POINT/COUNTERPOINT

Suggestions for topics suitable for these Point/Counterpoint debates should be addressed to the Moderator: William R. Hendee, Medical College of Wisconsin, Milwaukee: whendee@mcw.edu. 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.

The growth of biomedical engineering is a major challenge to medical physics

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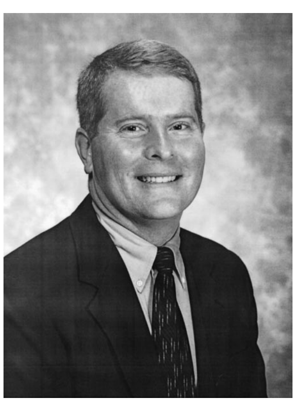
OVERVIEW

Educational programs in biomedical engineering are rapidly establishing and growing, in large measure because of funding from the Whitaker Foundation and National Science Foundation. In these programs, the most popular instructional track is imaging. Some diagnostic physicists feel that this pipeline of imaging-trained biomedical engineers is a major challenge to physicists in imaging. Others think that this influx of engineers is an opportunity that should be capitalized on. This difference in perspective is the subject of this month's Point/Counterpoint.



Arguing for the Proposition is Randell Kruger, Ph.D. Dr. Kruger is the Medical Physics Section Head in the Radiology Department of the Marshfield Clinic. Dr. Kruger received his Ph.D. from the Medical College of Ohio and completed a post-doctoral medical physics residency at the Mayo Clinic. Prior to his doctoral program he earned a master's degree in mechanical engineering from Arizona State University. He has seven years of engineering work experience with the U.S. Air Force and Allied-Signal, Inc. He is certified in Diagnostic Physics by the ABR and is president of the North Central Chapter of the AAPM.

Arguing against the proposition is Bruce Curran, ME, MS. Mr. Curran received his Masters Degrees from Dartmouth College (Engineering Science-Biomedical Engineering) and Northeastern University (Computer Science). He is Clinical Assistant Professor of Radiation Oncology at the University of Michigan and responsible for clinical physics within the Department of Radiation Oncology. He currently serves as chair of the Meeting Coordination Committee of the AAPM and co-chair of a task group on clinical implementation of Monte Carlo dose calculations. He is a fellow of the AAPM and the ACMP.

FOR THE PROPOSITION: Randell L. Kruger, Ph.D.

Opening Statement

Can an engineer become a medical physicist? I am a personal testimonial that engineers can and do migrate into medical physics, after receiving the proper educational and clinical training. During the 2003 AAPM Annual Business Meeting in San Diego the topic of changing the academic requirements for AAPM membership was discussed. The proposed amendment adds two words to ARTICLE IV, Section 4 of the Bylaws—they are ("or Engineering" added to the existing text of Physical Science). This change would add engineering degrees to the criteria for AAPM Membership eligibility. The motivation for the change is the need to create consistency between current practice and the bylaws.

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However, some diagnostic medical physicists are concerned that imaging-trained biomedical engineers would challenge the role of, and seek to replace, the diagnostic medical physicist.

The clinical and research applications of medical imaging in bioengineering have contributed to the explosive growth of biomedical engineering jobs.[1–3] Of the more than 100 college and university programs that offer academic programs in biomedical engineering, more than half offer imaging educational or directed-research programs.[1] Significant job growth and interest in biomedical imaging has been accelerated with the lure that ''all teaching hospitals, have a growing need for bioengineers trained in imaging methods.''[2] The U.S. Labor Department's Bureau of Labor Statistics projects that the number of biomedical engineering jobs will increase by 31.4 percent through 2010.[1] Are all of these imaging-trained biomedical engineers planning to work for industry or in research? The National Institutes of Health Bioengineering Consortium provides a definition of bioengineering, which does not include the word ''imaging'' anywhere in its 59-word statement.[4] Yet the rapid development of a biomedical imaging curriculum and career field in biomedical engineering indicates a shift in focus of the biomedical community.

The roles of the medical physicist in diagnostic imaging have been well documented and comprehensively defined by the AAPM, the American College of Radiology (ACR), and the European Federation of Organisations for Medical Physics.[5–7] These organizations have described and defined the diagnostic medical physics professional role, and the practice, training, and qualification requirements in the field. A primary responsibility of the diagnostic medical physicist is the development and supervision of a quantitative quality control program. However, the diagnostic medical physicist has several other responsibilities and duties (such as: radiation safety; compliance activities; radiobiological, shielding and equipment evaluations; educational activities; and research, to name just a few). An imaging-trained biomedical engineer is not prepared or trained to perform these duties and responsibilities. Most members of the biomedical engineering and medical physics communities understand the differences between a diagnostic medical physicist and a biomedical engineer. The concern is that other members of the medical community might assume (or be misled to understand) that an imaging-trained biomedical engineer can perform the duties and responsibilities of a diagnostic medical physicist. This would jeopardize the quality of diagnostic imaging services provided to the medical facility and its patients.

Rebuttal

I agree with my colleague that medical physics is an applied branch of physics that deals with the application of physical principles to the diagnosis and treatment of human disease.[8] However, I disagree with his statements that link engineers and medical physicists. The logic he employs to support the equivalence of biomedical engineering and medical physics is flawed.

Medical physics is a focused field of study that requires clinical training or preceptorship. Biomedical engineering is a broad interdisciplinary field of study with little or no clinical training. A description of biomedical engineering provided from a large state university biomedical engineering department[9] states ''the Biomedical Engineering Graduate Program is an interdisciplinary program designed to provide broad familiarity with the interactions among the engineering, biological and medical sciences and in-depth training in one of the traditional engineering disciplines.'' Medicine in general is an application of science to the treatment of human disease and health, and its practitioners are educated and trained specifically for expertise in their field. It appears my colleague proposes an exception to this rule for biomedical engineers. Medical physics is significantly influenced by the technological advances, as is all of medicine. An individual with broad familiarity would lack the specific training and experience necessary to provide the required clinical services.

