RADIOPHARMACEUTICALS

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ABSTRACT

Radiopharmaceuticals (Nuclear Medicine) is a medical specialty that allows modern diagnostic techniques and treatments using radiopharmaceuticals original radiotracers (drugs linked to a radioactive isotope). Globally, radiopharmaceuticals are considered a special group of drugs and thus their preparation and use are regulated by a set of policies that have been adopted by individual member countries. The radiopharmaceuticals used in diagnostic examinations are administered in mild doses. So, they have no desired pharmacological action, side effects or serious adverse reactions. The major disadvantage associated with the use are their alterations in the biodistribution which may cause diagnostic errors. Nuclear Medicine is growing considerably but are influenced by the appearance and development of new radiopharmaceuticals in both the diagnostic and therapeutic fields and primarily to the impact of new multimodality imaging techniques (SPECT-CT, PET-CT, PET-MRI, etc.). It's mandatory to know the limitations of such techniques, distribution and eventual physiological alterations of radiopharmaceuticals, contraindications & adverse reactions of radiological contrasts, & the possible interference of both.

Keywords- Radiopharmaceuticals, imaging, disease, diagnostic, therapeutics, techniques.

I.INTRODUCTION

Radiopharmaceuticals, or healthful radio compounds, are a bunch of pharmaceutical medication containing radioactive isotopes. The term isotope, refers radioactive atom (radionuclide), is used as diagnostic and therapeutic agents. Radiopharmaceuticals emit radiation themselves, containing radioisotopes that are employed in major clinical areas for diagnosing and medical care. Radiopharmacology is the branch of pharmacological medicine that makes a speciality of these agents.

The facilities & procedures for the production, use & storage of radiopharmaceuticals are subject to licensing by international, national and regional authorities. They'll run to the patient in many alternative ways.

The main cluster of these compounds are the radiotracers accustomed diagnose pathology in body tissues, whereas not all medical isotopes are radioactive, radiopharmaceuticals are the oldest and still most typically used medication [1].

II.CHARACTRISTICS OF RADIOPHARMACEUTICALS

Radiopharmaceuticals are a drug grouping of distinctive healthful formations. These formations use radioactive isotopes, conjointly called radioisotopes, in clinical diagnosing, yet as for therapeutic interventions. Common uses of radiopharmaceuticals in clinical diagnoses are to work out the functioning of the liver, lungs, and kidneys, blood flow to the brain, bone growth, the predictive effects of surgery, and to assess changes since treatment. Common uses of radiopharmaceuticals in therapeutic interventions are cancer and neoplasm treatment, thyroid disease, palliative treatment of bone metastasis, and inflammatory disease.

Radiopharmaceuticals actively emit radiation. The compound is used for diagnosing or medical care, reckoning on what style of radiation it emits. For instance, a compound that emits beta or gamma radiation particles is used for diagnosing, whereas a compound that emits alpha particles can usually be used for therapeutic interventions. Beta particles and alpha particles are some of the characteristics of radiopharmaceuticals. Here are a number of the foremost ideal characteristics of pharmaceutical compounds.

A. Half-Life Time

The ideal pharmaceutical ought to have a brief or long physical half-life time reckoning on what the property is being employed for. The half-life time is that the quantity of your time it takes for the radioactive nuclei accustomed decay to 1/2 its radioactive lifetime. Radiopharmaceuticals used for diagnostic functions ought to have a brief physical half-life to soundly limit radiation doses and to decay quickly when diagnostic imaging. Therapeutic uses of radiopharmaceuticals should have an extended physical half-life, as a brief decay amount would decrease the therapeutic properties of the compound, creating it less effective as time goes on. In diagnostic imagining, the effective half-life time ought to even be adequate to the examination amount. Effective half-life time is that the quantity of your time it takes for the radiation in specific radioactive substances distributed within the body to decrease to 1/2 their radioactive lifetime. This eliminates overexposure for radiation to the form on the far side the examination amount.

B. Gamma Radiation Emission

Gamma ray or beta particle emission is imperative to the diagnostic functions of radiopharmaceuticals. Gamma rays are varieties of lightweight that move at completely different wavelengths than actinic radiation. SPECT scans, or single proton computed axial tomography scans, and PET scans, or positron emission tomography scans, are commonly used in diagnostic by following the gamma radiation emissions. In SPECT scans, gamma cameras will track the gamma emissions from the radiolabelled compounds injected within the patient's body. Through the gamma radiation emission, description scans will diagnose and track the progression of heart diseases, bone disorders, movement disorders, dementia, and Parkinson's malady. PET scans don't measure the gamma rays emitted. During a PET scan, the decay of the radio labelled compound creates tiny particles known as positrons. Positrons then act with electrons within the body produce to form photons that may be measured and used to create pictures of internal organs.

