Health Physics Society
Fact Sheet
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Health Physics Society
Specialists in Radiation Safety

Radiation Exposure From Medical Exams and Procedures

CT Scanner
Photo courtesy of UConn Health Center

Ionizing *radiation*[*] is used daily in hospitals and clinics to perform diagnostic imaging exams and medical interventions. For the purposes of this fact sheet, the word radiation refers to ionizing radiation; the most common forms of radiation in medicine are x rays and gamma rays.

Exams and procedures that use radiation are necessary for accurate diagnosis of disease and injury. They provide important information about your health to your doctor and help ensure that you receive appropriate care.

Physicians can also use radiation to make some procedures, such as heart valve replacement, less time-consuming and less invasive. Physicians and technologists performing these procedures are trained to use the minimum amount of radiation necessary for the procedure. Benefits from medical procedures greatly outweigh the potential small risk of harm from the amount of radiation used. Radiation therapy is another important medical use of radiation, but is outside the scope of this fact sheet.

A more quantitative assessment of the benefits of medical radiation was prepared recently for the Health Physics Society website (hps.org/hpspublications/articles/Benefitsofmedradexposures.html).

Between the 1980s and 2006, the exposure of the US population to radiation from medical procedures increased significantly, primarily due to increased use of computed tomography (CT) and nuclear medicine (NCRP 2009). A report published in 2019 by the National Council on Radiation Protection and Measurements (NCRP) shows that there has been a reduction of 15–20% in medical radiation *doses* from diagnostic imaging and image-guided procedures between 2006 and 2016 (NCRP 2019). The NCRP, the American College of Radiology, the World Health Organization, and others have worked to improve the referral process for procedures involving CT and nuclear medicine so that they are based on objective, medically relevant criteria. The imaging protocols have also been optimized to use only the radiation necessary to obtain the information needed.

Which types of diagnostic imaging procedures use radiation?

- In x-ray procedures, x rays pass through the body to form pictures on a computer or television monitor, which are viewed by a radiologist. If you have an x ray, it will be performed with a standard x-ray machine or with a more sophisticated x-ray machine called a CT machine.

[*] Words in italics are defined in the Glossary on page 4.

- During interventional procedures, *fluoroscopy* is used by cardiologists, gastroenterologists, pain specialists, and radiologists to perform procedures inside the body.

- In nuclear medicine procedures, a small amount of radioactive material is inhaled, injected, or swallowed by the patient. If you have a nuclear medicine procedure, a special camera will be used to detect energy given off by the radioactive material in your body and form a picture of your organs and their level of function on a computer monitor. A radiologist or nuclear medicine physician views these pictures. The radioactive material typically disappears from your body within a few hours or days.

Do benefits from medical examinations using radiation outweigh the risks from the radiation?

Your doctor will order imaging for you when it is needed for accurate diagnosis of your condition. There is no conclusive evidence of radiation causing harm at the levels patients receive from diagnostic x-ray exams. Although high doses of radiation are linked to an increased risk of cancer, the effects of low doses of radiation used in diagnostic imaging are either nonexistent or too small to observe. The benefits of diagnostic medical exams are vital to good patient care.

What are typical doses from medical procedures involving radiation?

Radiation dose can be estimated for some common diagnostic x-ray, fluoroscopic, and nuclear medicine procedures. It is important to note that these are only typical values. Radiation doses differ for each person because of differences in x-ray machines and their settings, the amount of radioactive material given in a nuclear medicine procedure, and the patient's metabolism.

The following tables give dose estimates for typical diagnostic x-ray, interventional, and nuclear medicine procedures. Many diagnostic exposures are less than or similar to the exposure we receive from natural background radiation. For comparison, in the United States each person receives about 3.0 *mSv* of radiation exposure from background sources every year. The effective dose listed is a comparable whole-body dose from the exam. The effective dose is given in mSv (an international unit of radiation measurement).

