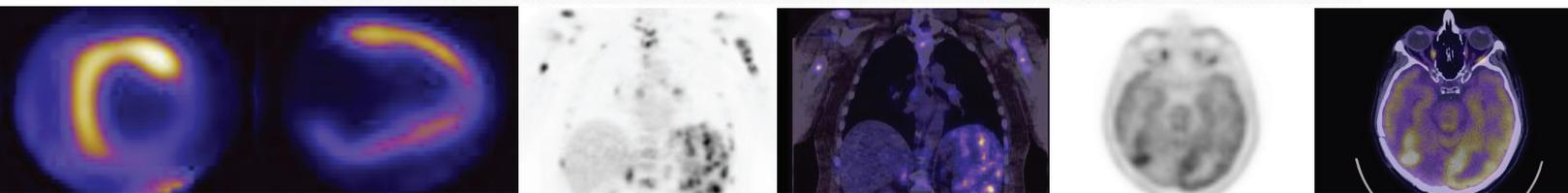


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Breast Cancer and Molecular Imaging: Get the Facts

About Breast Cancer

Every year, approximately 184,000 patients are newly diagnosed with breast cancer and it is estimated that each year, more than 40,000 people die from breast cancer.

New developments in molecular imaging technologies are dramatically improving the ways in which breast cancer is diagnosed and treated. Research in molecular imaging is also contributing to our understanding of breast cancer and helping to direct more effective care of patients with breast cancer.

What are molecular imaging procedures, and how can they help breast cancer patients?

Molecular imaging procedures are highly effective, safe and painless diagnostic imaging and treatment tools that present physicians with a detailed view of what's going on inside an individual's body at the cellular level. Most nuclear medicine procedures are molecular imaging procedures using radioactive substances.

The most commonly used molecular imaging procedure for diagnosing or guiding treatment of breast cancer is Positron Emission Tomography (PET) scanning, which is often used in conjunction with Computed Tomography (CT) scanning. The National Oncologic PET Registry (NOPR)—a nationwide database documenting the use of PET and PET/CT in managing cancer—shows that in more than one out of three cases, PET/CT scan results prompt changes in a patient's treatment. The results, published in *The Journal of Clinical Oncology*, demonstrate the vital role that PET/CT can play to properly diagnose or verify the suspected recurrence. [For more information on PET/CT scanning, please read SNM's fact sheet "PET/CT Scans: Get the Facts" on SNM's Web site at <http://interactive.snm.org/index.cfm?PageID=7988>.] In addition, the National Comprehensive Cancer Network (NCCN) has incorporated FDG PET/CT in the practice guidelines and management algorithm of most malignancies^{1, 2}

What types of molecular imaging technologies currently are available for breast cancer patients?

The MI technologies most commonly used in diagnosing and guiding treatment of breast cancer patients include techniques to perform sentinel

node localization for biopsy and full body PET/CT scanning (see also "PET/CT scanning: Get The Facts").

What is sentinel node biopsy?

When a person is diagnosed with breast cancer, physicians need to accurately pinpoint the location of cancerous tumors and determine whether the cancer has spread to other parts of the body. This information is critical for choosing which course(s) of treatment is best for each patient. If the cancer has spread beyond the lining of the breast duct and is picked up by the blood vessels or lymph vessels, then it can potentially spread elsewhere in the body, or "metastasize." If the breast cancer is not confined to the breast duct, it is important to determine if the cancer has spread to lymph nodes in the axilla.

Traditionally, a surgeon would perform an axillary lymph node dissection, taking out most of the lymph nodes under the arm to see if the cancer had spread. This procedure requires hospitalization and often has long-lasting side effects. However, today, a technique called sentinel lymph node biopsy is commonly used that employs MI technologies to determine whether cancer has spread to the lymph nodes—without having to perform a fully axillary lymph node dissection.

What are the advantages of sentinel node biopsy?

