



College of Health and Medical Technologies

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Radiobiology

The first stage

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The Severity of Radiation effect

Lecture No.8

Ionizing radiation injures tissues variably, depending on factors such as

- ❖ radiation dose,
- ❖ rate of exposure,
- ❖ type of radiation, and
- ❖ part of the body exposed.

Types of radiation

Radiation includes:

- ❖ High-energy electromagnetic waves (x-rays, gamma rays)
- ❖ Particles (alpha particles, beta particles, neutrons)
- ✓ Alpha particles are energetic helium nuclei emitted by some radionuclides with high atomic numbers (eg, plutonium, radium, uranium); they cannot penetrate skin beyond a shallow depth (< 0.1 mm).

- ✓ Beta particles are high-energy electrons that are emitted from the nuclei of unstable atoms (eg, cesium-137, iodine-131). These particles can penetrate more deeply into the skin (1 to 2 cm) and cause both epithelial and subepithelial damage.

- ✓ Neutrons are electrically neutral particles emitted by a few radionuclides (eg, californium-252) and produced in nuclear fission reactions (eg, in nuclear reactors); their depth of tissue penetration varies from a few millimeters to several tens of centimeters, depending on their energy.

- ✓ Gamma radiation and x-rays are electromagnetic radiation (ie, photons) of very short wavelength that can penetrate deeply into tissue (many centimeters).

Because of these characteristics, alpha and beta particles cause the most damage when the radioactive atoms that emit them are within the body (internal contamination) or, in the case of beta-emitters, directly on the body; only tissue in close proximity to the radionuclide is affected.

Gamma rays and x-rays can cause damage distant from their source and are typically responsible for acute radiation syndromes.

In general, the amount and duration of radiation exposure affects the severity or type of health effect. There are two broad categories of health effects: chronic (long-term) and acute (short-term).

Acute radiation syndromes

Acute Effects

Acute health effects occur when large parts of the body are exposed to a large amount of radiation.

The large exposure can occur all at once or from multiple exposures in a short period of time. Instances of acute effects from environmental sources are very rare. Examples include accidentally handling a strong industrial radiation source or extreme events like nuclear explosions.

can be caused by a sufficient dose of some internally deposited radionuclides that are widely distributed in tissues and organs and have a high specific activity.

People exposed to radiation will get ARS only if:

- The radiation dose was high
- The radiation was able to reach internal organs (penetrating)
- The person's entire body, or most of it, received the dose
- The radiation was received in a short time, usually within minutes

Symptoms of ARS

- Symptoms of ARS may include nausea, vomiting, headache, and diarrhea.
 - These symptoms start within minutes to days after the exposure, can last for minutes up to several days, and may come and go.
 - If you have these symptoms after a radiation emergency, seek medical attention as soon as emergency officials determine it is safe to do so.
- After the initial symptoms, a person usually looks and feels healthy for a period of time, after which he or she will become sick again with variable symptoms and severity that vary depending on the radiation dose that he or she received.
 - These symptoms include loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, and possibly even seizures and coma.
 - This seriously ill stage may last from a few hours up to several months.
 - People who receive a high radiation dose also can have skin damage. This damage can start to show within a few hours after exposure or it

may be delayed for several days. It can include swelling, itching, and redness of the skin (like a bad sunburn) or may be more severe and include blisters or ulcers.

- The skin may heal for a short time, followed by the return of swelling, itching, and redness days or weeks later.
- Complete healing of the skin may take from several weeks up to a few years.
- The time for skin to heal depends on the radiation dose the person's skin received.
- People who receive a high radiation dose to all or part of the body also may experience temporary hair loss. It may take several weeks for the hair to grow back.

Treatment of ARS

- Treatment of ARS focuses on reducing and treating infections, maintaining hydration, and treating injuries and burns. Some patients may benefit from treatments that help the bone marrow recover its function.
- The lower the radiation dose, the more likely it is that the person will recover from ARS.
- The cause of death in most cases is the destruction of the person's bone marrow, which results in infections and internal bleeding.
- For survivors of ARS, the recovery process may last from several weeks up to 2 years.
- **Cutaneous Radiation Injury (CRI)** happens when exposure to a large dose of radiation causes injury to the skin. A doctor will suspect the presence of a CRI when a skin burn develops in a person who was not exposed to a source of heat, electrical current, or chemicals.

Chronic Exposure

Chronic exposure is continuous or intermittent exposure to radiation over a long period of time. With chronic exposure, there is a delay between the exposure and the observed health effect.

These effects can include cancer and other health outcomes such as benign tumors, cataracts, and potentially harmful genetic changes.

Low Levels of Radiation Exposure

Current science suggests there is some cancer risk from any exposure to radiation. However, it is very hard to tell whether a particular cancer was caused by very low doses of radiation or by something else.

While experts disagree over the exact definition and effects of “low dose,” U.S. radiation protection standards are based on the premise that any radiation dose carries some risk, and that risk increases directly with dose.

This method of estimating risk is called the "linear no-threshold model (LNT). The assumption that the risk of cancer increases linearly as radiation dose increases. The risk of cancer from radiation also depends on age, sex, and factors such as tobacco use.

More
Radiation



Less
Radiation

Category

5

Death may occur in days to weeks

4

Increased risk of radiation sickness,
but death is not likely
(symptoms may appear in hours to days)

3

Increased risk of cancer later in life
(symptoms may take decades to appear)

2

Above the range of normal, everyday radiation
levels, but no health effects expected

1

Within the range of normal, everyday
radiation levels