POINT/COUNTERPOINT

Suggestions for topics suitable for these Point/Counterpoint debates should be addressed to Colin G. Orton, Professor Emeritus, Wayne State University, Detroit: ortonc@comcast.net. Persons participating in Point/Counterpoint discussions are selected for their knowledge and communicative skill. Their positions for or against a proposition may or may not reflect their personal opinions or the positions of their employers.

All graduate medical physics programs should have an original research component

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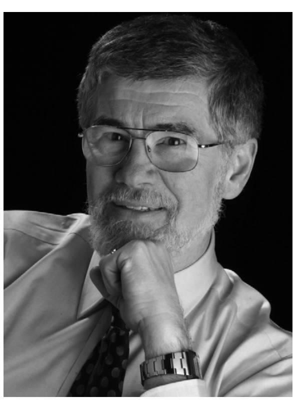
OVERVIEW

With the rapid rise in the number of medical physics residency programs, most of which provide no opportunity to do research but, instead, deliver intensive clinical training, there is a fear that most M.S.-level physicists entering the field will have done so without any exposure to research. This, along with the threat of emerging Doctorate in Medical Physics programs that have little or no research requirements, has led some to question whether it is appropriate for medical physics graduate programs to allow students to graduate with no research experience. This is the topic debated in this month's Point/Counterpoint.



Arguing for the Proposition is David W. O. Rogers, Ph.D. Dr. Rogers received his Ph.D. in experimental nuclear physics from the University of Toronto in 1972. After a postdoctoral fellowship in Oxford, he joined the National Research Council (NRC) in Ottawa in 1973 in what is now the Ionizing Radiation Standards Group. At the NRC, Dr. Rogers headed the radiation dosimetry program until he took up a Canada Research Chair in Medical Physics in the Physics Department at Carleton University in 2003. Dr. Rogers has served on numerous committees and Task Groups in the AAPM, including the Board of Directors, and is currently a Deputy Editor of *Medical Physics*. As program Director of the Medical Physics program at Carleton University, he has supervised 15 graduate students and 17 research associates. He received the William D. Coolidge Award in 2010 for his contributions to medical physics.

Arguing against the Proposition is Janelle A. Molloy, Ph.D. Dr. Molloy obtained her Ph.D. from the University of Virginia in 1990 and subsequently worked in the Department of Radiation Oncology, University of Virginia, Charlottesville, where she attained the level of Associate Professor. In 2008, she moved to the Department of Radiation Medicine, University of Kentucky, Lexington, where she is Director of Medical Physics and of the Medical Physics Graduate Program. Dr. Molloy has served on numerous committees and Task Groups of the AAPM, including the Board of Directors, and is the current Treasurer. She has served on CAMPEP since 2002, where she is a member of the Residency Education Program Committee.

FOR THE PROPOSITION: David W. O. Rogers, Ph.D.

Opening statement

This debate is really about whether or not all medical physicists should be expected to do research, a question that is not new.[1,2] The answer is that they must do research or our profession will die out and our nonresearch oriented clinical roles will be filled by technicians who are paid much less. If I can convince you of this argument, then it becomes obvious that all graduate medical physics programs must have an original research component—how else are upcoming medical physicists going to learn how to tackle a research problem? Research is a skill and an attitude, which is only learned by doing.

Medical physicists have created almost all of the major advances in radiation oncology and in imaging for medical diagnosis and intervention. This historical fact means that medical physicists have been recognized as an essential part of radiotherapy and imaging teams. As the equipment becomes more and more complex, it is tempting to think that only highly skilled and very highly paid medical physicists can keep the equipment running smoothly. This is self-delusion. I recently reviewed a university BSc program for radiation technologists and these students were very well educated, learning lots of Physics, Mathematics, and Statistics as well as getting all sorts of hands-on experience with clinical equipment (e.g., their laboratory had a dozen Pinnacle treatment planning systems and they spend many months in clinical placements—sounds like some Medical Physics MSc programs). This is the future. As the equipment gets more and more complex, it will become more and more automated, as well as more and more amenable to highly skilled technicians handling it well.

So, what is the role of a clinical medical physicist going to be if it does not include doing research? Certainly, many highly paid medical physicists do no research today—but the high pay came about because of the historical role of medical physicists as researchers and will not continue without on-going research.

The research I am talking about for clinical physicists will not necessarily change the world—not everyone can develop a new treatment technique or a new class of imager. However, useful research can be as incremental, but nonetheless complex, as investigating how well some new technology works (not just running the standard acceptance tests), finding new and different ways to use the technology, or demonstrating the effectiveness of a new way to do routine tasks. Perhaps this research will not lead to publications, but it should lead to interesting presentations at conferences. This is real research, and the only way to learn how to tackle a research problem is to struggle with a significant problem as part of one's graduate training.

Mark my words, if we do not regain the attitude that medical physicists are also researchers, our role in clinical practice will slowly erode, and no amount of job protection via licensure and other quasi-union means will protect our high paying jobs since they will be taken over by the upcoming generation of highly trained and competent technologists who are significantly less costly to the health care system.

If we must do research in our clinical practice, and if we have not learned how to do it by having a substantive original research component in our graduate programs, when are we going to learn it?

AGAINST THE PROPOSITION: Janelle A. Molloy, Ph.D.

Opening statement

Medical physics graduate programs must be allowed to focus their training in a way that is consistent with their strengths and resources. I am therefore opposing the proposition so that programs that focus on clinical training can educate their students in an effective and efficient manner.

