

Radiopharmaceuticals

Transforming Precision Medicine with Targeted Therapies

Dr. Jean Chatellier, PhD (December 2024)

Executive Summary – Radiopharmaceuticals are transforming precision medicine by offering targeted diagnostic and therapeutic solutions. These innovative treatments focus radiation on diseased tissues, minimizing damage to healthy cells. With significant advancements in diagnostics, theranostics, and radionuclide therapies, radiopharmaceuticals are transforming oncology, cardiology, and neurology. Despite challenges like isotope supply constraints and infrastructure costs, the field is poised for exponential growth, driven by strategic investments and cutting-edge research.

Introduction – Radiopharmaceuticals are at the forefront of a paradigm shift in medicine, enabling highly targeted treatments and diagnostics that were unimaginable a few decades ago. Imagine a cancer treatment that delivers radiation directly to a tumor, sparing the surrounding healthy tissues. This is not science fiction but the reality radiopharmaceuticals offer today. The global radiopharmaceutical market, valued at \$6.8 billion in 2024, is projected to nearly triple by 2035, underscoring its immense potential. This article delves into the history, advancements, and future of this transformative field.

What Are Radiopharmaceuticals? – Radiopharmaceuticals are drugs that incorporate radioactive isotopes for diagnostic or therapeutic purposes. These molecules bind to specific receptors or biomolecules, enabling precise imaging or treatment. They can be categorized into:

- **Diagnostics:** Radiopharmaceuticals are used in imaging techniques like Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) to detect diseases at their earliest stages.
- **Therapeutics:** Targeted radionuclide therapies deliver radiation directly to disease sites, such as tumors, offering localized and highly effective treatments.
- **Theranostics:** This innovative hybrid approach combines diagnostics and therapy, enabling a "see and treat" model where real-time imaging guides personalized treatment plans.

Historical Context and Development – Radiopharmaceuticals have a rich history rooted in the discovery of radioactivity by Henri Becquerel and subsequent work by Marie and Pierre Curie in the early 20th century. Their development reflects a trajectory of scientific and technological innovation:

- **1930s:** Artificial radioisotopes like iodine-131 and phosphorus-32 introduced targeted therapeutic applications.
- **1950s:** Technetium-99m revolutionized diagnostic imaging, becoming the cornerstone of nuclear medicine.
- **1970s–1990s:** Advancements in PET and SPECT imaging established radiopharmaceuticals as essential diagnostic tools for cancer, heart disease, and neurological disorders.
- **2000s:** Targeted radionuclide therapies emerged, enabling precise delivery of cytotoxic radiation to tumors.

- **2010s:** The rise of theranostics, integrating imaging and treatment, marked a new era of personalized medicine.

Today, radiopharmaceuticals are experiencing a renaissance, driven by cutting-edge isotopes like actinium-225 and lutetium-177, increased research funding, and advancements in molecular biology.

Industry Momentum and Key Investments – The radiopharmaceutical sector is growing rapidly, with the global market valued at approximately USD 6.8 billion in 2024 and projected to reach USD 19.0 billion by 2035, reflecting a compound annual growth rate (CAGR) of 9.8%. Recent high-profile investments highlight the industry's momentum:

- **Bristol Myers Squibb and RayzeBio:** Bristol Myers Squibb acquired RayzeBio for \$4.1 billion. RayzeBio's lead candidate, RYZ101, is in Phase 3 trials for neuroendocrine tumors and may become the first actinium-225 (Ac225) approved drug.
- **AstraZeneca and Fusion Pharmaceuticals:** AstraZeneca acquired Fusion Pharmaceuticals for \$2.4 billion, focusing on next-generation radiolabeled conjugates (RDCs).
- **Sanofi and OranoMed:** Sanofi invested \$300 million for a 16% stake in OranoMed to develop new radiopharmaceutical cancer treatments, valuing OranoMed at €1.9 billion.
- **Novartis and Mariana Oncology:** Novartis acquired Mariana Oncology to enhance radiopharmaceutical capabilities, with an upfront payment of \$1 billion and up to \$750 million in potential milestone payments, totaling \$1.75 billion.
- **Eli Lilly and Radionetics Oncology:** Collaboration to develop small molecule GPCR-targeted radiopharmaceuticals for solid tumors, involving a \$140 million upfront payment and an exclusive acquisition right for \$1 billion, totaling \$1.14 billion.
- **Full-Life Technologies and SK Biopharmaceuticals:** Collaboration to develop a radiopharmaceutical for treating multiple solid tumors, valued at \$571.5 million.
- **Siemens Healthineers and Novartis:** Siemens Healthineers purchased part of Novartis' radioactive chemical production business for €200 million, bolstering its capabilities in cancer imaging.

Applications in Novel Therapies – Radiopharmaceuticals have diverse applications across healthcare:

- **Cancer Treatment:** Targeted radionuclide therapies are particularly effective in treating neuroendocrine tumors and metastatic prostate cancer by delivering precise radiation to cancer cells.
- **Early Diagnosis:** PET and SPECT imaging enable the detection of conditions like cancer, Alzheimer's disease, and heart disease at their earliest and most treatable stages.
- **Theranostics:** By combining diagnostic and therapeutic capabilities, theranostic radiopharmaceuticals allow personalized treatment adjustments based on real-time imaging.

Challenges and Future Outlook – Despite their promise, the development of radiopharmaceuticals faces hurdles, including:

- **Isotope Supply:** Limited availability of critical isotopes like actinium-225 and lutetium-177 can hinder production and adoption.
- **Cost and Infrastructure:** High production costs and the need for specialized facilities pose barriers to widespread implementation.

Nonetheless, growing investments, strategic partnerships, and advancements in isotope production signal a robust future for radiopharmaceuticals. They align seamlessly with the trend toward personalized medicine, offering the potential for tailored treatments that optimize efficacy and safety.

Conclusion – Radiopharmaceuticals represent a paradigm shift in medicine, delivering targeted and effective treatments that were once unimaginable. With their dual role in diagnostics and therapeutics, they are poised to redefine healthcare, making diseases like cancer more detectable and treatable than ever before. As innovation continues, radiopharmaceuticals are set to play an even greater role in shaping the future of precision medicine.

Author: **Dr. Jean Chatellier, PhD**
Partner, EVP & Managing Director
KYBORA
Email: jean@kybora.com | Cell/WhatsApp: +33 609 102 105