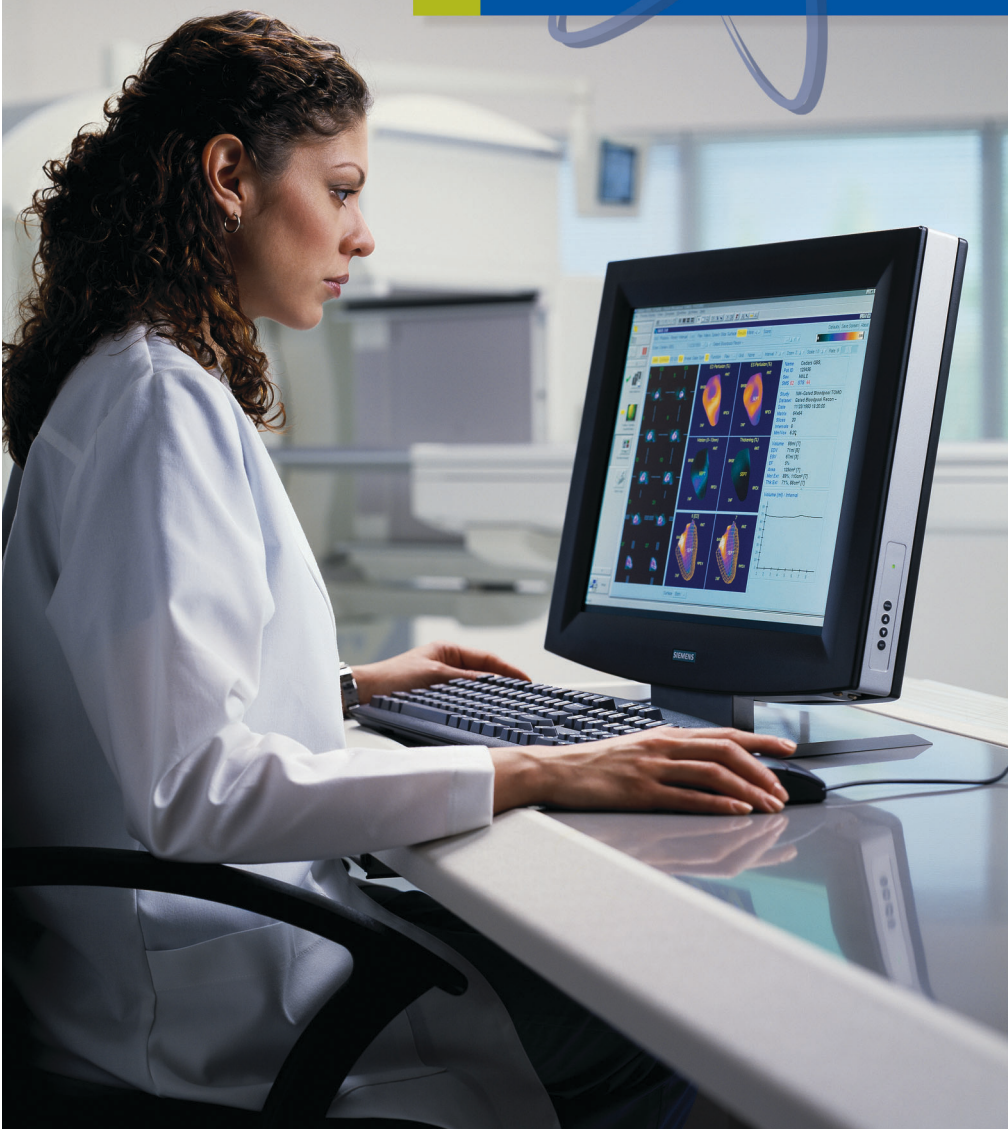


What is Nuclear Medicine?

