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Advancing Theranostics' Potential for Precision Medicine

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Abstract

Theranostics is a fascinating field of molecular medicine. Theranostic uses targeted pharmaceuticals for both imaging and treating cancer, made feasible by molecular imaging methods like PET and SPECT (SPECT). Patients with cancer may benefit from its ability to identify subgroups that respond to targeted treatment. And doctors admire its achievements and promise to help them manage illnesses more efficiently by matching patients with the most effective medications.

Industry leaders are improving molecular imaging technology and seeking innovative tracers for targeted therapies. They provide access to new drugs and push the limits of molecular imaging using PET/CT and SPECT/CT. New molecular imaging technology provides additional imaging data for processing and AI-powered automated tools and reconstruction algorithms to aid clinicians in making a difficult diagnosis. Theranostics uses molecular imaging to non-invasively evaluate drug uptake, tumor tissue, and therapy response.

With extensive data, theranostic target pairs have been established, confirmed, and successfully used to treat neuroendocrine tumors, lymphomas, neuroblastomas, and, more recently, various forms of the prostate.

Keywords: PET; SPECT; Thranostic; AI

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Introduction

A fascinating area of molecular medicine is theranostics. The theranostic method employs specialized targeted drugs for both imaging and treatment of particular cancer and is made possible by molecular imaging techniques like Positron Emission Tomography (PET) and Single Photon Emission Tomography (SPECT). Patients with cancer may benefit greatly from its capacity to pinpoint disease subtypes that are more likely to respond to targeted therapy. And physicians are applauding its accomplishments and promise to assist them in managing diseases more effectively by matching patients with the therapies that will have the greatest impact on them.

Industry leaders are strengthening the whole molecular imaging pipeline with the development of improved imaging technologies and the ongoing quest for novel tracers for targeted therapeutics. They start by giving access to developing compounds and then keep pushing the boundaries of molecular imaging with technologies like PET/Computed Tomography (CT) and SPECT/CT. New developments in molecular imaging technology provide substantially more imaging data for processing, as well as very sophisticated automated tools and reconstruction algorithms powered by Artificial Intelligence (AI) to support doctors in making challenging diagnoses. Theranostics requires molecular imaging because it enables non-invasive, repeated evaluation of the chemical uptake and characterization of the tumor tissue as well as the evolution of therapeutic response.

Theranostic target pairings have been created, verified, and effectively employed to treat neuroendocrine tumors, lymphomas, neuroblastomas, and, more recently, several types of prostate cancer in this setting of abundant data.

The demand for more diagnostic and treatment combinations to enhance cancer patients' quality of life and results remains high in areas like prostate and other malignancies.

Prostate Cancer Outcomes with Theranostics

Clinically significant prostate cancer frequently has a better prognosis when it is discovered and treated early, before metastasis has taken place, using therapies including radiation and prostate cancer surgery [1]. Prostate cancer, on the other hand, is the fourth-leading cause of cancer mortality in males worldwide and the most often diagnosed male malignancy [2]. Radiation therapy and radical prostatectomy are now the most frequent treatments for prostate cancer, although these options are not always available because of the difficult procedure needed to find tumors. Current prostate cancer screening techniques include blood tests to measure Prostate-Specific Antigen (PSA) or hormone levels [3].

Despite advancements in prostate cancer treatment, certain prostate cancer subtypes, known as castrate- or hormone-resistant, continue to spread even after the patients' hormone levels rise over the predetermined low threshold [4]. Theranostics activities are focused on treating these castrate-resistant, more deadly prostate tumors. The procedure combines a radioactive particle that is injected into the patient with a targeting substance, also known as a ligand, to specifically target the cancer cells.

Prostate-Specific Membrane Antigen (PSMA), which is strongly expressed in more than 95% of prostate malignancies, is one of the new diagnostic and theranostic biomarkers for prostate cancer detection as well as targeted therapies [5] and is a predictive biomarker for prostate cancer [6]. Clinicians keep an eye on the metabolic changes that the tumor experiences as a result of the therapy; these changes serve as a predictor of the chance that the treatment will be effective. Targeting PSMA in theranostics may have an influence on clinical treatment choices and assist identify individuals who would benefit most from targeted therapy.

Based on the findings of the phase III VISION clinical study, the FDA has authorized a novel lutetium-based treatment known as 177Lu-PSMA-617 [7]. Adult patients who have had Androgen Receptor (AR) pathway inhibition and taxane-based chemotherapy for metastatic Castration-Resistant Prostate Cancer (mCRPC) and PSMA positivity are eligible for the treatment. Numerous additional small compounds and antibodies that target PSMA have been created and tagged, including 177Lu, 161Tb, 131I, 90Y, 67Cu, and 47Sc, and are now being investigated in preclinical and clinical trials [8].

Molecular Imaging and Radiopharmaceuticals

With the long-term success of PET imaging biomarker 18F-FDG (FDG) in cancer and recently licensed medicines like 177Lu-PSMA-617, many more diagnostic and theranostic biomarker discoveries are anticipated to acquire clinical approval to promote customized treatments and better outcomes. Clinical interest in novel radiopharmaceuticals grows as molecular imaging technology advances [9]. Producing and distributing these novel tracers to doctors is critical.

Cyclotrons, PET radiochemistry systems, and tracer manufacturing facilities are needed to distribute FDG to many customers or supply a research program with many tracers. Having this assistance helps with clinical scheduling, research methods and distribution needs.

Theranostics will become standard of care when molecular imaging tools such as PET/CT and SPECT/CT are paired with competent doctors to obtain, interpret, and evaluate therapy efficacy. PET imaging may scan the body for therapeutic target expression [10]. Target expression affects therapeutic response. PET imaging probes are predictive biomarkers [11].

Advances in molecular imaging devices and software enhance productivity, test length, and study interpretation. AI and deep learning help classify images. Experts feel that owing to the complexity of molecular medicine, additional training is required to incorporate these techniques into patient care and retain a positive perspective for the future of the specialty and potential in molecular diagnosis and therapy [11].

Theranostics and Precision Medicine's Bright Future

Theranostics is an attractive and quickly developing therapy option for a variety of cancers, such as lymphoma, melanoma, neuroendocrine tumor, and prostate cancer. Nuclear Medicine equipment such as PET/CT and SPECT/CT continue to support clinicians' search for new biomarkers and therapies with data-rich, high-quality diagnostic imaging and image processing tools for tumor characterization and evaluating therapy response. Theranostics approaches, as they are transitioned to the standard of care and more widely accessible, have the potential to successfully improve the management and outcomes of patients affected by many cancers, as well as future possible applications in other clinical areas.

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