WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review of Radioisotopes and it's Therapeutics.

Akshay Sudhakar Gavali, Dr. Rajendra Kawade, Angad B. Newre, Akash S. Pagar, Omkar M. Kadam. Rushikesh A. Nikam

Nandkumar Shinde College of Pharmacy, Vaijapur, Chhatrapati Sambhajinagar, 423701.

ABSTRACT:-

Radioisotopes, or radioactive isotopes, play a crucial role in various therapeutic applications within the field of medicine.This abstract provides a concise overview of the key aspects surrounding the use of radioisotopes for therapeutic purposes.The document begins by elucidating the fundamental properties of radioisotopes, emphasizing their unstable nature and emission of ionizing radiation.Subsequently, it delves into the therapeutic applications, focusing on two primary modalities: radiotherapy and targeted radionuclide therapy.In radiotherapy, high-energy radiation emitted by radioisotopes is harnessed to target and destroy cancer cells.The abstract explores the mechanism of action, advancements in delivery techniques, and the balance between efficacy and minimizing damage to surrounding healthy tissues.The second aspect, targeted radionuclide therapy, involves the use of radiopharmaceuticals that selectively accumulate in specific tissues or organs.This section discusses the development of novel radiopharmaceuticals, their administration, and their role in treating various conditions such as neuroendocrine tumors and metastatic bone pain. Furthermore, the abstract touches upon challenges and future prospects in the field, including regulatory considerations, safety concerns, and ongoing research endeavors. The potential for personalized medicine through the integration of radioisotope-based therapies is also highlighted. In conclusion, this abstract provides a succinct overview of the significant role radioisotopes play in therapeutic applications, contributing to advancements in the treatment of various medical conditions.

Keywords:- Radioisotopes, Therapeutic applications ,Radiation therapy, Brachytherapy, Cancer treatment, Radioactive tracers, Nuclear medicine, Targeted radionuclide, therapy ,Radiopharmaceuticals, Alpha radiation therapy.

Introduction

In the field of medicine, radionuclide imaging, also known as functional imaging, offers the sole method for evaluating physiological alterations that is a direct as a result of changes in metabolism. Physicians typically use the information to quickly and accurately diagnose the patient's illness[10]. The radiotracer method, on which this imaging is based, is predicated on the idea that because radioactive atoms and molecules are chemically indistinguishable from their stable counterparts, they behave in the same way within an organism.By measuring biochemical changes, radiotracers can measure tissue function in vivo and offer an early disease marker.Nuclear specialists administer certain types of radiation therapy, such as radioisotope management.While these elements have the same atomic number but different atomic masses, isotopes have the same number of protons but different numbers of neutrons.These unstable elements decay by releasing energy as gamma, beta (positron), and beta (electron) rays. Radioisotopes are those isotopes that emit radiation [2,3].Another name for these radioisotopes is radionuclides because of these isotopes' properties, a variety of industries, including agriculture, healthcare, and research centers, use them. The distinctive quality of radiation emissions and their associated energies.Radiopharmaceuticals are products that are radioactive and used in medicine [4].Because they contain radionuclide and are typically administered in minute quantities that elicit no pharmacological response,radiopharmaceuticals are different from other medications used in medicine. By attaching the proper radioactive isotope to the selected carrier component, they are made ready.The radiopharmaceutical's carrier component is a physiologically active molecule, such as pyrophosphate and methylene diphosphonate (MDP) compounds in skeleton bone tissues, that is used to localize the drug in a particular organ or group of organs to provide diagnostic information about those tissues

.DEFINATION :

A radiopharmaceutical is a radioactive pharmaceutical agent that is used for diagnostic or therapeutic procedures

TERMINOLOGY:

Nuclide: An individual atom identified by the number of protons in the nucleus and the atomic mass number. (total number of protons and neutrons in the nucleus) and stable enough to measure the lifetime of the object. The same element is made up of all atoms with the same atomic number.I

sotopes: Isotopes are atoms of the same element that have distinct atomic mass numbers.

