Health Physics Society
Specialists in Radiation Safety

Fact Sheet
Adopted: June 2012
Revised: June 2015

Background Radiation

Background radiation surrounds us at all times—it is everywhere. Since the earth was formed and life developed, all life on earth has been exposed to *ionizing radiation**. This fact sheet addresses the baseline sources of background ionizing radiation.

Sources of Background Radiation

Background radiation is emitted from both natural and human-made radionuclides. Some naturally occurring radiation comes from the atmosphere as a result of radiation from outer space, some comes from the earth, and some is even in our bodies as a result of radionuclides in the food and water we ingest and the air we breathe. Additionally, human-made radiation enters our environment from consumer products, activities such as medical procedures, and nuclear power plants. The largest source of human-made radiation exposure or *dose* is from medical testing and treatment (NCRP 2009).

Figure 1 depicts the typical distribution of exposure from all sources of background radiation. As can be seen, natural background radiation is the largest source of radiation exposure to humans (50 percent). However, medical sources of radiation exposure are almost as large (48 percent). The remaining 2 percent comes from consumer products, occupational exposure, and industrial exposure, which includes the exposure from nuclear power plants. Each of these sources is discussed below.

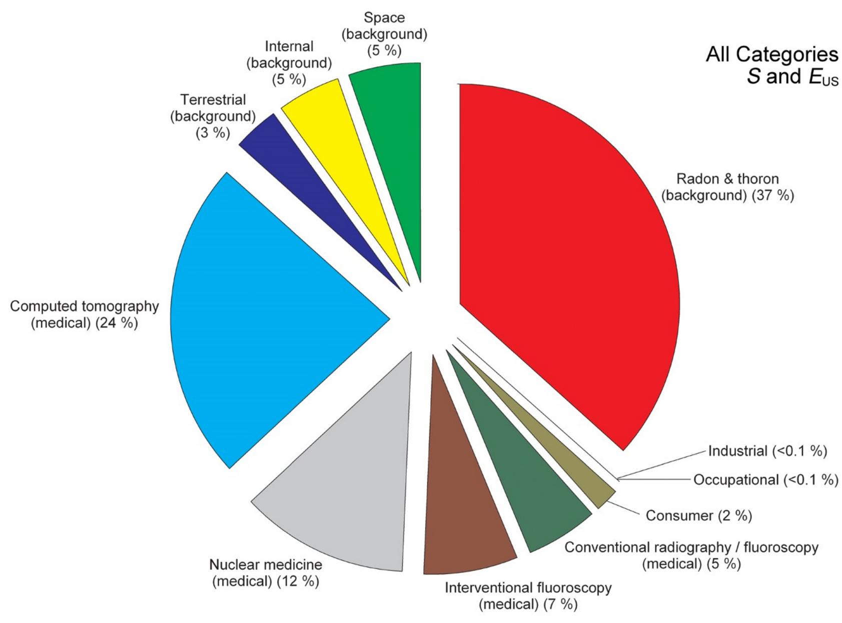

Figure 1: Source Distribution for all Radiation Dose – Percent contribution of various sources of exposure to the total dose per individual in the U.S. population for 2006 (Figure 1.1 from NCRP 160), reprinted with permission of the National Council on Radiation Protection and Measurements, http://NCRPonline.org.

Radionuclides in the Body

Terrestrial and *cosmogenic radionuclides* enter the body through the food we eat, the water we drink, and the air we breathe. The most significant radionuclides that enter the body are terrestrial in origin. Primary among them is *radon* gas (and its *decay* products) that we constantly inhale (Figure 2). Radon levels depend on the uranium and thorium content of the soil, which varies widely across the United States.

Other radionuclides in the body include uranium and thorium and their decay products, as well as potassium-40. These terrestrial radionuclides are in the soil, subsequently being incorporated into our food and water supply. Most drinking-water sources have very low levels of terrestrial radionuclides, including radium-226,

*Words in italics are defined in the Glossary on page 3.

radium-228, and uranium. These radionuclides may be higher in some areas of the United States than in others. Typically these levels are less than the drinking-water standards established by the United States Environmental Protection Agency.[1]

The average dose from all inhaled radionuclides is about 2.3 mSv (milli*sieverts*) per year, which is about 73 percent of the average total dose from background radiation. The average dose from all ingested radionuclides is about 0.3 mSv per year. This is about 9 percent of the average total dose from background radiation.

