Radiotherapy and Oncology 114 (2015) 285–288

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Editorial

The research versus clinical service role of medical physics

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Medical physicists working in radiotherapy departments in hospitals are often facing a challenge in balancing their time and efforts between clinical demands in routine practice and their ambitions toward research and development of the field. This dilemma is certainly not unique to medical physics, but it may be accentuated in our field because of the contrast between physics as a scientific discipline, and the clinical realities in a hospital. The dilemma reminds one of the classical dilemma in Goethe's Faust: "Two souls, alas, are dwelling in my breast".

One "soul" of the medical physicist is strictly devoted to guaranteeing the safe and accurate delivery of radiation to patients, including the search for optimal treatment solutions, efficiently solving the associated technical and clinical problems, and ultimately to providing a considerable contribution to the care of cancer patients in close collaboration with radiation oncologists and other professionals.

The research "soul" of medical physicists, on the other hand, is devoted to explore new methods, tools, and models. These endeavors have led to extraordinary innovation and growth, incorporating the intrinsic inter-disciplinary and translational vocation of our discipline. The dramatic evolution of radiation oncology in the last decades was largely initiated and progressed by medical physics [1]. However, this rapid evolution has changed the role and the perspectives of medical physicists over time, putting more and more emphasis on the support of the increasingly demanding complex technologies [2,3]. Today the two cited "souls" of medical physicists appear sometimes competitive and sometimes synergistic, but in many cases they are not clearly enough identified and understood. This paper is based on a symposium dedicated to this issue, organized at the annual ESTRO meeting held in Vienna in April 2014 in collaboration with the American Association of Physicists in Medicine (AAPM) and the European Federation of Medical Physics (EFOMP). The aim of the paper is to convey and synthesize the perspectives shared in this session.

Harmonization of the medical physics profession within Europe

The standing of medical physicists both as researchers and as clinical service providers is highly variable across the globe, particularly within Europe. In Europe, EFOMP has worked toward the harmonization of the medical physics profession, issuing several policy statements, providing recommendations on the roles of the medical physicist and promoting it as a Regulated Health Care Profession [4]. Despite pressure from EFOMP and the recent Directives 2005/36/EC and 2013/55/EC related to professional qualifications [5,6], the medical physicist has not yet been included in a formal recognition process in many European countries.

The implementation of a robust educational track is an essential foundation to the path toward recognition and accreditation of medical physicists within Europe: in line with this, EFOMP and ESTRO developed a Qualification and Curricular framework based on the Bologna Process [7]. Despite the existence of this powerful harmonization tool, a recent survey still revealed a lack of professional recognition within the medical physics community. There seems to be a dichotomy between medical physicists as professionals applying science in healthcare "having a role in research and development of new methodologies" [8] and a widespread feeling to be mainly involved in technical support.

The changing professional role of medical physics in the US

In the United States, the American Board of Radiology (ABR) certification requirements for medical physicists have had a profound impact toward tightening of both the professional role and the research role of medical physicists. Compliance with the ABR certification requirements is overseen by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP), and now training from a CAMPEP-accredited medical physics program is compulsory to obtain ABR certification.

These requirements have triggered a chain of events, ranging from detailed specification of the professional training requirements, establishment of a number of Doctorate of Medical Physics (DMP) degree programs and creation of new residency training

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http://dx.doi.org/10.1016/j.radonc.2015.02.003

programs. While all these changes are welcome developments to better define the clinical service role of medical physics in the United States, they have at the same time a number of negative implications on the research role of medical physics.

Trends in medical physics research

The major general trends in the biomedical sciences, such as inter-disciplinary approaches, translational research as well as personalized medicine, are all very relevant for medical physics, and are likely to influence also the research medical physicists will perform in the future. First, medical physics is by definition *inter-disciplinary*, representing a merging of two different academic disciplines, in an interaction between exploratory and confirmatory research. Today medical physics mostly relates to radiation oncology, radiology and nuclear medicine, but should connect also outside of these domains [1,2,9]. The concept of 'converging sciences' has been branded as the 3rd revolution in biomedicine [10], referring to the creation of new research areas/activities through joining different disciplines (e.g., neuroscience and genomics), breaking out of the traditional research/professional boundaries.

Second, medical physics also has a strong *translational* tradition, transferring physical concepts into clinical applications [1]. Although parts of this translation are being taken over by industry, there is still a large potential for medical physics research in this direction, exploiting the strong support of academia-industry collaborations in research programs.