C. Auger Electrons or Alpha Particles

For therapeutic functions, Auger electrons or alpha particles are emitted for molecular nuclear therapies. During this technique, they are targeted at a selected location, like a tumour. These electrons bind to Associate in Nursing organic molecule and are then emitted domestically over a precise quantity of your time to the harmful tissue. The radioactive emissions emit to the native tissue solely to cure or destroy the unhealthy mass whereas going away healthy tissues and organs uninjured.

D. Specific Activity

Specific activity refers to the number of radiations per unit mass of the part or compound. Typically, high specific activity is right for radiopharmaceuticals to properly localize to the receptor site.

E. Localize Largely and Quickly

Radiopharmaceutical compounds ought to localize mostly and quickly round the receptor site. Considering radiation is dangerous to healthy areas of the body, radiopharmaceuticals mostly used in the localized treatment space. This may not solely specialize treatment to the direct space required, however it'll conjointly keep healthy tissue and organs unaffected by harmful radiation. Localizing to the treatment space quickly conjointly permits for the treatment to require place quicker, that is commonly required in nosology or life-saving treatments like tumour removal.

F. Stability

Radiopharmaceutical stability is incredibly important, particularly in diagnostic imaging. The stability of radioisotopes can be affected by light, temperature, and hydrogen ion concentration balances. If these impacts aren't taken under consideration throughout the preparation and storing of compounds, metabolically-decomposed radiopharmaceuticals employed in diagnostic imaging may end up in undesirable distribution of radiation and decrease quality of the image, creating diagnosing tough.

G. Cost, Handiness, And Care

Design characteristics are imperative to the creation of pharmaceutical compounds. Whereas the planning of a compound heavily depends on the characteristics previously listed, the ease, handiness, and price of production are vital factors. Like every clinical test or treatment, the supply and price of production play an outsized role in making helpful radiopharmaceuticals. Pharmaceutical producing firms should take into account the price of production and also the wide-scale handiness of parts required like the acceptable nuclide required for treatment or diagnosing. Correct storage handiness should be accounted for yet. Radiopharmaceuticals actively emit radiation so, they need to be ready to be keep during a selected space, like a sealed instrumentation to lower potential exposure to the safest and least levels.

H. Safety

Radiopharmaceuticals is a dangerous business, like several pharmaceutical production correct policies and procedures that are in situ to handle the creation of compounds. Good Manufacturing Practices should be followed like proper sanitization and correct labelling on materials, to soundly handle any pharmaceutical compounds. In radiopharmaceuticals specifically, the As Low As Responsibly Achievable or ALARA principle should be followed. This idea needs that exposure to radiation is decreased the maximum amount as attainable, correct shielding from the radiation supply is gift, and also the most correct distance between personnel and also the radiation supply is achieved.

Radiopharmaceuticals have a wide array of uses within the pharmaceutical business from unwellness heart condition cardiopathy cardiovascular disease identification to therapeutic treatment of cancerous tumors or thyroid disease. Radiopharmaceuticals need specific characteristics in their composition and creation to with success diagnose and treat health complications. Half-life time, electromagnetic radiation particles, alpha particles, specific activity, localization, stability, and also the style and care preparations all play imperative roles in pharmaceutical compound creation and composition [2].

III. DRUG NOMENCLATURE FOR RADIOPHARMACEUTICALS

As with different pharmaceutical medication, there's standardization of the drug nomenclature for radiopharmaceuticals, although varied standards coexist. The International Non-proprietary Name (INN) gives the base drug name, followed by the radioisotope (as mass number, no space, element symbol) in parentheses with no superscript, followed by the ligend (if any). It’s common to visualize square brackets and superscript superimposed onto the INN name, because chemical nomenclature (such as IUPAC nomenclature) uses those. The United State Pharmacopeia (USP) name offers the base drug name, followed by the radioisotope (as element symbol, space, mass number) with no parentheses, no hyphen, and no superscript, followed by the matter (if any). The USP style isn't the INN style, despite their being represented jointly and also the same in some publications (e.g., AMA, whose style for radiopharmaceuticals matches the USP style). The United State Pharmacopeial Convention could be a sponsor organization of the USAN Council, and also the USAN for a given drug is usually an equivalent because the USP name [3-6].

IV. ROLE OF RADIOPHARMACEUTICALS

Radiopharmaceuticals are radioisotopes absolute to biological molecules ready to target specific organs, tissues or cells among the organic structure. This radioactive medication is used for the identification and, progressively, for the medical care of diseases.

The number of radiopharmaceuticals in clinical use is rapidly growing, therefore permitting the medical profession higher access to detail data on the characteristics of the various types of tumours.

A pharmaceutical is seen as associate degree entity created from a radionuclide and a vehicle molecule with high affinity – or binding power – for a tissue or a selected perform of somebody's organ. It should additionally comprise solely the isotope itself if it shows appropriate biological properties.

Radiopharmaceuticals are used to produce image of organs or tissues of interest, a method that's referred to as scintigraphy. a sort of medical device called gamma camera is in a position to discover the gamma rays emitted by the isotope. It generates in an exceedingly non-invasive manner pictures that replicate the perform of the organ or tissue underneath investigation.

