MAR16-2015-020131

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Future Directions in Medical Physics: Models, Technology, and Translation to Medicine[1]

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The application of physics in medicine has been integral to major advances in diagnostic and therapeutic medicine. Two primary areas represent the mainstay of medical physics research in the last century: in radiation therapy, physicists have propelled advances in conformal radiation treatment and high-precision image guidance; and in diagnostic imaging, physicists have advanced an arsenal of multi-modality imaging that includes CT, MRI, ultrasound, and PET as indispensible tools for noninvasive screening, diagnosis, and assessment of treatment response. In addition to their role in building such technologically rich fields of medicine, physicists have also become integral to daily clinical practice in these areas. The future suggests new opportunities for multi-disciplinary research bridging physics, biology, engineering, and computer science, and collaboration in medical physics carries a strong capacity for identification of significant clinical needs, access to clinical data, and translation of technologies to clinical studies. In radiation therapy, for example, the extraction of knowledge from large datasets on treatment delivery, image-based phenotypes, genomic profile, and treatment outcome will require innovation in computational modeling and connection with medical physics for the curation of large datasets. Similarly in imaging physics, the demand for new imaging technology capable of measuring physical and biological processes over orders of magnitude in scale (from molecules to whole organ systems) and exploiting new contrast mechanisms for greater sensitivity to molecular agents and subtle functional / morphological change will benefit from multi-disciplinary collaboration in physics, biology, and engineering. Also in surgery and interventional radiology, where needs for increased precision and patient safety meet constraints in cost and workflow, development of new technologies for imaging, image registration, and robotic assistance can leverage collaboration in physics, biomedical engineering, and computer science. In each area, there is major opportunity for multi-disciplinary collaboration with medical physics to accelerate the translation of such technologies to clinical use.

[1]Research supported by the National Institutes of Health, Siemens Healthcare, and Carestream Health