

General Nuclear Medicine

This information is reviewed by a physician with expertise in the area presented and is further reviewed by committees from the American College of Radiology (ACR) and the Radiological Society of North America (RSNA), comprising physicians with expertise in several radiologic areas.

What is General Nuclear Medicine?

Nuclear medicine is a branch of medical imaging that uses small amounts of radioactive material to diagnose or treat a variety of diseases, including many types of cancers, heart disease and certain other abnormalities within the body.

Nuclear medicine or radionuclide imaging procedures are noninvasive and usually painless medical tests that help physicians diagnose medical conditions. These imaging scans use radioactive materials called radiopharmaceuticals or radiotracers.

Depending on the type of nuclear medicine exam you are undergoing, the radiotracer is either injected into a vein, swallowed or inhaled as a gas and eventually accumulates in the organ or area of your body being examined, where it gives off energy in the form of gamma rays. This energy is detected by a device called a gamma camera, a (positron emission tomography) PET scanner and/or probe. These devices work together with a computer to measure the amount of radiotracer absorbed by your body and to produce special pictures offering details on both the structure and function of organs and tissues.

In some centers, nuclear medicine images can be superimposed with computed tomography (CT) or magnetic resonance imaging (MRI) to produce special views, a practice known as image fusion or co-registration. These views allow the information from two different studies to be correlated and interpreted on one image, leading to more precise information and accurate diagnoses. In addition, manufacturers are now making single photon emission computed tomography/computed tomography (SPECT/CT) and positron emission tomography/computed tomography (PET/CT) units that are able to perform both imaging studies at the same time.

Nuclear medicine also offers therapeutic procedures such as radioactive iodine (I-131) therapy that uses radioactive material to treat cancer and other medical conditions affecting the thyroid gland.

What are some common uses of the procedure?

Physicians use radionuclide imaging procedures to visualize the structure and function of an organ, tissue, bone or system of the body.

Nuclear medicine imaging scans are performed to:

- analyze kidney function.
- visualize heart blood flow and function (such as a myocardial perfusion scan).
- scan lungs for respiratory and blood flow problems.
- identify inflammation in the gallbladder.
- evaluate bones for fractures, infection, arthritis and tumors.
- determine the presence or spread of cancer in various parts of the body.
- identify bleeding into the bowel.
- locate the presence of infection.
- measure thyroid function to detect an overactive or underactive thyroid.
- investigate abnormalities in the brain, such as seizures, memory loss and abnormalities in blood flow.
- localize the lymph nodes before surgery in patients with breast cancer or melanoma.

Nuclear medicine therapies include:

- Radioactive iodine (I-131) therapy used to treat hyperthyroidism (overactive thyroid gland, for example, Graves' disease) and thyroid cancer.
- Radioactive antibodies used to treat certain forms of lymphoma (cancer of the lymphatic system).

- Radioactive phosphorus (P-32) used to treat certain blood disorders.
- Radioactive materials used to treat painful tumor metastases to the bones.

How should I prepare?

You may be asked to wear a gown during the exam or you may be allowed to wear your own clothing.

Women should always inform their physician or technologist if there is any possibility that they are pregnant or if they are breastfeeding their baby.

You should inform your physician and the technologist performing your exam of any medications you are taking, including vitamins and herbal supplements. You should also inform them if you have any allergies and about recent illnesses or other medical conditions.

Jewelry and other metallic accessories should be left at home if possible, or removed prior to the exam because they may interfere with the procedure.

You will receive specific instructions based on the type of scan you are undergoing.

What does the equipment look like?

Most nuclear medicine procedures are performed using a gamma camera, a specialized camera encased in metal that is capable of detecting radiation and taking pictures from different angles. It may be suspended over the examination table or it may be beneath the table. Often, gamma cameras are dual-headed with one camera above and one camera beneath the table. The camera could also be located within a large, doughnut-shaped scanner similar in appearance to a computed tomography (CT) scanner. In some imaging centers, the gamma camera is located beneath the exam table and out of view.

A positron emission tomography (PET) scanner is a large machine with a round, doughnut shaped hole in the middle, similar to a CT or MRI unit. Within this machine are multiple rings of detectors that record the emission of energy from the radiotracer in your body.

A computer aids in creating the images from the data obtained by the camera or scanner.

A probe is a small hand-held device resembling a microphone that can detect and measure the amount of the radiotracer in a small area of your body.

There is no specialized equipment used during radioactive iodine therapy, but the technologist or other personnel administering the treatment may cover your clothing and use lead containers

to shield the radioactive material you will be receiving.

How does the procedure work?

With ordinary x-ray examinations, an image is made by passing x-rays through your body from an outside source. In contrast, nuclear medicine procedures use a radioactive material called a radiopharmaceutical or radiotracer, which is injected into your bloodstream, swallowed or inhaled as a gas. This radioactive material accumulates in the organ or area of your body being examined, where it gives off a small amount of energy in the form of gamma rays. A gamma camera, PET scanner, or probe detects this energy and with the help of a computer creates pictures offering details on both the structure and function of organs and tissues in your body.

Unlike other imaging techniques, nuclear medicine imaging studies are less directed toward picturing anatomy and structure, and more concerned with depicting physiologic processes within the body, such as rates of metabolism or levels of various other chemical activity. Areas of greater intensity, called “hot spots,” indicate where large amounts of the radiotracer have accumulated and where there is a high level of chemical activity. Less intense areas, or “cold spots,” indicate a smaller concentration of radiotracer and less chemical activity.

