



Children's (Pediatric) Nuclear Medicine

Children's (pediatric) nuclear medicine imaging uses small amounts of radioactive materials called radiotracers, a special camera and a computer to help diagnose childhood disorders that are present at birth or that develop during childhood. It provides unique information that often cannot be obtained using other imaging procedures.



Tell your doctor about your child's recent illnesses, medical conditions, medications and allergies. Depending on the type of exam, your doctor will instruct you on what your child may eat or drink beforehand, especially if sedation is to be used. Most nuclear medicine exams will involve an injection in a vein in your child's arm or hand. Your child should wear loose, comfortable clothing and may be asked to wear a gown.

What is Children's (Pediatric) Nuclear Medicine?

Nuclear medicine is a branch of medical imaging that uses small amounts of radioactive material to diagnose and determine the severity of or treat a variety of diseases, including many types of cancers, heart disease, gastrointestinal, endocrine, neurological disorders and other abnormalities within the body. Because nuclear medicine procedures are able to pinpoint molecular activity within the body, they offer the potential to identify disease in its earliest stages as well as a patient's immediate response to therapeutic interventions.

Children's (pediatric) nuclear medicine refers to imaging examinations done in babies, young children and teenagers.

Nuclear medicine imaging procedures are noninvasive and, with the exception of intravenous injections, are usually painless medical tests that help physicians diagnose and evaluate medical conditions. These imaging scans use radioactive materials called radiopharmaceuticals or radiotracers.

Radiotracers are molecules linked to, or "labeled" with, a small amount of radioactive material that can be detected on the PET scan. They are designed to accumulate in cancerous tumors or regions of inflammation. They can also be made to bind to specific proteins in the body. The most commonly used

radiotracer is F-18 fluorodeoxyglucose, or FDG, a molecule similar to glucose. Cancer cells may absorb glucose at a higher rate, being more metabolically active. This higher rate can be seen on PET scans, and that allows your doctor to identify disease before it may be seen on other imaging tests. FDG is just one of many radiotracers in use or in development for a variety of conditions throughout the body.

Depending on the type of nuclear medicine exam, the radiotracer is either injected into the body, swallowed or inhaled as a gas and eventually accumulates in the organ or area of the body being examined. Radioactive emissions from the radiotracer are detected by a special camera or imaging device that produces pictures and provides molecular information.

In many 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 exams 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 exams at the same time. An emerging imaging technology, but not readily available at this time is PET/MRI.

What are some common uses of the procedure?

Children's (pediatric) nuclear medicine imaging is performed to help diagnose childhood disorders that are congenital (present at birth) or that develop during childhood.

Physicians use nuclear medicine imaging to evaluate organ systems, including the:

- kidneys and bladder.
- bones.
- liver and gallbladder.
- gastrointestinal tract.
- heart.
- lungs.
- brain.
- thyroid.

Nuclear medicine scans are typically used to help diagnose and evaluate:

- urinary blockage in the kidney.
- backflow of urine from the bladder into the kidney (reflux).
- bone cancer, infections and trauma.
- gastrointestinal bleeding and motility.
- tumors and the spread of cancerous cells in the body.
- jaundice in newborns and older children.
- epilepsy.
- location, anatomy and function of the thyroid gland.

How does the nuclear medicine procedure work?

With ordinary x-ray examinations, an image is made by passing x-rays through the patient's body. In contrast, nuclear medicine procedures use a radioactive material, called a radiopharmaceutical or radiotracer, which is injected into the 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. Special cameras detect this energy, and with the help of a computer, create pictures offering details on both the structure and function of organs and tissues in your body.

Hybrid imaging techniques (PET/CT, SPECT/CT and PET/MR) are most often used in children with cancer, epilepsy and back pain.

What does the equipment look like?

The special camera and imaging techniques used in nuclear medicine include the gamma camera and single-photon emission-computed tomography (SPECT).

The gamma camera, also called a scintillation camera, detects radioactive energy that is emitted from the patient's body and converts it into an image. The gamma camera itself does not emit any radiation. The gamma camera is composed of radiation detectors, called gamma camera heads, which are encased in metal and plastic and most often shaped like a box, attached to a round circular donut shaped gantry. The patient lies on the examination table which slides in between two parallel gamma camera heads that are positioned above the patient and beneath the examination table. Sometimes, the gamma camera heads are oriented at a 90 degree angle and placed over the patient's body.

