Many patients are referred by their physicians for noninvasive cardiac tests. Among these tests are cardiac imaging tests, which take pictures of the heart’s structure or function. There are different types of cardiac imaging tests, which were explained in a recent Cardiology Patient Page,1 and these tests are performed more than 20 million times per year in the United States. One concern shared by many patients referred for cardiac imaging tests is their exposure to radiation. If an imaging test is performed for a good reason and using good technique, the expected benefits provided by the test will far outweigh the risks related to radiation. Radiation is referred to as a weak carcinogen, which means that it is very rare for radiation to cause cancer. Moreover, it generally takes at least a decade for someone to develop cancer related to radiation exposure. However, an imaging test can provide very valuable information about your heart that can immediately affect treatment, prevention, and ultimately health outcomes. The right imaging test undoubtedly has the potential to save a life.

Nevertheless, it is very understandable that patients referred for cardiac imaging are concerned about risks from radiation, because any unnecessary risk is too much of a risk. Unfortunately, there is no “Good Housekeeping Seal of Approval” for imaging tests, so it is hard for patients to know whether their imaging test will be performed for a good reason and with good technique.

First, know what type of test is being ordered. An echocardiogram, which uses sound waves, or a magnetic resonance imaging (MRI) test, which uses magnetic fields, does not involve the type of radiation (ionizing radiation) that leads to DNA mutations that may cause cancer. This is not to say that these tests are always harmless, but radiation-related cancer should not be a concern with echocardiograms or MRIs.

The cardiac imaging tests that involve ionizing radiation are computed tomography (CT) scans and nuclear medicine tests. These tests come in different varieties. The 2 common types of CT scans are coronary artery calcium scores and CT angiograms of the heart. Both involve x-rays that are used to reconstruct a 3-dimensional picture of the heart. A calcium score does not use an intravenous line or contrast, whereas a CT angiogram involves putting an intravenous line in a patient’s arm vein, through which a contrast material is injected. The most common type of nuclear medicine test used for cardiac imaging is a nuclear stress test, in which pictures are taken in conjunction with some type of stress placed on the heart, either exercise or a medication that simulates the effects of exercise. Together, CT scans and nuclear medicine tests of the heart account for virtually all of the ionizing radiation in noninvasive cardiac imaging.

The remainder of this article lists questions that patients can ask their doctors and the staff of the laboratories in which their tests are performed, to serve as a foundation for a discussion to ensure that cardiac imaging tests are performed for good reason and with good technique. With an answer of “yes” to each pertinent question, a patient should feel reassured that his or her test will be performed with attention paid to keeping radiation exposure low.

The information contained in this Circulation Cardiology Patient Page is not a substitute for medical advice, and the American Heart Association recommends consultation with your doctor or healthcare professional.

From the Division of Cardiology, Department of Medicine, and Department of Radiology, Columbia University Medical Center and New York-Presbyterian Hospital, New York, NY.

Correspondence to Andrew J. Einstein, MD, PhD, Columbia University Medical Center, 622 W 168th St, PH 10–203, New York, NY 10032. E-mail andrew.einstein@columbia.edu

(Circulation. 2013;127:e495-e497.)

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Circulation is available at http://circ.ahajournals.org

DOI: 10.1161/CIRCULATIONAHA.112.146043
Two Questions for All Types of Tests

1. Is my test being performed for an appropriate indication according to appropriate use criteria established by professional societies, and if not, is there a good clinical reason why I’m having the test?

If you’re concerned about radiation, you should ask this question of the doctor referring you for the test. Several professional organizations have developed expert criteria for classifying when it’s appropriate to perform a cardiac imaging test, when it’s uncertain, and when it’s inappropriate. The most comprehensive criteria for cardiac imaging are those established by the American College of Cardiology, a professional society for heart doctors, together with several other societies. Separate but very similar criteria have been established by the American College of Radiology. For example, for someone with persistent chest pain that their doctor deems to be of intermediate or high likelihood of being caused by heart disease, appropriate use criteria classify a nuclear stress test as appropriate. Avoidance of inappropriate tests will eliminate radiation exposure. The appropriate use criteria cover dozens of different scenarios in which someone might be considered for a cardiac imaging test. Although these include the most common clinical situations, by their nature they cannot incorporate every detail of a patient’s medical condition, and therefore, there may be legitimate reasons for performing a test that is not classified as appropriate.