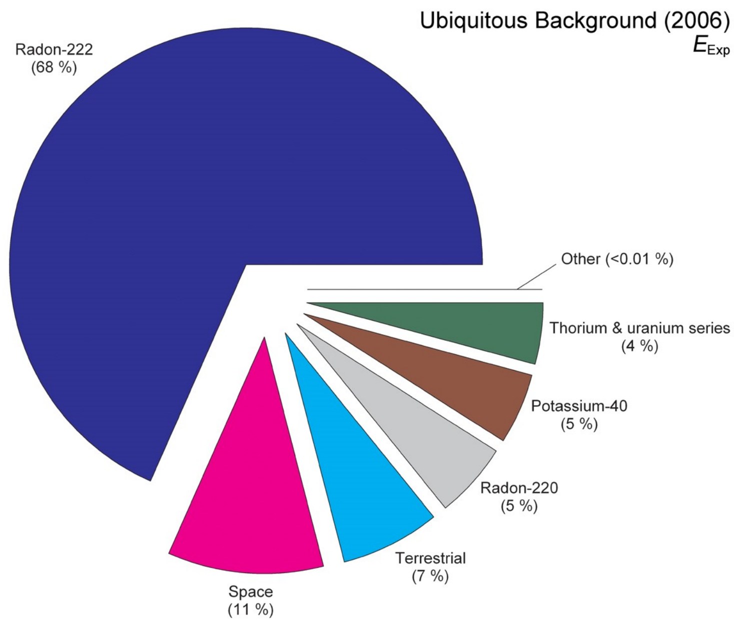

Figure 2: Source Distribution of Ubiquitous Background Dose – Distribution of the population dose among the various sources of background radiation (Figure 3-19 from NCRP 160); reprinted with permission of the National Council on Radiation Protection and Measurements, http://NCRPonline.org.

Radiation From Space

Radiation from outer space is called cosmic radiation. Radiation from beyond the solar system has enough energy to generate additional radiation and cosmogenic radionuclides as it passes through the earth's atmosphere. Some of this radiation reaches the earth's surface, with most entering near the poles, where shielding by the earth's magnetic field is the weakest, and at high altitudes, where the earth's atmosphere is the thinnest. Cosmogenic radionuclides consist primarily of tritium (hydrogen-3), carbon-14, and beryllium-7. In the United States, the average dose from space radiation is about 0.04 µSv in an hour, or about 0.33 mSv each year. This dose varies and depends on the latitude and altitude where a person lives. The average space radiation dose makes up about 11 percent of the average total dose from background radiation (see Resources listed at the end of this fact sheet for more information).

Radionuclides Originating on Earth

Radiation that originates on earth is called terrestrial radiation. Radionuclides that were present when the earth formed are referred to as primordial. They are found around the globe in sedimentary and igneous rock. From rocks, these radionuclides migrate into soil, water, and even the air. Human activities such as uranium mining have also redistributed some of these radionuclides (for more information, see the Health Physics Society "Uranium" Fact Sheet[2]). Primordial radionuclides include the series of radionuclides produced when uranium and thorium decay, as well as potassium-40 and rubidium-87. In the United States, the average dose from terrestrial radiation (not including the dose from ingested and inhaled radionuclides) is about 0.024 µSv in an hour, for about 0.21 mSv per year. The dose from terrestrial radiation also varies with location: doses on the Atlantic and Gulf coastal plains are lowest, while those in the mountains of the western United States are highest. The average terrestrial radiation dose (not including the dose from radionuclides in the body, discussed below) is about 7 percent of the average total dose from background radiation (see Resources listed at the end of this fact sheet for more information).