The widest used radioisotope in diagnostic medicine is technetium-99m. It is hooked up too many specific molecules, permitting the identification of the many diseases, together with bound sorts of cancers. for example, technetium-99m-MDP (methylene diphosphonate) is widely used to discover bone metastasis related to cancer.

A. Diagnosis in Cancer

Cancer identification frequently needs imaging studies that in several cases use little amounts of radiation. Procedures like X-rays; computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and single-photon emission CT (SPECT) are necessary in clinical decision-making, together with medical care and follow-up.

- **Imaging Tests**

Taking photos of the within of the body – area unit of crucial importance within the identification and management of cancer patients. the utilization of diagnostic imaging is one in all the primary steps within the clinical management of cancer. Diagnostic radiology and medicine studies play a vital role within the screening, staging (finding out the extent of the cancer, like however giant the tumour is, and if it's unfolded on the far side the first site), follow-up, medical care coming up with, analysis of medical care response and also the long police work of patients.

A reliable identification is important to spot the positioning of the first tumor, and to assess its size and dissemination to encompassing tissues and to different organs and structures within the body. Associate degree applicable identification is of predominate importance decide the therapeutic approach to require and establishing the prognosis.

- **Early identification**

The chance of cure for a cancer patient powerfully depends on the stage of the malady at the time of identification. once it's diagnosed at associate degree early stage – before it's large or has unfold – a tumour is a lot of probably to be with success treated. The first detection of cancer hinges on several factors: the screening of at-risk population; the power of patients and health professionals to recognise warning signs; and also, the use of diagnostic ways to differentiate between cancer and different processes, similarly on exactly confirm the placement and also the extension of the tumour. Trendy diagnostic imaging technologies give the power to discriminate tissues right down to a mm, using magnetic resonance imaging (MRI) and X-ray computed tomography (CT), while the range of positron emission tomography (PET) and single photon emission tomography (SPECT) are a few millimetres.

- **Anatomy Versus Function**

Diagnostic imaging is divided into 2 broad categories: those ways that outline terribly exactly anatomical details and people that manufacture useful or molecular pictures.

The first technique (using CT and MRI) will give exquisite details on lesion location, size, morphology and structural changes to encompassing tissues, however solely delivers restricted data on the tumour's functioning.

The second technique (using PET and SPEC) will provide insight into the tumor physiology right down to the molecular level, however cannot give anatomical details.

Combining these 2 ways allows the combination of anatomy and performance in an exceedingly single approach. The introduction of such "hybrid" imaging has allowed for the characterization of tumours in all stages.

- **Role of Nuclear Techniques**

The use numerous} diagnostic imaging techniques that use various styles of radiation like X-rays (CT and radiography) and gamma rays (PET and SPECT) has revolutionized the management of cancer patients. Technologies like positron emission tomography (PET) that suppose the utilization of radiopharmaceuticals represent a breakthrough within the practice because of their capability to decipher, without opening the human body, what's happening at molecular level in a very sure cell or tissue. The data obtained from these techniques has enabled vital enhancements in patient management and therefore the correct distribution of tending resources.

B. Diagnosing of Cardiovascular Diseases

According to the UN agency, cardiovascular diseases are the foremost common explanation for death worldwide. Diagnostic procedures victimisation radiation plays a central role in managing these diseases and have considerably contributed to the decrease in morbidity and mortality related to them within the last twenty years.

Almost all diagnostic imaging strategies for cardiovascular diseases need radiation. They'll be divided into invasive and non-invasive strategies.

With invasive techniques, a tube – an extended, thin, versatile tube – is inserted into a peripheral artery and rib to the centre. Through this tube, a distinction media is injected into the blood stream, following that X-rays are accustomed take photos of the center's anatomy and therefore the arteries that bring blood to the heart muscle to assess the degree of their openness, additionally referred to as patency. This procedure, referred to as viscus catheterization, is that the "gold standard" to judge the viscus anatomy and therefore the severity of a physiological pathology. It's suggested for numerous reasons, the foremost common of that is to judge pain. However, its wide usage is proscribed by its invasive nature.

Instead, non-invasive viscus imaging techniques area unit progressively used. These strategies will delineate viscus structures and assess coronary arteries patency and heart muscle insertion (showing however well blood flows through heart muscles) in addition as their perform and metabolism. a number of them use radiation and coronary CAT roentgenography, a heart imaging take a look at that helps verify if plaque build-up has narrowed a patient's coronary arteries. Others use non-nuclear strategies, like diagnostic technique, a picture of the centre victimisation ultrasound, or viscus resonance imaging, a technology that employs pulses of radio emission energy.