A sentinel lymph node biopsy is highly reliable in detecting cancerous cells and can more accurately assess whether the cancer has spread to the lymph nodes. In a traditional axillary dissection, the pathologist receives at least 10 lymph nodes or more; there is no way of telling which one is the sentinel lymph node. Therefore, the pathologist must make one cut in each lymph node and look for cancer. When the pathologist receives only one, or a few, lymph nodes from a sentinel lymph node procedure, he or she can make many cuts through that lymph node to look for cancer. A negative sentinel lymph node indicates a better than 95 percent chance that the remaining lymph nodes are also cancer-free. Therefore, there is no need to undergo a full axillary lymph node dissection or to risk long-term complications and side effects from an axillary dissection. What's more—sentinel node biopsy can be performed on an outpatient basis with no need for hospitalization. Recuperation from the procedure is also faster, with most patients resuming regular activities within a few days; incisions generally heal within a few weeks.

How is the procedure performed?

The morning of the operation, a nuclear medicine specialist who is specially trained will inject the radioactive agent used for the procedure. The injections are done in the area of the breast where the tumor is and/or around the nipple of the breast. Pictures may be taken, which show the pathways the radioactive material takes as it leaves the breast. This will help guide the surgeon in identifying the sentinel lymph node. Then, the patient proceeds to the operating room. At the beginning of the operation, the surgeon injects a blue dye. The surgeon then makes an incision underneath the arm in the area of the axillary lymph tissue. A hand-held sterile probe measures areas that have the radioactivity. The lymph nodes that have taken up the radioactive dye, or are stained with the blue dye, are removed; usually one to three nodes are removed. If the procedure is unsuccessful in identifying the sentinel node (which occurs in less than five percent of the procedures), a full axillary dissection is done.

PET/CT Scanning

How can PET/CT scanning help breast cancer patients?

Specifically, PET/CT scanning is a powerful tool for breast cancer:

- Establishing how advanced the cancer is and whether it has spread to other parts of the body;
- Helping physicians and patients decide on courses of treatment that are tailored to patients' individual conditions and needs;
- Determining early on whether chemotherapy or other treatments are working as intended; and
- Detecting whether the disease is recurring after treatments are completed and assisting physicians in determining a site that is appropriate for biopsy, if necessary.

How does PET/CT scanning work?

PET scanning is a molecular imaging procedure that allows physicians to obtain three-dimensional images of what is happening in a patient's body at the molecular and cellular level. For a PET scan, a patient is injected with a very small amount of a radiotracer such as fluorodeoxyglucose (FDG), which contains both a sugar and a radioactive element. The radiotracer travels through the body and is absorbed by tumors or cancer cells. The patient then lies down on an examining table and is moved to the center of a PET/CT scanner. The PET/CT scanner contains a PET scanner and a CT scanner next to each other. The CT scan and the PET scan are obtained one after the other. The PET scanner is composed of an array of detectors that receive signals emitted by the radiotracer. Using these signals, the PET scanner detects the amount of metabolic activity while a computer reassembles the signals into

images. (For more information on PET/CT scans and how they work, visit [PET/CT Scanning: Get the Facts.](#))

How can PET/CT scanning help in the long-term management of breast cancer?

PET/CT scanning can help physicians gain a clear understanding of where the disease is occurring and how aggressive it is. Armed with this knowledge, physicians and patients can decide together on the best courses of treatment. PET/CT scanning can help determine how effective treatments are as soon as one cycle of treatment is completed. It may also eliminate the need for unnecessary surgeries after treatments are finished because PET/CT can determine whether any suspicious tissue masses are active tumors or residual masses.

How many PET/CT scans will patients require?

Depending on the course of treatment selected by physicians and patients, breast cancer patients may require several PET/CT scans during the course of their disease to make an accurate diagnosis and determine whether courses of chemotherapy or radiation are working as intended and ensure that patients are cancer-free after treatments have ended.

How long does it take to get PET/CT scan results?

A trained radiologist or nuclear medicine physician will interpret the results and write a report for the physician who ordered the tests. A verbal report is available the day of the PET/CT scan and the written report is usually delivered to the physician within two or three days.

Will insurance reimburse for PET/CT scans?

Insurance companies will cover the cost of most PET/CT scans. Because of the mounting evidence of the effectiveness of PET/CT scanning for the diagnosis and treatment of a wide range of cancers, coverage levels continue to expand. For the most updated figures, check with your insurance carrier or physician as the levels at which Medicare reimburses for PET/CT are under review with the Centers for Medicare and Medicaid Services (CMS) and subject to change.