Human-Made Sources of Radiation

By far, the major source of human-made radiation is from medical applications. The medical exposure in Figure 1 represents the total exposure for medical procedures averaged over the entire U.S. population. The increase in the medical use of radiation accounts for the largest part of the overall increase in radiation exposure over the last several years. However, like natural background radiation, this dose is not evenly distributed across the population. People with health issues receive the majority of the dose, especially older individuals.

[1]http://water.epa.gov/lawsregs/rulesregs/sdwa/radionuclides/index.cfm
[2]http://hps.org/documents/uranium_fact_sheet.pdf

Much of the increase in radiation from medical applications is due to advances in technology, especially the increased use of computed tomography (CT). As illustrated in Figure 1, CT scans are the major medical source of radiation and account for half of the medical exposure (for more information, see the Health Physics Society "Radiation Exposure from Medical Exams and Procedures" Fact Sheet[3]).

Other sources of radiation include consumer products and uses of natural radioactivity, such as in some smoke detectors, energy-saving compact fluorescent light bulbs, timepieces, ceramics, fertilizers, and lantern mantles (for more information, see the Health Physics Society "Consumer Products Containing Radioactive Materials" Fact Sheet[4]).

Medical doses have increased to the point that by 2006 the average dose was about 3 mSv per year, almost half of all exposure. Since the 1980s, there has been more than a three-fold increase, resulting in an increased concern by the medical community and efforts to make sure that these exposures to radiation are medically justified. As illustrated in Figure 1, the use of CT scans is the major medical source of radiation and accounts for half of the medical exposure. Other consumer products and occupational and industrial exposure, which includes the exposure from the operation of nuclear power plants, only contribute about 0.1 mSv per year (2 percent of the exposure).

Total Average Dose from Background Radiation

Each year, residents of the United States receive an average dose from natural background radiation of about 3.1 mSv. The various source components of this dose are shown in Figure 2 and discussed later. This figure does not include man-made doses, such as from medical procedures, which add about another 3.1 mSv for a total of about 6.2 mSv per year.

Glossary

This fact sheet may use nuclear terms that are unfamiliar. Many of these are denoted in italics in the text and are defined in this glossary. More can be found on the Radiation Terms and Definitions page on the Health Physics Society website at http://hps.org/publicinformation/radterms.

Cosmogenic Radionuclides
Radionuclides produced in the atmosphere by cosmic radiation interacting with molecules.

Decay (Radioactive Decay)
The decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission from the nuclei of either alpha or beta particles, often accompanied by gamma radiation. Radioactive material decays with a half-life that is specific to that particular substance. The half-life is the time in which one-half of the radioactive material decays through spontaneous emissions.

Dose (Radiation Dose)
Refers to the effect on a material that is exposed to radiation. It can denote either the amount of energy absorbed by a material or, more loosely, the potential biological effect in tissue exposed to radiation. It is calculated to account for the different types of radiation (such as alpha, beta, and gamma) and how sensitive different organs are to the exposing radiation.

Ionizing Radiation
That part of the electromagnetic radiation spectrum with sufficient energy to remove an electron from an atom or molecule. Examples are alpha particles, beta particles, and gamma rays. Examples of nonionizing radiation are visible light, infrared light, microwaves, and radio waves.

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[3] http://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf
[4] http://hps.org/documents/consumerproducts.pdf

Radon
The radioactive element with atomic number 86. It is an alpha decay product of uranium and thorium and is a gas, which results in its movement through soil.

Sievert (Sv)
The international system (SI) unit for dose equivalent equal to 1 joule per kilogram in tissue. The sievert replaced the traditional U.S. units of rem. One sievert is equal to 100 rem.

Reference

National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States. Bethesda, MD: National Council on Radiation Protection and Measurements; NCRP Report No. 160; 2009. Available at: http://www.ncrponline.org/Publications/Press_Releases/160press.html. Accessed 15 June 2012.

Resources for more information

Environmental Protection Agency. Monitoring radiological incidents. Available at: http://www.epa.gov/rpdweb00/rert/monitoring.html. Accessed 15 June 2012.

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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 5,500 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 1313 Dolley Madison Blvd., Suite 402, McLean, VA 22101; phone: 703-790-1745; fax: 703-790-2672; email: HPS@BurkInc.com.