Effects of Nuclear Radiation: A Silent Killer

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Abstract:

Nuclear radiation is the worst effect of a nuclear explosion. Radiation is perhaps the most frightening direct effect of nuclear explosions. Blast can be seen, heat can be sensed but ionizing radiation cannot be detected so, a person can die without knowing what caused it. It not only damages the health but through its effect on reproductive cells and fetuses, it also has prospective effect on health.

This paper will analyze the kinds of radiation and its effect on the human society. Roughly, during the first six months after the explosion, for every sevenfold increase in time, the radiation dose received is decreased by a factor of 10.

The next section of the paper will be dedicated to the medical effects of nuclear radiation. The medical effects of ionizing radiation depend on the dose i.e. the amount of energy actually deposited in the body. The more energy absorbed, the greater are the risk of irreparable damage. Within the intermediate range of exposure, a victim may develop a variety of symptoms, including loss of appetite, nausea, vomiting, intestinal cramps, diarrhea, apathy, fever, and headache. The incidence of stillbirths, infant mortality, mental retardation, malformations, and cancer among human beings exposed to intermediate radiation during their embryonic stage of development will be higher. There might also be an increased number of genetic defects among the survivors' descendants. There is no effective cure for radiation sickness. Further, the paper concludes and emphasizes on the need to have a check and balance system on the use of nuclear weapons and provides suggestions for improving the present state.

Keywords: *radiation, ionization, energy, medical effects, radiation dose, stillbirths*

Introduction

The consequence of a nuclear explosion is quite drastic. Numerous nuclear explosions have occurred in the last five decades like the accident at Three Mile Island nuclear power plant in the USA, March 1979, caused some people near the plant to receive very minor doses of radiation, immediately after the Chernobyl nuclear power plant disaster in 1986, much larger doses were experienced, apart from the residents of nearby Pripyat, who were evacuated within two days, some 24,000 people living within 15 km of the plant. In this explosion a total of 14,000 PBq of radioactivity (iodine-131 equivalent) was released. In 1987 at Goiania in Brazil, an old radiotherapy source stolen from an abandoned hospital caused four deaths, 20 cases of radiation sickness and significant contamination of many more. Another accident which is more recent occurred in the March 2011 accident at Fukushima Daiichi nuclear power plant in Japan which released more radioactivity than Three Mile Island, but much less than Chernobyl.[1] As can be seen that even a small nuclear is a cause of great anxiety among the people then, imagine what will happen if this explosion is caused deliberately by a person on a large scale. Nuclear weapons are not the safest of weapons for mankind. Nuclear energy is very good for the development but in the wrong hands, it is a weapon of massive destruction. So, proper care should be taken while handling nuclear energy or a nuclear weapon.

There are two basic types of nuclear weapons. In an A-bomb (atomic or fission bomb), atoms of heavy elements (uranium-235 or plutonium-239) break up (fission) into lighter elements and release energy. In an H-bomb (hydrogen, fusion, or thermonuclear bomb), two isotopes of the lightest element (hydrogen) are fused into a heavier element (usually helium, the next lightest) and produce an enormous explosion[1].

[11] Nuclear radiation and health effect

Several variations of these two bombs exist. For any given weight of explosives, the yield of nuclear bombs is roughly 3.5 million times greater than the yield of conventional explosives [2]. The physical characteristics and effects of a single nuclear explosion are determined by many variables, including the type of bomb used, its yield, the height at which detonation occurs, weather conditions, and the type of target[3]. Any brief description is therefore abstract and simplified. The following the main effects of a nuclear explosion:

Ultraviolet Pulse: For a person standing outdoors some distance from ground zero, the first indication that a nuclear explosion has occurred is a blinding flash of intense ultraviolet radiation.[4] This flash can dazzle observers miles away and temporarily blind them.

Electromagnetic Pulse: Wherever this pulse occurs, it can be absorbed by power lines, antennae, long wires, and other collectors, and carried to the electrical and electronic devices to which these collectors are attached.[5] EMP can therefore lead to temporary interference in communication and power. However, its direct effects on people are negligible: only the few people who happen to hold a pipe, long wire, or similar collector at the moment of explosion could die of severe shock.