- **Key Methods of Nuclear Medicine**

Nuclear medical specialty studies assess the circulation of blood within the blood vessels of the centre muscle, additionally referred to as heart muscle blood flow. Among the techniques of nuclear medical specialty, heart muscle insertion imaging is that the most generally used. Combined with exercise on a treadmill or stationary bicycle, the photographs made with this technique are often accustomed assess the blood flow to the centre muscle. To produce these pictures, a little quantity of a chemical (a supposed imaging agent) is injected into the blood stream. Then, a scanning device (for instance a gamma camera) is employed to live the uptake by the centre of the imaging material. If there's vital blockage of an arterial blood vessel, the centre muscle might not receive enough blood offer. This decrease in blood flow is often detected on the photographs.

Myocardial insertion studies will determine areas of the centre muscle that have inadequate blood offer and people regions which may be scarred from a heart failure. This provides the required data to assist determine that patients carry Associate in Nursing enhanced heart failure risk and will be candidates for invasive procedures like coronary roentgenography, surgical operation (a procedure to widen narrowed or impeded arteries) or surgery.

C. Diagnosing of Degenerative Diseases

Imaging techniques play a crucial role in identification and managing chronic disorders like those touching the brain (Alzheimer and Parkinson’s disease) and musculoskeletal system (osteoporosis and arthritis).

- **Nuclear Medicine and Brain Disorders**

In the last thirty to forty years, going hand-in-hand with the worldwide rise of lifetime, neurodegenerative diseases of the brain touching particularly aged individuals became progressively taxing for society. Alzheimer’s disease is that the commonest and most generally celebrated of those disorders, because it each attacks the intellect and emotional well-being of its victims, probably devastating their lives which of their families.

Neurodegenerative diseases area unit terribly difficult to diagnose. Patients typically show solely delicate and unclear signs and symptoms and even the findings of diagnostic imaging don't seem to be perpetually clear-cut. By the time the photographs show clear signs of disease, patients typically already show decent symptoms for a transparent diagnosing.

Diagnostic imaging has a wide range of roles within the study of Alzheimer’s disease over the past four decades. Initially, CAT and, later magnetic resonance imaging (MRI) were accustomed rule out different causes of dementedness. Additional recently, a range of imaging strategies, as well as structural and practical imaging and antilepton emission pictorial representation studies, have shown characteristic changes within the brains of patients with Alzheimer’s. However, no imaging technique will serve all functions as every has its distinctive strengths and weaknesses.

Imaging has additionally a crucial role to play in analysis, because it helps address several scientific queries and provides insights into the consequences of Alzheimer’s and its explanation. it's a long-time tool in drug discovery and progressively needed in clinical trials to check for medicine.

D. Nuclear Medicine and Disorders of the musculoskeletal System

Diagnostics exploitation nuclear techniques also are relevant for diseases that attack the system. the foremost common of those is pathology, that is especially frequent in girls within the biological time age. This sickness is characterised by insufficient bone formation, excessive bone loss or a mixture of each, resulting in bone fragility Associate in Nursing a magnified risk of fractures of the hip, spine and carpus. X-ray ways is wont to live bone density. the foremost correct is dual-energy x-ray absorptiometry scanning, that detects tiny changes in an exceedingly patient’s bone mass by examination his or her bone density thereto of healthy adults and adults of a similar age.

E. Diagnosis of Infectious Diseases

To diagnose infectious diseases, in-vivo and in-vitro diagnostic procedures involving radiation area unit applied. In-vivo procedures give pictures of living organisms and are wont to diagnose such diseases as infectious disease or osteitis. In-vitro techniques, exploitation take a look at tubes or culture dishes, are used to diagnose as an example protozoal infection, viral haemorrhagic fever or HIV.

Every year, thirteen million individuals die worldwide from infectious diseases, most of them in developing countries. The human immunological disorder virus/acquired immunological disorder syndrome (HIV/AIDS), infectious disease and protozoal infection area unit the foremost common and important of those sicknesses. Globally, a complete of 36 million individuals bear HIV, with 2 million recently infected in 2014.

Tuberculosis is with eleven per cent of all deaths the second greatest killer from one infective organism. Some 1.5 million individuals died in 2013 from this sickness, whereas protozoal infection, next on the list, infected 198 million individuals and took 584,000 lives within the same year. Migration from low-income to higher-income countries any exacerbates the matter, as will the potential for co-infection with HIV/AIDS and also the development of drug-resistant strains of infectious disease.

Overall international health care prices from solely lower metabolic process infections (including pneumonia), HIV/AIDS and protozoal infection quantity to quite US$34 billion, ranking third once those for cancer and cardiopathy.

- **How Nuclear Medicine Helps Diagnose Infectious Diseases**

Both in-vivo imaging and in-vitro ways are a part of the medicine tool-kit to diagnose infectious diseases. In-vitro techniques involving imaging and molecular laboratory tests facilitate determine infections and manage drug resistance.