Research training does not possess a monopoly in terms of teaching critical thinking or instilling intellectual courage. Appropriate clinical education will teach these higher cognitive capacities but, in addition, it will yield specific technical skills and directly relevant experience. For example, it is not infrequent for quality assurance tests to return results that fail the acceptance criteria. Resolution of such situations requires understanding of the characteristic behavior of subsystems, critical thinking, context-appropriate judgment, and prioritization. Within this context, all of the skills traditionally credited to research training are taught but, in addition, students acquire valuable experience in many others aspects of clinical medical physics that will be directly applicable in their careers.

We must not disparage the teaching of specific and useful technical skills in favor of vague "critical thinking." A clinical physicist must possess very specific technical skills in order to function effectively. Those who lack this knowledge will have limited value in a clinical setting. We should consider the acquisition of specific technical skills as a necessary but not sufficient condition of medical physics education.

The medical physicist is the person tasked with safely applying technologies that have been commercially developed. This is not science. For example, commissioning a new treatment planning system is, by necessity, an exercise in "black box" testing.[3] Detailed knowledge of the source code and specifics of the algorithm flow are impossible to obtain due to complexity, proprietary concerns, and time constraints. Knowledge of the theoretical calculation algorithms is necessary, but the skill required for this is more similar to that of a diligent student rather than that of an independent researcher.

The mindset required to properly implement new clinical technology requires diligent consideration of failure modes and human factors.[4] In a laboratory experiment, it is sufficient to simply get the equipment working long enough to collect data. This is insufficient in a clinical setting, where the *robustness* of the technical and human systems is of paramount importance. Medical physicists must recognize likely failure points and develop robust QA strategies. These are skills that are typically not acquired during focused research training.

There is, however, significant overlap between clinical practice and research. Perhaps both supporters and opponents of the proposition have much in common. Scholarly activities are abundant in the clinical environment. For example, implementation of new radiation treatment modalities is often accompanied by comparisons of new treatment plans to those using conventional methods. The exercise of collecting these data and drawing conclusions could be considered science or it could be considered clinical practice. Regardless, I believe that all medical physics graduate programs should prepare their students to engage in such activities. However, I believe that the best way to do this is to mentor students through the resolution of authentic and timely clinical problems.

Rebuttal: David W. O. Rogers, Ph.D.

I agree with most of what my opponent has said. However, in almost every instance, one could replace "medical or clinical physicist," with "new generation of radiotherapy technician" and it would be applicable. This observation is the underlying threat to our profession. Without an emphasis on the research nature of our profession, it will surely decline. Without a significant original research component in our graduate medical physics programs, the next generation of medical physicists will not be researchers.

It is the role of the soon-to-be-mandatory residency programs to ensure that a minimum set of "specific technical skills" are acquired. This is not the role of the graduate programs which should ensure a broad base of knowledge and teach how to do research. At the same time, it must become mandatory that research be part of all residency programs since we must make clear to all entry-level physicists that research is an essential part of clinical practice. In addition, a 2-year break from research during residency would mean the research edge is lost forever. If one feels there is not enough time for research during training, then this is again delusion. There can never be enough time to learn all the specific skills of a medical physicist in a 2-year residency. Maintaining research capability is certainly as important as the skills missed, since research capability implies an ability to continuously learn the skills needed, either those missed in training or the new ones invented the day after the residency is completed.

To summarize the stature of medical physics as a profession is based on our research contributions, and unless we maintain these research contributions, the profession as we know it will die out because we are so costly to the health care system. If we are to continue with research, it is essential that research be a significant component of all graduate medical physics programs.

Rebuttal: Janelle A. Molloy, Ph.D.

Mindless technical practice as the only alternative to research is an unfounded assertion. Clinical medical physicists provide value that a technician cannot. Moreover, research performed in the clinical setting is a luxury that compromises our ability to address important clinical issues.

Dr. Rogers asserts that the value clinical physicists enjoy is based on their indirect association with researchers. We work in an unforgiving, market-driven economy. Medical physicists receive high salaries because we provide services that require a unique skill set. We provide a deep understanding of physical and technical processes so that these processes can be applied over a wide and appropriate range of scenarios.

Physics education, more than research, is responsible for our clinical success. Physicists are trained to understand basic principals over memorization, to scrutinize the behavior of systems, and to think critically. Physicists are intelligent and have a strong work ethic. These are attributes that are correlated with, but not caused by, research training.

The educational standards for our profession are progressing. There is an irony, however, in that the more directly relevant the training, the more suspicion is evoked in terms of its intellectual integrity. We are concerned that the farther we move away from "real" physics backgrounds, the more our brand equity will degrade.

Our practice requires some repetitive data collection that, in fact, could be delegated to technicians. We must not assume however that the ability to efficiently perform these tasks degrades our ability and willingness to think. We will not be skilled problem solvers if our understanding of the equipment we use is theoretical. The clinically valuable physicist is one who is fluent with the details of specific technologies and who can lead a treatment team through clinical problem solving. This is not research; it is the practice of clinical medical physics.

[1]G. Gagliardi, "The role of the radiotherapy physicist." ESTRO Newsletter #76, 34–36 (Summer 2010).

[2]H. I. Amols, F. Van den Heuvel, and C. G. Orton. "Radiotherapy physicists have become glorified technicians rather than clinical scientists," Med. Phys. **37**, 1379–1381 (2010).

[3]B. Beizer, *Black Box Testing: Techniques for Functional Testing of Software and Systems* (John Wiley & Sons, New York, 1995).

[4]AAPM Task Group Report, "Method for evaluating QA needs in radiation therapy: Report of Task Group 100 of the Radiation Therapy Committee of the American Association of Physicists in Medicine" (in preparation).