CONDITION

Radiation effects

Radiation effects are short- or long-term health changes caused by ionizing radiation damaging cells and tissues.

WHAT IT IS
Tissue injury or later health changes from ionizing radiation

BODY SYSTEM
Whole body, especially skin, blood-forming tissues, bowel, and organs

MAIN SYMPTOMS
Skin changes, fatigue, nausea, diarrhea

WHAT CAUSES IT
Ionizing radiation damaging cells and DNA

HOW IT IS DIAGNOSED
Exposure assessment, blood counts, dosimetry, and targeted tests

MAIN TREATMENT
Decontamination, supportive care, and organ-specific treatment

CAN IT BE CURED?
Sometimes - acute injury heals; some late damage persists

IS IT AN EMERGENCY?
Sometimes - major exposure or severe symptoms need emergency care

LONG-TERM OUTLOOK
Many recover; higher doses can cause lasting illness

Overview

Radiation effects are health changes caused by ionizing radiation . This is radiation with enough energy to damage cells and their DNA. Sources include X-rays, CT scans, radiation therapy, radioactive materials, and some workplace or nuclear incidents.

This article does not cover non-ionizing radiation such as visible light, mobile phone signals, or microwaves. Ultraviolet radiation from sunlight can also damage DNA, but sunburn and skin cancer are discussed separately.

The effect of ionizing radiation depends on the dose, how quickly it was received, which body areas were exposed, and whether radioactive material entered or remained on the body. Age, pregnancy, and existing health conditions can also affect risk.

A small, controlled medical exposure is very different from a large accidental exposure. Routine diagnostic imaging does not cause acute radiation syndrome. Radiation therapy uses higher, carefully planned doses directed at a tumor, so side effects are usually concentrated in the treated area.

Radiation can cause:

Radiation effects are a condition caused by an exposure, not an infection. They cannot spread from person to person. Someone exposed to external radiation is not automatically radioactive. A person is contaminated only if radioactive material is on or inside their body.

- Early tissue effects , such as skin inflammation, nausea, or reduced blood cell production
- Late tissue effects , such as scarring, cataracts, or reduced organ function
- A higher future cancer risk , which may appear years or decades later

Symptoms

Symptoms may begin within hours, days, months, or years. Some exposures cause no noticeable symptoms.

A large dose to much of the body over a short time can cause acute radiation syndrome . Early symptoms may include nausea, vomiting, diarrhea, headache, unusual tiredness, fever, or loss of appetite. Symptoms can briefly improve before blood, bowel, or other problems develop.

Damage to blood-forming tissues can reduce white blood cells, red blood cells, and platelets. This may lead to infections, weakness, shortness of breath, easy bruising, or bleeding.

Radiation injury to the skin may not be obvious immediately. It can cause redness, itching, swelling, pain, blistering, peeling, hair loss in the exposed area, or a wound that heals slowly. Symptoms may appear in waves over days or weeks.

Radiation therapy side effects depend on the body area treated. They may include:

Late effects can include skin or tissue thickening, persistent dryness, swelling caused by impaired lymph drainage, cataracts, fertility problems, or reduced function of an exposed organ. Not everyone develops late effects.

- Skin irritation and fatigue
- Mouth soreness or difficulty swallowing after head, neck, or chest treatment
- Nausea, diarrhea, or bladder irritation after abdominal or pelvic treatment
- Hair loss limited mainly to the treated area

Causes and risk factors

Radiation transfers energy to tissue. This can damage cells directly or produce unstable molecules that damage DNA. Cells may repair the damage, stop working, die, or survive with a DNA change.

The chance and type of injury are influenced by:

Bone marrow, the digestive tract, reproductive organs, and developing tissues are especially sensitive because their cells divide often. The brain and muscles are generally less sensitive to lower doses, although very high doses can injure any tissue.

Medical imaging and radiation therapy are common planned sources. Occupational exposure can occur in healthcare, research, aviation, mining, and nuclear industries. Accidental exposure may involve an industrial source, damaged equipment, or a radiation emergency.

Radioactive material can enter the body by breathing it in, swallowing it, or through an open wound. The health effect then depends partly on where that material collects and how long it remains.

Children have more years ahead in which a radiation-related cancer could develop. A fetus may also be sensitive to radiation, with the possible effect influenced by the pregnancy stage and dose. This does not mean that every medical exposure during pregnancy causes harm.