Third, radiotherapy is already a highly *personalized* medical discipline, and medical physics is a driving force in this direction [11]. The field of predictive outcome modeling in radiotherapy would be one example in this context, progressing from conventional radiobiological modeling to complex decision-support systems. Using patient-specific, biologically relevant parameters and an adaptive loop of data collection and model application, such predictive models are likely to play an important role in establishing clinical evidence (complimentary to randomized trials) with the continuing evolvement of radiotherapy.

In a more general sense, the physics approach to science (describing nature through models) has great potential in bio-medical research beyond conventional medical physics areas, helping to secure the further growth of our profession [12,13], exemplified by the work of the physical sciences in oncology centers (PS-OC) of the National Cancer Institute in the United States [14].

Medical physics in Europe between research and clinical service

The tasks that medical physicists perform during clinical service in hospitals are becoming more and more complex, and the safe management of the increasingly complex tasks that medical physicists perform during clinical service in hospitals is essential for the intended clinical outcome of radiotherapy. Although this represents a clinical service, the highly demanding and skilled work of the medical physicist is largely unrecognized; medical physics departments are often considered as mainly "support services" and, consequently, insufficiently consulted in many cases, with negative implications such as unwise purchasing decisions, inefficient or even hazardous workflows, and a potential increased risk of radiation accidents. Similarly, a strong interaction between academic (medical) physics and clinical medical physics is essential to maximize both the scientific *and* the clinical output of research resources. On the other hand, a better recognition of the role of the clinical medical physicist as clinical scientist by the academic physics world seems to be often still lacking.

Highlights of the discussion

The research and clinical service roles of medical physics – are they inseparable?

Medical physics today faces the two roles between research ambitions and the daily clinical reality. On the one hand, it is deemed important that "*there is a medical physics society that has high scientific standards*". "*We need scientists, we need scientific thinking, we need scientific understanding*". "*Physics is really an academic discipline*". On the other hand, medical physicists are primarily employed by hospitals for their clinical service work, not for doing research (with important exceptions in academic hospitals). However a fundamental part of the service role is to carry out translation/clinical research and service development, to implement new technology and techniques. Incidentally, this is not different from MDs, who basically are employed for treating patients, and not for research. Not only are most medical physicists employed for providing a clinical service, but "*they are in a situation where their funders, their managers, are always increasingly trying to cut numbers, cut resources, cut money* [...] *There aren't enough physicists really to do the clinical service*". "*Basically, there's no time for any research* [*during the day*]". "*You cannot expect that at the end of the day that a person is going to have the courage to start doing research*".

The importance of research training was also re-emphasized. "*I firmly believe that it is unreasonable to ask a clinical physicist to do research if they haven't been trained for it. And that training is called a PhD*". The doctorate in medical physics (DMP), which is being introduced in the United States and elsewhere, is not deemed a good enough basis for an academic career in medical physics by some. "*There is absolutely no doubt that we need medical professional training programs for physicists*". But: "We are losing academic standards if we don't maintain research training as well". Clearly, the research training adds to the time burden for medical physicists wishing to pursue a career both in clinical physics and research.

Based on the observation that it is very challenging to be both a well-versed clinical physicist and an innovative researcher, should the research and clinical service roles of medical physics be separated? Several participants expressed serious concern about this idea. "*I am completely against having that kind of separation*". Most participants who contributed to the discussion were from large academic hospitals and some were concerned that "*it is easy for some of us in academic departments and large departments to say we should all be out there doing research. I think that tends probably to leave a lot of physicists quite depressed*".

How to make medical physics research happen in a busy clinic?

Many constructive suggestions were made on how to find the time, money, and other resources for research, given the clinical realities mentioned above. First of all, what do we mean by research? "*We have to face that as medical physicists we are mainly problem solvers*". It was said that by introducing innovative technologies into the clinic we are doing "service development", or perhaps research "with a small r". "*A lot of pseudo research – and this is not negative at all – is being done currently at hospitals*". Yet, all those activities require measurements, computer simulations, and problem solving skills that are publishable, in addition to being of immense benefit to the clinic. "*I think that there is a very clear underestimation of the value of all those things*". The research "with the small r" has also the added benefit that one can "sell" it to the administration. However, the time horizon of these activities is of the order of only a few years. Those endeavors will not be able to secure a vibrant future to medical physics in the long run.