Radioactivity: The ability of some nuclides to spontaneously change their nuclei into those of other nuclides, resulting in the emission of radiation.The characteristic of unstable nuclides that causes them to spontaneously change inside their nuclei is known as radioactive decay.

As a result of this alteration, the atoms release energetic particles or electromagnetic energy and produce a different nucleus.

Units of radioactivity: The number of spontaneous nuclear transformations that occur in a unit of time is used to express the activity of a given quantity of radioactive material.The reciprocal second is known by its special name, the Becquerel (Bq), which serves as the SI unit of activity.

Assessment of Isotopes-

The term "radioactive" was first used in 1898 when Pierre and Marie Curie discovered polonium [7].With the assistance of chemist G. Bemont, Curie discovered radium six months after polonium was discovered [8]. Polonium was not nearly as significant as radium.Its notable separation made it possible for it to be used in laboratories as well as in industry and medicine.Later, "uranic radiation" was made in 1900 by Henri Becquerel [7].There are 1800 isotopes in total, but only 200 radioisotopes are currently in regular use, and the majority of them are created artificially.Numerous processes can be used to produce radioisotopes. In a nuclear reactor, neutron activation is the most widely used method.This is where an atom's nucleus absorbs a hineutron, producing an excess of neutrons (neutron rich), which in turn produces the desired radioisotope [2, 3].In 1932, Lawrence and Livingston invented the cyclotron, which is used to produce some radioisotopes [9, 10]. wherein the nucleus is exposed to charged particles like protons, deuterons, and alpha particles, leading to a neutron deficit (proton rich). After being accelerated to high energies, these particles are permitted to collide with the target material. Some of the isotopes that can be created in a cyclotron are 11C, 13N, 18F, 123I, etc.Reactor isotopes employed for medical purposes.Isotopes Half life Uses Molybdenum -99 66 hours Used as the 'parent' in a generator to produce technetium-99m.Most widely used isotope in nuclear medicine Technetium -99m 6 hours Used in to image the skeleton and heart muscle in particular, but also used for brain, thyroid, lungs (perfusion and ventilation), liver, spleen, kidney (structure and filtration rate), gallbladder,bone marrow, salivary and lacrimal glands, heart blood pool, infection numerous specialisedmedical studies.Copper -64 . 13 hours Used to study genetic diseases affecting copper. Selenium -75 -120 days Used in the form of selenomethionine to study the production of digestive enzymes.Iron- 59 -46 days Used in studies of iron metabolism in the spleen. Pottasium -42.12 hours Used for the determination of exchangeable potassium in coronary blood flow. Holmium-166 126 hours Being developed for diagnosis and treatment of liver tumors.

Mode of Administration:

These isotopes can be inhaled for either therapeutic or diagnostic purposes. IV (thallium, gallium), oral (iodine), or intravenous (xenon, argon, nitrogen).The liquid radionuclides technetium-99m, iodine-123, iodine-131, thallium-201, and gallium-67 are the most often used ones.The most often utilized gaseous, aerosol, and radionuclides are technetium-99M, xenon-133, krypton-81m, and DTPA (diethylene-thiamine-pentaacetate).The most commonly used gaseous/aerosol/radionuclides are xenon-133, krypton-81m, Technetium-99M and DTPA (diethylene-thiamine-pentaacetate).

