SNMMI | SOCIETY OF NUCLEAR MEDICINE & MOLECULAR IMAGING

Molecular Imaging and Breast Cancer

Breast cancer is the most common cancer in women and the second leading cause of cancer death. It is estimated that for every eight women in the United States, one will be diagnosed with breast cancer at some point in her lifetime. Breast cancer can occur in both women and men, though it is rarer in men. According to estimates by the American Cancer Society, more than 310,720 women in the United States will be diagnosed with breast cancer in 2024.

Accurately pinpointing the location of the tumor(s) and determining whether the cancer has spread to other parts of the body helps determine the treatment options for people with breast cancer.

What is molecular imaging and how does it help people with breast cancer?

Molecular imaging is a type of medical imaging that provides detailed pictures of what is happening inside the body at the molecular and cellular level. Where other diagnostic imaging procedures—such as x-rays, computed tomography (CT) and magnetic resonance imaging (MRI)—mainly offer pictures of the anatomy of the body, molecular imaging allows physicians to see how the body is functioning and to measure some of its biological processes such as sugar metabolism.

Molecular imaging offers unique insights into the human body that allow physicians to choose a treatment that is specific to the distinct characteristics of a patient's cancer and tailor the management of their care. Molecular imaging is able to:

- provide information that cannot be found with other imaging technologies or that would require more invasive procedures such as biopsy (removing a sample of tissue from the body in order to examine it more closely) or surgery
- identify disease in its earliest stages and determine the exact location of a tumor, often before symptoms occur or abnormalities can be detected with other diagnostic tests
- determine the extent or severity of the disease, including whether it has spread elsewhere in the body
- select the best therapy based on the unique biologic characteristics of the patient and the molecular properties of a tumor or other disease
- predict the likelihood that a tumor will respond to specific drugs
- assess how well a treatment is working
- change a treatment plan quickly in response to early signs that it is not working
- determine whether a disease is progressing
- monitor for whether the disease comes back

How does molecular imaging work?

When disease occurs, some cells in the body begin to change their behavior. For example, cancer cells multiply at a much faster rate and are more active than normal cells. Molecular imaging can detect these cellular changes that often occur well before changes can be seen on other kinds of imaging such as CT and MRI.

Most molecular imaging procedures involve an imaging device, such as a PET scanner, and an imaging agent called a radiotracer. A radiotracer is a compound that includes a very small amount of a radioactive atom.

Once the radiotracer is introduced into the body, it collects in a target organ or sticks to specific types of cells. The scanner detects the radiotracer and creates pictures that show where the radiotracer has gone in the body. This helps physicians locate diseases such as cancer.

What molecular imaging technologies are used for breast cancer?

Some of the molecular imaging technologies currently being used for breast cancer can evaluate:

- **The breast**:
  - Molecular Breast Imaging (MBI)—This is especially useful for detecting tumors in dense breasts. MBI is available at select medical centers in the United States. Ask your primary care practitioner about MBI in your community. If your provider is unsure about the status of MBI cameras in your community, please encourage your provider to discuss MBI with a local nuclear medicine physician or radiologist to learn more. MBI is FDA approved; however insurance coverage may vary. Ask your specific insurance carrier regarding coverage.
  - Dedicated Breast PET (dbPET)—This images the breast using Positron Emission Tomography (PET) scanning, usually combined with computed tomography (CT) scanning, or PET-CT.
- **Lymph nodes that drain the breast**:
  - Lymphoscintigraphy helps identify the first few, or "sentinel," lymph nodes that filter lymph fluid from the site of a cancer—and are most likely to contain cancer cells if the tumor has metastasized, or spread. A biopsy of these lymph node(s) can be performed, if deemed necessary.
- **The whole body:**
  - Full-Body PET—In addition to scanning only the breast, PET scans can be used to scan the entire body to check for potential spread of the cancer to the bones or other organs.

What is PET?

