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EDITORIAL

Molecular imaging for better theranostics

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The ability to "see" has been a clinical necessity. Although the discovery of X-ray sparked the idea of seeing through and inside of our body and propelled the development of modern medicine, it was the advent of molecular imaging that has been driving the ongoing clinical shift toward individualized and precision healthcare [1, 2]. Nuclear medicine techniques, including positron emission tomography (PET) and single photon emission computed tomography (SPECT), enable us to appreciate the complex structural and molecular dynamics that play out in our bodies. The ability to see how drug molecules metabolize, to observe how biological processes progress, and to visualize how cells and organs function is an incredible leap forward in understanding human health and safeguarding it.

As our observations expand, so does our desire to understand. While [^{18}F]FDG PET/CT has become a clinical routine to inform the status of glucose metabolism for diagnosis and staging of cancers, it was not until recently that researchers confirming tumor-recruited immune cells are the true major source of increased FDG uptake [3]. Similar cases are [^{68}Ga]/[^{177}Lu]-PSMA tracers for prostate cancer theranostics; recent evidence has confirmed that these tracers are also good for imaging and treatment of non-prostate cancers such as hepatocellular carcinoma by targeting angiogenesis [4, 5]. Fibroblast activating protein (FAP)-targeted agents are rapidly shaping the clinical management of various kinds of diseases, especially cancers [6, 7]. Meanwhile, massive preclinical studies are being conducted to improve the therapeutic efficacies [8–10]. A similar example goes with C-X-C chemokine receptor 4 (CXCR4)-targeted radiopharmaceuticals [11, 12]. These findings highlight the importance of preclinical imaging research and translational studies in updating our knowledge, guiding better diagnosis and treatment, generating personalized treatment plan, and expanding the current landscape of precision medicine.

To facilitate clearer, deeper, and better molecular imaging, interdisciplinary efforts are called upon. In response to the current shortage of specific imaging tracers, several novel nuclear imaging probes, in the forms of small molecules, peptides, oligonucleotides [13], antibodies [14–16], and antibody fragments, have been developed and evaluated in not only animals but also first-in-human studies. New tracers demand updated theories on "structure-effect" relationships [17], and studies regarding the choice of radionuclides, chelators, linkers, functional groups, molecular modifications, and overall drug pharmacokinetics have been another research hot spot [18]. Other than drug development to see disease lesions clearer, accurate image quantification and reconstruction have been vital in helping researchers and clinicians understand disease progress and underlying mechanisms. Traditional theory on PET and SPECT image spatial-temporal resolution and sensitivity has been challenged by modern techniques. New imaging machines, faster reconstruction algorithms, reconstruction-free PET imaging [19], and the implementation of artificial intelligence (AI) have encouraged deeper research in the fields of nuclear medicine. Total-body PET machine has awed many of us since it undoubtedly shows the potential to change clinical practice and preclinical tracer development. Very recently, scientists reported a newly developed tracing algorithm with the ability of probing one single cell on the whole-body level [20]. Another latest study shows that new imaging methods can differentiate co-administrated PET and SPECT isotopes with excellent image quality and quantification accuracy [21]. In the field of antibody theranostics [14], molecular imaging of pivotal biomarkers on the tumor cells [22, 23] and immune

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cells [24–26] broadened our understanding of the expression spectrum of those biomarkers across the body, facilitated precise evaluation of specific types of cancers, and preliminary enabled better clinical management of those diseases. Meanwhile, exquisite methods and toolbox are being developed for more facile total synthesis [27–29] and labeling of proteins/antibodies [30–32]. Along with the stride in molecular imaging, exciting progress has been made in terms of pre-targeted radioimmunotherapy [33] and targeted alpha therapy [34–36].

These exciting advances across various aspects of preclinical imaging and theranostics encouraged us to organize this collection on "Preclinical Molecular Imaging and Cancer Theranostics." As we celebrate the 50th anniversary of the *European Journal of Nuclear Medicine and Molecular Imaging* [37], we are immensely grateful and humbled for the opportunity to host this collection, gathering opinions from researchers and clinical experts, on the latest development of molecular imaging tracers, theranostic agents, imaging technologies, and clinical translation. Despite we added the attribute "preclinical" in the title, we do welcome submissions reporting clinical evaluation of novel radiopharmaceuticals. Although clinical translation of radiopharmaceuticals should aim to solve unmet clinical demand, preclinical studies are designed to address challenges in various fields. We have carefully selected 35 research articles to include in the collection (https://link.springer.com/collections/ifdgbhigbj) and look forward to receiving exciting and inspiring work on molecular imaging and cancer theranostics enriching the collection. We genuinely believe that, through the power of molecular imaging, our ability to "see" would stand firmly in the realm of cancer theranostics and reach out toward the vast possibilities of medical exploration, on all frontiers, for all of us.

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Declarations

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Conflict of interest The author declares no competing interests.

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