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

Common Sources of 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*[1]. This fact sheet addresses the baseline sources of background ionizing radiation and other sources of radiation to which we are commonly exposed on a daily basis.

Sources of Radiation

Background radiation is emitted from both natural and human-made radionuclides, or radioactive atoms. 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, some human-made radiation sources include consumer products, nuclear and coal-burning power plants, and medical uses such as nuclear medicine and computed tomography (CT). Annually, a US citizen is exposed to an average radiation *dose* of 6.2 *millisieverts (mSv*)

Fig. 1 depicts the typical distribution of exposure from all sources of radiation. As can be seen, natural background radiation, also called "ubiquitous" since it is around us at all times, is the largest source of radiation exposure to humans (50% or about 3.1 mSv).

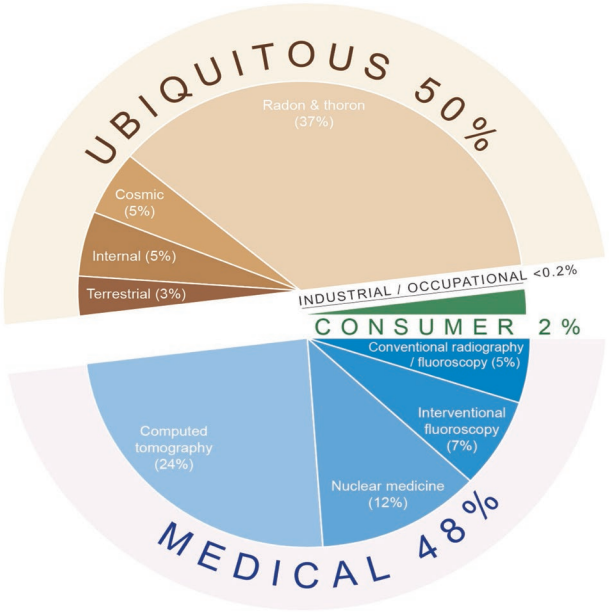

Fig. 1. Source distribution for all radiation dose—percent contribution of various sources of exposure to the total dose per individual in the US population. Adapted from Ionizing Radiation Exposure of the Population of the United States (NCRP 2009). Courtesy of Risk Assessment Corporation.

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 *radioactive decay* products), which we constantly inhale. Radon levels depend on the uranium and thorium content of the soil, which varies widely across the United States. Other radionuclides in the body may include uranium and thorium and their decay products, as well as potassium-40.

These terrestrial radionuclides in the soil are subsequently incorporated into our food and water supply. Most drinking-water sources have very low levels of terrestrial radionuclides, including radium-226, radium-228, and uranium, and are considered harmless at these low levels. 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 (EPA).

[1] Words in italics are defined in the Glossary.

The average dose from all inhaled radionuclides is about 2.3 mSv per year, which is about 37% of the average total dose. The average dose from all ingested radionuclides is about 0.3 mSv per year. This is about 5% of the average total dose.

Radiation From Space

Radiation from outer space is called cosmic radiation. Particles and electromagnetic waves from outer space may have 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 space radiation dose makes up about 5% of the average total dose. This dose varies and depends on the latitude and altitude where a person lives.

Radionuclides From 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. 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 0.022 μSv in an hour, for about 0.19 mSv per year.

Human-Made Sources of Radiation

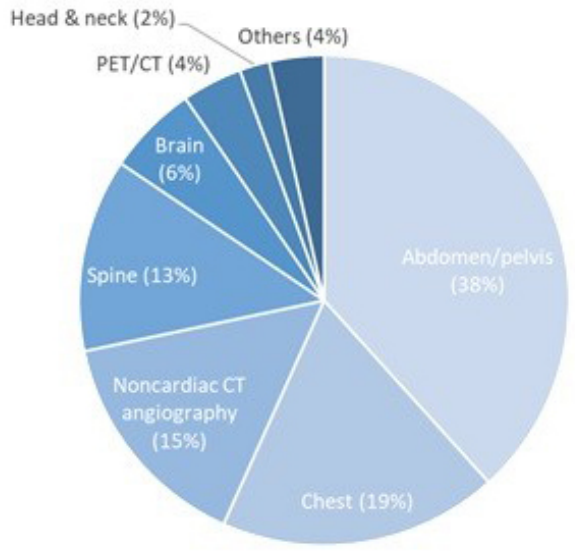

Fig. 2. Percent contribution of various CT scans to total CT dose (444,000 person-Sv) for 2016. Adapted from Figure ES.1. of Medical Radiation Exposure of the Population of the United States (NCRP 2019).

Fig. 1 shows in part the total exposure for medical procedures averaged over the entire US 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. The average medical dose was about 2.16 mSv per year in 2016 (ICRP 2015). 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. Much of the increase in radiation from medical applications is due to advances in technology, especially the increased use of CT. As illustrated in Fig. 1, CT scans are the major medical source of radiation and account for half of the medical exposure. As illustrated in Fig. 2, among various types of CT scans, abdomen CT contributes 38% of the radiation dose from CT scans.

Other sources of radiation exposure include consumer products such as smoke detectors, timepieces, ceramics, fertilizers, and lantern mantles. Other consumer products and occupational and industrial exposure, which includes the exposure from the operation of nuclear or coal-burning power plants, only contribute about 0.1 mSv per year (2% of the exposure). Medical radiation exposures to radiation therapy are not included in the scope of this document, but more information can be found on the Health Physics Society (HPS) "Ask the Experts" website.

Personal Radiation Dose Estimators and Calculators

Both the Nuclear Regulatory Commission (NRC) and the EPA provide free individual radiation dose calculators. These are not products of the HPS but are useful to the curious individual reading this fact sheet:

- NRC Personal Annual Radiation Dose Calculator
- EPA Radiation Dose Calculator

Conclusion

Radiation is all around us and has been since the earth formed. It was present when life first evolved and when dinosaurs lived and is still present today. Our human bodies and cells (and indeed the cells of other organisms) have adapted over time to respond to and repair the very slight damage that may occur from low levels of ionizing radiation. In fact, some scientists argue this action may actually stimulate our immune system to make us healthier.

This radiation is not to be feared! The HPS supports public education such that we all can appreciate the many common sources and uses of radiation in our daily lives.

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 HPS website at http://hps.org/publicinformation/radterms.

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

Decay (Radioactive Decay)
The process by which an unstable atomic nucleus emits radiation and transforms into a different element or into a lower-energy state of the same element.

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).

Ionizing Radiation
Electromagnetic waves or particles of high-enough energy to create ions, that is, to remove electrons from an atom.

Millisievert (mSv), Sievert (Sv)
The sievert is 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.

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.

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Resources for more information

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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.