However, in-vivo ways like radiolabelling white blood cells are still the gold customary technique for infection detection. This method relies on the property of leukocytes (white blood cells) to migrate into infected areas to destroy microorganism. With this technique, a sample of white blood cells is tagged with the medical isotope Technetium-99m and reinjected into the patient. The imaging of the areas to that the cells unfold within the body – a movement known as focal uptake – then permits the infected regions to be known.

Nuclear medicine studies and resonance imaging are employed in the identification and follow-up of various diseases, like osteitis (infections of the bone which will involve the complete structure right down to the bone marrow); fevers of unknown origin and infected tube prosthetic device. The latter area unit microorganism infections that may occur throughout operations to interchange or bypass with a graft broken or morbid blood vessels.

Considered terribly difficult medical conditions, of these infections is caused by microorganism carried from a remote website through the bloodstream; through immunization from direct trauma; a contiguous focus of infection; or infection following surgery. The identification of osteitis isn't forever obvious, and radionuclide procedures area unit of performed as a part of the identification.

Positron emission pictorial representation will diagnose a spread of infections with a reasonably high degree of certainty, as an example large-vessel vasculitis; abdominal infections like inflammatory gut disease; and pectoral and soft-tissue infection. it's conjointly helpful in tumour-induced fever caused by Hodgkin’s disease; aggressive non-Hodgkin’s lymphoma; body part cancer; and malignant neoplastic disease. In patients with fever of unknown origin, in-vitro or in-vivo tagged white-blood cells ways area unit of restricted price owing to the rather low prevalence of white corpuscle processes in an exceedingly clinical setting.

F. Diagnosing and Treating Disease in Children (Paediatric Illnesses)

Using diagnostic imaging to notice sickness in youngsters needs further safety measures and care. Radiation doses should be unbroken as low as potential and examinations ought to be absolutely even so edges exceed far and away any potential risk.

A sick kid and a sick adult should be approached otherwise. A child can not consider simply a miniature adult. Treating youngsters with nuclear medicine techniques needs a tailored approach. Physicians and technologists ought to show a wide range of capacities and capabilities to effectively handle sick youngsters, particularly once exploitation radionuclides for identification and medical aid. The terribly nature of radionuclide use demands awareness of radiation questions of safety and technical proficiency to make sure quality control.

The UN agency provides variety of distended learning and coaching opportunities on paediatric nuclear medicine, as well as multidisciplinary clinical management; applicable dosimetry; sedation and immobilization of patients throughout medical procedures; image magnification; radioactive material management; and protective family relations from radiation. The principles sent within these courses are used to great advantage in the early detection or prompt identification of diseases like childhood cancer and inborn and organic process malformations that arise in infancy and childhood.

In most countries, nuclear medical specialty diagnostic and therapeutic applications became mature technologies by currently. Hospitals and medical centres equipped with medical specialty facilities habitually use radionuclide techniques, whether or not the patient is Associate in Nursing adult or a child. The high volume of such cases has conjointly typically translated into a robust experience and skill-set among physicians and technologists managing sick kids.

Paediatric medical specialty follow refers to examinations drained babies, young kids and teenagers (up to the age of 18). Diseases occurring in kids gift issues and peculiarities that will not be seen or may be unnoticed in routine diagnostic imaging investigations designed for adults. There square measure higher incidences of biological process malformations and inborn anomalies discovered in childhood than later in life.

Paediatric nuclear medical specialty imaging is performed to assist diagnose dangerous childhood disorders that square measure infectious, non-infectious or inborn, or that develop throughout childhood, like cancer. Nuclear medical specialty imaging techniques used to measure children with cancer and different conditions that have an effect on organ systems, like the kidney, urinary bladder, bones, liver, gallbladder, duct tract, heart, lungs, and thyroid.

Several medical specialty techniques are in use to diagnose and manage inborn and bought system diseases and childhood cancers: planar nuclear medical specialty imaging techniques; SPECT (single photon emission computed tomography) and SPECT/CT (computed tomography); positron emission tomography (PET)/CT; and nuclear medicine therapy technology.

Nuclear medicine scans are measure usually want to facilitate diagnose urinary blockage within the urinary organ, flowing of excreta from the bladder into the urinary organ, bone cancer, infections and trauma, duct haemorrhage, jaundice in new-borns and older kids, inborn adenosis, and most significantly cancer and its metastasis within the body [10-15].

V. THERAPEUTIC APPLICATIONS OF RADIOPHARMACEUTICALS

A. Treatment of Hyperthyroidism

131-iodine is employed extensively for the treatment of hyperthyroidism. Upon oral administration of the radionuclide, approximately 60% of the radioactivity is taken up by the overactive gland. The principal disadvantage of the radioiodine medical aid is that the high incidence of early and late adenosis, creating it necessary to watch patients adequately once treatment. As a consequence, treatment isn't any longer restricted to older patients and currently adolescents and even kids, being treated with radio iodine.

