

Cardiac 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 Cardiac 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.

Cardiac nuclear medicine studies provide pictures of the structure and function of the heart.

What are some common uses of the procedure?

Physicians use cardiac nuclear medicine studies to help diagnose cardiac disease. The symptoms include:

- unexplained chest pain.
- chest pain brought on by exercise (called angina).

Cardiac nuclear medicine imaging is also performed:

- to visualize blood flow patterns to the heart walls, called a myocardial perfusion scan.
- to evaluate the presence and extent of suspected or known coronary artery disease.
- to determine the extent of injury to the heart following a heart attack, or myocardial infarction.
- to evaluate the results of bypass surgery or other revascularization procedures designed to restore blood supply to the heart.
- in conjunction with an electrocardiogram (ECG), to evaluate heart-wall movement and overall heart function with a technique called cardiac gating.

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.

You should inform your physician if you have asthma or a chronic lung disease or have problems with your knees, hips or keeping your balance, which may limit your ability to perform the exercise needed for this procedure.

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 should avoid caffeine (caffeinated as well as decaffeinated coffee, hot and cold tea, energy drinks, etc.) and smoking for 48 hours before your examination.

You should not eat or drink anything after midnight on the day of your procedure, but you may continue taking medications with small amounts of water unless your physician says otherwise.

If you take beta-blocker medication (Inderal, metoprolol, etc.) you should specifically ask your physician about temporary discontinuation.

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.

Most nuclear medicine procedures use a gamma camera, a specialized camera encased in metal.

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

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.

In order to evaluate the coronary arteries, heart scans are often performed immediately after patients have engaged in physical exercise (called a stress test) so that blood flow throughout the heart is maximized, making any blockages of the coronary arteries easier to detect. These images of the heart are compared with heart images taken while the patient is at rest. Patients who are unable to exercise are given a drug that increases blood flow to the heart.

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. A nurse or technologist will insert an intravenous (IV) line into a vein in your hand or arm.

The exam will begin with a stress test, which requires you to exercise either by walking on a treadmill or pedaling a stationary bicycle for a few minutes. While you exercise, the electrical activity of your heart will be monitored by electrocardiography (ECG) and your blood pressure will be frequently measured. When blood flow to the heart has reached its peak, you will be given the radiotracer through your IV. About a minute later, you will stop exercising and you will be positioned on a moveable examination table.

If you are unable to use a treadmill or bicycle, you will not exercise but you will be given a drug that will increase blood flow to the heart.

Approximately one half-hour later, the imaging will begin. Once the technologist has positioned the gamma camera, it will move slowly in an arc over your chest.

This same heart scan will be performed at another time, when you have not been exercising (called a resting scan). Images of your heart obtained after you exercise will be compared with images of your resting heart.

Actual scanning time for each heart scan varies from 16-30 minutes, depending on the type of scanner used. Total time in the nuclear medicine department will be approximately two to four hours.

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.

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.

You will be asked to exercise until you are either too tired to continue or short of breath, or if you experience chest pain, leg pain, or other discomfort that causes you to want to stop.

If you are given a medication to increase blood flow because you are unable to exercise, the medication may induce a brief period of feeling anxious, dizzy, nauseous, shaky or short of breath. Mild chest discomfort may also occur. Any symptoms that do develop typically resolve as soon as the infusion is complete. In rare instances, if the side effects of the medication are severe or make you too uncomfortable, other drugs can be given to stop the effects.

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

- If you have coronary artery disease, it is possible that you could experience chest pain during the exercising or when a drug is given for the stress test. However, your heart will be monitored and if necessary, medication can be given for your chest pain.
- If life threatening cardiac disease is suspected because of the test findings, your cardiologist may consider same-day cardiovascular intervention.
- 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 Cardiac 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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