Heat: Some 35 percent of the bomb's energy is given off as heat (thermal radiation). The heat pulse given off by the fireball starts fires over a large area. Fires may also start as an indirect result of the blast. These fires increase the number of casualties[6].

Blast: Some 50 percent of the bomb's energy is taken up by the blast. The blast lasts a few seconds. As is the case with all nuclear bombs' effects, its severity and physical characteristics depend on the bomb's yield.

The most dangerous effect is that of a radiation. Radiation is energy in the process of being transmitted, which may take such forms as light, or tiny particles much too small to see. [7] Radiation particularly associated with nuclear

medicine and the use of nuclear energy, along with X-rays, is 'ionizing' radiation, which means that the radiation has sufficient energy to interact with matter, especially the human body, and produce ions, *i.e.* it can eject an electron from an atom. About 15% of the energy released in a nuclear air burst is in the form of ionizing radiation: neutrons, gamma rays, alpha particles and electrons moving at speeds up to the speed of light.[8] Blast and thermal injuries in many cases will far outnumber radiation injuries. However, radiation effects are considerably more complex and varied than are blast or thermal effects.[9] From the psychological point of view, and from the point of view of humankind's long-term future, radiation is perhaps the most frightening direct effect of nuclear explosions. We can sense blast, heat, and fire, but we can't detect ionizing radiation (except at very high intensities when it produces a tingling sensation) without the aid of special instruments; we can be irradiated to death without knowing it. Unlike fire and blast, ionizing radiation not only damages our health, but, through its potential impact on fetuses and on reproductive cells, it may damage the health of our descendants. Though the heat and the blast wreak incredible havoc, their direct effects are gone within seconds, or, in the case of the fires they cause, within hours or days. In contrast, poisonous radioactivity may linger for years.[10]

The character of the radiation received at a given location also varies with distance from the explosion. Radiation consists of three types of rays, each with a different capacity to penetrate bodies. These are alpha, beta and gamma rays. Radiation is not harmful in all cases. In fact, some types of radiations are unavoidable, like cosmic radiation which originates from stars. The Sun too, radiates cosmic energy produced by nuclear reactions on its surface, consisting of short wavelength emissions of electrons and neutrons.[11]

Nuclear radiation arises from hundreds of different kinds of unstable atoms. While many exist

in nature, the majority are created in nuclear reactions. Ionizing radiation which can damage living tissue is emitted as the unstable atoms (radionuclides) change ('decay') spontaneously to become different kinds of atoms.

The principal kinds of ionizing radiation are[12]:

Alpha particles

These are helium nuclei consisting of two protons and two neutrons and are emitted from naturally-occurring heavy elements such as uranium and radium, as well as from some man-made transuranic elements. They are intensely ionizing but cannot penetrate the skin, so are dangerous only if emitted inside the body.

Beta particles

These are fast-moving electrons emitted by many radioactive elements. They are more penetrating than alpha particles, but easily shielded – they can be stopped by a few millimetres of wood or aluminium. They can penetrate a little way into human flesh but are generally less dangerous to people than gamma radiation. Exposure produces an effect like sunburn, but which is slower to heal. Beta-radioactive substances are also safe if kept in appropriate sealed containers.

Gamma rays

These are high-energy beams much the same as X-rays. They are emitted in many radioactive decays and are very penetrating, so require more substantial shielding. Gamma rays are the main hazard to people dealing with sealed radioactive materials used, for example, in industrial gauges and radiotherapy machines. Radiation dose badges are worn by workers in exposed situations to detect them and hence monitor exposure. All of us receive about 0.5-1 mSv per year of gamma radiation from cosmic rays and from rocks, and in some places, much more. Gamma activity in a substance (*e.g.* rock) can be measured with a scintillometer or Geiger counter.

X-rays are also ionizing radiation, virtually identical to gamma rays, but not nuclear in origin.

Cosmic radiation consists of very energetic particles, mostly protons, which bombard the Earth from outer space.

Neutrons are mostly released by nuclear fission (the splitting of atoms in a nuclear reactor), and and hence are seldom encountered outside the core of a nuclear reactor. Thus they are not normally a problem outside nuclear plants. Fast neutrons can be very destructive to human tissue.