Application of Radioisotopes:-

In Diagnostics Aspects:

In nuclear medicine with advances included as positron emission ptomography (PET), imaging has value in cardiovascular, neurological, psychiatric, and oncological diagnosis. Positron emission tomography is a functional imaging modality that allows the measurement of metabolic reactions within the whole body. Fluorodeoxyglucose, or FDG, is an analogue of glucose, and its detection has become crucial for malignancies and the use of PET to track the effectiveness of treatment. Fusion imaging is the process of simultaneously obtaining structural and biochemical information (fused images) under nearly identical conditions using a single device that combines a computed tomography (CT) scan and a PET scan. This minimizes the temporal and spatial differences between the two imaging modalities. The technique known as single-photon emission computed tomography (SPECT) imaging was created to improve planar imaging by precisely pinpointing the anatomical location of the emission source.Using this method, gamma rays released singly, or as a single photon, from radionuclides like technetium-99m and thallium 201 are detected.detection of radioimmuno The highly sensitive method of in vitro nuclear medicine known as radioimmunoassay is used to determine concentrations of antibodies against antigens.

Therapeutic Aspects:

Certain radioisotopes, such as radiocobalt (60Co), which is used to treat brain tumors, radiophosphorus (32P), which is used to treat bone diseases, and radioiodine (131I), which is used to treat thyroid cancer, emit radiations that are very effective in curing certain diseases. [4]Depending on the kind of treatment, radioactive sources with multiple nuclides and a range of sizes and shapes are also available.energy and emission of radiation.Targeted alpha therapy, also known as alpha radioimmunotherapy, is a relatively new field that is particularly useful for controlling dispersed cancers.A monoclonal antibody that has been tagged with the radionuclide that emits alpha is used as a carrier to deliver the short range, highly energetic alpha emissions directly to cancer cells.In cases of malignant brain tumors, 0 concentrates A monoclonal antibody tagged with a short range of highly energetic alpha emissions is used as a carrier to target cancer cells.the radionuclide that emits alpha.In brain tumors that are malignant, 0 concentrates.Over time, radionuclide therapy has proven to be effective in treating persistent disease with minimally harmful side effects.The goal of any therapeutic procedure is to limit radiation to the patient's well-defined target volumes. The doses per therapeutic procedure are typically 20–60 Gy[12].

Medical Uses :

Radioisotopes and their formulations find varied applications in diagnosis, therapy and healthcare. Bhaba Atomic Research Centre (BARC) supplies reactor produced radioisotopes and radionuclides for medical use.The radioisotopes processed and supplied by Board of Radiation & Isotope Te chnology (BRIT), Mumbai to medical uses across the country, include radiopharmaceuticals, branchy-therapy wires, radio-immunoassay (RIA) kits and various other products, and services.The accelerator at VECC manufactures radioisotopes, which are processed for medical applications.The Regional Radiation Medicine Centre (RRMC) meets the requirements of the eastern region of the country, for radiodiagnosis and therapy. The radiations given out by some radioisotopes are very effective in curing certain diseases. For example, radio-cobalt (60Co) is used in the treatment of brain tumor, radio phosphorous (32P) in bone diseases and radio-iodine (131I) in thyroid cancer.The radiations, besides destroying the ailing tissue, also damage the healthy tissue and hence a careful control over the quantity administered is necessary Bacteria and other disease-carrying organisms can be destroyed by irradiating them with γ-rays.The process is used to sterilize medical instruments, plastic hypodermic needles, packets of antibiotics, and hospital blankets; whereas heat sterilization would damage them. A portable source of γ -rays for sterilization is radio-cobalt (60Co). X-ray photography in medical diagnosis can be replaced by γ -ray photography with advantage.The γ-ray source (radioisotope) is compact and needs no power supply.In the field of medicine the tracer technique is employed in a number of ways.For example, the doctor can find out any obstruction in the circulation of the blood in the human body.He injects radio-phosphorous (32P) into the blood of the patient and examines the movement of the blood by detecting radiations emitted by 32P by means of G. M. counter. He can thus locate clots of blood present in the body.In a similar way, the passage of a particular element in the body and the rate at which it accumulates in different. organs can be studied. For example, phosphorous accumulatesin bones, and iodine in thyroid gland.