Table 1. Typical effective radiation dose from diagnostic x ray—single exposure (NCRP 2019)

Exam	**Effective Dose** (mSv)
Chest	0.1
Cervical Spine	0.2
Thoracic Spine	1.0
Lumbar Spine	1.4
Pelvis	0.4
Abdomen	0.6
Mammogram	0.36
Dental Bitewing	0.005
Dental (panoramic)	0.026
DEXA (whole body)	0.001
Skull	0.14
Hand or Foot	Negligible

Table 2. The dose a patient could receive if undergoing an entire procedure that may be diagnostic or interventional. For example, a lumbar spine series usually consists of five x-ray exams. (NCRP 2019)

Examinations and Procedures	**Effective Dose** (mSv)
Urography	3.0
Upper GI	6.0
Barium Enema	6.0
CT Head and Neck	1.2
CT Chest	6.1
CT Abdomen/Pelvis	7.7
Cardiac CT	8.7
CT Angiography (noncardiac)	5.1
Calcium Scoring	1.7
Coronary Angiography	20.0
Percutaneous Cardiac Intervention	23.0
Pacemaker Placement	1.0
Peripheral Vascular Angioplasties	2.0
Noncardiac Embolization	55.0
Vertebroplasty	8.0

How can I obtain an estimate of my radiation dose from medical exams?

Ask your doctor to refer you to a medical health physicist or diagnostic medical physicist for information on medical radiation exposure and an estimate of exposure. You can also get an estimate of typical doses for procedures with the RADAR Medical Procedure Radiation Dose Calculator (https://www.doseinfo-radar.com/RADARDoseRiskCalc.html).

Table 3. Typical effective radiation dose from nuclear medicine examinations (NCRP 2019)

Nuclear Medicine Scan	**Effective Dose** (mSv)
PET/CT	22.7
Neurology	6.6
Bone	4.0
Lung Perfusion/Ventilation	2.5
Inflammation	5.9
Heart (stress-rest)	9.7
Genitoruinary	1.4
Gastrointestinal	2.9
PET Studies for tumor imaging	12.7

Do magnetic resonance imaging (MRI) and ultrasound use ionizing radiation?

No. MRI and ultrasound procedures do not use ionizing radiation. If you have either of these types of studies, you are not exposed to ionizing radiation.

Glossary

Dose
A general term used to refer either to the amount of energy absorbed by a material exposed to radiation (**absorbed** dose) or to the potential biological effect in tissue exposed to radiation (**equivalent** dose). The **effective** dose listed is a comparable whole-body dose from the exam.

Fluoroscopy
The use of x rays to produce real-time video images, similar to an x-ray movie. Fluoroscopy can be used to view motion within the body, such as blood flow or the heart beating, and to guide the placement of catheters through blood vessels.

Radiation
Energy in the form of electromagnetic waves or particles.

Sv or Sievert
The International System of Units (SI) unit for dose equivalent equal to 1 joule/kilogram. The sievert has replaced the rem; one sievert is equal to 100 rem. One millisievert is equal to 100 millirem. The average person in the United States receives about 6 mSv annually.

References

National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States. Washington, DC: NCRP; NCRP Report No. 160; 2009. A summary of the report is available at https://ncrponline.org/publications/reports/ncrp-report-160-2/. Accessed 8 April 2020.

National Council on Radiation Protection and Measurements. Medical radiation exposure of patients in the United States. Washington, DC: NCRP; NCRP Report No. 184; 2019.

Resources for more information

American Cancer Society. Understanding radiation risk from imaging tests [online]. 2018. Available at https://www.cancer.org/treatment/understanding-your-diagnosis/tests/understanding-radiation-risk-from-imaging-tests.html. Accessed 8 April 2020.

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The Health Physics Society is a nonprofit scientific professional organization whose mission is excellence in the science and practice of radiation safety. Formed in 1956, the Society has approximately 3,500 scientists, physicians, engineers, lawyers, and other professionals. Activities include encouraging research in radiation science, developing standards, and disseminating radiation safety information. The Society may be contacted at 950 Herndon Parkway, Suite 450, Herndon, VA 20170; phone: 703-790-1745; fax: 703-790-2672; email: HPS@BurkInc.com.