**REVIEW ARTICLE ON NUCLEAR MEDICINE**

**Ms. Harsha. K. Donde1, Ms. Archana. D. Kahar2 and Dr. Sachin B. Somwanshi3**

1. Research Scholar, Department of Pharmaceutics, PRES’s, College of Pharmacy (For Women), Chincholi, Nashik, MH,India-422102.

E-mail:dondeharsha@gmail.com

1. Research Scholar, Department of Pharmaceutics, PRES’s, College of Pharmacy (For Women), Chincholi, Nashik, MH, India-422102.

E-mail:archanakatte2018@gmail.com

1. Associate Professor, Department of Pharmaceutics, P.R.ES’s, College of Pharmacy (For Women), Chincholi, Nashik, MH, India-422102.

E-mail:sachinsomwanshi27@gmail.com

**Abstract:**

Over the course of decades, the field of nuclear medicine (NM) has seen both evolutionary and revolutionary changes, mostly due to responsive and dynamic trends in the global manufacture and use of radiopharmaceuticals (RPh), as well as the development of advanced technologies. imaging systems having the ability to quantify images, such as single-photon emission computed tomography/computed tomography [CT], positron emission tomography [PET]/CT, and PET/magnetic resonance. Naturally, as NMRPh progress is made, many important lessons are also learned along the way. To ensure effective communication with the referral medical community and healthcare policymakers, it is felt essential for the NM-RPh community to have list(s) of indications for NM, classified on the basis of value levels, at NM gross level and specific medical specialty-wise, and the corresponding RPh needed. A "NM value matrix" is presented in this regard.

**Keyword**: Nuclear medicine, radiopharmaceuticals, value matrix, clinical advancements, PET-CT, single-photon emission computed tomography.

**Introduction:**

The radiotracer concept, which underlies the use of radionuclides and radiopharmaceuticals to study the body, was originally explained by George de Hevesy, recognized as the "father of nuclear medicine" stability of atoms and molecules. According to the "tracer principle," "radiopharmaceuticals" can be used to explore the system and take part in biological processes in very small doses without changing or disturbing them[1]. The field of nuclear medicine (NM) is unique regarding its intricate cum essential dependence on the use of radiopharmaceuticals (RPh) for every procedure. RPh comprises a radioisotope (radioisotopes [RI), produced in a research reactor [RR] or particle accelerator like medical cyclotron [MC] delivering radiation used for detection‑based imaging, or for targeted therapy, and a carrier‑molecule to render bio‑specificity for the organ or lesion or dysfunction being addressed RPh consists of a radioisotope (radioisotopes [RI], produced in a research reactor [RR] or particle accelerator like a medical cyclotron [MC]) delivering radiation used for detection-based imaging or for targeted therapy, and a carrier molecule to render biospecificity for the organ, lesion, or dysfunction being addressed[2]. In nuclear medicine, treatments consist of either metabolically active radiopharmaceuticals, like radioiodine, selectively binding radiopharmaceuticals (compounds that target certain antigens or receptors), or locoregional therapies, such locally injected microspheres. in order to cure liver cancer). A list of the most significant and well-known therapies that have received marketing approval[3].

**Developmental Advances and Milestones Radiopharmaceuticals**

A significant upsurge was first supplied by 99mTc-based imaging agents in NM throughout the 1980s and 1990s (planar initially and SPECT later), and then by PET tracers, namely 18F (since 2000), after the widespread use of 131I for both diagnosis and therapy. The development of RPh progressed along a route that has become progressively sound, from chemistry-basonger. by using better targeted techniques and carefully finding the proper biochemically derived moieties linked to a particular lesion or clinically relevant malfunction. The development and introduction of several radiopharmaceuticals (RPh), particularly in three key ametastasis

The following significant clinical achievements might be mentioned: innovations to multidisciplinary initiatives, and has become even strhas progressed along a route that has become progressively sound, from chemistry-based innovations to multidisciplinary initiatives, and has become even stronger. by using better targeted techniques and carefully finding the proper biochemically derived moieties linked to a particular lesion or clinically relevant malfunction. The development and introduction of several RPh was facilitated by the R&D emphasis on addressing clinical needs, particularly in areas: (i) for the skeletal system—bone is a frequent site of cancer metastasis; (ii) for myocardial imaging—management aid for the large volume of cardiac patients—utility proved first with 201TlCl and later more widely done with 99mTc based RPh (sestamibi, tetrofosmin); The following significant clinical achievements might be mentioned[1,2].