Positron emission tomography (PET) is a type of molecular imaging that is able to show certain radiotracers that collect in the body's tissues and organs. Like other types of molecular imaging, PET involves the use of an imaging device (PET scanner) and a radiotracer that is injected into the patient's bloodstream. Different kinds of radiotracers can show different kinds of information about what is happening in the body.

Once the radiotracer has had time to collect in the body's tissues and organs, the patient is placed in a PET scanner, which takes pictures of the radiotracer and creates 3D images that show how the radiotracer is distributed throughout the body.

Because some types of cancer cells absorb more radiotracer than normal cells, they appear brighter on PET scans. Areas where a large amount of radiotracer collects are sometimes called "hot spots" because they appear brighter than the surrounding tissue. These images help physicians determine how well organs and tissues are working and detect problem areas such as tumors.

PET-CT is a combination of PET and computed tomography (CT), which produces highly detailed views of the body. This combination allows information from two different types of scans to be viewed in a single set of pictures. CT imaging uses advanced x-ray equipment to produce detailed 3D pictures of the body. A combined PET-CT study provides detail on both the anatomy (CT) and function (PET) of the body's tissues.

A qualified imaging professional such as a nuclear medicine physician or nuclear radiologist reviews the scans and shares the results with the patient's doctor.

Are there different types of PET exams?

Yes. The most common type of PET exam uses a radiotracer called FDG (fluorodeoxyglucose). FDG is a type of sugar containing a tiny amount of a radioactive element (fluorine 18) that can be detected by the PET scanner. FDG PET scans the body for cancer cells, which often use more sugar than normal cells.

