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## Effects of High and Low Doses of Radiation

### **What's the Problem?**

Ionizing radiation has sufficient energy to cause chemical changes in human cells and damage them. Fortunately, our bodies are extremely efficient at repairing cell damage. The extent of the damage to the cells depends upon the amount and duration of the exposure, as well as the organs exposed.

A lot of radiation over a short period, such as from a radiation emergency, can cause burns or radiation sickness. If the exposure is large enough, it can cause premature aging or even death.

### **Acute Radiation Syndrome:**

Acute radiation syndrome (ARS), also known as radiation poisoning, radiation sickness or radiation toxicity, is caused by a large dose of ionizing radiation often received over a short period of time. When cells are exposed to ionizing radiation, their chromosomes are damaged. If this damage is high enough, then the cell will die or become unable to divide, leading to the eventual death of tissue.

A high acute exposure can lead to a variety of symptoms including loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, seizures and coma. At very high levels, radiation exposure can cause death within weeks. Signs and symptoms of acute radiation syndrome are affected by the type of exposure—such as total or partial body and whether contamination is internal or external—and how sensitive to radiation the affected tissue is. The diagnosis of ARS can be difficult to make because ARS causes no unique disease. Depending on the dose, symptoms may not occur for hours or days after exposure; and after initial symptoms appear, they may subside during a latent phase. By the time the patient receives treatment, that person may already be suffering irreversible internal damage.

### **Other Effects:**

Large doses of ionizing radiation can cause a measurable increase in solid cancers and leukemias (“cancer of the blood”) after some years delay. The effects of long-term, low-dose radiation are difficult to measure. However, DNA damage from any level of ionizing radiation can cause mutations that lead to cancer, especially in tissues with high rates of cell division, such as the gastrointestinal tract, reproductive cells and bone marrow. With small doses, there is only a chance that cancer will develop—the chance increases as the dose or duration of exposure increases.

### **Who's at Risk?**

Although anyone exposed to radiation may experience health effects, a developing fetus is particularly vulnerable to the effects of low-level radiation exposure.

Additionally, children, the elderly, and people with compromised immune systems are more vulnerable to health effects from radiation exposure than healthy adults. The susceptibility of infants is a particular concern because in a radiation emergency, it is possible for nursing mothers who are near the affected area to ingest or inhale radioactive material that can be passed to babies through breast milk.

During a nuclear emergency, radioactive materials may be released into the air and then breathed into the lungs, or may get into the body through open wounds. Populations closest to the release site face the highest risk of exposure as radioactive materials can contaminate the local food supply and get into the body through eating or drinking. This is called internal contamination.

Various sources of contamination from different types of sources result in different types of impacts. Radiation exposure could occur if radioactive materials are released into the environment as the result of an accident, an event in nature, or an act of terrorism. For example, the concern from industrial sources to the public is primarily the threat that sources could be stolen and used in dirty bombs. The public could also be imperiled by either accidents or terrorist attacks at nuclear reactors, industrial irradiators or industrial radiography sources. Such a release could both directly expose the general population and contaminate their surroundings and personal property.

### **Can it be prevented?**

Yes, through rigorous regulation of the safety and security of all facilities that use or store nuclear materials, and through comprehensive emergency planning.

Tens of thousands of people in technologically advanced countries work in medical and industrial environments where they may be exposed to radiation above normal background levels. Accordingly, they wear monitoring 'badges' while at work, and their exposure is carefully monitored. The health records of these occupationally exposed groups often show that they have lower rates of mortality from cancer and other causes than the general public and, in some cases, significantly lower rates than other workers who do similar work without being exposed to radiation. In fact, many nuclear sites have a workforce where workers tend to be physically fit and generally illness-free. They tend to be "healthier" to start with and exhibit fewer illnesses than the general public. This is known as "healthy worker effect."

In the past, many accidents commonly resulted from failure to follow safety procedures.

