



MotherToBaby

Medications & More During Pregnancy & Breastfeeding
Ask The Experts

Fact Sheet

by the **Organization of Teratology Information Specialists (OTIS)**

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Ionizing Radiation in the Workplace

This sheet talks about working around ionizing radiation in medical work settings and outlines some resources available to help create a safe work environment. This information should not take the place of medical care and advice from your health care provider.

What is ionizing radiation?

Radiation occurs when an item gives off energy. Radiation waves are generally invisible. They have no weight or odor.

Radiation is grouped into two categories: non-ionizing and ionizing. Non-ionizing radiation is lower energy radiation such as radio waves, ultraviolet rays, microwaves and sunlight. Non-ionizing radiation does not carry enough energy to electrically charge molecules. Ionizing radiation refers to x-rays, gamma rays, and some of the higher ultraviolet electromagnetic spectrum. X rays are used in diagnostic imaging and in therapeutics. Gamma radiation is used in therapeutics. Ionizing radiation can have enough energy to produce ions (molecules or atoms that are charged). This fact sheet will focus on x-rays.

How are doses of radiation exposure measured?

Radiation is measured in different ways. A *roentgen* (r) is a measurement of ionization in air from X-rays. A *joule* (J) is the measure of energy transferred from exposure to x-rays.

Dose refers to the amount of ionizing radiation that is absorbed by any part of the body. There are several different units of dose measurement that are used when discussing radiation, such as gray (Gy), rad, rem, or sievert (Sv).

When discussing absorbed doses, you may hear references to rads or grays (Gy). *Rad* refers to the dose of ionizing radiation to body tissues in terms of the energy absorbed per unit of mass of the tissue. *Gray* is defined as the absorption of one joule of radiation energy.

Rem refers to the dose of ionizing radiation to body tissue in terms of an estimated biological effect in relation to a dose of 1 roentgen (r) of X-rays. *Sievert* (Sv) is a measure of the health effect of low levels of ionizing radiation on the human body.

In general, one rad is the same as 1 rem. One gray (Gy) is the same as 100 rads, and one sievert (Sv) is about 100 rems. One milli-rad is equal to 0.001 rads; one milli-rem is equal to 0.001 rems.

To measure your specific workplace exposures, your employer should give you appropriate personnel monitoring equipment, which may include: film badges, pocket chambers, pocket dosimeters, or film rings.

What work settings might have ionizing radiation?

Ionizing radiation is everywhere. It is in our soil, water, and air. These sources of radiation are naturally occurring radiation called background radiation. Most people are exposed to approximately 2 to 3 milli-sieverts (mSv) of background radiation every year. That is about 0.2 to 0.3 rems per year.

Ionizing radiation is also found in some work settings such as: health care facilities, research institutions, air travel, baggage x-ray screening, construction, nuclear reactors and nuclear support facilities, transportation industry, and nuclear weapon production facilities, to name a few.

In your work setting, ionizing radiation can be produced by x-ray machines. Exposure to ionizing radiation could also occur with use of radioactive isotopes (radionuclides), and radiation therapy machines (for example: assisting in fluoroscopy procedures and working in nuclear cath labs). This fact sheet will focus on x-ray exposure from working with or near x-ray machines.

How do I know if I work in an area with radiation?

Areas with possible radiation are required to post a sign similar to what you see here.



The sign will distinguish between:

- Radiation areas (an area where the body could receive a dose of more than 5 millirems in an hour, or more than 100 millirem in 5 consecutive days);
- High radiation areas (an area where a body could be exposed to more than 100 millirems in one hour); or
- An airborne radioactivity area (an area where a person can be exposed to higher than permissible amounts of airborne radioactive material).

Areas that store certain amounts of radioactive materials must also display signs that will state: “Caution, Radioactive Materials”.

What are established limits for ionizing radiation at work places?

Your work place will probably have a Radiation Safety Officer who can keep you up to date on current workplace limits for your job. In general, the occupational limit for ionizing radiation exposure to the whole body is 5 rems (5 rads) per year. There are also regulations for specific parts of the body, as measured per a calendar quarter (3 months).

Some regulation agencies have established limits for an embryo or fetus (unborn baby). Some of these agencies recommend that an unborn baby should not receive more than 500 millirems (500 millirads, 0.5 rads) over the course of the entire pregnancy (some agencies may have different guidelines). Looking at one gestational month (one month during a pregnancy), the recommendation by some regulating agencies is that exposure should not be more than 50 millirem (50 millirads, 0.05 rads) in any one month.

I am around ionizing radiation. Will this harm my pregnancy?