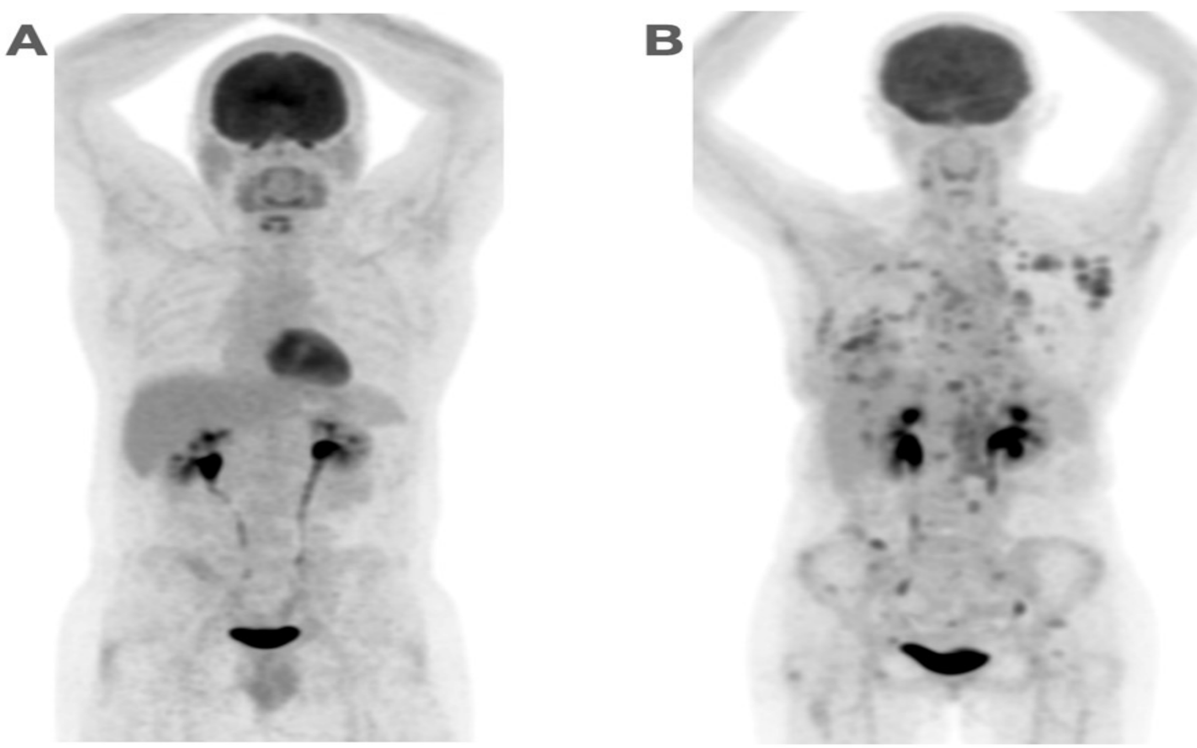

Image created by and used with permission from Courtney Lawhn Heath, MD, UCSF.

Figure 1: This figure shows what an FDG ("sugar") PET scan looks like in two different patients with breast cancer. The FDG PET scan labeled "A" is a normal scan, with no evidence of cancer. The FDG PET scan labeled "B" has multiple abnormal "hot spots" throughout the body, indicating the presence of metastatic disease (cancer that has spread outside the breast).

A new type of PET exam approved by the FDA in 2020 uses a radiotracer called FES (fluoroestradiol, brand name Cerianna). FES PET images estrogen receptors throughout the body and can detect breast cancer tumor deposits for tumors that have these receptors. Your doctor may use the information from an FES PET scan to help select the most appropriate treatment for you.

FES PET is available at [select medical centers in the United States.]