In radioactive iodine (I-131) therapy, radioactive iodine (I-131) is swallowed, absorbed into the bloodstream in the gastrointestinal (GI) tract and concentrated from the blood by the thyroid gland where it destroys cells within that organ.

How is the procedure performed?

Nuclear medicine imaging is usually performed on an outpatient basis, but is often performed on hospitalized patients as well.

You will be positioned on an examination table. If necessary, a nurse or technologist will insert an intravenous (IV) line into a vein in your hand or arm.

Depending on the type of nuclear medicine exam you are undergoing, the dose of radiotracer is then injected intravenously, swallowed or inhaled as a gas.

It can take anywhere from several seconds to several days for the radiotracer to travel through your body and accumulate in the organ or area being studied. As a result, imaging may be done immediately, a few hours later, or even several days after you have received the radioactive material.

When it is time for the imaging to begin, the gamma camera will take a series of images. The camera may rotate around you or it may stay in one position and you will be asked to change positions in between images. While the camera is taking pictures, you will need to remain still for brief periods of time. In some cases, the camera may move very close to your body. This is necessary to obtain the best quality images. If you are claustrophobic, you should inform the technologist before your exam begins.

If a probe is used, this small hand-held device will be passed over the area of the body being studied to measure levels of radioactivity. Other nuclear medicine tests measure radioactivity levels in blood, urine or breath.

The length of time for nuclear medicine procedures varies greatly, depending on the type of exam. Actual scanning time for nuclear imaging exams can take from 20 minutes to several hours and may be conducted over several days.

When the examination is completed, you may be asked to wait until the technologist checks the images in case additional images are needed. Occasionally, more images are obtained for clarification or better visualization of certain areas or structures. The need for additional images does not necessarily mean there was a problem with the exam or that something abnormal was found, and should not be a cause of concern for you. You will not be exposed to more radiation during this process.

If you had an intravenous line inserted for the procedure, it will usually be removed unless you are scheduled for an operating room procedure that same day.

During radioactive iodine (I-131) therapy, which is most often an outpatient procedure, the radioactive iodine is swallowed, either in capsule or liquid form.

What will I experience during and after the procedure?

Most nuclear medicine procedures are painless and are rarely associated with significant discomfort or side effects.

If the radiotracer is given intravenously, you will feel a slight pin prick when the needle is inserted into your vein for the intravenous line. When the radioactive material is injected into your arm, you may feel a cold sensation moving up your arm, but there are generally no other side effects.

When swallowed, the radiotracer has little or no taste. When inhaled, you should feel no differently than when breathing room air or holding your breath.

With some procedures, a catheter may be placed into your bladder, which may cause temporary discomfort.

It is important that you remain still while the images are being recorded. Though nuclear imaging itself causes no pain, there may be some discomfort from having to remain still or to stay in one particular position during imaging.

Unless your physician tells you otherwise, you may resume your normal activities after your nuclear medicine scan. If any special instructions are necessary, you will be informed by a technologist, nurse or physician before you leave the nuclear medicine department.

Through the natural process of radioactive decay, the small amount of radiotracer in your body will lose its radioactivity over time. It may also pass out of your body through your urine or stool during the first few hours or days following the test. You may be instructed to take special precautions after urinating, to flush the toilet twice and to wash your hands thoroughly. You should also drink plenty of water to help flush the radioactive material out of your body as instructed by the nuclear medicine personnel.

Who interprets the results and how do I get them?

A radiologist who has specialized training in nuclear medicine will interpret the images and forward a report to your referring physician.

What are the benefits vs. risks?

Benefits

- The information provided by nuclear medicine examinations is unique and often unattainable using other imaging procedures.
- For many diseases, nuclear medicine scans yield the most useful information needed to make a diagnosis or to determine appropriate treatment, if any.
- Nuclear medicine is less expensive and may yield more precise information than exploratory surgery.

Risks

- Because the doses of radiotracer administered are small, diagnostic nuclear medicine procedures result in low radiation exposure, acceptable for diagnostic exams. Thus, the radiation risk is very low compared with the potential benefits.

- Nuclear medicine diagnostic procedures have been used for more than five decades, and there are no known long-term adverse effects from such low-dose exposure.
- Allergic reactions to radiopharmaceuticals may occur but are extremely rare and are usually mild. Nevertheless, you should inform the nuclear medicine personnel of any allergies you may have or other problems that may have occurred during a previous nuclear medicine exam.
- Injection of the radiotracer may cause slight pain and redness which should rapidly resolve.
- Women should always inform their physician or radiology technologist if there is any possibility that they are pregnant or if they are breastfeeding their baby.

What are the limitations of General Nuclear Medicine?

Nuclear medicine procedures can be time-consuming. It can take hours to days for the radiotracer to accumulate in the part of the body under study and imaging may take up to several hours to perform, though in some cases, newer equipment is available that can substantially shorten the procedure time. You will be informed as to how often and when you will need to return to the nuclear medicine department for further procedures.

The resolution of structures of the body with nuclear medicine may not be as clear as with other imaging techniques, such as CT or MRI. However, nuclear medicine scans are more sensitive than other techniques for a variety of indications, and the functional information gained from nuclear medicine exams is often unobtainable by any other imaging techniques.

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