

# Nuclear Medicine: Looking at Disease in a New Light

The idea of putting a radioactive material into the body might seem like an unlikely way of diagnosing or curing a disease.

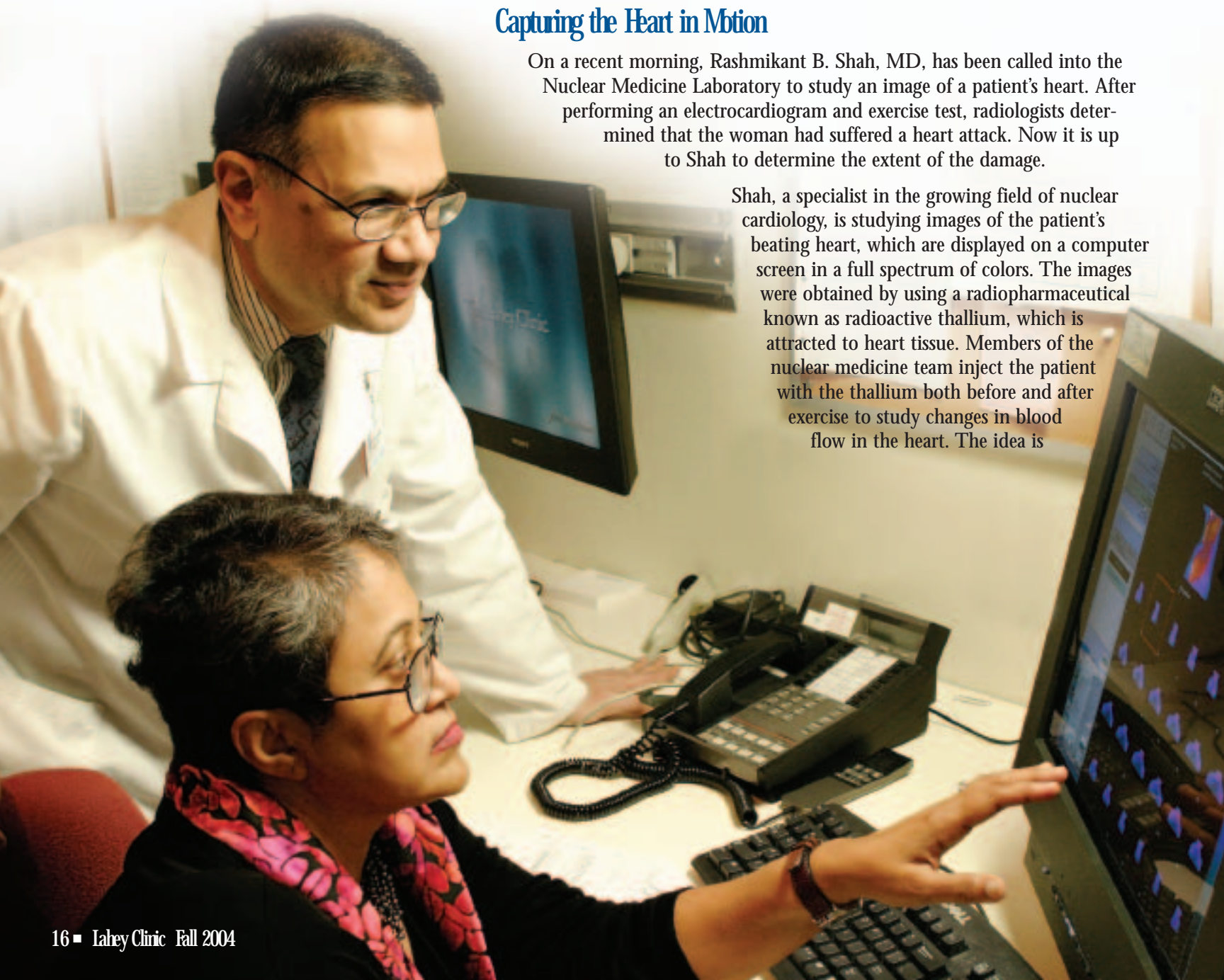
But to physicians in the rapidly evolving field of nuclear medicine, small radioactive particles known as “radiopharmaceuticals” are the key to early diagnosis of life-threatening conditions such as cancer and heart attack.

With the aid of new digital computer technologies, health care teams at Lahey Clinic are combining their expertise in nuclear medicine and other subspecialties in radiology to do just this. They are also researching new types of radiopharmaceuticals that, if proven effective, could make imaging techniques more sensitive and accurate than ever before.

## Capturing the Heart in Motion

On a recent morning, Rashmikant B. Shah, MD, has been called into the Nuclear Medicine Laboratory to study an image of a patient’s heart. After performing an electrocardiogram and exercise test, radiologists determined that the woman had suffered a heart attack. Now it is up to Shah to determine the extent of the damage.

