Measuring radiation

If you mention the measurement of radiation, many people will recall the classic Geiger counter with its crescendo of clicks. But Geiger counters detect only the intensity of radioactive emissions. Measuring their impact on human tissues and health is more difficult. That's where the sievert (Sv) and millisievert (mSv) come in. These units, the ones most commonly used in comparing imaging procedures, take into account the biological effect of radiation, which varies with the type of radiation and the vulnerability of the affected body tissue. Taking these into account, millisieverts describe what's called the "equivalent dose."

Ionizing radiation and cancer risk

We've long known that children and teens who receive high doses of radiation to treat lymphoma or other cancers are more likely to develop additional cancers later in life. But we have no clinical trials to guide our thinking about cancer risk from medical radiation in healthy adults. Most of what we know about the risks of ionizing radiation comes from long-term studies of people who survived the 1945 atomic bomb blasts at Hiroshima and Nagasaki. These studies show a slightly but significantly increased risk of cancer in those exposed to the blasts, including a group of 25,000 Hiroshima survivors who received less than 50 mSv of radiation — an amount you might get from two or three CT scans. (See "Imaging procedures and their approximate effective radiation doses.")

The atomic blast isn't a perfect model for exposure to medical radiation, because the bomb released its radiation all at once, while the doses from medical imaging are smaller and spread over time. Still, most experts believe that can be almost as harmful as getting an equivalent dose all at once.

Imaging procedures and their approximate effective radiation doses*

Procedure	Average effective dose (mSv)	Range reported in the literature (mSv)
Bone density test+	0.001	0.00–0.035
X-ray, arm or leg	0.001	0.0002–0.1
X-ray, panoramic dental	0.01	0.007–0.09
X-ray, chest	0.1	0.05–0.24
X-ray, abdominal	0.7	0.04–1.1
Mammogram	0.4	0.10–0.6
X-ray, lumbar spine	1.5	0.5–1.8
CT, head	2	0.9–4
CT, cardiac for calcium scoring	3	1.0–12
Nuclear imaging, bone scan	6.3	
CT, spine	6	1.5–10
CT, pelvis	6	3.3–10

CT, chest	7	4.0–18
CT, abdomen	8	3.5–25
CT, colonoscopy	10	4.0–13.2
CT, angiogram	16	5.0–32
CT, whole body	variable	20 or more
Nuclear imaging, cardiac stress test	40.7	
*The actual radiation exposure depends on many things, including the device itself, the duration of the scan, your size, and the sensitivity of the tissue being targeted.		
+Dual energy x-ray absorptiometry, or DXA.		
Source: Mettler FA, et al. "Effective Doses in Radiology and Diagnostic Nuclear Medicine: A Catalog," *Radiology* (July 2008), Vol. 248, pp. 254–63.		

Higher radiation–dose imaging

Most of the increased exposure in the United States is due to CT scanning and nuclear imaging, which require larger radiation doses than traditional x-rays. A chest x-ray, for example, delivers 0.1 mSv, while a chest CT delivers 7 mSv (see the table) — 70 times as much. And that's not counting the very common follow-up CT scans.

In a 2009 study from Brigham and Women's Hospital in Boston, researchers estimated the potential risk of cancer from CT scans in 31,462 patients over 22 years. For the group as a whole, the increase in risk was slight — 0.7% above the overall lifetime risk of cancer in the United States, which is 42%. But for patients who had multiple CT scans, the increase in risk was higher, ranging from 2.7% to 12%. (In this group, 33% had received more than five CT scans; 5%, more than 22 scans; and 1%, more than 38.)

What to do

Unless you were exposed to high doses of radiation during cancer treatment in youth, any increase in your risk for cancer due to medical radiation appears to be slight. But we don't really know for sure, since the effects of radiation damage typically take many years to appear, and the increase in high-dose imaging has occurred only since 1980.

So until we know more, you will want to keep your exposure to medical radiation as low as possible. You can do that in several ways, including these:

Discuss any high-dose diagnostic imaging with your clinician. If you need a CT or nuclear scan to treat or diagnose a medical condition, the benefits usually outweigh the risks. Still, if your clinician has ordered a CT, it's reasonable to ask what difference the result will make in how your condition is managed; for example, will it save you an invasive procedure?

Keep track of your x-ray history. It won't be completely accurate because different machines deliver different amounts of radiation, and because the dose you absorb depends on your size, your weight, and the part of the body targeted by the x-ray. But you and your clinician will get a ballpark estimate of your exposure.

Consider a lower-dose radiation test. If your clinician recommends a CT or nuclear medicine scan, ask if another technique would work, such as a lower-dose x-ray or a test that uses no radiation, such as ultrasound (which uses high-frequency sound waves) or MRI (which relies on magnetic energy). Neither ultrasound nor MRI appears to harm DNA or increase cancer risk.

Consider less-frequent testing. If you're getting regular CT scans for a chronic condition, ask your clinician if it's possible to increase the time between scans. And if you feel the CT scans aren't helping, discuss whether you might take a different approach, such as lower-dose imaging or observation without imaging.