- The total absorbed dose
- Whether the dose was received at once or spread over time
- How much of the body was exposed
- The type and energy of radiation
- Whether contamination was outside or inside the body
- The sensitivity of the exposed tissue

Diagnosis

There is no single test that confirms every radiation effect. Diagnosis combines the exposure history with symptoms, examination findings, and test results.

For a known workplace or medical exposure, personal dosimeters and treatment records may provide a dose estimate. After an unplanned event, specialists may reconstruct the likely dose using the source, distance, exposure time, and affected body area.

The absorbed dose is often described in gray , abbreviated Gy. A gray measures how much

radiation energy tissue absorbed. Sievert , abbreviated Sv, accounts for the radiation type and the sensitivity of exposed tissues and is often used when discussing long-term risk.

Repeated complete blood counts can show whether white blood cells, red blood cells, or platelets are falling. The timing of vomiting and changes in certain white blood cells can help estimate the seriousness of a whole-body exposure.

Specialized laboratories may examine chromosomes in blood cells for patterns linked to radiation. This is called biological dosimetry. It is not available everywhere and is generally used for significant or uncertain exposures.

Other tests are chosen for the affected area. They may include eye examinations, fertility testing, lung or heart tests, wound assessment, or imaging. Imaging may show tissue injury, but it does not usually measure the original radiation dose.

Treatment and management

Treatment depends on whether exposure is still occurring, whether radioactive contamination is present, and which tissues have been injured.

During a radiation emergency, the first priorities are leaving the radiation source, treating life-threatening injuries, and following public health instructions. Removing outer clothing can take away much of the radioactive material on the body. Gentle washing with soap and lukewarm water may remove more. Scrubbing hard can damage the skin and should be avoided.

Contamination should not delay urgent care for trauma, breathing problems, or severe bleeding. Emergency teams can use protective measures while providing treatment.

Early radiation illness is usually managed with supportive care. This can include fluids, medicines for nausea or pain, nutritional support, wound care, and treatment for infection. People with severely reduced blood cell production may need close monitoring, blood products, or medicines that support blood cell recovery. Stem cell treatment is considered only in selected severe cases.

Skin injury may require specialist wound care. Deep tissue damage can take months to become fully visible, so repeated assessment may be needed. Surgery is sometimes used for tissue that does not heal.

Late effects are treated according to the organ involved. Management may include rehabilitation, treatment for swelling or scarring, cataract surgery, fertility support, or care for heart, lung, bowel, thyroid, or other organ problems.

During radiation therapy, the cancer team may adjust the treatment plan or provide symptom relief. Treatment should not be stopped without discussing it with that team.

Potassium iodide protects only the thyroid from certain forms of radioactive iodine. It does not protect the rest of the body or help with most radiation sources. It should be taken only when public health authorities or an appropriate healthcare professional advise it.

Complications

The possible complications reflect the dose and body area exposed. A major whole-body exposure can cause severe loss of blood cells, leading to infection, anemia, or bleeding. Significant bowel injury can cause fluid loss, infection, and difficulty absorbing nutrients.

Local radiation injury may develop into a long-lasting wound, loss of underlying tissue, or restricted movement from scarring. Damage to lymph vessels can cause persistent swelling.

Later complications can include cataracts, infertility, changes in growth or development after childhood exposure, and reduced function of an exposed organ. Radiation to the chest, for example, may sometimes affect the lungs or heart.

Ionizing radiation can increase the chance of developing cancer later in life. It is usually impossible to determine whether an individual cancer was caused by a particular low-dose exposure. Risk is assessed using the dose, age at exposure, body area, and other cancer risk factors.

A frightening or unexpected exposure can also affect sleep, mood, and concentration. Emotional support may be useful even when physical testing shows a low dose.

Prevention

Not every radiation exposure can be prevented. Radiation effects from a past exposure cannot be undone, although complications may be treated or monitored.

Medical imaging and radiation therapy can provide important benefits. Imaging teams aim to use the lowest dose needed to answer the medical question. Keep a record of major imaging and radiation treatment, but do not delay necessary care because of radiation concerns.

Tell the imaging or treatment team if you are or may be pregnant. They can decide whether the test should proceed, be changed, or be postponed. A necessary examination can often be performed with steps to limit fetal exposure.