B. Treatment of Thyroid Carcinoma

Radioiodine has been used for many decades within the treatment of differentiated thyroid malignant neoplastic disease, a neoplasm that metastasis to bone, lungs and different soft tissues. However, it's sloe growing and therefore the prognosis is comparatively sensible, permitting long run follow up treated patients. repetition radionuclide imaging with radioiodine will assess response to medical aid and, if necessary, any therapeutic dosages of 131I is also needed in advanced or resistant cases.

C. Treatment of Neuroendocrine

Tumours Metaiodobenzyleguanidine is analogous in structure to the adrenergic somatic cell blocker guanethidine and therefore the neurochemical nor-adrenaline. because of the structural similarity, it's taken of by the endocrine and different tissues with wealthy sympathetic innervations however in contrast to nor-adrenaline it's not metabolized and is basically excreted unchanged within the excreta. 131I-metaiodobenzyleguanidine (131I-MIBG) has been used successfully within the treatment of system tumours like metastatic tumour, tumour tumours and medullary malignant neoplastic disease of the thyroid. many different agents square measure being investigated as alternatives to 131I-MIBG and embrace 161-Terbium-diethylenetriaminepentaacetic acid-octreotide and 111-Indium-diehylnetriaminepentaacetic acid (111In-DTPA) for tumours containing somatostatin receptors.

D. Treatment of Bone Tumours

Bone metastases square measure a typical finding in patients stricken by cancers of the prostate, breast and lungs and in these patients’ management of bone pain may be a important clinical downside. External beam actinotherapy, together with analgesic medicine, remains the mainstay of treatment however the proportion of the body which will be treated is restricted. many beta emitting radionuclides, in an exceedingly style of chemical forms, may be used for the treatment of bone metastases. 32P, 89Sr, 186-Rhenium and 153-Samaraum are dole out.

E. Treatment of Myeloproliferative

Diseases 32P has been used for over fifty years within the treatment of a spread of medical specialty disorders. Following shot, 32P because the inorganic phosphate, is targeted by selection by chop-chop proliferating tissue and there's conjointly bone uptake. during this method, a big radiation dose is delivered to the bone slim and ends up in growth retardation of the haemopoietic cell lines. the first application of 32P is within the treatment of polycythaemia rubra vera. during this condition there's Associate in Nursing abnormal increase within the variety of red cells within the circulation. However, treatment with bloodletting, radioactive phosphorus or therapy all ends up in important increase in lifetime [7-9].

❖ SOME SPECIFIC RADIOPHARMACEUTICALS

Name	Investigation	Route of administration	In vitro / in-vivo	Imaging / non-imaging
Ca-47-Ca^{2+}	Bone metabolism	IV	In-vitro	Non-imaging
C11-L-methyl-methionine	Brain tumour imaging Parathyroid imaging	IV	In-vivo	Imaging
C14-Glycocholic acid	Breathing test for small intestinal bacterial overgrowth	Oral	In-vitro	Non-imaging
C14-PABA (para-amino benzoic acid)	Pancreatic studies	Oral	In-vitro	Non-imaging
C14-Urea	Breath test to detect Helicobacter pylori	Oral	In-vitro	Non-imaging
C14-d-xylose	Breathing test for small intestinal bacterial overgrowth	Oral	In-vitro	Non-imaging
Cr51-heart scan/blood volume scan	RBC volume heart scan; sites of sequestration; gastrointestinal blood loss	IV	In-vitro	Non-imaging
Cr51-Cr^{3+}	Gastrointestinal protein loss	IV	In-vitro	Non-imaging
Cr51-EDTA (Ethylenediaminetetraacetic acid)	Glomerular filtration rate measurement	IV	In-vitro	Non-imaging
Co57-Cyanocobalamin (Vitamin B_{12})	For Gastrointestinal absorption	Oral	In-vitro	Non-imaging
Co58 Cyanocobalamin (Vitamin B_{12})	For Gastrointestinal absorption	Oral	In-vitro	Non-imaging
F18-FDG (Fluorodeoxyglucose)	Tumour imaging Myocardial imaging	IV	In-vivo	Imaging
F18-Sodium Fluoride	Bone imaging	IV	In-vivo	Imaging
F18-Fluorocholine	Prostate tumour imaging	IV	In-vivo	Imaging
F18-Desmethoxyfallypride	Dopamine receptor imaging	IV	In-vivo	Imaging
Ga67-Ga^{3+}	Tumour imaging	IV	In-vivo	Imaging
Ga67-Ga^{3+}	Infection/inflammation imaging	IV	In-vivo	Imaging
Ga68-Dotatoc or Dotatate	Neuroendocrine tumour imaging	IV	In-vivo	Imaging
Ga68-PSMA	Prostate cancer imaging	IV	In-vivo	Imaging
H3-water	Total body water	Oral or IV	In-vitro	Non-imaging

