Name: Abdulraheem Farida
Course: mls 314 medical physics
Matric number: 17/mhs06/003

Questions:

1. What are radioactive tracers?

2. Discuss explicitly one application of tracer in medicine.

Answers:

Tracers are substances with atomic or nuclear, physical, chemical or biological properties that can help identify, observe or follow the behavior of various physical, chemical or biological processes. Radioactive tracers are widely used to diagnose industrial reactors, for instance by measuring the flow rate of liquids, gases and solids.

A radioactive tracer is a chemical compound in which one or more atoms have been replaced by a radioisotope. Monitoring its radioactive decay, a radiotracer can be used to explore the mechanism of chemical reactions. They are also used for flow visualization through different technologies, such as Single Photon Emission Computed Tomography (SPECT), Position Emission Tomography (PET) and Computed Radioactive Particle Tracking (CARPT).

Radiotracer technology is playing a more and more important role in industry. It is used to diagnose specific causes of inefficiency in a plant or process operation and to generally investigate processes in industries and those related environments where a great cost-benefit ratio can be gleaned from process optimization and troubleshooting, such as in the transport of sediments. It is expected that this important role will continue to expand, especially if students and engineers are exposed in their academic training to the many possibilities of this tool for research, development and application.

Through its technical cooperation projects, the IAEA plays a major role in facilitating the transfer of radiotracer technology to developing Member States. It assists them with the development of its human resources, supports the education of young specialists and helps maintain good practices that are needed to ensure the sustainability of technologies and knowledge transfer. Training material developed for radiotracer specialists and radiotracer practitioners worldwide include for instance the radiotracer residence time distribution method for industrial and environmental applications.

Practitioners of nuclear medicine utilize small amounts of radioactive isotopes for diagnostic purposes. These isotopes, called radioactive tracers, enter the body by injection or ingestion. They emit a signal, usually gamma rays, that can be identified. The medical provider targets a particular organ or body part. The tracer provides valuable information that assists in making a diagnosis.

Process

Radioactive tracers utilize the positive qualities of radioactivity, the ability to emit a signal, while minimizing the negative effects. Isotopes use elements with a short half-life to reduce the dangers of radioactive exposure to the patient. A half-life represents the amount of time it takes for one-half of a substance's radioactivity to decay. For example, a material with a half-life of six hours will lose half of its radioactivity in six hours and then another one-half at the 12-hour mark, leaving one-fourth of its strength. The shorter the half-life the less radioactive exposure.

Material

The most common radioactive isotope used in radioactive tracers is technetium-99m, used in almost 30 million procedures in 2008, representing 80 percent of all nuclear medicine procedures, according to World Nuclear Association. It is an isotope of an artificial element, technetium, with a half-life of six hours, which provides enough time to perform the necessary diagnostic procedures, but provides patient safety. It is versatile and can be targeted to a specific organ or body part and emits gamma rays that provide the necessary information. Other radioactive tracers include iodine-131 for thyroid conditions, iron-59 iron to study metabolism in the spleen and potassium-42 for potassium in the blood.

CT scan

A major use of radioactive tracers involves computed X-ray tomography or CT scans. These scans constitute approximately 75 percent of medical procedures with tracers. The radioactive tracer produces gamma rays or single photons that a gamma camera detects. Emissions come from different angles and a computer uses them to produce an image. The treating physician orders a CT scan that targets a specific area of the body, like the neck or chest, or a specific organ, like the thyroid.

PET

Positron emission tomography, or PET, represents the latest technology to use radioactive tracers. It provides a more precise image and is used frequently in oncology with Flourine-18 as the tracer. PET is also used in cardiac and brain imaging with carbon-11 and nitrogen-13 radioactive tracers. Another innovation involves the combination of PET and CT into two images known as PETCT.

2.

In medicine, tracers are applied in a number of tests, such as autoradiography and nuclear medicine, including single photon emission computed tomography (SPECT), positron emission tomography (PET) and scintigraphy. The urea breath test for helicobacter pylori commonly used a dose of 14C labeled urea to detect h. pylori infection. If the labeled urea was metabolized by h. pylori in the stomach, the patient's breath would contain labeled carbon dioxide. In recent years, the use of substances enriched in the non-radioactive isotope 13C has become the preferred method, avoiding patient exposure to radioactivity.

- SPECT scans are primarily used to diagnose and track the progression of heart disease, such as blocked coronary arteries. There are also radiotracers to detect disorders in bone, gall bladder disease and intestinal bleeding. SPECT agents have recently become available for aiding in the diagnosis of Parkinson's disease in the brain, and distinguishing this malady from other anatomically-related movement disorders and dementias.
- The major purpose of PET scans is to detect cancer and monitor its progression, response to treatment, and to detect metastases. Glucose utilization depends on the intensity of cellular and tissue activity so it is greatly increased in rapidly dividing cancer cells. In fact, the degree of aggressiveness for most cancers is roughly paralleled by their rate of glucose utilization. In the last 15 years, slightly modified radiolabeled glucose molecules (F-18 labeled deoxyglucose or FDG) have been shown to be the best available tracer for detecting cancer and its metastatic spread in the body.
- A combination instrument that produces both PET and CT scans of the same body regions in one examination (PET/CT scanner) has become the primary imaging tool for the staging of most cancers worldwide.
- Recently, a PET probe was approved by the FDA to aid in the accurate diagnosis of Alzheimer's disease, which previously could be diagnosed with accuracy only after a patient's death. In the absence of this PET imaging test, Alzheimer's disease can be difficult to distinguish from vascular dementia or other forms of dementia that affect older people.