There were suggestions on how to enable medical physics research "with a capital R" as well. One idea is to collaborate with medical physicists and researchers from other hospitals, universities and industry. Any serious research endeavor requires not only a critical mass of people but time and money. As for the latter, the writing of research grants has unfortunately become less and less promising in recent years. Working with industry is currently perhaps a more promising way to get research money, even though it can be a double edged sword, as will be outlined below. Sabbaticals could be a way to provide the time for research. "*Exchange the medical physicists and give them time to do research outside their own institution, in another institution* [...] *In addition, the other institution can profit from the experience of these people* [...], *AAPM, ESTRO and EFOMP should promote sabbaticals*". Of course, sabbaticals have to be supported by the leadership. "*Heads of department – the more senior people – should be trying to make space for their junior people to be encouraged* [*to do research*]". It should also be understood that research requires a time commitment not only at the department level but also from the individual researcher. There must be a willingness to put in extra hours, which in turn requires a strong desire to get the research done. Overall, at several levels, "*it is really important that we are fighting for research*".

Are we losing the field to the industry?

A highly debated point of discussion concerned the involvement of industry in medical physics research and development. The good news is that "*there is money in industry!*" Different points of view were expressed regarding the benefit of industry involvement. Some felt that medical physicists "*are losing the field*" to the industry. Several potential reasons for this development were mentioned, including that "*we are no longer being educated or trained appropriately to perform in the field*" and that "*right now this process goes to industry because of safety concerns and things like that*...". As a consequence, "*the industry comes in at a much earlier stage and there's a risk that things are being driven by financial interest much more than by clinical interest*".

From another point of view, the question was raised whether "*we should own the field in that sense*" that we can actually lose it. Instead, the relevant question should be: "*are we developing things or is industry developing things ?*", and the answer may be that "*we're developing things*" and that "*the change from 30 to 40 years ago when physicists developed things AND implemented them is a change around regulation and safety*".

Overall it was deemed important that medical physics makes a crucial contribution to the industrial product. The correct and responsible use of our position in suggesting/developing/accepting different products should also critically influence the industrially driven research, while maintaining and defending our independence and intellectual freedom from industry. Obviously, "... *we are not in the right position if our choice is influenced by industrial interests and other aspects*" that do not put the real clinical needs of our patients at the center of research and development.

High-level, high-recognition standing of medical physics in radiotherapy

The presentations raised the problems related to the (lack of) recognition of medical physics and of the huge variation of its profile in different countries. The discussion touched this issue several times. In particular, the need to have the appropriate visibility within "your" hospital/department was mentioned by few, including the persisting asymmetry between physicist and physician ("*many of you don't put at the same level the role of the physician and the physicist*").

Having a high standing, someone said, is crucial for us, "*otherwise, we become a sort of specialized technicians, and we forget about physics!*". With that being said, it was underlined that the recognition of the high-level role of the medical physicists in "your" department should not only depend on the research but should mainly come from the clinical service: "*we can't tell the hospital why they're employing us; they are telling us why they're employing us. They're employing us for safety, for clinical service, etc*...". Although most physicists "*are not employed to do research*", it is also to us to realize that "*we should be doing research*", but "*we've got to be very careful in our arguments to management because there's a spectrum of jurisdiction, there's a spectrum of healthcare systems about what we say we're for*". And, at the end, it is up to us to tell "*other people in the hospital (physicians, administrators) that they need medical physicists*", we should stand up and demonstrate "*to the management that we are fundamental for radiation oncology*".

Final remarks and actions

It is clear that the two "souls" of medical physics, clinical service and research, are indeed inseparable. Without research and development, medical physicists do indeed become "glorified technicians" as has been provocatively stated in a recent point-counterpoint debate [3]; without real clinical goals in mind, medical physics research may tend to explore clinically insignificant problems.

This does not mean that every medical physicist has to be equally versed in both domains. However, it means that medical physics as a field has to nurture both sides and provide opportunities for developing synergies between the two. It means that larger physics groups and hospital departments in particular have to provide opportunities for both clinical service and research in medical physics. It also means that there must be educational tracks and career paths for both research and clinical service oriented medical physics. In the current climate of emphasizing the professional role of medical physics, of board certification requirements and of cutting cost everywhere, there is a big risk that medical physics research will fall over the cliff, which is not acceptable.

There is a clear need to emphasize how much value research and development in medical physics has already added and continues to add to the field. The reasons why radiation oncology has been thriving and will continue to do so are largely due to innovations from medical physics, as clearly pointed in dedicated symposia recently held at the 2014 AAPM [15] and ASTRO meetings.

Medical physics research helps the reputation of its own field as well as radiation oncology in general, by publishing high impact papers: for example, seven of the twenty Green Journal publications with the highest number of citations over the last 5 years (2009–2014) are physics papers (source: ISI Web of Science).