**Challenges**

Since quantitative imaging may often be used to quantify the biodistribution of the chemical, radionuclide treatment is more than merely radioactive chemotherapy. Furthermore, it is indirect. due to the geographical and temporal variability of the radiopharmaceutical's biodistribution, analogous to external beam treatment. A large influence is also played by dose-rate effects, DNA damage repair, and varied biology within a tumor. Since the radiopharmaceutical is frequently supplied systemically and ionizing radiation is the primary source of the therapy effect, the potential radiation risk associated with the treatment for patients is both deterministic (in target organs and lesions) and stochastic (in non-targeted tissue).As a result, there are a number of issues with radionuclide therapy that need to be resolved at the European level[4,5].

**SPECT and PET Imaging, Radiotracers, and Molecular Imaging**:

The tremendous growth of Nuclear Cardiology over the past forty years is a result of an inventive and creative shift away from subjective interpretations of Using quantitative planar pictures and subpar radiotracers, the technique is digitally based. Myocardial perfusion imaging has become a more important technique for risk-stratifying patients for future intervention, medical treatment, or more intensive intervention with coronary angiography and potential revascularization. The development and optimization of novel radiotracers that reflect the underlying molecular physiology of various cardiac disease states has advanced at a rate that is comparable to that of planar imaging, which was quickly replaced by single photon emission tomography (SPECT), positron emission tomography (PET), and magnetic resonance imaging (MRI).These developments offer increased illness detection diagnostic precision and decreased exposure with no loss of picture quality[6-10].

**Production of radiopharmaceuticals**

Directives 2001/83/EC govern the production of radiopharmaceuticals used in clinical trials or as medical goods with marketing authorization in the EU[11]. 2001/20/EC[12] Specific EU and European Medicines Agency (EMA) guidelines further detail these criteria. Examples are the Good Manufacturing Practice (GMP) rules in EudraLex Volume 4 and its annexes [16]. The introduction of GMP and its demanding standards for radiopharmaceuticals resulted in a considerable drop in clinical trials following the implementation of the aforementioned recommendations . In April 2014, Regulation EU 536/2014, which repeals Directive 2001/20/EC and regulates clinical trials for pharmaceuticals intended for human use, went into effect [17].

**Nuclear Medicine Radiopharmaceuticals Roles Classification, with the Option of "Value Matrix" Projection**

NM-RPh provides "unique value (indispensable role)" in a few specific situations, such as radioiodine treatment of metastatic (well-differentiated) thyroid cancer and high-resolution PET/CT imaging to precisely locate cancer metastasis (and plan the best course of action), such as metastasis of NET and prostate cancer (using 18F-FDG, 68Ga-ligand-vector conjugates). NM‑RPh provides "significant value addition" in many other cases, e.g., myocardial imaging (perfusion using 99mTc products, 82Rb, 13NH3 , and viability using 18F‑FDG), infection imaging (using 99mTc‑leucocytes, 99mTc‑UBI, 18F‑FDG, 68Ga‑UBI), palliative treatment of metastatic bone pain in cancer patients (using 89SrCl2 , 153Sm/177Lu‑EDTMP). The rapidly expanding advancements of NMRPh for neurology will soon add entries to the "significant value addition" list, if not to the "unique value list"[2].

**Positron Emission Tomography/Computed Tomography Recommendations for Oncology Practice**

Due to the fact that 18F FDG PET/CT is now deeply ingrained into standard clinical oncology practice, it is crucial to comprehend both the important areas in which F-18 FDG PET/CT has a significant influence and the prospective areas in which further clinical expertise may be necessary. The most recent guidelines for the application of F-18 FDG PET/CT in cancer practice[18].

**Conclusion**

A special technique known as nuclear medicine or molecular imaging (MI) offers functional pictures on inside organs. administration of tracer doses of radioisotopes. This specialty has advanced quickly during its more than 80-year career in medical science. improvements in radiochemistry, theranostics, and hybrid imaging technology (PET/CT and SPECT/CT) The use of this modality has undergone a revolution in the management of the majority of solid tumors and other diseases as a result of the "treat what you see" and "see what you treat" philosophy. cancer of the blood, or hemo oncology. It is influencing the therapy of conditions in different therapeutic fields, including musculoskeletal disorders, infections and inflammations, pediatrics, endocrinology, neurology, and cardiology.

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2)Natesan Ramamoorthy1,2 1 Adjunct Faculty, National Institute of Advanced Studies (NIAS), IISc Campus, Bangaluru, Karnataka, India, 2 Division of Physical and Chemical Sciences, International Atomic Energy Agency (IAEA), Vienna, Austria.

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