Radiation and Its Effects on Humans

Radiation is a form of energy. The radiation of concern is ionizing radiation. Atoms release radiation as they change from unstable, energized forms to more stable forms.

All matter is composed of elements, and elements that are radioactive are generally referred to as **radionuclides.** Each element can take many different forms (called isotopes). Some of these isotopes are unstable and emit radiation; these unstable isotopes are known as radioisotopes or radionuclides. Stable isotopes do not undergo radioactive decay and therefore do not emit radiation.

TYPES OF RADIATION

- Alpha particles can travel only a few inches in the air and lose their energy almost as soon as they collide with anything. They are easily shielded by a sheet of paper or the outer layer of a person's skin. Alpha particles are hazardous only when they are inhaled or swallowed.
- Beta particles can travel in the air for a distance of a few feet. Beta particles can pass through a sheet of paper but can be stopped by a sheet of aluminum foil or glass. Beta particles can damage skin, but are most hazardous when swallowed or inhaled.
- Gamma rays are waves of pure energy and are similar to x-rays. They travel at the speed of light through air or open spaces. Concrete, lead, or steel must be used to block gamma rays. Gamma rays can present an extreme external hazard.
- Neutrons are small particles that have no electrical charge. They can travel long distances in air and are released during nuclear fission. Water or concrete offer the best shielding against neutrons. Like gamma rays, neutrons can present an extreme external hazard.

TERMS USED FOR RADIATION MEASUREMENTS

- Radiation is measured in different ways. Measurements used in the United States include the following (the internationally used equivalent unit of measurement follows in parenthesis):
- Rad (radiation absorbed dose) measures the amount of energy actually absorbed by a material, such as human tissue (Gray=100 rads).
- Roentgen is a measure of exposure; it describes the amount of radiation energy, in the form of gamma or x-rays, in the air.
- Rem (Roentgen equivalent man) measures the biological damage of radiation. It takes into account both the amount, or dose, of radiation and the biological effect of the type of radiation in question. A millirem is one one-thousandth of a rem (Sievert=100 rems).
- Curie is a unit of radioactivity. One curie refers to the amount of any radionuclide that undergoes 37 billion atomic transformations a second. A nanocurie is one one-billionth of a curie (37 Becquerel = 1 nanocurie).

WHAT LEVELS OF RADIATION ARE PEOPLE EXPOSED TO IN EVERYDAY LIFE?

To put an emergency situation in perspective, it helps to be aware of the radiation levels people encounter in everyday life. Individual exposures vary, but humans are exposed routinely to radiation from both natural sources, such as cosmic rays from the sun and indoor radon, and from manufactured sources, such as televisions and medical x-rays. Even the human body contains natural radioactive elements.

Because individual human exposures to radiation are usually small, the millirem (one one-thousandth of a rem) is generally used to express the doses humans receive. The following table shows average radiation doses from several common sources of human exposure.

Radiation Source **Dose (millirems)**

Chest X-ray.....10

Mammogram.....30

Cosmic rays.....31 (annually)

Human body.....39 (annually)

Household radon.....200 (annually)

Cross-country airplane flight.....5

LEGAL LIMITS FOR RADIATION EXPOSURE

Another way to help put a radiological emergency into perspective is to be aware of the radiation exposure limits for people who work with and around radioactive materials full time, as shown in the following table:

Worker Category **Legal Limit**

18-year old male.....5 rem/year
Pregnant woman.....500 millirem (mrem) during pregnancy

THE EFFECT OF RADIATION ON HUMANS

Radiation effects fall into two broad categories: deterministic and stochastic. At the cellular level, high doses of ionizing radiation can result in severe dysfunction, even death, of cells. At the organ level, if a sufficient number of cells are so affected, the **function of the organ is impaired**. Such effects are called **"deterministic."** Deterministic effects have definite threshold doses, which means, that the effect is not seen until the absorbed dose is greater than a certain level.

Once above that threshold level, the severity of the effect increases with dose. Also, deterministic effects are usually manifested soon after exposure. Examples of such effects include radiation skin burning, blood count effects, and cataracts.

In contrast, **stochastic effects are caused by more subtle radiation-induced cellular changes** (usually DNA mutations) that are random in nature and have no threshold dose. The probability of such effects increases with dose, but the severity does not. Cancer is the only observed clinical manifestation of radiation-induced stochastic effects. Not only is the severity independent of dose, but also, there is a substantial delay between the time of exposure and the appearance of the cancer, ranging from several years for leukemia to decades for solid tumors. Cancer can result from some DNA changes in the somatic cells of the body, but radiation can also damage the germ cells (ova and sperm) to produce hereditary effects. These are also classified as stochastic; however, clinical manifestations of such effects have not been observed in humans at a statistically significant level. (Source: Los Alamos Science, No. 23, 1995)

The nature and extent of damage caused by ionizing radiation depend on a number of factors, including the amount of exposure, the frequency of exposure, and the penetrating power of the radiation to which an individual is exposed. Rapid exposure to very large doses of ionizing radiation is rare but can cause death within a few days or months. The sensitivity of the exposed cells also influences the extent of damage. For example, rapidly growing tissues, such as developing embryos, are particularly vulnerable to harm from ionizing radiation.

IMPORTANT EMERGENCY RESPONSE TERMS

- **ERAMS (Environmental Radiation Ambient Monitoring System)** is the EPA-operated monitoring system used to measure radioactivity and other contaminants in the environment. There are 260 ERAMS sampling stations throughout the U.S. In an emergency, the sampling stations can be used to provide information on how far contamination has spread.

- **Plume -** The airborne "cloud" of material released to the environment. The plume may contain nuclear materials and may or may not be visible.
- **Protective Action -** Any action taken to reduce or avoid a radiation dose to the public.
- **Protective Action Guide (PAG) -** A predetermined projected dose level at which specified actions should be taken to protect the public from exposure to radiation.

Most of this information is courtesy of US Government CDC. In times of an emergency, much of this material may not apply when it comes to specialized care and testing. These are guidelines to help you when that care is not available. Some of this information is very technical and difficult to understand, but hopefully someone will be available for help in treatment and understanding.

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