
- All students take a 1-credit Survey of Medical Physics course in their first summer (starting 2019), which covers professional development and career planning topics including:
  - Subspecialties of medical physics
  - Work environments in medical physics
  - Rules and regulations that impact physicists
  - QC, QA, medical errors
  - The role of professional societies
  - All about medical physics residency
  - The board certification process
  - Ethics and professionalism

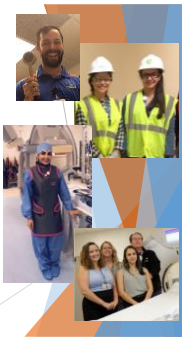
Students prepare a CV and complete 2 mock residency interviews

Each student interviews a working medical physicist about their career and presents to the class

Students do an assignment to plan their career path from the present time through board certification

Students analyze ethical scenarios in small groups, write up their impressions, and participate in a round table discussion

## Opportunities for clinical experience



- All students have labs in diagnostic and therapy physics that are part of the courses
- Students with an interest in clinical diagnostic physics may be hired as Graduate Assistants (GAs) in Radiology (started 1986!)
- GAs are responsible for testing mobile radiographic and mobile c-arm fluoroscopic units
  - There are always 2-3 GAs present during testing
  - At least one GA in the testing group must have completed a competency assessment with a faculty member
  - Reports are reviewed by a medical physics resident and then signed by a faculty member
- GAs may act as assistants for other clinical activities
- GAs work on their research when not busy with clinical responsibilities
- We also often have 1-2 undergraduate volunteers who shadow and assist when needed

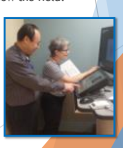
## Residency Programs in Diagnostic and Nuclear Medicine Physics

## How to structure a residency program

- AAPM Report 249: Essentials and Guidelines for Clinical Medical Physics Residency Training Programs
- CAMPEP Standards for Accreditation of Residency Educational Programs in Medical Physics

- Have strong involvement from clinical physicists who work in and know the field!

C A M P E P



## AAPM Report 249 contents

- Structure of a residency program
- General educational competencies (ethics and professionalism, liability, professional societies, soft skills, administration, accreditation and regulatory agencies)
- Didactic knowledge requirements
- Guidelines for training programs
  - Facilities and resources (equipment, volume and variety of patients)
  - Training requirements (length of program, evaluations, supervision)
  - Expected areas of competence in general and for each modality
    - Specification, acceptance testing, and QA of imaging equipment
    - How specifications are used in a request for proposal
    - Measurement and calculation of radiation exposure and dose
    - Improving and maintaining image quality
    - Training and education of various health professionals in imaging physics and radiation effects
- Published 2013 – there are a few things that are already aging

## How to become certified in 2+ specialties

- Complete a 2nd CAMPEP-accredited residency


- Find an ABR-certified physicist (in the specialty desired) who is willing to supervise you
  - Develop a prospective 1-year training plan
  - Get approval by the ABR *before training begins*
  - When training is completed, the supervisor completes an attestation and the candidate becomes board-eligible in the additional specialty
  - https://www.theabr.org/medical-physics/initial-certification/certification-requirements/certification-additional-disciplines
- Complete a CAMPEP-accredited combined residency
  - Only available for diagnostic and nuclear medicine physics

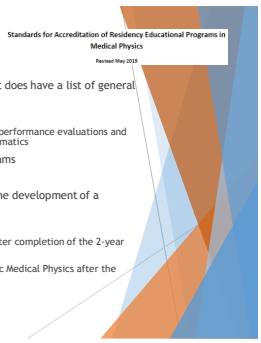
## AAPM Report 249 contents

- Areas of competence for imaging:
  - General radiography
  - Hard-copy and image displays
  - Angiography and fluoroscopy
  - CT
  - Ultrasound
  - Mammography
  - MRI
  - Nuclear Medicine and PET
  - Imaging informatics
  - Safety
- Areas of competence for nuclear medicine:
  - Gamma camera with/without SPECT
  - PET and PET/CT
  - CT (with SPECT or PET)
  - Non-imaging equipment
  - Radiation safety
  - Patient dosimetry
  - Informatics
  - Radiopharmacy
  - Clinical Studies
  - Radionuclide Therapy

## AAPM Report 249: Appendix C

- Appendix C covers advice on combining imaging and nuclear medicine residencies
- Adding nuclear medicine to an imaging residency "may be accomplished in an additional year (following the completion of an imaging residency)"
  - The "2 + 1" model
- Requires at least one nuclear medical physicist certified by an appropriate certifying board and a nuclear medical physician certified by the ABR or equivalent
- The ratio of full-time nuclear medical physicists to residents enrolled in the additional year should be at least 1:1

## What does CAMPEP say?




- The document focuses largely on program structure, but does have a list of general and specialty-specific curriculum requirements
  - Ethics, professionalism, leadership
  - For imaging physics and nuclear medicine physics: system performance evaluations and quality control for each modality, safety evaluations, informatics
- Does not specifically address combined residency programs
- My experience communicating with CAMPEP regarding the development of a combined program:
  - The "2+1 model" is mandatory
  - The nuclear medicine residency must be in the 3rd year, after completion of the 2-year imaging residency - they cannot be intermixed
  - Rationale: so the resident can take ABR Part 2 in Diagnostic Medical Physics after the second year

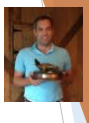
## About UF's residency program

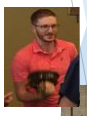
- The Diagnostic Imaging Medical Physics Residency (DIMPR) program was founded by Libby Brateman
  - Accepted its first resident in 2011
  - Received CAMPEP accreditation in 2013
- The program has been a 2-year diagnostic-only program until recently, but this year we are applying to expand it to a 3-year combined program

DINMMPR?

## What makes UF's program unique?

- DIMPR is supported by our medical school's GME (Graduate Medical Education) office, and is treated just like the radiology residency in terms of pay and benefits
- Training progresses in a (mostly) logical sequence but the "rotations" do not have fixed schedules. The resident's competency is a given area is assessed by a faculty member when he or she is ready.
- "Resident as a teacher" is a major philosophy of our program, and the senior resident takes the role of primary teacher to the junior resident. They do almost all equipment testing together.
- Faculty provide direct supervision during all mammography and nuclear medicine testing, and during acceptance and ACR submission testing of other modalities. Indirect supervision provided otherwise.
- The annual year-end evaluation is structured as a mock oral exam





## It's not all work!

## Conclusions

- AAPM Reports and CAMPEP provide valuable advice for the structure and content of graduate education and residency programs, but are not 100% comprehensive
- Making education truly comprehensive and clinically-oriented requires the involvement of clinical physicists with a strong interest in teaching
- Mentoring should be an essential part of the program structure. Be available for mentoring of former students and residents even after graduation, and build a strong network of supportive colleagues!

## Thank you!