Agricultural Uses :

Radiations from certain radioisotopes are used for killing insects which damage the food grains. Certain seeds and canned food can be stored for longer periods by gently exposing them to radiations. Better yields of milk from cows, and more eggs from hens have been obtained on the basis of information gained by mixing radioisotopes with their diet. Radioisotopes are used for determining the function of fertilizer in different plants. Radioisotopes are also used for producing high yielding crop seeds.Thus the agricultural yield is increased. The research at Tomboy in the field of crop development has led to the development of 23 high yielding varieties of pulses, oilseeds, rice and jute.The BARC has developed groundnut varieties, which are very popular amongst farmers. BARC has also developed a tissue culture based protocol for rapid multiplication of 12 commercial cultivators of banana. In agriculture, the tracer technique is used to study the rate and direction of movement of an element in a plant. For this a radioisotope of that element is injected in the ground near the plant. After a few days the plant is laid on a photographic paper to produce an autoradiograph.The dark areas in the radiograph show the positions reached by the element. This technique gives valuable information regarding the optimum season for fertilizing crops and for poisoning weeds.

Industrial Uses :

There are many different uses to which radioisotopes are put in industry.These include radiography, gamma scanning of processequipment, use of radiotracers to study sediment transport at ports and harbors, flow measurements, hydrology and water resource management.Theisotope related services like sediment transportation, gamma scanning leakage detection and others have led to considerable monetary savings to the nation.By γ- ray photography we can find out wearing of cutting tools and lathes and can locate internal cracks in stones.We can check any non-uniformity in the thickness ofa sheet by β or γ- absorption measurements.The sheet is made to run continuously between a radioisotope (emitting β or γ-rays) and a counter.A change in the counting rate indicates a variation in the thickness of the sheet.The output from the counter may be used to correct the machinery, which is rolling the sheet as soon as a variation is detected, and thus the thickness is automatically kept constant.This method is used as a thickness control in the manufacture of paper, plastic, metal sheet, etc.The same method can be used to check sealed cigarette packets whether they are full or if one or more cigarette is missing.The packets areplaced on a conveyer belt running between radioisotope and a counter.An empty or partially filled packet gives a higher counting rate due to less absorption of radiation than with a completely filled packet.The increase in counting rate can be converted into an electronic signal which knocks the incomplete packet off the belt.In industry, the tracer technique is used for testing the uniformity of mixtures. For testing a chocolate mixture, a small quantity of short-lived radioisotopes such as 24Na or 56Mn is added to the primary ingredients. Several different samples of the final products are then tested for radioactivity by means of a G. M. counter. If each sample gives the same counting rate, then the mixing has been uniform. This method can be used in mixing processes occurring in the manufacture of chocolate, soap, cement paints, fertilizers, cattle food and medical tablets. The tracer technique is extremely sensitive in testing the sealing process in making envelopes for radio valves. A sample valve is filled with radio-krypton (85 Kr) and a G. M.counter is held outside the valve. The counter detects even an extremely poor leakage.

2 Medical Imaging:

The National Council on Aging and Quality estimates that 68 million CT scans are done in the United States.

Therapy with radiation (NCRP):-

About 10% of medical procedures involve the use of radiation to treat a range of illnesses, such as heart disease, gastrointestinal, endocrine, neurological, and other abnormalities within the body, as well as various cancers. Imaging in Medicine.A patient is positioned between an x-ray tube and a photographic plate to create an X-ray image.After that, a picture of the exposed area on the film can be examined.

• Teeth, bones, and breasts (mammograms) are the subjects of common x-rays.

Magnetic Resonance Imaging (MRI):

MRI is a diagnostic method that allows for detailed visualization of the body's internal structure MRI can create more detailed images of the human body than is possible with X-rays.• This procedure uses a magnetic field and pulses or radio waves to make pictures of organs and structures inside the body.The water in our bodies is made up of millions of atoms that are magnetically charged.When placed in a magnetic field these atoms line up with a field much like a compass points to the North Pole. Compared to X-rays, MRI can produce more precise images of the human body.• A magnetic field is used in this process.and radio waves or pulses to create images of the body's internal organs and structures.Our bodies' water is composed of millions of magnetically charged atoms.These atoms align with a magnetic field in a similar way to how a compass points in the direction of the North Pole.