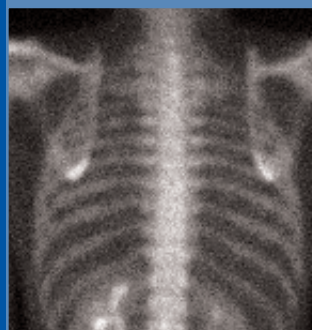


What is Nuclear Medicine?

Nuclear medicine specialists use safe, painless, and cost-effective techniques to image the body and treat disease. Nuclear medicine imaging is unique, because it provides doctors with information about both structure and function. It is a way to gather medical information that would otherwise be unavailable, require surgery, or necessitate more expensive diagnostic tests. Nuclear medicine imaging procedures often identify abnormalities very early in the progress of a disease—long before many medical problems are apparent with other diagnostic tests.

Nuclear medicine uses very small amounts of radioactive materials (radiopharmaceuticals) to diagnose and treat disease. In imaging, the radiopharmaceuticals are detected by special types of cameras that work with computers to provide very precise pictures about the area of the body being imaged. In treatment, the radiopharmaceuticals go directly to the organ being treated. The amount of radiation in a typical nuclear imaging procedure is comparable with that received during a diagnostic x-ray, and the amount received in a typical treatment procedure is kept within safe limits.

Today, nuclear medicine offers procedures that are essential in many medical specialties, from pediatrics to cardiology to psychiatry. New and innovative nuclear medicine treatments that target and pinpoint molecular levels within the body are revolutionizing our understanding of and approach to a range of diseases and conditions.



What Happens During a Nuclear Medicine Procedure?

Nuclear medicine tests (also known as scans, examinations, or procedures) are safe and painless. In a nuclear medicine test, small amounts of radiopharmaceuticals are introduced into the body by injection, swallowing, or inhalation. Radiopharmaceuticals are substances that are attracted to specific organs, bones, or tissues. The amount of radiopharmaceutical used is carefully selected to provide the least amount of radiation exposure to the patient but ensure an accurate test. A special camera (PET, SPECT or gamma camera) is then used to take pictures of your body. The camera detects the radiopharmaceutical in the organ, bone or tissue and forms images that provide data and information about the area in question. Nuclear medicine differs from an x-ray, ultrasound or other diagnostic test because it determines the presence of disease based on biological changes rather than changes in anatomy.

Safety

Nuclear medicine procedures are among the safest diagnostic imaging exams available. To obtain diagnostic information, a patient is given a very small amount of a radiopharmaceutical. Because such a small amount is used, the amount of radiation received from a nuclear medicine procedure is comparable to, or often times less than, that of a diagnostic x-ray. The nuclear medicine team will carefully perform the most appropriate examination for the patient's particular medical problem and thereby avoid any unnecessary radiation exposure.

Although we don't think much about it, everyone is continually exposed to radiation from natural and manmade sources. For most people, natural background radiation from air and space, rocks, soil, and even atoms in your own body, accounts for 85 percent of the radiation you receive annually. Additional exposure to radiation comes from consumer products such as household smoke detectors, color television sets, and luminous clock dials. The remaining radiation is from x-rays and radioactive materials used for medical diagnosis and therapy. Most nuclear medicine procedures expose patients to about the same amount of radiation as they receive in a few months of normal living.

The History of Nuclear Medicine

One of the earliest instances of nuclear medicine occurred in 1946 when radioactive iodine, via an “atomic cocktail,” was first used to treat thyroid cancer. The thyroid gland took up the radioactive iodine and the radiation eradicated the cancer cells, curing the patient. Widespread clinical use of nuclear medicine began in the early 1950s.

In addition to curing thyroid cancer, radioactive iodine, in much smaller doses, was used to measure the function of the thyroid and to diagnose thyroid disease. Physicians began to use “nuclear medicine” for the treatment of hyperthyroidism, a condition where the thyroid over-produces thyroid hormones.