In111-DTPA (diethylenetriaminepenta-acetic acid)	Ventriculo-peritoneal shunt (LaVeen Shunt)	intraperitoneal injection	In-vivo	Imaging the radioactive substance
In111-DTPA (diethylenetriaminepenta-acetic acid)	Cisternography	Intra-cisternal	In-vivo	Imaging
In111-Leukocytes	Infection/inflammation imaging	IV	In-vivo	Imaging
In111-Platelets	Thrombus imaging	IV	In-vivo	Imaging
In111-Pentetreotide	Somatostatin receptor imaging	IV	In-vivo	Imaging
In111-Octreotide	Somatostatin receptor imaging (Octreoscan)	IV	In-vivo	Imaging
I123-Iodide	Thyroid uptake	Oral or IV	In-vivo	Non-imaging
I123-Iodide	Thyroid imaging Thyroid metastases imag ing	Oral or IV	In-vivo	Imaging
I123-o-Iodohippurate	Renal imaging	IV	In-vivo	Imaging
I123-MIBG (m-iodobenzylguanidine)	Neuroectodermal tumour imaging	IV	In-vivo	Imaging
I123-FP-CIT	SPECT imaging of Parkinson's Disease	IV	In-vivo	Imaging
I125-fibrinogen	Clot imaging	IV	In-vivo	Imaging
Fe59-Fe^{2+} or Fe^{3+}	Iron metabolism	IV	In-vitro	Non-imaging
Kr81m-Gas	Lung ventilation imaging	Inhalation	In-vivo	Imaging
Kr-81m-Aqueous solution	Lung perfusion imaging	IV	In-vivo	Imaging
^{177}Lu-DOTA-TATE	gastroenteropancreatic neuroendocrine tumours (GEP-NETs)	IV	In-vivo	
N13-Ammonia	Myocardial blood flow imaging	IV	In-vivo	Imaging
O15-Water	Cerebral blood flow imaging As Myocardial blood flow imaging	IV bolus	In-vivo	Imaging
P32-Phosphate	Polycythaemia and related disorders	IV or Oral		
Ra223 cation ($^{223}RaCl_2$)	metastatic cancer in bone	IV		
Rb-82 chloride	Myocardial Imaging	IV		
Se75-Selenorcholesterol	Adrenal gland imaging	IV	In-vivo	Imaging
Se75-SeHCAT (23-Seleno-25-homo-tauro-cholate)	Bile salt absorption	Oral	In-vivo	Imaging
Na22-Na^{+}	Electrolyte studies	Oral or IV	In-vitro	Non-imaging
Na24-Na^{+}	Electrolyte studies	Oral or IV	In-vitro	Non-imaging
Tc99m-pertechnetate	Thyroid uptake and thyroid imaging Stomach and salivary gland imaging Meckel's diverticulum imaging Brain imaging Micturating cystogram First pass blood flow imaging First pass peripheral vascular imaging	IV	In-vivo	Imaging
Tc99m-pertechnetate	Lacrimal imaging	Eye drops	In-vivo	Imaging

Tc99m-Human albumin	Cardiac blood pool imaging	IV	In-vivo	Imaging
Tc99m-Human albumin	Peripheral vascular imaging	IV	In-vivo	Imaging
Tc99m-Human albumin macroaggregates or microspheres	Lung’s perfusion imaging	IV	In-vivo	Imaging
Tc99m-Human albumin macroaggregates or microspheres	Lung’s perfusion imaging with venography	IV	In-vivo	Imaging
Tc99m-Phosphonates and phosphates (MDP/HDP)	Bone imaging	IV	In-vivo	Imaging
Tc99m-Phosphonates and phosphates	Myocardial imaging	IV	In-vivo	Imaging
Tc99m-DTPA (Diethylenetriaminepenta-acetic acid)	Renal imaging First pass blood flow studies Brain imaging	IV	In-vivo	Imaging
Tc99m-DTPA (Diethylenetriaminepenta-acetic acid)	Lung ventilation imaging	Aerosol inhalation	In-vivo	Imaging
Tc99m-DMSA(V) (dimercaptosuccinic acid)	Tumour imaging	IV	In-vivo	Imaging
Tc99m-DMSA(III) (dimercaptosuccinic acid)	Renal imaging	IV	In-vivo	Imaging
Tc99m-Colloid	Bone marrow imaging GI Bleeding	IV	In-vivo	Imaging
Tc99m-Colloid	Lymph node imaging	Interstitial	In-vivo	Imaging
Tc99m-Colloid	Oesophageal transit and reflux imaging Gastric emptying imaging	Oral	In-vivo	Imaging
Tc99m-Colloid	Lacrimal imaging	Eye drops	In-vivo	Imaging
Tc99m-HIDA (Hepatic Iminodiacetic acid)	Functional biliary system imaging	IV	In-vivo	Imaging
Tc99m-Denatured (heat damaged) red blood cells	Red cell volume Spleen imaging	IV	In-vitro	Non-imaging
Tc99m-Whole red blood cells	GI bleeding Cardiac blood pool imaging Peripheral vascular imaging	IV	In-vivo	Imaging
Tc99m-MAG3 (mercaptoacetyltriglycine)	Renal imaging First pass of blood flow imaging	IV	In-vivo	Imaging
Tc99m-Exametazime (HMPAO)	Cerebral blood flow imaging	IV	In-vivo	Imaging
Tc99m-Exametazime labelled leucocytes	Infection/inflammation imaging	IV	In-vivo	Imaging
Tc99m-Sestamibi (MIBI - methoxy isobutyl isonitrile)	Parathyroid imaging Non-specific tumour imaging Thyroid tumour imaging Breast imaging Myocardial imaging	IV	In-vivo	Imaging
Tc99m-Sulesomab (IMMU-MN3 murine Fab'-SH anti-granulocyte monoclonal antibody fragments)	Infection/inflammation imaging	IV	In-vivo	Imaging