Radiation injuries have also been caused by lost or stolen medical or industrial sources containing large quantities of radioactive material. People seeking medical care for these injuries may be unaware that they

were exposed to radiation. For certain scenarios, it is possible that members of the public could be exposed to radiation levels high enough to cause ARS and death to thousands of people.

Time is the most important step to thwarting deadly health consequences from radiation exposure. The longer a human is exposed to radiation, the larger the hazardous dose, the more harm it will cause. It is imperative that persons exposed to radiation get away from the potential source as soon as possible. If you are injured or think you are injured, seek medical attention right away. Injuries could be at high risk for infection and other long-lasting health effects.

### **The Bottom Line:**

Although exposure to any level of ionizing radiation carries a risk, we cannot avoid it entirely. Even if we wanted to, this would be impossible. Radiation has always been present in the environment and in our bodies. However, we can and should minimize unnecessary exposure to significant levels of manmade radiation.

Radiation is very easily detected. There is a range of simple, sensitive instruments capable of detecting minute levels of radiation from natural and manmade sources. But that doesn't mean you shouldn't be prepared in case this situation worsens—or for when the next nuclear disaster happens.

## **Case Examples**

### **Tokaimura**

Japan's worst nuclear radiation accident took place in 1999 at a uranium fuel fabrication facility in Tokaimura. Three workers were exposed to radiation after a criticality event where too much of the material was concentrated and it resulted in fissioning. Three workers were exposed to high doses of radiation, and one of these workers, Hiroshi Ouchi, was admitted to the University of Tokyo Hospital emergency room. Mr. Ouchi appeared relatively well for someone who had just been subjected to a massive level of radiation (this is known as the prodromal period), and was even able to talk with doctors.

His condition gradually got worse as his cells, damaged by the radiation exposure, were unable to divide. Ouchi was kept alive over a period of three months as his skin blackened and blistered and began to fall off his body. His internal organs eventually failed. He was eventually put into a medical coma but did not survive. The internal damage caused by powerful neutron beams passing through his body was irreparable. A second worker eventually died of ARS as well.

### **Los Alamos**

In 2013, a close call involving fissionable material that could have generated a deadly burst of radiation prompted the shutdown of America's only scientific laboratory that produces and tests nuclear plutonium cores. The shutdown of this facility, located in Los Alamos, New Mexico, has caused major delays in planned plutonium "pit" production and related projects supporting the U.S. nuclear weapons stockpile. Various reports from Los Alamos have described flimsy workplace safety policies and previously unpublicized accidents that repeatedly left workers uninformed of proper procedures. Plutonium was packed hundreds of times into dangerously close quarters or without appropriate shielding to prevent a serious accident. The lab management's callousness about nuclear risks and its desire to put its own

profits above safety clearly outweighed the safety of its own workers. It is imperative that facility directors, the United States Government and nuclear experts remain vigilant in their inspections of weapons facilities and nuclear laboratories.

**Related Links:**

<https://emergency.cdc.gov/radiation/ars.asp>

<http://www.who.int/mediacentre/factsheets/fs371/en/>

<http://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/nuclear-radiation-and-health-effects.aspx>

<http://abcnews.go.com/Health/arafat-mystery-10-cases-radiation-poisoning/story?id=20815459>

[https://www.washingtonpost.com/world/national-security/safety-lapses-undermine-nuclear-warhead-work-at-los-alamos/2017/06/17/87f051ee-510d-11e7-b064-828ba60fbb98\\_story.html?utm\\_term=.5bad6e8edec0](https://www.washingtonpost.com/world/national-security/safety-lapses-undermine-nuclear-warhead-work-at-los-alamos/2017/06/17/87f051ee-510d-11e7-b064-828ba60fbb98_story.html?utm_term=.5bad6e8edec0)

<http://www.elpasotimes.com/story/news/national/2017/06/19/nuclear-near-disaster-slows-work-los-alamos/406059001/>