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Theranostic potential of Lutetium-177: Characteristics and applications

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The purpose of this paper is to comprehensively describe the characteristics of Lutetium-177 and highlight its significant potential in nuclear medicine in the era of personalized medicine.

Its real-time imaging capabilities empower clinicians to introduce treatments based on individual patient characteristics. This personalized approach not only improves treatment efficacy but also minimizes adverse effects.

With a half-life of 6.65 days and the emission of beta β(-) particles (max = 497 keV), Lutetium-177 stands out as an ideal candidate for targeted radionuclide therapy. The therapeutic range of its beta particles enables precise irradiation of pathological tissues (tissue path length (mean path length = 0.16 mm, maximum path length = 2 mm), presenting a promising avenue for effective cancer treatment while minimizing collateral damage to adjacent healthy cells.

Simultaneously, with the emission of gamma photons (208 keV (11%) and 113 keV 6.4%)), Lutetium-177 can perform accurate imaging, localize lesions, and monitor treatment responses. This dual functionality of this radioisotope encapsulates the essence of theranostics, integrating diagnostic and therapeutic capabilities within a single radionuclide.

The clinical application making it compatible with a diverse range of targeting agents, spanning from peptides to large biomolecules such as monoclonal antibodies. Its chemical attributes, including a small ionic radius (0.86–1.03 Å), facilitate chelation with clinically endorsed bifunctional chelators like DOTA and DTPA.

The biodistribution and pharmacokinetics of Lutetium-177 further enhance its theranostic potential. Demonstrating a high affinity for specific tumor receptors, Lutetium-177 exhibits selective accumulation in cancerous tissues, optimizing therapeutic outcomes and reducing systemic side effects. The chelation adaptability of this radioisotope facilitates the development of various radiolabeled compounds, extending its applications beyond oncology to diverse medical fields, such as neurology and cardiology.

Lutetium-177 based radiopharmaceuticals have significantly transformed the landscape of personalized medicine in nuclear medicine and oncology. However, their successful clinical implementation necessitates a multidisciplinary team approach with comprehensive training on various aspects of radiopharmaceuticals and patient management. Unlike conventional chemotherapy, the clinical use of radiotheranostics can pose additional complexities due to logistical challenges and regulatory hurdles.

As ongoing research continues to unveil new applications for Lutetium-177-based theranostics, its potential continues to evolve. The comprehensive exploration of its theranostic capabilities is underway, holding considerable promise for advancing medical science and improving patient outcomes.