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Nuclear Medicine: The Future in the Modern Healthcare

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At the state of art, the practice of medicine is projected toward a "personalized" approach and to find diagnostic and treatment pathways specific for patient's characteristics and his disease. Disease is defined by relating the patient's genome, body structures, histopathology, and cellular chemistry to specific problems; their manifestations are expressed in units of micromoles/minute/milliliter; diseases are treated by correcting abnormal cellular or molecular processes, and therapeutic drugs are designed by defining illness at the cellular and molecular levels [1]. Molecular imaging is one of the 3 disciplines - with genetics and pharmacology - that woven together to create a new, knowledge-based health care system and is in a key position to bring "personalized medicine" into routine clinical practice [1]. The success of molecular imaging is supported by its diversity of imaging technologies and expertise and in integration of imaging modalities. We should be careful to avoid confining the patient to a diagnostic box; instead, cellular and molecular dysfunction should be the basis for diagnosis and treatment. Nuclear Medicine has a pivotal role in this process thanks to the continuous and rapid advances in pharmaceutical and instrumental technology. Radiopharmaceuticals reveal the anomalous cells behavior and the technological progress is introducing even more molecules for the study of specific pathways of cells metabolism. Significant technological breakthroughs in imaging hardware and image processing algorithms have been introduced. Recently PET tomography has improved lesion detection capabilities through better contrast and spatial resolution performance. In parallel with these hardware developments, advanced implementations of image reconstruction algorithms have further improved image quality and quantitative performance. Associated developments include spatial resolution modeling, incorporation of prior object information in the reconstruction algorithms, better motion estimation and correction, and improved scatter correction [2]. Multimodality hybrid imaging have accelerated the evolution of Nuclear Medicine thanks to the chance to acquire complementary information and create synergism by data fusion which may be needed to reach a definitive diagnostic conclusion, exclude certain pathologies, or obtain quantitative values and to plan therapeutic procedures and monitor treatment [3]. It is now widely recognized that the merger of information is more efficiently achieved by the hardware approach that utilizes a hybrid design comprising two imaging modalities that are contained within a single device. The advantage of this approach is that the imaging modalities acquire data sequentially while the patient lies on the bed. The introduction of hybrid scanners has led to an expansion of this approach through the rapid adoption of the technology into the clinical arena. Otherwise also the "software-" based approach is a valid method of co-registration. With this approach alignment is achieved by manipulating the acquired data from different devices to achieve the best match; this approach is susceptible to noise and artifacts, but on the other hand it allows better versatility [4]. As demonstrated by PET/CT in the oncology field, hybrid imaging devices, such also as SPECT/CT, are finding widespread acceptance within the clinical environment and some are already contributing to patient care and management [5]. Multimodality imaging is the major area of research today in Nuclear Medicine and the degree of confidence of Nuclear Physicians, needed to interpret the CT portion of PET/CT, should be as much as a diagnostic radiologist. The requirement for training in CT will be strengthened and it need to be included in educational programs. Technological advances, accompanied to pharmaceuticals ones, significantly increases the quality of the procedures and widely expand the application fields.

Nuclear Medicine is the only disciplines that provide for diagnosis and therapy with different radiopharmaceuticals, furthermore it is the unique disciplines to which belongs the concept of "Theranostic", a combination of therapy and diagnostics using the same Biomolecular labeled with different radioisotopes to provide inherently synergistic imaging and therapy; examples include radio peptides such as the somatostatin analogues and PSMA, monoclonal antibodies against CD20, bone scan and metabolic therapy of bone metastases, and radionuclide imaging and therapies using 123I and131I, respectively [2]. This concept strengths the role of Nuclear imaging in the perspective of "Personalized Medicine". Healthcare systems are today confronted with continuing reductions in

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funding while being under societal pressure to maintain high-quality patient care. At the same time, the incidence of cancer, cardiovascular diseases and chronic illnesses rises with the progressive ageing of the population, and the coming decades will see increases in the number of patients needing care. Molecular imaging is non-invasive, effective and safe for the diagnosis, staging, prognostication and follow-up of many clinical indications. It helps distinguish early responders from non-responders, thus, saving patients from unnecessary treatments, which reduces patient discomfort and side effects. This may be the most effective way to personalize therapy to cut down on the waste of financial resources and to better target therapies in patients with appropriate disease genotype [2]. Despite the funding reduction, we should not forget the economic value of knowledge, which is the most valuable asset we possess. A valid way of combining studies of therapy and diagnosis allows to achieve safer, more effective and less costly results. We can be proud to estate that in the Nuclear Medicine field what has been imagined, has been achieved, but is necessary looking back and thinking forward. Extraordinary changes have come to Nuclear Medicine in only a short time. Until today, positron-emitting tracers have become dominant and accepted as a routine adjunct in clinical practice, SPECT/CT still thrive and is gaining rapidly in use and clinical units and companies have become active and complementary in research endeavors and in some areas of clinical practice.

Considering all these goals, now is necessary developing our competence in all aspects of imaging including chemistry and function, and work proactively for the future by interacting with other specialists more than ever before presenting our unique and always updated approach to the practice of medicine. New opportunities are yet to be for exploring disease and health on a molecular level and speeding novel discoveries from the laboratory to routine clinical use.

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