Future Molecular Imaging Technologies and Research for Breast Cancer

What are some molecular imaging procedures and pharmaceuticals currently being developed that could benefit breast cancer patients in the future?

There are many new and emerging molecular imaging technologies that can benefit breast cancer patients. Other molecular imaging procedures under development often combine imaging systems to form hybrid technologies that improve accuracy and allow physicians to see how cancer may be affecting other systems in the body. One of the more promising research areas is in investigational PET imaging biomarkers, such as fluorothymidine (FLT) and fluoroestrogen (FES). FLT has promise for demonstration of tumor proliferation and FES for demonstration of estrogen receptors.

One exciting area of study is radioimmunotherapy, a form of treatment that targets cancer-killing radiation directly to cancer cells.

What is Positron Emission Mammography (PEM)?

PEM is high-resolution PET scanner that provides functional imaging specifically for breast cancer detection. PEM can isolate and enhance breast images with more accuracy than full-body PET scans and works much like a full-body PET scans. First, the patient is injected with a very small amount of a radiotracer such as fluorodeoxyglucose (FDG), which contains both sugar and a radioactive element. If cancer is present, cells begin to grow at a much faster rate than in normal cells, feeding on sugars like glucose. The radiotracer travels through the body and is absorbed by the tissues or the organ being studied. The patient is then examined with detectors, which are mounted on compression paddles and are used to take an image of the breast. Similar to conventional mammography, the breast is slightly compressed as it is imaged. However, PEM images are able to produce much more accurate images of smaller lesions.

What advantages does PEM offer?

PEM is often used to help physicians and patients newly diagnosed with breast cancer make more informed decisions about surgery and other courses of treatment. Before surgery is undertaken, for example, PEM provides physicians with a tool to pinpoint the location of tumors and help determine whether patients can safely avoid mastectomy or breast removal. PEM has been shown to have a high accuracy in correctly identifying tumors. When used with other imaging modalities, PEM can reduce the number of biopsies required and improve surgical planning. In addition, PEM may be especially helpful for detecting and determining the size of a certain type of breast cancer called ductal carcinoma in situ (DCIS), which makes up about 30 percent of reported breast cancers and can be difficult to identify with conventional technologies.

What is radioimmunotherapy (RIT) and how does it work?

RIT is a relatively new personalized cancer treatment that combines the cancer-killing ability of radiation therapy with the precise targeting capacity of immunotherapy. A tumor-killing dose of a radioactive substance is linked to a specific kind of cell called a monoclonal antibody that, when injected into a patient, hones in on and attaches to cancerous tumor cells. The ability of the antibody to bind to a tumor-associated antigen—a molecule that can stimulate an immune response—ensures that the tumor gets a high dose of radiation, which kills the targeted cancer cells and nearby cancer cells. RIT is a more highly targeted therapy than traditional treatments because molecular imaging techniques and therapies can pinpoint the exact location of disease. Several radioimmunotherapy agents targeted toward treating advanced cancer under development or in clinical trials.

Where can I get more information about breast cancer and molecular imaging?

To learn more about breast cancer, visit www.snm.org/facts. To learn more about PET/CT scanning or other nuclear medicine procedures, visit the SNM Molecular Imaging Center of Excellence.

(Endnotes)

1 Podoloff DA, Advani RH, Allred C, Benson AB, Brown E, Burstein HJ, Carlson RW, Coleman RE, Czuczman MS, Delbeke D, Edge SB, Ettinger DS, Grannis FW, Hillner BE, Hoffman JM, Keil K, Komaki R, Larson SM, Mankoff DA, Rozenzweig KE, Skibber JM, Yahalom J, Yu JM, Zelenetz AD. NCCN Task Force Report: Positron Emission Tomography (PET/Computed tomography (CT) scanning in cancer. *J Natl Compr Canc Netw* 2007;May;5 Suppl 1: S1-S22.

2 http://www.nccn.org/professionals/physician_gls/f_guidelines.asp