In addition to the importance and inseparability of research and clinical service in medical physics, the second take-home-message is the need to further strengthen the standing of the unified (between research and clinic service) standing of medical physics. For this to happen, medical physicists may have to take a few steps out of their 'comfort zone' (e.g., the dosimetry "niche"), where it is too easy for them to be marginalized. As Dick Fraass said during his acceptance speech for the William Coolidge award [16]: "*The real reason there are medical physicists in a hospital is ..... to solve problems. The hospital needs us because we use (and believe in) the scientific method, approach any problem with logic, do well-designed experiments, use careful data analysis, consider all the possibilities, not just the obvious. Hospitals do not have many people who can do this*." Medical physicists should use their unique skill set to reach out and participate in relevant clinical activities and developments that are of greater and broader interest. One area that will become more important is efficiency and cost reduction: here medical physics can make a great contribution. Medical physicists could and should also be more adventurous in their selection and pursuit of research projects. Several promising research areas were mentioned above, including translational research, modeling, and advanced imaging: highly original and innovative medical physics work with such ambitions are being published in high impact journals such as Nature, Science, and Cell [13].

Without any doubt the goals set out above are very ambitious and require significant dedication from individual medical physicists and from the field as a whole to make progress along those lines. Building networks both within the hospitals and with colleagues across different hospitals will help. To team up with physicians and with the other professions in the field will be essential: the goals of medical physics must be aligned with the overall clinical goals. The ESTRO vision statement [17] provides useful guidance on where the field of radiation oncology is going. Societies like ESTRO, AAPM, and EFOMP can help by providing a supporting framework and by showing opportunities for development. The workgroup FUTURE (Future of Medical Physics Research and Academic Training) of the AAPM has been successful in raising awareness of current issues within medical physics, in particular with respect to research, but also through making connections, building networks, and beginning to work on the solutions. The organization of the symposium on which this paper is based has been triggered in part by efforts of the workgroup FUTURE, and the establishment of similar workgroups in the other societies is under discussion.

Such initiatives are of paramount importance; the efforts are substantial, but the rewards will be great. The opportunities for physicists in medicine, and their contribution to it, are simply enormous.

Acknowledgment

We wish to thank Ms Jocelyn Woods of the Massachusetts General Hospital Boston for the transcript of the discussion at the Joint Symposium and Roundtable ESTRO-AAPM-EFOMP – Future of medical physics in radiotherapy: Academic *vs* professional role, which took place at ESTRO 33 in Vienna, 2014.

References

[1] Bortfeld T, Jeraj R. The physical basis and future of radiation therapy. Br J Radiol 2011;84:485–98.
[2] Jeraj R. Future of physics in medicine and biology. Acta Oncol 2009;48:178–84.
[3] Amols HI, van den Heuvel F, Orton C. Radiotherapy physicists have become glorified technicians rather than clinical scientists. Med Phys 2010;37:1379–81.
[4] Malaga declaration (<http://www.efomp.org/index.php/ct-menu-item-9/87-professionalissues/105-malaga-declaration>).
[5] Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications, OJ L225; 30.09.2005, p. 22.
[6] Directive 2013/55/EU of the European Parliament and of the Council of 20 November 2013 amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System, OJ L354; 28.12.2013, p. 132.
[7] The Bologna Declaration of 19 June 1999 Joint Declaration of the European Ministers of Education <http://www.uka.amu.edu.pl/bologna.html>.
[8] Guidelines on Medical Physics Expert Project TREN/09/NUCL/SI2.549828 Proceedings on the EC International Workshop Seville; May 2011.
[9] NIHs 'Research teams of the future' <http://grants.nih.gov/grants/guide/rfa-files/RFA-NR-14-001.html>.
[10] MIT report; 2011 <http://dc.mit.edu/sites/dc.mit.edu/files/MIT%20White%20Paper%20on%20Convergence.pdf>.
[11] Grau C, Høyer M, Alber M, et al. Biology-guided adaptive radiotherapy (BiGART) – more than a vision? Acta Oncol 2013;52:1233–7.
[12] Tse HTK, Gossett DR, Moon YS, et al. Sci Transl Med 2013;5:a163.
[13] Leder K, Pitter K, Laplant Q, et al. Mathematical modeling of PDGF-driven glioblastoma reveals optimized radiation dosing schedules. Cell 2014;156:603–16.
[14] NCIs Physical Science – Oncology Centers <http://physics.cancer.gov/centers>.
[15] Symposium "Innovation in Medical Physics and Engineering", AAPM Austin; 2014. <http://www.aapm.org/meetings/2014AM/PRAbs.asp?mid=90&aid=25236>.
[16] B. Fraass. AAPM Newsletter 38: No 5; 2013.
[17] Valentini V, Bourhis J, Hollywood D. ESTRO 2012 strategy meeting: vision for radiation oncology. Radiother Oncol 2012;103:99–102.