Workplaces that use ionizing radiation should provide training, shielding, monitoring, and

controlled access. Follow local safety procedures and wear a personal dosimeter when required.

Testing homes for radon may help identify a preventable source of long-term exposure. Radon advice and testing methods differ by country and region.

In a radiation emergency, follow official instructions. The usual public health message is to get inside, stay inside, and stay informed. Do not travel toward the event or take potassium iodide unless authorities direct you to do so.

Living with it and what to expect

The course over months and years depends mainly on the dose, exposure pattern, and tissues involved. Mild skin or general symptoms may settle over days to weeks. Blood counts can take weeks or longer to recover after a significant exposure.

Some injuries become clearer with time. Skin and deeper tissue damage may worsen after an early period of improvement. Follow-up is therefore important after a substantial local exposure, even if the area initially looks normal.

After radiation therapy, many early side effects improve within weeks or months of treatment ending. Some fatigue, bowel changes, dryness, or discomfort may last longer. Late effects can first appear months or years later and may remain stable, progress slowly, or respond to treatment.

People with a meaningful exposure may need long-term checks based on the affected organs. Follow-up might include blood tests, skin or eye examinations, cancer screening, or assessment of heart, lung, thyroid, reproductive, or digestive health. Routine screening is usually based on the person's actual dose and treatment history rather than exposure fear alone.

Many people recover from limited radiation injury and return to their usual activities. Higher-dose injuries can require prolonged rehabilitation or ongoing medical care. Keeping exposure records can help future healthcare teams choose appropriate monitoring.

When to get medical help

Seek emergency help after a known or suspected major radiation incident if you have repeated vomiting, confusion, fainting, breathing difficulty, severe weakness, extensive burns or blistering, uncontrolled bleeding, or a serious injury.

Follow emergency-service and public health directions if radioactive contamination may be present. If possible, avoid spreading loose material, but do not delay lifesaving care to wash or change clothes.

During or after cancer treatment, seek urgent advice for fever, shaking chills, new breathing problems, inability to keep fluids down, severe diarrhea, unusual bleeding, or rapidly worsening pain. Use the specific emergency instructions provided by your treatment team.

Arrange routine medical follow-up for a persistent skin change, a wound that is not healing, new swelling, ongoing bowel or bladder symptoms, vision changes, or other problems in an area that received radiation. New symptoms years later do not automatically mean radiation damage, but they should be assessed in the context of your exposure history.

Common questions

Can one X-ray cause radiation sickness?

No. Acute radiation syndrome requires a much larger dose to most or all of the body over a short period. A routine X-ray uses a much lower dose. Even so, imaging should have a clear medical reason because small exposures add to lifetime radiation dose.

Am I radioactive after an X-ray or CT scan?

No. X-rays and CT scans expose you to radiation only while the equipment is operating. They do not leave radioactive material in your body. Some nuclear medicine tests use radioactive material, so temporary precautions may be recommended for certain tests.

How soon do radiation effects appear?

Early effects can begin within hours or days after a large exposure. Local skin injury may take days or weeks to appear. Late tissue effects and radiation-related cancers may develop years later. Timing alone cannot confirm the dose or cause.

Can radiation damage be reversed?

Some effects heal as damaged cells are replaced. Other injuries, such as deep scarring or permanent loss of tissue function, may not fully reverse. Treatment can often reduce symptoms or manage complications.

Does radiation exposure always cause cancer?

No. Radiation can increase cancer risk, but it does not mean cancer will occur. The increase is influenced by dose, age, exposed tissues, and other risk factors. A low-dose exposure usually cannot be linked to a future cancer in one individual.

Should I take potassium iodide after radiation exposure?

Only when public health authorities or an appropriate healthcare professional advise it. Potassium iodide protects the thyroid from radioactive iodine only. It does not treat radiation sickness or protect against other radioactive substances.

Sources

- World Health Organization - Ionizing radiation and health effects
- US Centers for Disease Control and Prevention - Acute Radiation Syndrome
- US Centers for Disease Control and Prevention - Cutaneous Radiation Injury
- Radiation Emergency Medical Management, US Department of Health and Human Services - Acute Radiation Syndrome
- National Cancer Institute - Radiation Therapy Side Effects
- International Commission on Radiological Protection - Publication 118: Tissue Reactions and Early and Late Effects of Radiation