Computerized Tomography (CT) scan:

This method can produce a three-dimensional x-ray and is frequently used to produce full motion heart scans for individuals with high used to identify tumors and brain bone trauma or as a risk factor for heart disease.

Conclusion

Radioisotopes have numerical applications in medicine, agriculture, industry and pure research. Many applications employ a special technique known as ―tracer technique‖.It is felt that in addition to the marathon efforts of scientists and engineers engaged in developing nuclear science and technology the sincere efforts of media in popularizing and propagating the beneficial uses of radioisotopes for national development are going to play a major role in realizing the full potential of atom and a radioisotope.Research and discovery of new radiopharmaceuticals generally involve initial studies in the various systems both of which present several inherent limitations.Many researchers performed the diagnostic and therapeutic studies with newly developed radiopharmaceuticals to investigate their imaging capability,cytotoxicity, receptor specificity.This review has outlined the samples of various radioisotopes explaning their therapeutic as well as diagnostic uses according the radioisotopes employed.

Reference

1) Hayter CJ.Radioactive Isotopes in Medicine: A Review J. Clin. Path. 1960; 13:369-90.

2) Lilley J.S.Nuclear Physics-Principles and Applications. John Wiley and Sons, Ltd, Singapore (2002); Ananthakrishnan M, Seminar talk on Applications of Radioisotopes and RadiationTechnology.

3)Bhubaneswar and Varma HC.Concepts of Physics Part 2, Bharati Bhawan Printers, Patna (1996).

4) Sahoo S. Production and Applications of Radioisotopes Physics Education 2006; 3:1-11.

5) Ansel's pharmaceutical dosage form and drug delivery system by loyd V.ALLEN ,Jr and thhoward C. ANSEL , 10 edition , published by wolters kluwer On page no. 638 .

6) The international pharmacopoeia (November 2008), World Health Org. Document QAS/08.262/ FINAL November 2008.

7) Becquerel H.Emission des radiations nouvelles par uranium metallique. CR Acad Sci Paris. 1896; 122:1086.

8) Curie mont G.Sur un nouvelle substance fortement radio-active contenue dans la pechblende. C R Acad Sci Gen.1898; 127:1215–18.

9) Roy RR and Nigam BP.Nuclear Physics-Theory and Experiment.John Wiley and Sons,Inc., New York (1967);Manchanda VK, technical talk on Radiation Technology Applications and Indian Nuclear Programme: Societal Benefits, in Aarohan 2K5 at NIT, Durgapur; Beiser A, Concepts of Modern Physics, McGraw-Hill Book Company, Singapore (1987).

10) Agarwal BS and Kedar Nath Ram Nath.Meerut (1996) A report on Atomic Energy in India: A Perspective ,Government of India, DAE, September (2002); and Kaplan I.Nuclear Physics, Narosa Publishing House, New Delhi (1992).

11) Radioisotope in medicine by EARLW W PEHLAN United states atomic energy commission chapter appendix instruments page 44-46 .

12) Radioisotopes: An overview by Kotya Naik Maloth, Nagalaxmi Velpula, Sridevi Ugrappa, Srikanth Kodangal EDORIUM JOURNAL ARTICLE January 2014 published on 25 April 2018 .

13) Production and Applications of Radioisotopes SUKADEV SAHOO1 AND SONALI SAHOO2 1Department of Physics, National Institute of Technology Durgapur 713209, India sukadevsahoo@yahoo.com 2 Indira Gandhi Memorial Ayurvedic Medical College and Hospital Pokhariput, Bhubaneswar, India.