The Future of NIH Research Funding: Writing Successful Medical Physics Grant Applications

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Learning Objectives/Outline

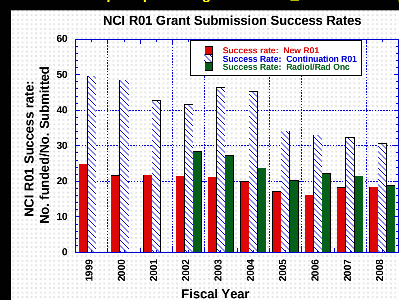
- What competitive odds do radiation oncology physics investigators face at NIH? How successful are we?
- What kinds of projects are being funded?
- How can one effectively present a research proposal to a review group?
- **Disclaimer:** The following "Editorial" presentation represents the Speaker's subjective opinion, not established fact or NIH policy

Role of NIH Funding in Medical Physics

- We are more dependent on extramural funding than ever before
  - Larger scale and more technically complex projects
  - Institutional funding sources increasingly squeezed
  - Initial successes become institutional expectations
    - Research infrastructure must be built and paid for
    - VCU: 5 tenure-track faculty, 4 research faculty, 15-20 students and post-docs, grant and data managers all dependent upon outside funding
- Competition for available funding seems more intense than ever before

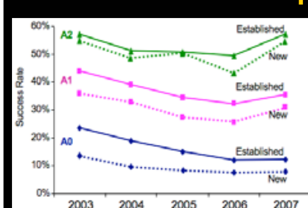
Role of NIH Funding in Medical Physics

Source: http://report.nih.gov/success_rates/index.aspx



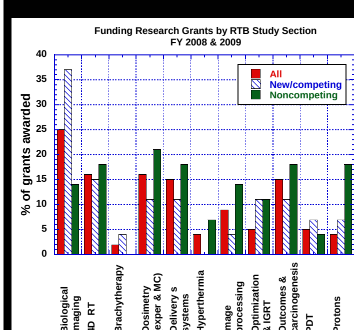
- Success rates for new NCI R01 grants: down from 25%-30% in 1999-2002 to about 18% in 2008

Application must present proposal in most favorable possible light



- Core features of a funded proposal
  - PI credibility and research team expertise
  - Scientific relevance and feasibility
  - Environment and resources
  - Quality of presentation
- For "new" investigators, competition is particularly intense compared to "established" PIs

What is Getting Funded?



- 37% new grants involve molecular imaging most including human or animal subjects
- 15% are 4D
- 15%: Outcomes modeling
- Dosimetry: fallen from 20% to 10%

Qualifications

- Only R01 and R21 grants reviewed by Radiation Therapeutics and Biology (RTB) study section examined
- Data are from NIH "CRISP" database: reports funded grants only, not submitted grants
- Why only 3 non-4D IGRT grants?
  - 15 RTB CRISP "image guided radiation" hits vs. 88 in all of NIH.
  - At least 10-15 other IGRT grants, including 2 Program project grants
  - Most IGRT grants reviewed elsewhere
- Looking at RTB grants: undercount MP support 2-3 fold

Features of Funded RTB grants

Feature	New/competing	Continuation	Total
Total grants funded	79	104	183
Medical Physics content	34%	37%	30%
AAPM member PI	63%	71%	67%
Department Radiation Oncology Radiology Engineering Other	 81% 4% 11% 4%	 57% 25% 18%	 69% 15% 15% 2%
MD/DVM	19%	7%	13%
Human subjects	63%	57%	60%
Animal models	22%	18%	20%

- 183 funded grants recorded in FY 2008-2009
  - 55 or 30% medical physics
  - 37/55 or 67% had AAPM PIs
  - 44/55 or 80%: human subjects component or used animal model

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Scientific Paper vs. NIH Grant Application

- Scientific Paper
  - Highly specialized audience
    - Technical terms OK
    - Shared "big picture" assumed
  - Literature review
    - Identify knowledge gap filled
    - Relevance assumed
  - Objective/factual report
    - Prove validity of results
    - Narrowly qualified conclusions
    - Not about the author but about the results
- Grant Application
  - Broad scientific audience
    - Must educate and show public health relevance
  - Literature review/rationale
    - Must establish "big picture" clinical/scientific impact
    - Novelty and originality
  - Polemical document
    - Persuade, convey enthusiasm, competence
    - Argue for potential impact
    - Show feasibility of method
    - Show off PI scientific skills, creativity, achievements
- Your job: make mostly sympathetic but overworked reviewers' jobs as easy as possible

"Spinning" a proposed research goal

- Find a place translational vs. basic science continuum
  - Basic science: Generality ⇒ addresses technical or scientific barrier that could alter direction of an entire field or solve a large class of problems
  - Translational: improves outcome of a specific patient group for a specific treatment modality
    - Read clinical literature, understand dose response, and estimate potential impact on outcomes
    - Tackling "part" of problem cluster that hinders a modality not easy. Further from implementation ⇒ harder to sell
    - Novelty: clever idea, e.g., applying fundamental engineering solution to a clinical problem

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Translational vs. Basic Science

