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 or general anesthesia 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 imaging uses small amounts of radioactive material to diagnose, evaluate or treat a variety of diseases. These include many types of cancers, heart disease, gastrointestinal, endocrine or neurological disorders and other abnormalities. Because nuclear medicine exams can pinpoint molecular activity, they have the potential to identify disease in its earliest stages. They can also show whether a patient is responding to treatment.

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

Nuclear medicine imaging procedures are noninvasive. With the exception of intravenous injections, they are usually painless. These tests use radioactive materials called radiopharmaceuticals or radiotracers to help doctors diagnose and evaluate medical conditions.

Radiotracers are molecules linked to, or "labeled" with, a small amount of radioactive material that can be detected on the PET scan. Radiotracers accumulate in tumors or regions of inflammation. They can also 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 are more metabolically active and may absorb glucose at a higher rate. This higher rate can be seen on PET scans. This 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.

Depending on the type of exam, the radiotracer is injected, swallowed or inhaled as a gas. It eventually accumulates in the area of the body under examination. A special camera or imaging device detects radioactive emissions from the radiotracer. The camera or device produces pictures and provides molecular information.

Many centers superimpose nuclear medicine images with computed tomography (CT) or magnetic resonance imaging (MRI) to produce special views. This is known as image fusion or co-registration. These views allow the doctor to correlate and interpret information from two different exams on one image. This leads to more precise information and accurate diagnoses. Single photon emission computed tomography/computed tomography (SPECT/CT) and positron emission tomography/computed tomography (PET/CT) units can perform both exams at the same time. PET/MRI is an emerging imaging technology. However, it is not universally available at this time.

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?

Ordinary x-ray exams create an image by passing x-rays through the body. Nuclear medicine exams use a radioactive material called a radiopharmaceutical or radiotracer. This material is injected into the bloodstream, swallowed or inhaled as a gas. The material accumulates in the area of your body under examination, 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 that offer details on the structure and function of organs and tissues.

Hybrid imaging techniques (PET/CT, SPECT/CT and PET/MR) acquire two types of scans at the same time and are most often used in children with cancer, epilepsy and back pain.

What does the equipment look like?

A PET scanner is a large machine with a round, donut-shaped hole in the middle. It looks similar to a CT or MRI unit. Multiple rings of detectors inside the machine record the energy emissions from the radiotracer in your body.

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. 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 helps create 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 performed on outpatients and hospitalized patients.

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

- **Intravenous** - a small needle is used to inject the radiotracer. The needle is removed immediately after injection. Sometimes, an intravenous catheter must stay in place for the duration of the exam.
- **Oral** - the radiotracer is taken by mouth, such as for a gastric emptying test.
- **Inhaled** - the radiotracer will be inhaled as a gas via a mask, such as with a lung scan.
- **Bladder** - a catheter is 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 require sedation or general anesthesia for your child, in which case you will receive preparation instructions prior to the exam.

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. They 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 remains 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, books and songs are also very helpful. Often, a monitor with children's programming and/or children's DVDs are available in the scanning room. You may also play your child's preferred videos on your personal mobile device or tablet.

Unless your physician tells you otherwise, your child may resume normal activities after the nuclear medicine scan. If your child has been sedated or received general anesthesia, 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 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.

Leave jewelry and other metallic accessories at home or remove them prior to the exam. Such objects may interfere with the procedure.

You should inform your physician of any medications your child is taking, including vitamins and herbal supplements, in addition to 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 or general anesthesia for the procedure.

Who interprets the results and how do we get them?

A radiologist or other doctor specially trained 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 radiotracers may occur but are extremely rare and are usually mild. Nevertheless, you should inform the nuclear medicine staff 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 area of interest, and imaging may take up to several hours to perform. In some cases, newer equipment can substantially shorten the procedure time.

The image resolution of nuclear medicine images may not be as high as that of CT or MRI. However, nuclear medicine scans are more sensitive for a variety of indications, and the functional information they yield is often unobtainable by other imaging techniques.

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