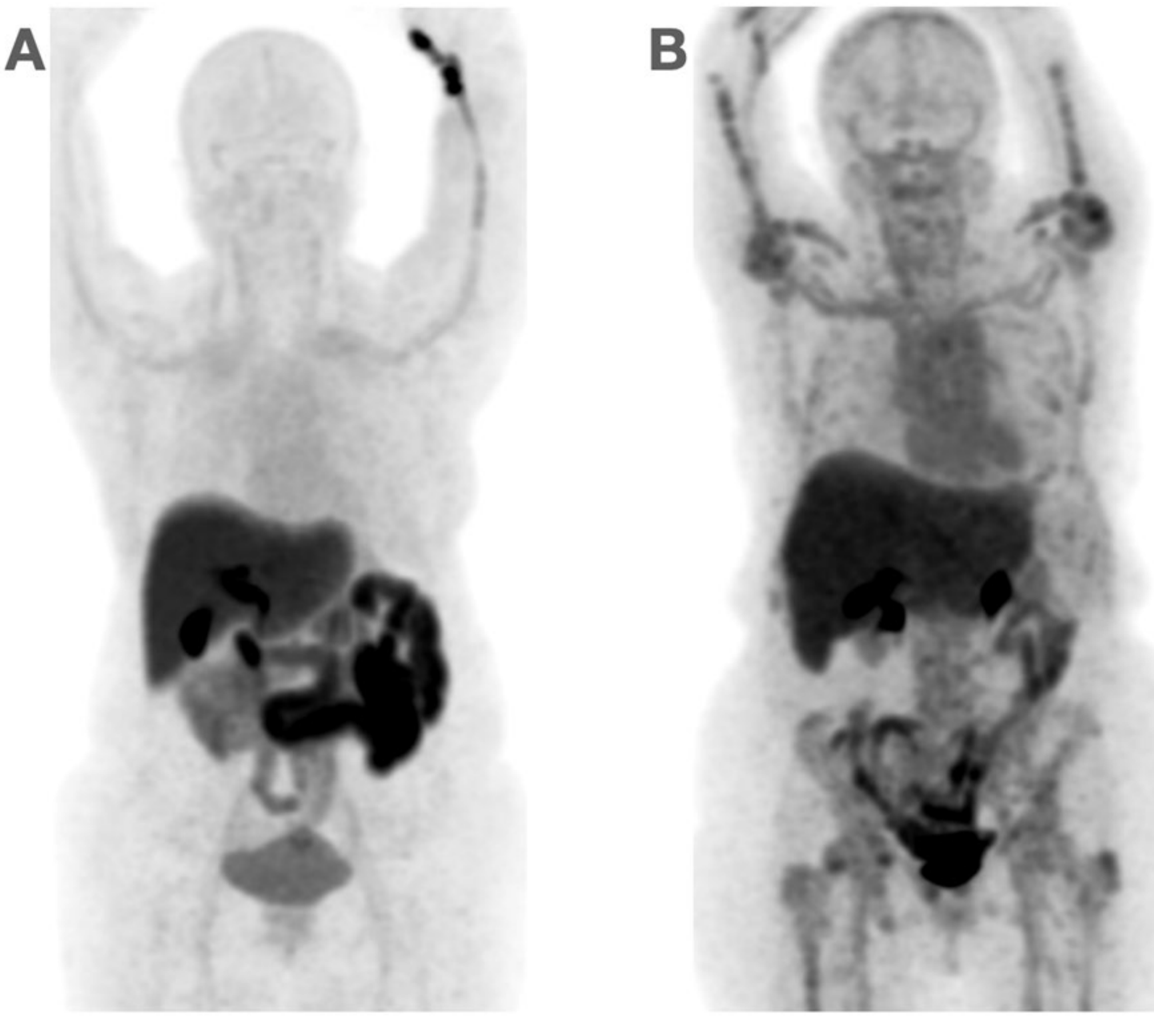

Image created by and used with permission from Courtney Lawhn Heath, MD, UCSF.

Figure 2: This figure shows what an FES ("estrogen receptor") PET looks like in two different patients with breast cancer. The FES PET scan labeled "A" is a normal scan, with no evidence of cancer. The FES PET scan labeled "B" has multiple abnormal "hot spots" throughout the skeleton, indicating the presence of estrogen receptor positive metastatic disease (cancer that has spread outside the breast) in the bones.

What do I need to know about radiation dose from molecular imaging?

We receive low levels of radiation all day, every day, simply by living on Earth. This is called background radiation. According to the Nuclear Regulatory Commission (NRC), on average, US residents receive an annual radiation exposure from natural sources of about 310 millirem per year, or just under 1 millirem per day. The NRC has set 5,000 millirem per year as the limit for radiation safety workers.

The exposure to radiation from most diagnostic procedures ranges from about 10 millirem (for a chest x-ray) to 1,500 millirem (for an FDG PET-CT scan).

Nuclear medicine specialists use the ALARA (As Low As Reasonably Achievable) principle to carefully select the amount of radiopharmaceutical that will provide an accurate test with the least amount of radiation exposure to the patient. The actual dosage is determined by the patient's body weight, the reason for the study and the body part being imaged. The targeted nature of radiopharmaceuticals allows them to be delivered mostly to the organ of interest while maintaining a low whole-body radiation exposure.

More information about nuclear medicine and radiation safety can be found here: Nuclear Medicine and Radiation Safety Factsheet

Are molecular imaging procedures covered by insurance?

Most PET-CT studies for breast cancer are covered by Medicare and Medicaid. Major insurance companies and health maintenance organizations also provide coverage for PET-CT studies for breast cancer. Patients should check with their insurance companies for specific information on their health plan's coverage and payment policies.

About SNMMI

The Society of Nuclear Medicine (SNMMI) is an international scientific and medical organization dedicated to raising public awareness about nuclear and molecular imaging and therapy and how they can help provide patients with the best health care possible. With more than 18,000 members, SNMMI has been a leader in unifying, advancing and optimizing nuclear medicine and molecular imaging since 1954.

The material presented in this pamphlet is for informational purposes only and is not intended as a substitute for discussions between you and your physician. Be sure to consult with your physician or the nuclear medicine department where the treatment will be performed if you want more information about this or other nuclear medicine procedures.