Shah, a specialist in the growing field of nuclear cardiology, is studying images of the patient’s beating heart, which are displayed on a computer screen in a full spectrum of colors. The images were obtained by using a radiopharmaceutical known as radioactive thallium, which is attracted to heart tissue. Members of the nuclear medicine team inject the patient with the thallium both before and after exercise to study changes in blood flow in the heart. The idea is



that areas with inadequate blood flow will contain little thallium and be displayed in a darker color.

Beginning with the lowest portion of the heart, Shah looks at each region carefully, using sophisticated computer equipment to filter out overlying tissues that would otherwise blur the image. "What we are looking at is the distribution of blood in the heart muscle," says Shah. "Then we look at other factors, such as the patient's age and whether they are diabetic, and by putting all of this information together into a formula, we come up with the patient's overall risk of a future event."

Looking at factors such as the motion and thickness of the heart wall, Shah can tell that a tiny region of muscle in the upper-left portion of the heart—which is blue, indicating a lack of blood flow—has suffered minimal damage. To the patient's relief, an operation will not be necessary.

Nuclear medicine, along with diagnostic radiology techniques such as cardiac MRI—which can show the actual movement of blood within the heart—have become critical to identifying patients who need further treatment. "Lahey Clinic has some of the best equipment in the area, but our greatest strength lies in the extensive number of imaging services we perform, and our experience in diagnosing and treating some of the most critically ill patients," says Shah.

## Looking at the Whole Picture

Nuclear imaging is unique in that it is often possible to identify abnormalities very early in the progression of a disease—long before some medical problems are apparent from other diagnostic tests.

Lahey Clinic uses nuclear medicine for a full range of imaging, including brain, bone, lung, kidney, thyroid and cardiac scans. Perhaps one of the most important applications of nuclear medicine is identifying sites of cancer tumors and spread.

Depending on the type used, radiopharmaceuticals—which give off the same

amount of radiation as a typical X-ray—are attracted to specific tissues or, in the case of cancer, to areas of rapid cell growth. After a patient is injected with the radioactive tracer, he or she undergoes a "gamma camera" scan. This camera contains a CT scanner that measures the amount of radioactive material being absorbed in each area of the body. An area that is dense with radioactive material—known as a "hot spot"—may contain cancer and will show up on the nuclear medicine scan as a patch of light.

"Nuclear medicine is very sensitive in that even if you have a small amount of abnormality, it will show up. Whereas diagnostic imaging techniques such as CT or MRI are anatomically exquisite and can show you great anatomic detail, in some instances they don't show you very early disease," says Anna K. Chacko, MD, chair, Diagnostic Radiology.

Chacko points to the recent case of a patient who was diagnosed with a very rare type of tumor known as a gastrinoma. Doctors became concerned about the patient when, after two months of treatment for a stomach ulcer, his condition had not improved. "When a stomach ulcer does not respond to treatment you have to ask why," says Chacko. "There may be a tumor secreting a hormone that is predisposing the patient to ulcers."

A team of nuclear medicine specialists and other radiologists subsequently discovered that the patient had a tiny tumor only 3 millimeters in length. When physicians looked at the tumor with CT, which uses X-rays to take pictures of tissue, they could barely see it. "But when we did the nuclear medicine study, because it was very sensitive, we were able to pick it up," says Chacko.

"To pinpoint where the tumor was, we really had to have a combination of CT with a nuclear medicine scan," Chacko explains. "The nuclear medicine showed where the 'hot spot' was, and the CT allowed us to say 'Oh, yes, it is this little area of tissue.' Having a combination of

the two images allows you to see things better. It's like looking with one eye or the other versus looking with both."

## A Legacy in the Field of Nuclear Medicine

While nuclear medicine is commonly used to diagnose disease, it also has a number of therapeutic applications, including treatment of overactive thyroid and thyroid cancer.

The first treatment of thyroid cancer with radioactive iodine, which occurred in 1946, is considered by many to be the first use of nuclear medicine. This radiopharmaceutical is readily absorbed by the thyroid gland, which naturally accumulates iodine for use in making thyroid hormone. Lahey Clinic was among the first medical centers to research the effectiveness of radioactive iodine treatments. Today, Lahey does more work in the area of thyroid imaging and treatment than any other medical center in New England.

Doctors, nurses, technicians and physicists in the department are collaborating to improve upon current methods for imaging the parathyroid gland. "Standard image processing sometimes does not provide good sensitivity, since there can be so much activity in the thyroid gland that it is difficult to view the parathyroid," says Shah.

A new method of parathyroid imaging that is being tested involves injecting the patient with a hormone that suppresses the thyroid gland. This way, Shah reasons, its motion may be less likely to interfere with the acquisition of nuclear medicine images. Another recent effort involves optimizing the dose of radioactive iodine delivered to patients undergoing thyroid cancer treatment, making it less likely that they have to come back for a second dose.

"The field of nuclear medicine is always undergoing growth," Shah says. "We are always asking 'Is the standard of practice good enough for us?' and whether we have to change."