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Letter to the Editor

On the original article by Ehsan Samei and Thomas Grist "Why physics in medicine" firstly published on the Journal of American College of Radiology (2018)

"Radiology and physics have always had a symbiotic relationship": this is Samei and Grist's article *incipit* [1], and most people in the field would agree with that. There is also a general agreement on the fact that modern[1] medical physics started its development after the discoveries of X-rays and natural radioactivity by the end of the XIXth century, the very same events that started a new medical discipline, presently named radiology.

Even though the title of the article refers to any possible application of physics to medicine, it is actually radiology the medical discipline authors take into consideration as an example for their arguments.

Any medical physicist and perhaps any radiologist should read, and read carefully, this paper published by Samei and Grist in the Journal of the American College of Radiology and now reproduced in this journal with permission of the authors. Each sentence is meaningful and any single word perfectly fits in it thus making its content extremely clear and at the same time smoothly viable towards the reader.

The authors give a consistent view of the relationship between radiology and physics since "the clinical practice of radiology rests on physics foundations, whereas medical physics exists to serve clinical interpretation". That relationship is not the mere result of an undoubtedly mutual interest emerging from the necessity of assuring the quality of radiological equipment but rather relies on a deep cultural symbiotic basis. This is the intellectual standpoint of the authors when they argue about the even closer relationship required by the new trajectories in medicine.

Evidence-based medicine, quantification (closely connected to personalized care) and value-based medicine have already started a new approach to the evaluation of medical practice, thus posing a challenge to any medical discipline, radiology and medical physics first and foremost. Samei and Grist argue to what extent such challenge could turn out in an even deeper and fruitful alliance between the two disciplines because of their intimate synergistic connection capable of effectively reaching the goal or responding to such "overarching new priorities of medicine". In this scenario, an essential step forward is required for medical physics, which has to move from the mere technical evaluation of technologies towards a more and more integrated role in delivering patient care. Consequently, the development of new quantitative metrics overcoming the present ones, based on resolution and noise, is foreseen. Moreover, the article tackles the additional changes imposed by the coming of AI to medicine and particularly to medical imaging as well as the unavoidable need for big data manipulation. Will AI and big data be properly managed by radiologists and medical physicists together in order to avoid the possibility of a drastic reduction in the number of professionals or of becoming radiological diagnosis just a commodity to be bought and sold at the most convenient price on the (global) market?

Those considerations bring to the last point addressed by the authors, that is the funding of radiology and medical physics services within their institution. In general, any service or any good of any kind gains value when its utility is properly recognized. In the lack of proper information about the advantages offered by high-quality, high-safety services, both in terms of patient care and wise investment with equipment acquisition, economic pressures could drive administrators to "opt for the minimum of regulatory compliance". To avoid this step backwards, the authors illustrate a number of conditions to be accomplished to allow the proper recognition of the actual relevance of radiology and medical physics departments within their institutions. It is doubtless true that the reputation of medical physicists as "scientists" able to face and solve complex problems as well as to be an active and flexible part of multi and inter-disciplinary teams (with the rare ability to speak in the meantime the language of clinicians and of technical experts such as computer engineering, data analysts and statisticians) is a pivotal, strong point for Medical Physics in the current, rapidly changing, context. Differently from other figures, such as computer scientists, these peculiarities characterize medical physicists as professionals and scientists merging technical competence and clinical experience, putting them in a unique position to manage and lead the coming AI revolution in radiology, as underlined by a recently published editorial by Sensakovic and Mahesh [2].

The new fields/roles depicted by Samei and Grist deal not only with radiology but may translate to all the main branches of physics applied to medicine. First, the world of medical physics in radiation oncology that is rapidly changing and is expected to accelerate this change thanks to the advancements of AI applications and automation. In this context, the integration of medical physicists in a real "clinical service" is historically strong in radiation oncology and may be considered as a paradigmatic example of how the role of medical physicists and their interaction with the clinical component will change in the future. The debate around these points is quite lively in the radiation oncology community and poses relevant questions regarding the need to update the role of medical physics, extending the actual competences to include AI applications, data analysis and automation [3–8]. Although with various and quite different evolutions, depending on local, regional and national situations (including the recognition and reputation of medical physics and its effective integration in the clinical activities), medical physics is perfectly in the middle of the picture, active and

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[1] To the curious reader eager of acquaintance with the history of "old" medical physics we recommend the intriguing and thought-provoking book "Physicists and physicians: a history of medical physics from the renaissance to Roentgen" by Francis Duck, IPEM 2013.

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strong in leading the AI revolution, especially in the field of planning optimization [3,4], and also in the fields of contouring/segmentation, planning QA, decision support systems and machine QA.

Diagnostic imaging and radiation oncology are not the only fields where medical physics is expected to play an essential role in the near future. Areas such as photonics, augmented reality, non-conventional imaging, therapeutic procedures based on physical principles other than ionizing radiation or targeted drug delivery are also likely to benefit from the support of medical physics. Medical physicists have the potential to help translating to the clinical realm approaches that are increasingly based on mathematical models and basic physical principles. The standpoint of a professional life in the clinic is an asset that medical physicists should leverage on in order to promote and encourage the application of physics to diagnosis and therapy.

Competences already acquired in radiomics – which essentially aims at the efficient extraction of (possibly hidden) information from medical images and quantitative maps – could be the bridge between medical physics and, for example, pathology or other disciplines, which heavily rely on images and spatial distributions of quantitative features.

Optics and photonics will probably represent another fruitful field of cooperation between physicists and clinicians. The recent literature shows a renewed interest in these topics, and the physical interactions and phenomena at the basis of many prospected applications are part of the cultural heritage of medical physicists. The same holds for the use of nanoparticles, nanostructures and in general of agents that partly show a behavior regulated by the laws of quantum mechanics – which is exquisitely the cultural background of physicists. For example, modeling the response of the immune system to drugs and radiation brings into play physics and mathematics.

These new opportunities will probably bring medical physicists close to specialists who are not used to work with them – a challenge as well as a great chance for the future of medical physics.

Despite this, the future is still unknown thus generating fear and uncertainty [2,5,6]; however, the need and the responsibility of medical physicists in guiding the process is indubitable. The way how this will happen is, at least in part, in their hands and will critically depend on their ability to quickly react to the new inputs and on quickly reshaping skills and activities to better face these challenges, suitably expecting actions to better tailor education, professional role and scientific reputation to the new requests.

Time will tell if medical physics will be successful on the variegated fields where it can contribute in driving (or at least supporting) the change, firstly in radiology and radiotherapy: its amazing history suggests that medical physics has always been able to adapt itself to changes and revolutions and our forecast is positive. However, it has to be recognized that current challenges are unique and potentially disruptive of well assessed activities and services: it is up to the whole medical physics community shifting any possible threat into an opportunity, with the firm conviction that the coming revolutions toward personalized medicine (and personalized radiology, radiation oncology, oncology etc.) absolutely needs the contribution of physics.

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