The **medical effects of a nuclear blast** upon humans can be put into four categories[13]:

- Initial stage—the first 1–9 weeks, in which are the greatest number of deaths, with 90% due to thermal injury and/or blast effects and 10% due to super-lethal radiation exposure
- Intermediate stage—from 10–12 weeks. The deaths in this period are from ionization radiation in the median lethal range
- Late period—lasting from 13–20 weeks. This period has some improvement in survivors' condition.
- Delayed period—from 20+ weeks. Characterized by "numerous complications, mostly related to healing of thermal and mechanical injuries coupled with infertility, sub-fertility and blood disorders caused by radiation." Also, ionizing radiation from fallout can cause genetic effects, birth defects, cancer, cataracts and other effects in organs and tissue.

High Doses

Exposure to high doses of radiation--at least 80 rem--kills human cells, damaging tissue and organs immediately. This anatomical response, referred to as "acute radiation syndrome," was seen in many atomic bomb survivors in 1945 and about 134 plant workers and firefighters in Chernobyl, Ukraine, the site of the world's worst nuclear power plant

disaster. Of the 134 workers, exposure rates of 80 rem to 1,600 rem killed 28 within three months of the accident. Exposures up to100 rem can damage the stomach lining, interfering with its water and nutrient intake function. The immune system sustains damage at exposure rates up to 300 rem, subjecting the subject to infection and disease, and exposures of 400 rem and above are expected to kill 50 percent of subjects within 60 days of exposure, largely due to infection.

Reproductive Tract

Because reproductive tract cells divide rapidly, these areas of the body can be damaged at rem levels as low as 200. Long-term, some radiation sickness victims will become sterile. Thus, the dose and its respective effect can be properly summarized in the following table:

Dose-rem	Effects
5-20	Possible late effects; possible chromosomal damage.
20-100	Temporary reduction in white blood cells.
100-200	Mild radiation sickness within a few hours: vomiting, diarrhea, fatigue; reduction in resistance to infection.
200-300	Serious radiation sickness effects as in 100-200 rem and hemorrhage; exposure is a Lethal Dose to 10-35% of the population after 30 days (LD 10-35/30).
300-400	Serious radiation sickness; also marrow and intestine destruction; LD 50-70/30.
400-1000	Acute illness, early death; LD 60-95/30.
1000-5000	Acute illness, early death in days; LD 100/10.

Blood transfusions may be necessary for patients suffering from anaemia.

Radiation-related illnesses tend to show themselves about 10 to 15 years after a radiation disaster. The body's endocrine, or hormone-

secreting, glands appear to be particularly sensitive to radiation.

It is now widely accepted that the Chernobyl nuclear disaster has led to a massive increase in thyroid cancers in the three countries most affected. Already, 680 cases of thyroid cancer have been recorded in Belarus, Russia and Ukraine. Belarus has shown a 100-fold increase, from 0.3 per million in 1981-85 to 30.6 per million in 1991-94.

Unicef has noted significant increases in many types of health disorders in Belarus since the disaster. For example, problems of the nervous and sensory organs have increased by 43%; disorders of the digestive organs by 28%; and disorders.

There is no specific treatment once exposure has occurred but management is generally supportive whilst the body recovers from the damage done - anti-nausea drugs and painkillers can be used to relieve symptoms of radiation sickness. Antibiotics may also be needed to fight off secondary infection.

Radiation, like many other scientific discoveries, can be put to both constructive and destructive uses. It is the responsibility of humanity to use this powerful tool for the benefit of nature and all of its elements. It can be a tool of massive destruction if in the wrong hands, while it can be put to a good cause like that of the development of the human society on the other hand. It is all upto the person who uses this resource.

References:

[1] Consequences of nuclear war

[2] ibid

[3] Effects of nuclear explosion

[4] Consequences of nuclear war

[5] Effects of nuclear explosion

[6] ibid

[7] Nuclear Radiation and health effect

[8] Effects of nuclear explosion

[9] Nuclear weapon radiation effect

[10] Consequence of nuclear war

[11] Effects of nuclear radiation

[12] Nuclear radiation and health effect

[13] Effects of nuclear explosion on human health