As more knowledge was gained about basic biochemical processes, using radioactive versions of certain elements to “trace” these metabolic processes led to dramatic breakthroughs in diagnostic medicine. (Unlike a diagnostic X-ray where radiation is passed through the body, nuclear medicine tracers are taken internally; external detectors measure the radiation that they emit. The amount of radiation that a patient is exposed to is about the same.)

In the 1960s and the years that followed, the growth of nuclear medicine as a specialty discipline was phenomenal. Initially, techniques were

developed to measure blood flow to the lungs and to identify cancer “hot spots.”

By the 1970s most organs of the body could be visualized with nuclear medicine procedures, including liver and spleen scanning, brain tumor localization, and studies of the gastrointestinal tract. In 1971 the American Medical Association officially recognized nuclear medicine as a medical specialty.

In the 1980s, radiopharmaceuticals were designed for such critical diagnoses as heart disease and cancer. Also in the 1980s compounds were developed, including monoclonal antibodies and FDG, that carried radioactive elements directly and specifically to cancer cells. At small doses, these radiopharmaceuticals can be used to identify the existence and location of cancer cells long before they are visible using traditional imaging methods. At higher doses, radiolabeled monoclonal antibodies are used today to deliver a therapeutic dose of radiation directly to cancer cells.

In 1989 the FDA approved the first positron radiopharmaceutical (Rubidium-82) for myocardial perfusion imaging. Special cameras can detect photons, not normally emitted by the body but produced in the blood stream by certain radiopharmaceuticals, and compute a map of the

way that blood is being distributed to heart tissue.

By the 1990s, PET (Positron Emission Tomography) was becoming an important diagnostic tool. PET also uses photos produced by positrons, but PET provides more detailed images. The history of PET has been one of continuous improvement in the resolution and sensitivity of the imaging devices. Despite advances in other imaging methods such as CT and MRI, the ability to image the metabolic abnormalities associated with disease has made PET one of the most significant diagnostic tools ever developed.

The next generation in PET technology, PET/CT fusion imaging, has the ability to combine CT structural information with PET's metabolic information into a single set of images. This ability to detect the exact location of a metabolic "hot spot" by overlaying the PET and CT images provides priceless information for physicians in the treatment of cancer and other metabolic diseases.

In the years to come, as more is learned about the fundamental processes of diseases and as new radiopharmaceuticals and analysis

tools are developed, PET and PET/CT scanning will prove to be an invaluable tool in the diagnosis and treatment of some of the most critical diseases challenging modern medicine.



Top: The first scanner was introduced by Benedict Cassen in 1951.
Middle: The Image Display and Analysis minicomputer system in 1968.
Bottom: Nuclear Medicine team evaluates patient scan.

High Degree of Training

Nuclear medicine is practiced only by licensed physicians who are assisted by certified technologists and supported by specially trained physicists and pharmacists. Nuclear medicine combines chemistry, physics, mathematics, computer technology, and medicine in using radioactivity to diagnose and treat disease.



Physicians

Physicians certified by the American Board of Nuclear Medicine must first receive a medical degree and have one or more years of training in a medical specialty other than nuclear medicine. A further two years of training in nuclear medicine is then required during which special instruction is given in physics, radiopharmacy and radiation biology, as well as patient evaluation, radionuclide therapy and diagnostic studies. Cost-effective approaches to patient care are emphasized.



Technologists

Approximately 100 accredited Nuclear Medicine Technology programs currently offer instruction and clinical internships. The general prerequisites depend on the type of program offered, but usually include a science and mathematics background along with an interest in working with patients.

The programs currently available are:

- A one-year certificate program
- A two-year associates program
- A four-year bachelors program

The student must then pass a certification to be designated as a Certified Nuclear Medicine Technologist (CNMT).



Scientists

Leading universities and teaching hospitals provide specialized training to (1) physicists, who ensure the reliability and quality of the instruments used in the performance of tests; (2) pharmacists, who specialize in providing reliable and safe radiopharmaceuticals for patient exams; and (3) radiochemists, who develop and improve radiopharmaceuticals.