SPECT involves the rotation of the gamma camera heads around the patient's body to produce more detailed, three-dimensional images.

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

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 child's body.

How is the procedure performed?

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

The type of nuclear medicine examination will determine how the radiotracer is introduced into your child's body:

- **Intravenous:** a small needle is used to inject the radiotracer. The needle is removed immediately after. At times, an indwelling intravenous catheter may be needed for the duration of the exam.
- **Oral:** for some exams, the radiotracer is taken by mouth, such as for a gastroesophageal reflux test.

- Inhaled: occasionally the radiotracer will be inhaled as a gas via a mask, such as with a lung scan.
- Bladder: some exams require a catheter to be inserted into the bladder, such as with a vesicoureteral reflux study.

It can take several seconds to a few days for radiotracers to travel through your child's body and accumulate in the organ or area being studied. As a result, imaging may be done immediately, a few hours later, or even a few days after your child receives the radioactive material.

When it is time for the imaging to begin, your child will lie down on an examination table. The gamma camera will then take a series of images. The camera may rotate around your child or the camera will stay in one position and your child will be asked to change positions in between images. While the camera is taking pictures, your child will need to remain still for brief periods of time. Actual scanning time varies from 20 minutes to several hours. Examinations that require longer imaging times may necessitate sedation for your child. You will receive instructions prior to the exam if your child will need sedation for the imaging.

During this procedure, parents are usually allowed and often encouraged to stay in the room. The exception to this is if the child's mother is pregnant.

When the examination is completed, your child will be asked to wait until the nuclear physician checks the images in case additional images are needed.

What will my child experience during and after the procedure?

Except for intravenous injections, most nuclear medicine procedures are painless and are rarely associated with significant discomfort or side effects.

If the radiotracer is given intravenously, your child will feel a pin prick, much like a shot, when the needle is inserted into the vein. When the radioactive material is injected into the arm, your child will generally not experience any discomfort. When swallowed, the radiotracer has little or no taste. If inhaled, your child should feel no differently than when breathing room air or holding his or her breath.

With some exams, a catheter may be placed into the bladder, which may cause temporary discomfort.

It is important that your child remain very still while the images are being recorded. Though nuclear imaging itself causes no pain, children may experience some discomfort from having to remain still during imaging. Parents are encouraged to stay with their children to help them remain calm and still during imaging. Comfort items such as pacifiers, blankets and books are also very helpful. Often, a monitor with children's programming and/or children's DVDs are available in the scanning room.

Unless your physician tells you otherwise, your child may resume his/her normal activities after the nuclear medicine scan. If the child has been sedated, you will receive specific instructions to be followed after leaving the nuclear medicine facility.

Through the natural process of radioactive decay, the small amount of radiotracer in your child's body will lose its radioactivity over time. In many cases, the radioactivity will dissipate over the first 24 hours following the test and pass out of your child's body through urine or stool. Your child should also drink

plenty of water to help flush the radioactive material from his or her body.

How should I prepare my child for the procedure?

You may reassure your child that you will be able to stay in the room with her/him during the procedure. If your child is old enough, you may choose to explain the procedure yourself. Most pediatric nuclear medicine exams will involve an injection into a vein in your child's arm or hand.

Children should wear comfortable, loose-fitting clothing to the exam, but they may be given a gown to wear during the 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 inform your physician of any medications your child is taking as well as vitamins and herbal supplements and if he or she has any allergies. Also inform your doctor of any recent illnesses or other medical conditions.

Depending on the type of nuclear scan being performed, you will receive specific preparation instructions for what your child may eat and drink before the exam, especially if your physician plans to use sedation for the procedure.

Who interprets the results and how do we get them?

A radiologist or other physician who has specialized training in nuclear medicine will interpret the images and send 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.

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. For more information about

safety in pediatric radiology procedures, visit the Image Gently website

- 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 your child may have or other problems that may have occurred during a previous nuclear medicine exam.

What are the limitations of Children's (Pediatric) Nuclear Medicine?

Nuclear medicine procedures can be time consuming. It can take several hours to days for the radiotracer to accumulate in the body part of interest 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.

The resolution of structures of the body with nuclear medicine may not be as high 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 other imaging techniques.

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