- More clinical ⇒
  - Novelty from feasible solution to a clinical outcome-limiting problem, not in methodology or understanding disease process
    - Specific, air-tight proof of potential clinical impact addressed to MD and physics reviewers
  - Less emphasis on conceptual novelty and "advancing a field"
  - Usually incremental advance
- More basic ⇒
  - Show that targeted knowledge gap has paradigm-changing, research-direction setting consequences
    - Underlying mechanism of therapeutic response
    - Novel game-changing technology or general engineering technique
    - Mechanism of detector response; fundamental property of medical images or modality
  - Well selected study section ⇒ reviewed by scientific peers
  - Either high-risk game-changing or low risk incremental advance

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Translational vs. Basic Continuum

- What is the Medical Physicist to do?
  - Basic: compete with experts in engineering or biology at your peril
  - MP strength: access to patient material and ability to mount therapeutic or observational studies
  - RTB MP grants: 60% use clinical material,. 20% use animal models. Not good for "basic" MP science
- More feasible strategy for most MP's: learn to adapt basic science to a clinical problem
  - Make basic scientist your ally not your competitor
- Selection of a review group is essential
  - Only reviewers from your scientific community will champion your proposal

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Example project: CT imaging of tissue inhomogeneities coupled to an ultra-fast Monte Carlo dose engine for seed implants

- Introduction
  - Cancer significance
  - Problem to be solved
  - Technology gap addressed
  - How we will address it
  - Hypothesis
  - Overview of aims
- Specific Aims
  - Short sentence fragment
  - Define important terms
  - 1 sentence per subaim
  - Identify novelty
- Recapitulation
  - Long term goal
  - Restate hypotheses

SA Introduction

- Clinical outcome shortfall
  - Detailed argument in §B
- Confounding problem
  - §B: convince reviewers of connection
- Hypothesis
  - Res. Results ⇒ clinical utility Y
  - Result X ⇒ Mech. Insight Z
- Technology barrier
  - Detailed arguments in §B
- Our approach
  - Team of experts assembled
  - Particular technical solutions
  - Claims of scientific novelty
- Audience: MD's and biologists

Anatomy of a Specific Aim

Short concise aim statement avoiding jargon

Key term defined

Transfer of previously developed but still cutting edge technology

Aim described as series of subaims again avoiding jargon

Engineering novelty

§C: Progress Report/Preliminary Data

- Establish feasibility of research plan (RP)
  - PI's team have needed skills and resources Support RP feasibility and/or underlying assumptions
  - Teach reviewer about your specialized techniques
- Advice
  - Build a team: get specialized expertise on board
  - Show off the team:
    - Cite team's publications when relevant to support project
    - Demonstrate project feasibility and team credibility
    - Novelty: always acknowledge competing approaches while arguing for benefits of your approach

§D: Research Plan

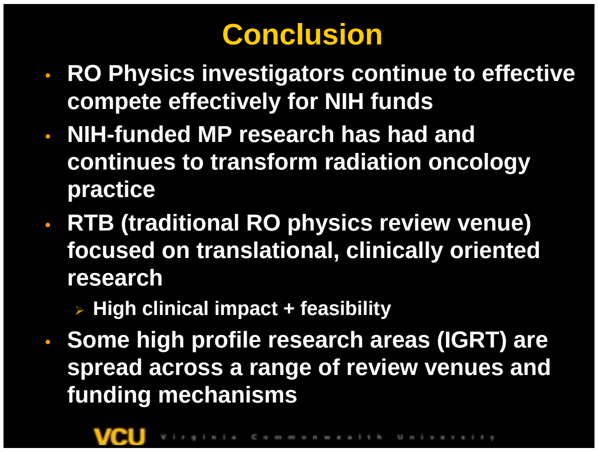
- Grant review process is profoundly conservative
  - NIH wants novelty and high-gain, high-risk , game-changing projects
  - Also very risk-averse: must convince reviews that RP is achievable as well as having high clinical impact
- General suggestions
  - Build on preliminary data: focus on experimental design, not on explaining specialized tools
  - Showcase your analytical skills and scientific ingenuity
  - Acknowledge/ difficulties, competing approaches & anticipate potential failures
    - Turn potential weaknesses into interesting hypotheses

Will new review format diminish risk adverseness?

Score	Descriptor	Additional Guidance on Strengths/Weaknesses
1	Exceptional	Exceptionally strong with essentially no weaknesses
2	Outstanding	Extremely strong with negligible weaknesses
3	Excellent	Very strong with only some minor weaknesses
4	Very Good	Strong but with numerous minor weaknesses
5	Good	Strong but with at least one moderate weakness
6	Satisfactory	Some strengths but also some moderate weaknesses
7	Fair	Some strengths but with at least one major weakness
8	Marginal	A few strengths and a few major weaknesses
9	Poor	Very few strengths and numerous major weaknesses

Minor Weakness: An easily addressable weakness that does not substantially lessen impact
Moderate Weakness: A weakness that lessens impact
Major Weakness: A weakness that severely limits impact

- New criteria still emphasize weaknesses


Conclusion
• RO Physics investigators continue to effective compete effectively for NIH funds
• NIH-funded MP research has had and continues to transform radiation oncology practice
• RTB (traditional RO physics review venue) focused on translational, clinically oriented research
➢ High clinical impact + feasibility
• Some high profile research areas (IGRT) are spread across a range of review venues and funding mechanisms
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