I think it is important to consider the fundamental factors driving this issue. The Whitaker Foundation's funding has significantly accelerated and expanded educational programs in biomedical engineering. The expansion of biomedical engineering into medical imaging, interestingly, comes at a time when the medical physics profession is experiencing a shortage of practitioners and a limited number of training programs. Donald Frey's statement[10] ''one of the more serious problems facing the profession of medical physics is the shortage of practitioners'' highlights this problem. The laws of supply and demand cannot be ignored.

Can an engineer become a medical physicist? The answer is yes, provided he or she obtains the proper academic preparation and clinical experience.

AGAINST THE PROPOSITION: Bruce Curran, ME, MS

Opening Statement

According to the AAPM, medical physics is ''an applied branch of physics concerned with the application of the concepts and methods of physics to the diagnosis and treatment of human disease.''[11] This definition focuses on the application of training and experience to the diagnosis and treatment of patients. There are few (if any) medical physicists engaged in pure research without thought to its future implementation, which distinguishes us from many of our colleagues engaged in more theoretical branches of physics (defined, at least from one source, as ''the science of matter and energy and of interactions between the two,...'').[12] An interesting observation on these definitions is that, for many universities, education in the field of ''Applied Physics'' often appears under the domain of the College of Engineering.[13]

Appropriate to this discussion is a look at the profession of engineer. One dictionary defines an engineer as ''one who is trained or professionally engaged in a branch of [engineering] the application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.''[12] Since physics is clearly a member of the sciences, it appears that engineers are individuals who can also be considered to be involved in the application of physics to the solution of a certain class of problems such as the diagnosis and treatment of human disease. It would thus seem that, with a slight twist on the origins of the phrase, ''We have met the enemy and he is us.''[14]

For the majority of medical physicists today, technological advancements in imaging and therapy have led to a new role for the medical physicist, namely that of manager of the complex equipment necessary to our profession. We are no longer expected only to understand how different radiations interact with materials and patients. Today, physicists must also be knowledgeable about computer systems, networks, and the myriad of new technologies essential to current clinical practice. The influx and influence of individuals with advanced training that includes an in-depth understanding of the technology itself is helpful, perhaps even necessary, to effectively carrying out our duties, as well as advancing state-of-the-art patient care. A collaborative environment that includes professionals with skills both in physics and engineering appears to be the best of all worlds.

Patients benefit from having a team of individuals with a broad range of skills available for designing, building, testing, and monitoring the techniques and equipment needed in the practice of medical physics. These skills require significant education, training and experience, and it is unlikely that any single individual will master all aspects. The inclusion of biomedical engineers, with their strengths in equipment and biological/equipment interfaces, in the profession of medical physics will strengthen our profession and allow it to grow. This in turn will improve our stature and acknowledgement as key individuals in the diagnosis and treatment of patients.

Rebuttal

One might as well ask ''Can a theoretical nuclear physicist become a medical physicist?'' The answer of course, is yes, as many of our colleagues can attest. Did their initial education completely prepare them for our field? Probably not. As Dr. Kruger notes, proper education and clinical training is necessary for most individuals entering our field, whatever their educational background.

Does an education in biomedical engineering prepare individuals less well for entering our field? It certainly prepares them differently. A biomedical engineer specializing in biomechanics would be no more suitable for clinical practice than the theoretical nuclear physicist. A review of the course offerings in a biomedical engineering program reveals courses in anatomy, instrumentation, physiology, radiological health, imaging (radiation, MR, optical), and medical imaging systems,[15] all appropriate to our profession.

So how do we ''separate'' those engineers (and physicists) not appropriately qualified to practice medical physics from those who are? Ideally, the certification/licensure process would ensure that only qualified individuals attain the title of medical physicist. The reality is, however, that many individuals are given the title long before they acquire the skills necessary for practice. This is mostly a result of history; the small number of educational programs in medical physics, the lack of appropriate residence and training programs that give us the time to acquire needed skills before certification, and the rapid increase in the need for properly trained professionals in our profession.

Medical physics as a career will continue to attract a polyglot of engineering and scientific professionals. It offers the alluring combination of interesting, challenging problems, the satisfaction of helping humanity, and good salaries and benefits. The incorporation of such diverse backgrounds has helped to keep the field fresh and innovative. We should continue to encourage entry into medical physics of persons with diverse backgrounds, while striving to improve the processes by which we identify those individuals who have earned the title of medical physicist.

[1] www.whitaker.org
[2] http://summit.whitaker.org/white/imaging.html
[3] http://summit.whitaker.org/white/basic.html
[4] www.becon.nih.gov/bioengineering_definition.htm
[5] www.AAPM.org
[6] www.ACR.org
[7] The European Federation of Organisations for Medical Physics (EFOMP) Policy Statement Number 5, ''Departments of Medical Physics—advantages, organization and management,'' Physica Medica **XI**(3), 126–128 (1995).
[8] ACR Guide to Medical Physics Professional Practice, http://www.acr.org
[9] www.whitaker.org/academic/database/index.html (search under: University of Minnesota)
[10] January/February 2004 AAPM Newsletter
[11] www.aapm.org/org/aapm_fact_sheet.html
[12] The American Heritage® Dictionary of the English Language: Fourth Edition, 2000.
[13] www.engin.umich.edu/departments/
[14] Walt Kelly, Earth Day Poster, 1970.
[15] http://www.engin.umich.edu/students/current/academics/courses/biomed.pdf