A Research Career in Medical Physics:
Skill Sets and Professionalization

Maryellen Giger, Ph.D.
A. N. Pritzker Professor
Department of Radiology/Medical Physics
The University of Chicago

COI

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Topics of session

• The changing education and skills of medical physicists
• The nature of medical physics research
• Professionalization
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• The changing education and skills of medical physicists
• The nature of medical physics research
• Professionalization

Exciting career as an academic researcher

Who am I?

• Academic medical physicist
  – the A. N. Pritzker Professor at the University of Chicago
  – Radiology, Medical Physics, and the College
• Research
  – NIH Grant-funded lab - CAD, quantitative image analysis, radiomics, machine learning
  – Ph.D. students, undergrads, post-docs, senior researchers
• Education
  – Teach in our CAMPEP-accredited Ph.D. program
  – Advise graduate, undergrad, medical students...

Who am I?

• Administration
  – Prior Director, CAMPEP-accredited Ph.D. program
  – Vice-Chair of Radiology for Basic Science Research
  – Chair and/or member of various university committees, etc.
    • E.g., Co-chair of Committee on Appointments and Promotions
Who am I?

- External Memberships and Leadership Roles
  - AAPM, RSNA, SPIE, AIMBE, IEEE ...
  - National Academy of Engineering
  - Editor-in-Chief, SPIE Journal of Medical Imaging (JMI)
  - Prior President of AAPM
  - Current President-Elect of SPIE
  - Grant reviewer for NIH and other funding agencies
  - Scientific Advisor/Consultant to various companies
    * Quantitative Insights

The nature of medical physics research

Destination of PhD graduates

- Approx. 60% go into residencies (RT or IP) or junior physicist position
- Approx. 40% go another route


- Students trained in my lab have pursued both routes.
- Main career difference is the % time allowed for research.

Research Chain

- Identification of an issue (problem)
- Collection of examples (cases)
- Investigation and potential solutions: equipment, algorithm, protocol
- Validation of the research finding
- Translation to clinical care: FDA clearance, clinical testing, clinical use
Research Chain

Identification of an issue (problem)

Collection of examples (cases)

• Need a better image (detector)
• Need lower dose
• Need better RT alignment
• Need better radiologist interpretations (CADe, CADx)

Investigation and potential solutions: equipment, algorithm, protocol

Validation of the research finding

Translation to clinical care: FDA clearance, clinical testing, clinical use

Research Chain

Identification of an issue (problem)

Collection of examples (cases)

• Patient cases
• Examples of errors

Investigation and potential solutions: equipment, algorithm, protocol

Validation of the research finding

Translation to clinical care: FDA clearance, clinical testing, clinical use

Research Chain

Identification of an issue (problem)

Collection of examples (cases)

• New detector material for higher sensitivity
• New CT reconstruction
• Novel radiomics & deep learning for CADe or CADx
• New contouring algorithm for precision treatment

Investigation and potential solutions: equipment, algorithm, protocol

Validation of the research finding

Translation to clinical care: FDA clearance, clinical testing, clinical use
Research Chain

Identification of an issue (problem)
Collection of examples (cases)
Investigation and potential solutions: equipment, algorithm, protocol
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Education for a Medical Physics Research Career

• Obtain a solid didactic education in a CAMPEP medical physics graduate program
• Be an active member of a lab
• Help supervise junior students/summer students
• Write abstracts/presentations and papers/peer-reviewed publications while a student
• Write pre-doctoral grants, seed grants
• Learn how to write an IRB
• Learn how to work with others
  – Collaboration (play nice in the sandbox)
Skills of a successful researcher

• Be creative
• Be hard working and dedicated
• Don’t give up & always look for opportunities
• Helps if you can program/code
• Know statistics
• Collaborate with others
• Communicate
• Realize that research is not a homework problem!
• Know how to work with others
  – Collaboration (play nice in the sandbox)

Thank you

My Life and Medical Physics

• Illinois Benedictine College (1974-1978)
  – Professor Shonka tissue-equivalent plastic (1960’s)
  – Professors Spokas and Meeker – started Exradin company
    making ion chambers for dosimetry (Standard Imaging, Inc.)
    • Exradin Miniature Shonka Thimble Chamber
  • Exradin Miniatures

For relative dosimetry scanning and measuring points in water, air, or other phantom material
My Life and Medical Physics

- **Illinois Benedictine College** (1974-1978)
  - Professor Rose Carney, who had worked on the Manhattan Project
  - Professor of Mathematics at IBC
  - My advisor & mentor in college
  - Many opportunities – teaching HS summer Algebra & at Fermi Lab

My Life and Medical Physics

- **Summers at Fermi National Labs** (1976-1978)
  - Drs. Mike Shea and Bob Goodwin – *beam line diagnostics*
  - “Protons are being accelerated through Linac’s nine cavities for the first time at 200 MeV. Here, at the control console, are Robert Goodwin and Mike Shea. (1970)”
  - Dr. MiguelAwschalom – *neutron therapy* center opened in 1976

My Life and Medical Physics

- **University of Exeter, England** (1978-1979)
  - Rotary Fellowship
  - M.Sc. in physics
  - The detection of low frequency rhythms in the electrocardiograms of male and female subjects
My Life and Medical Physics

- **The University of Chicago** (1979-1985)
  - Ph.D. in medical physics: Basic Imaging Properties in Digital radiography
  - \[ q = \frac{\int_{\text{min}}^{\text{max}} \frac{e^{-x}}{x} \, dx}{\left( \int_{\text{min}}^{\text{max}} \frac{e^{-x}}{x} \, dx \right)^2} \]

My Life and Medical Physics

- **The University of Chicago** (1986-present)
  - Assistant Professor to A. N. Pritzker Professor (tenured full professor)
  - Run a federally-funded research lab on CAD/quantitative radiomics
    - Apply for grants constantly
    - NIH (NCI, NIBIB, NIAMS), DOD, DOE, Whitaker, ACS, ...
  - Involve senior members of lab in the training and supervision of junior members in the lab.
  - All are "equal" around the research table and learn to ask probing questions
  - Involved in teaching within our CAMPEP-accredited PhD. Program
  - Have 4-6 summer students (HS, undergrads) each year
  - Best "payback" - When a student/trainee becomes a colleague!