2. Does the facility performing my test modify the protocol to the particulars of each patient?

There are numerous “recipes” or protocols that can be used to perform a cardiac imaging test. If a laboratory uses an identical protocol for each patient, it is missing opportunities to reduce radiation exposure to some patients. These include adjustments for a patient’s weight, size of the heart, and age. For example, many protocols can be weight-based, whereby less radiation is used to take pictures of skinnier patients.

Questions for CT Angiograms

1. Do some patients receive scans using reduced tube voltage? Tube voltage determines the energy of x-rays that are made by a CT scanner. All other factors being equal, a lower tube voltage translates to lower radiation exposure. For some patients, particularly thinner patients, tube voltage can be reduced without worsening the quality of the pictures obtained.

2. Do some patients receive scans using a prospectively triggered protocol? This refers to a protocol that turns off the x-ray tube during part of the study, determined on the basis of the patient’s electrocardiogram (ECG or EKG), to reduce radiation exposure. Prospective triggering is not appropriate for all patients; for example, it is generally avoided in CT angiograms of patients with frequent extra heartbeats. Nevertheless, if a laboratory does not ever use prospective triggering, then it misses opportunities to reduce radiation exposure to some patients. The same can be said for reduced tube voltage.

3. Is iterative reconstruction used? Iterative reconstruction is a technique for generating pictures that reduces the noisiness of images of the heart. Iterative reconstruction can be used to reduce radiation exposure, because a good-quality study can be performed with fewer x-rays. This technique is relatively new, and some excellent institutions that are committed to low-dose imaging do not yet have it available because of its considerable expense.

Questions for Radiation Stress Tests

1. Does the laboratory avoid using thallium in most patients? Several different radioactive medicines can be used to generate the images for a nuclear stress test. One, called thallium 201, exposes patients to an especially high amount of radiation. Although there are legitimate reasons for some patients to undergo a stress test involving thallium, and in fact it may be preferred for certain types of patients, a laboratory that routinely uses thallium in most patients may not be as careful as it could be about keeping the radiation dose low.

2. Does the laboratory perform stress-only imaging in some patients? Nuclear stress tests typically involve obtaining and comparing 2 sets of pictures: one in which the radioactive medication is injected while the patient is undergoing stress testing, and one in which the medication is administered while the patient is at rest. One type of protocol, called stress-only imaging, eliminates the performance...
of rest imaging for patients with completely normal stress imaging. Thus, the study can be completed with 1 rather than the standard 2 injections of radioactive medication. Although stress-only imaging is not the right protocol for every patient, a laboratory that does not use it at all misses opportunities to reduce radiation exposure to some patients.

3. **Does the laboratory perform either attenuation correction or prone imaging?** These terms refer to 2 techniques that can remove artifacts from images of the heart, thus improving the quality of pictures. A laboratory that does not use either of these techniques may have too many patients without actual heart disease but with pictures that are not completely normal, thus significantly limiting opportunities to perform stress-only imaging.

**Source of Funding**

This report was sponsored by a grant from the Margaret Q. Landenberger Research Foundation in memory of Professor A. Donny Strosberg.

**Disclosures**

Dr Einstein has served as a consultant to the International Atomic Energy Agency, received research grants from GE Healthcare, Philips Healthcare, and Spectrum Dynamics, and lectured for Spectrum Dynamics.

**Reference**


**Key Words:** cardiac imaging techniques ◼ computed tomography ◼ imaging ◼ nuclear medicine ◼ radiation
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Andrew J. Einstein

Circulation. 2013;127:e495-e497
doi: 10.1161/CIRCULATIONAHA.112.146043
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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World Wide Web at:
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