MAYO CLINIC

PATIENT EDUCATION

Radiation Exposure During Imaging Exams

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Introduction

The imaging examination ordered for you will include taking pictures (images) of some areas inside your body. The information learned from these images is needed to help your health care provider make a diagnosis and/or make decisions about your treatment.

In many situations, if your health care provider could not get these images, he or she would have to use less-effective tests or surgery to make a diagnosis and/or make decisions about your treatment.

This material is provided to answer questions you may have about the radiation you are exposed to during imaging exams.

What types of radiation are used in medical imaging?

There are several kinds of radiation used in medical imaging. X-rays, gamma rays, radio waves, and even sounds waves all send (transfer) energy into your body. Of these, X-rays and gamma rays are a type of "ionizing" radiation. This means they can make changes in the cells as they pass through your body. However, at the low doses used in medical imaging typically, any changes that occur are repaired by the cells or are minor.

A description of the types of radiation follows.

1. **Radiography (known informally as "X-rays"):** Uses X-rays to make two-dimensional images, like a chest or dental image (radiograph).
2. **Fluoroscopy:** Uses X-rays to create a moving, three-dimensional (3-D) picture. This is useful when a health care provider has to guide small instruments, such as cameras and catheters, into the body or when they want to watch how something is moving inside the body.
3. **Computed tomography (CT) scan:** Uses a small amount of X-rays to create very detailed, non-moving, 3-D images. CT images also can be made of moving body parts, such as the heart.
4. **Nuclear medicine:** Uses gamma rays to create images of the body. This 3-D exam shows how tissues in the body are working, such as how much sugar is being burned by a tissue or how much blood is getting to an organ.
5. **Ultrasound:** Uses sound waves to put energy into the body — similar to the sonar used by submarines to find objects in the ocean. This 3-D exam can show moving body parts or measure how blood is flowing. Sound waves used for medical imaging do not harm body tissue or cells.

6. **Magnetic resonance imaging (MRI):** Uses radio waves to help create images of the body. A nearby computer receives the radio-wave information and uses it to make three-dimensional images of the body. MRI exams can show both what the inside of the body looks like and how tissues and organs are working. Radio waves used for medical imaging do not harm body tissue or cells.

Are imaging examinations safe?

Exposure to medical imaging that uses X-rays or gamma rays (radiographs, fluoroscopes, CT scans, and nuclear medicine) potentially may increase the risk of a cancer occurring later in life. Because the doses of radiation given in medical imaging are low, it is not possible to provide an accurate estimate of risk. The risks are very small compared to a person's normal risk of cancer. (See Figure 1.) The radiations used in ultrasound and MRI are considered to be safe.

For most imaging exams, the health benefits that may be gained from any medically necessary exam are very high compared to the small potential risk. At Mayo Clinic, every effort is taken to use the lowest radiation dose needed to diagnose or treat your condition.

	Estimated number of deaths per 1000 individuals
Cancer (in the U.S., according to 2008 American Cancer Society data)	228
Radon in home	
High exposure (1% to 3%)	21
US average	3
Arsenic in drinking water	
50 µg/L (acceptable limit before 2006)	13
2.5 µg/L (U.S. estimated average)	1
Motor vehicle accident	12
Pedestrian accident	1.6
Drowning	0.2
Bicycling	0.2
Lightning strike	0.013
Imaging exams* (effective dose)	
Coronary CT angiogram, abdomen-pelvis or chest CT, invasive coronary angiography, radio-nuclide myocardial perfusion study (10 mSv)	.5
Head CT, spine radiographs, nuclear medicine lung or bone scan, barium enema, calcium score or lung screening CT (1 mSv)	0.05

*Estimated number of *potential* deaths per 1000 individuals who have had one of those imaging exams

Chest radiographs, mammogram (0.1 mSv)	0.005
Hand or foot, dental or bone mineral radiographs (<0.1 mSv)	< 0.005

Figure 1. The risk of dying from common causes for a typical healthy person in the United States

Does any radiation stay in the body after an imaging exam?