Tc99m-Technegas	Lung ventilation imaging	Inhalation	In-vivo	Imaging
Tc99m-Human immunoglobulin	Infection/inflammation imaging	IV	In-vivo	Imaging
Tc99m-Tetrofosmin	Parathyroid imaging Myocardial imaging	IV	In-vivo	Imaging
Tc99m-ECD (Ethyl Cysteinate Dimer)	In Brain imaging	IV	In-vivo	Imaging
Tl201-Tl^{+}	Non-specific tumour imaging Thyroid tumour imaging Myocardial imaging Parathyroid imaging	IV	In-vivo	Imaging
Xe133-gas	Lung ventilation studies	Inhalation	In-vivo	Imaging
Xe133 (isotonic solution sodium chloride)	Cerebral blood flow	IV	In-vivo	Imaging
Y90-Silicate	Arthritic conditions	Intra-articular		
Y90-Silicate	Malignant disease	Intracavitary		

Table 1. List of Some Specific Radiopharmaceuticals [2]

VI. ADVANTAGES OF RADIOPHARMACEUTICALS IN HEALTHCARE SYSTEM

• It may be used as diagnosing and treatment of patient.
• It will offer quick onset of pain relief.
• It's common to cure cancer.
• Can treat multiple illness sites.
• Wide accessible mode of treatment.
• Directly treats neoplasm, particularly helpful for bone metastasis.
• Single dose is effective for a few patients.
• Nuclear medicine tests may be performed on children.
• Nuclear medicine procedure has no side effect and are completely safe.

VII. DISADVANTAGES OF RADIOPHARMACEUTICALS IN HEALTH CARE SYSTEM

• Once multiple fractions are given, it's going to turn out prolonged inconvenience and discomfort for patients.
• Higher doses of head and neck radiation is related to vas complication, thyroid disfunction and pituitary axis disfunction.
• Nuclear medicine tests are non-recommended for pregnant ladies, as a result of unborn babies have a bigger sensitivity to radiation than kids or adults.
• Filling in patient-'s teeth, dental braces and permanent bridges could cause some distortion round the mouth space.
• Will turn out some hypersensitivity.
• It has a radiation risk.
• Myelosuppression could occur, particularly with prior chemotherapy.

VIII. STORAGE OF RADIOPHARMACEUTICAL SUBSTANCES

- Radiopharmaceuticals should be kept in well-closed containers
- The storage conditions should be such that the maximum radiation dose rate to which person shall be exposed is reduced to an acceptable level.
- Care should be taken in compliance with national regulations for protection against ionizing radiation.
- Radiopharmaceutical preparations intended for parenteral use must be kept in a glass vial, ampoule or syringe that is sufficiently transparent to permit the visual inspection of the contents.
- Glass containers shall get darken under the effect of radiation.
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IX. LABELING OF RADIOPHARMACEUTICAL SUBSTANCES

The label on the primary container includes:
- A statement showing that the product is radioactive or the international symbol for radioactivity
- The name of the radiopharmaceutical preparation.

- Where appropriate, that the preparation is for diagnostic or for medical use.
- The route of administration.
- The total radioactivity present at a stated date & where mention time & for solutions, a statement of the radioactivity in a suitable volume (for example, in MBq per ml of the solution) may be given instead.
- The expiry date and, with necessary time should be labelled.
- The batch (lot) number assigned by the manufacturer should be given.
- For solutions, the total volume.

The label on the outer package includes:

- A statement showing that the product is radioactive or the international symbol for radioactivity
- The name of the radiopharmaceutical preparation.
- Where appropriate, that the preparation is for diagnostic or for medical use.
- The route of administration.
- The total radioactivity present at a stated date and, where necessary, time; for solutions, a statement of the radioactivity in suitable volumes (for example, in MBq per ml of the solution) may be given instead.
- The expiry date and, with necessary time should be labelled.
- The batch (lot) number assigned by the manufacturer should be given
- For solutions, the total volume.
- Any special storage requirements and conditions with respect to temperature and light.
- Wherever applicable, the name and concentration of any added microbial preservatives or, where necessary, that no antimicrobial preservative has been added.

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