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PLENARY TALK

Artificial Intelligence-powered Computational Models for Theranostic Digital Twins

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Short bio: Habib Zaidi is Chief physicist and head of the PET Instrumentation & Neuroimaging Laboratory at Geneva University Hospital and full Professor at the medical school of the University of Geneva. He is also a Professor at the University of Groningen (Netherlands), the University of Southern Denmark (Denmark) and Óbuda University (Hungary). His research is supported by the Swiss National Foundation, the European Commission, private foundations and industry (Total 11M+ US$) and centres on hybrid imaging instrumentation (PET/CT and PET/MRI), computational modelling and radiation dosimetry and deep learning. He was guest editor for 14 special issues of peer-reviewed journals and serves as founding Editor-in-Chief (scientific) of the *British Journal of Radiology (BJR)|Open*, Deputy Editor for *Medical Physics* and is on the editorial board of leading journals in medical physics and medical imaging. He has been elevated to the grade of fellow of the IEEE, AIMBE, AAPM, IOMP, AAIA and the BIR. His academic accomplishments in the area of quantitative PET imaging and artificial intelligence-powered multimodality imaging have been well recognized by his peers since he is a recipient of many awards and distinctions among which the *2003 Bruce Hasegawa Young Investigator Medical Imaging Science Award* given by the IEEE, the prestigious (100'000$) *2010 Kuwait Prize of Applied Sciences* (known as the *Middle Eastern Nobel Prize*) and the *2023 John Mallard Award* given by the *IOMP* for innovative developments of high scientific quality. Prof. Zaidi has been an invited speaker of over 250 keynote lectures and talks at an international level, has authored over 492+ peer-reviewed articles (h-index=87, >27'500+ citations) in prominent journals and is the editor of four textbooks.

Abstract: Cancer research is going through a paradigm shift, transitioning towards exploring and treating malignancy as a systemic disease through multi-scale modelling of cancer diagnosis and therapy. Yet, the bulk of research in the field is directed towards understanding the genetic and molecular characteristics of this disease. A holistic approach is adopted through cancer systems biology to comprehend the behavior of malignancies. The role of multimodality precision imaging in the management of cancer patients is well-established. Costly and time-consuming animal testing and human clinical trials are limiting factors in clinical research. A new concept in the field of radiopharmaceutical therapies (RPTs) of cancer, referred to as computational nuclear oncology, involving the use of theranostic digital twins (TDTs) and in silico virtual clinical trials, which is the central topic of this talk, has recently emerged and is expected to result in a major breakthrough in theranostics. Computational models, such as DTs—virtual patient replicas created from but not limited to imaging and clinical data, have emerged as tools to generate synthetic data and simulate radiopharmaceutical kinetics to guide in silico treatment planning. The theoretical foundations and ethical aspects have been described at some level of detail; yet the methodological basis and translational underpinning remain unexplored. Its implications will be far reaching, with substantial potential impact in basic science, clinical practice, and biomedical research.

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