In most cases of occupational exposure, the actual dose received by the embryo/fetus is less than the dose received by the mother. This is because some of the dose is absorbed by the mother’s body. X-ray exposure of less than 5 rads has not been associated with an increased chance for birth defects over the background risk that all pregnant women have. It has been estimated that a woman would need about 125 unshielded pelvic x-rays for the fetus to be exposed to 5 rads of radiation.

Exposure to high doses of radiation (more than 50 rads) could be harmful to a pregnancy, and has been associated with miscarriage, small head size, learning difficulties, intellectual disability, and poor growth. Some studies have looked at whether prenatal exposure to x-ray could increase the risk of cancer in children, but this is still unclear. If there is a cancer risk, it would be small.

Can I work with our x-ray machine while I am pregnant?

Yes, if you follow the proper safety procedures. X-ray machines are not radioactive, which means they are not giving off radiation when not in use. X-ray machines are designed to make radiation and the radiation is controlled by the person who runs the machine (turned on and off by the press of a button or the flip of a switch).

X-rays travel in straight lines. When x-rays hit an object, most of the energy waves will travel straight into the object, but some will bounce off and can travel in any direction – this is called “scatter”. X-rays will lose energy as they travel through an object. Since an x-ray is just energy, when the energy is gone so is the x-ray. This is called “attenuation”.

Follow the Safe Work Practices outlined for your job by your radiation safety officer or industrial hygienist.

Below are some general tips:

- Minimize the time of exposure
- Maximize the distance from the source of exposure
- Shield yourself from the source of exposure by: (a) Using appropriate personal protective equipment (such as lead gloves and aprons), test aprons and gear when you receive them and as recommended by the manufacturer and radiation safety officer; (b) Standing the appropriate distance from the machine, or be out of the room or behind the appropriate shielding walls; and (c) Not standing in a direct line from a machine's beam source.
- Wear your personal radiation monitoring badge (dosimeter) as supplied by your employer.
- In extreme situations in which you cannot avoid being in the room while x-rays are being taken, wear a protective apron of preferably 0.5 millimeters (mm) lead-equivalent but not less than 0.25 mm that wraps around with full coverage of the abdomen along with lead goggles, gloves and shields.

Can I breastfeed if I work with x-ray machines?

X-rays are present only during the time that an image is being taken and leave no radiation or radioactivity in the body or in milk. Diagnostic X-rays have no known effect on the milk in the breast at the time of a procedure, and it would not be expected to affect milk production. Be sure to talk to your health care provider about all your choices for breastfeeding.

What if the father of the baby works with x-ray machines?

Several studies have not found an association between low-level occupational radiation exposure in men and birth defects or childhood cancer in their children. It is possible that high radiation exposure to the testes (around 10 rems) could cause a temporary reduction in sperm count. In general, exposures that fathers have are unlikely to increase risks to a pregnancy. For more information, please see the MotherToBaby fact sheet Paternal Exposures and Pregnancy at <https://mothertobaby.org/fact-sheets/paternal-exposures-pregnancy/pdf/>.

Who can I contact for more information? What agencies regulate radiation?

We have listed some of the agencies involved in regulating radiation and their website information.

- Canadian Nuclear Safety Commission: The Basics of Ionizing Radiation. http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/0754_3.pdf and <http://www.nuclearsafety.gc.ca/eng/resources/radiation/index.cfm>
- The Centers for Disease Control and Prevention (CDC): <https://www.cdc.gov/nceh/radiation/basics.html> and <https://emergency.cdc.gov/radiation/radbasics.asp>
- Conference of Radiation Control Program Directors (CRCPD): <http://www.crcpd.org/>
- Environmental Protection Agency (EPA): <http://www3.epa.gov/>
- Federal Aviation Administration, Office of Aerospace Medicine, Civil Aerospace Medical Institute: <http://jag.cami.jccbi.gov/cariprofile.asp>
- Health Physics Society: <http://hps.org/>
- International Commission of Radiological Protection (ICRP): www.icrp.org
- International Commission on Radiation Units and Measurements (ICRU): www.icru.org
- National Council on Radiation Protection and Measurements (NCRP): www.ncrponline.org
- National Institute for Occupational Safety and Health (NIOSH): <http://www.cdc.gov/niosh/>
- Occupational Safety and Health Administration (OSHA): <https://www.osha.gov/SLTC/reproductivehazards/index.html>, <https://www.osha.gov/SLTC/radiationionizing/index.html>, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10098, and <https://www.osha.gov/SLTC/radiationionizing/pregnantworkers.html>
- Organization of Agreement States (OAS): <http://www.agreementstates.org/>
- Radiation Safety Institute of Canada: <http://www.radiationsafety.ca/>
- US Department of Energy (DOE): <http://www.energy.gov/>
- U.S. Nuclear Regulatory Commission (USNRC): www.nrc.gov

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