After a radiographic, fluoroscopic, CT, ultrasound, or MRI exam, no radiation remains in your body. For nuclear medicine imaging, a small amount of radiation can stay in the body for a short time.

Is there a suggested limit to the number of images a person should have taken?

No. Your health care provider has ordered the images he or she needs to help diagnose and/or treat your condition. For medically necessary imaging, the benefits outweigh the potential risk associated with radiation exposure.

Are there special radiation concerns for children?

The risk of cancer from radiation is increased for children and young adults because they are growing quickly, and their cells are more sensitive than those of an older adult.

Children also are expected to live for many years, which may be long enough for potential effects from ionizing radiation to be detected.

At Mayo Clinic, we carefully adjust the radiation dose to the patient's size, so children receive smaller doses than adults. Just as for adults, the benefits of medically necessary imaging outweigh the potential risk.

What are some other sources of ionizing radiation exposure?

People are exposed to ionizing radiation from many sources every day.

- **Natural sources:** Examples are radon gas in your home, which seeps out of the ground (especially in the Midwest); radiation from outer space; radiation in rocks and soil, and even naturally occurring radiation in our bodies. These amounts vary throughout the country. On average, natural sources account for approximately 50 percent of the total annual exposure to radiation in the U.S. For some people, radon may be the largest contributor to this.
- **Man-made sources:** The primary source of this radiation is medical imaging. Nationally, man-made sources account for the remaining 50 percent of the total annual exposure to radiation in the U.S.

How is radiation exposure measured?

A "dose of radiation" is often measured using the phrase "effective dose." When calculating the effective dose, many issues are considered, including the exam type and patient size. The effective dose is given in units called "millisievert" (mSv).

How much radiation exposure do these imaging exams give?

The amount of radiation exposure varies for each type of imaging used (radiography, fluoroscopy, CT scanning, and nuclear medicine imaging). Because some tissues absorb more radiation than others, and because only certain parts of the body receive radiation during imaging exams, it takes the expertise of a radiation specialist to calculate how much radiation the body receives during any particular exam. *Each person and imaging type is different.*

How does Mayo Clinic monitor the use of radiation?

Mayo Clinic has a team of medical professionals who manage all aspects of the Clinic's medical imaging and radiation safety. The technical staff who perform the examinations receive frequent training on the proper set-up and use of the equipment. All of the people involved in medical imaging work to ensure high-quality images while exposing you to the lowest radiation dose possible.

Are X-ray imaging exams OK to have during pregnancy?

If your condition requires images to help make a diagnosis or guide treatment, yes, they may be necessary. For most images taken during pregnancy, the radiation exposure to the fetus is quite small. Special techniques can be used to reduce the exposure. If you may be pregnant, tell your health care provider so additional precautions may be taken if necessary.

Conclusion

Imaging exams play a very important role in helping your health care providers make diagnoses and provide treatment for you. Radiation doses per exam are low, usually much less than your annual exposure to naturally occurring radiation in the environment. Great care is taken to provide the best imaging information possible, while keeping your radiation dose as low as possible.

If you have questions after reading this information, talk to your health care provider.

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BARBARA WOODWARD LIPS PATIENT EDUCATION CENTER

Mrs. Lips, a resident of San Antonio, Texas, was a loyal patient of Mayo Clinic for more than 40 years. She was a self-made business leader who significantly expanded her family's activities in oil, gas and ranching, even as she assembled a museum-quality collection of antiques and fine art. She was best known by Mayo staff for her patient advocacy and support.

Upon her death in 1995, Mrs. Lips paid the ultimate compliment by leaving her entire estate to Mayo Clinic. Mrs. Lips had a profound appreciation for the care she received at Mayo Clinic. By naming the Barbara Woodward Lips Patient Education Center, Mayo honors her generosity, her love of learning, her belief in patient empowerment and her dedication to high-quality care.

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