Nuclear Medicine: An Integral Part of Patient Care

Nuclear medicine studies can help diagnosis and treat many diseases. Some areas in which nuclear medicine is used include:



Neurologic Applications:

- Stroke
- Alzheimer's Disease
- Demonstrate Changes in AIDS Dementia
- Evaluate Patients for Carotid Surgery
- Localize Seizure Foci
- Evaluate Post Concussion Syndrome
- Diagnose Multi-Infarct Dementia

Oncologic Applications:

- Tumor Localization
- Tumor Staging
- Identify Metastatic Sites
- Judge Response to Therapy
- Relieve Bone Pain Caused by Cancer

Orthopedic Applications:

- Identify Occult Bone Trauma (Sports Injuries)
- Diagnose Osteomyelitis
- Evaluate Arthritic Changes and Extent
- Localize Sites for Tumor Biopsy
- Measure Extent of Certain Tumors
- Identify Bone Infarcts in Sickle Cell Disease

Renal Applications:

- Detect Urinary Tract Obstruction
- Diagnose Renovascular Hypertension
- Measure Differential Renal Function
- Detect Renal Transplant Rejection
- Detect Pyelonephritis
- Detect Renal Scars

Cardiac Applications:

- Coronary Artery Disease
- Measure Effectiveness of Bypass Surgery
- Measure Effectiveness of Therapy for Heart Failure
- Detect Heart Transplant Rejection
- Select Patients for Bypass or Angioplasty
- Identify Surgical Patients at High Risk for Heart Attacks
- Identify Right Heart Failure
- Measure Chemotherapy Cardiac Toxicity
- Evaluate Valvular Heart Disease
- Identify Shunts and Quantify Them
- Diagnose and Localize Acute Heart Attacks Before Enzyme Changes

Pulmonary Applications:

- Diagnose Pulmonary Emboli
- Detect Pulmonary Complications of AIDS
- Quantify Lung Ventilation and Perfusion
- Detect Lung Transplant Rejection
- Detect Inhalation Injury in Burn Patients

Other Applications:

- Diagnose and Treat Hyperthyroidism (Graves' Disease)
- Detect Acute Cholecystitis
- Chronic Biliary Tract Dysfunction
- Detect Acute Gastrointestinal Bleeding
- Detect Testicular Torsion
- Detect Occult Infections
- Diagnose and Treat Blood Cell Disorders

Ask your physician or local nuclear medicine department for more details on specific nuclear medicine procedures.

Nuclear Medicine Fast Facts

- « An estimated 16 million nuclear medicine imaging and therapeutic procedures are performed each year in the United States. Of these, 40-50% are cardiac exams and 35-40% are cancer related.
- « Nuclear medicine procedures are cost-effective.
- « There are nearly 100 different nuclear medicine imaging procedures available today.
- « Unlike other tests/procedures, etc., nuclear medicine provides information about the function of virtually every major organ system within the body.
- « Nuclear medicine procedures are among the safest diagnostic imaging tests available.
- « The amount of radiation in a nuclear medicine procedure is comparable to that received during a diagnostic x-ray.
- « Children commonly undergo nuclear medicine procedures to evaluate bone pain, injuries, infection, or kidney and bladder function.
- « Nuclear medicine procedures are painless and do not require anesthesia.
- « Common nuclear medicine applications include diagnosis and treatment of hyperthyroidism (Graves' Disease), cardiac stress tests to analyze heart function, bone scans for orthopedic injuries, lung scans for blood clots, and liver and gall bladder procedures to diagnose abnormal function or blockages.
- « There are approximately 4,000 board-certified nuclear medicine physicians and 15,700 certified nuclear medicine technologists worldwide.
- « Nuclear medicine is an integral part of patient care and contributes to the well being of patients worldwide.

Brochure images courtesy of Henry N. Wagner, Jr., M.D.; Siemens Medical Solutions, USA, Inc.; Philips Medical Systems; and Digirad.



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