

Lesson learnt from nuclear disasters - health hazards & its prevention

Abstract

The United Nations Disaster Relief Organization (UNDRO) defines a disaster as “a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using its resources.”

A number of nuclear disasters have occurred in the world which includes the worst disaster of Hiroshima and Nagasaki bombing, the Chernobyl disaster and the Fukushima tragedy.

Acute Radiation Syndrome also is known as radiation sickness caused by a high dose of penetrating radiation. The three classic ARS Syndromes are: Bone Marrow Syndrome, Gastrointestinal (GI) Syndrome and Cardiovascular (CV)/ Central Nervous System (CNS) syndrome. Survival is extremely unlikely in the case of GI syndrome whereas death may occur within two weeks in the case of cardiovascular syndrome.

Human beings are badly affected by head to toe by radiation exposure. There may be hair loss in clumps, Damage to nerve cells leading to seizures, thyroid carcinoma, increased long term risk for leukemia, lymphoma, sterility, and radiation burn, etc.

The best prevention of radiation sickness is to minimize the exposure dose. This can be achieved by increasing the distance from the radiation source and early evacuation. We have to find out and respect the regulations regarding production, transport, handling and storage of radioactive substances. In the case of nuclear fallout, stay in house/ shelter as advised. If a nuclear explosion occurs- take shelter behind a solid wall and if you are outside, lie down in a ditch facing the ground and protect your face with your arms.

Sustained Information, Education and Communication (IEC) activities should be carried out vigorously to sensitize the people of health hazards of radiation exposure that can occur in the health sector or due to nuclear fallout that may be accidental or intentional.

Volume 9 Issue 4 - 2020

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Received: December 31, 2019 | **Published:** August 07, 2020

Introduction

United Nations Disaster Relief Organization (UNDRO), defines disaster is “an event, concentrated in time and space, in which a community undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential function of the society is prevented”.¹⁻⁶ A number of nuclear disasters have

occurred in the world which includes the worst disasters of Hiroshima and Nagasaki bombing, the Chernobyl disaster and the Fukushima tragedy. A list of disaster is given in Table 1.

Adverse effects of radiation exposure

Radiation disasters affect the whole body from head to toes (Table 2).⁷

Table 1 Worst Nuclear Disasters in the world^{2,3,4,5,6}

Date	Location	Description of accident or incident	Deaths	INES Level
Aug. 6 1945	Hiroshima, Japan	Atom Bomb dropping by USA	1,40,000	7
Aug. 9 1945	Nagasaki, Japan	Atom Bomb dropping by USA	75,000	7
Sept. 29, 1957	Mayak, Kyshtym, Soviet Union	The Kyshtym disaster was a radiation contamination accident (after a chemical explosion that occurred within a storage tank) at Mayak, a Nuclear fuel reprocessing plant in the Soviet Union.	Estimated 200 possible cancer fatalities	6
Oct. 10, 1957	Sellafield aka Windscale fire, Cumberland, United Kingdom	A fire at the British atomic bomb project (in a plutonium-production-reactor) damaged the core and released an estimated 740 terabecquerels of iodine-131 into the environment. A rudimentary smoke filter constructed over the main outlet chimney successfully prevented a far worse radiation leak.	0 direct, estimated up to 240 possible cancer victims	5

Table Continued...

Date	Location	Description of accident or incident	Deaths	INES Level
Jan. 3, 1961	Idaho Falls, Idaho, United States	Explosion at SL-1 prototype at the National Reactor Testing Station. All 3 operators were killed when a control rod was removed too far.	3	4
Jan. 21, 1969	Lucens reactor, Vaud, Switzerland	On January 21, 1969, it suffered a loss-of-coolant accident, leading to meltdown of one fuel element and radioactive contamination of the cavern, which before was sealed.	0	4
Dec. 7, 1975	Greifswald, East Germany	Electrical error in Greifswald Nuclear Power Plant causes fire in the main trough that destroys control lines and five main coolant pumps	0	3
Jan. 5, 1976	Jaslovské Bohunice, Czechoslovakia	Malfunction during fuel replacement. Fuel rod ejected from reactor into the reactor hall by coolant (CO ₂).	2	4
March 28, 1979	Three Mile Island, Pennsylvania, United States	Loss of coolant and partial core meltdown due to operator errors and technical flaws. There is a small release of radioactive gases. See also Three Mile Island accident health effects.	0	5
April 26, 1986	Chernobyl, Ukraine	A flawed reactor design and inadequately trained personnel led to a failed backup generator test. This test led to a power surge which overheated the fuel rods of reactor no. 4 of the Chernobyl power plant, causing an explosion and meltdown	28 direct, 19 not entirely related and 15 minors due to thyroid cancer, as of 2008. Estimated up to 4000 possible cancer deaths.	7
13 Sept. 1987	Goiania, Brazil	Forgotten radiotherapy source was taken from an abandoned hospital site	4 deaths and 249 contaminated	5
Sept. 30, 1999	Ibaraki Prefecture, Japan	Tokaimura nuclear accident killed two workers, and exposed one more to radiation levels above permissible limits.	2	4
Feb. 16, 2002	Oak Harbor, Ohio, United States	Severe corrosion of reactor vessel head forces 24-month outage of Davis-Besse reactor	0	3
April 10, 2003	Paks, Hungary	Collapse of fuel rods at Paks Nuclear Power Plant unit 2 during its corrosion cleaning led to leakage of radioactive gases. It remained inactive for 18 months.	0	3
Aug. 2004	Fukui Prefecture, Japan	Steam explosion at Mihama Nuclear Power Plant kills 4 workers and injures 7 more	4	1
July 25, 2006	Forsmark, Sweden	An electrical fault at Forsmark Nuclear Power Plant caused multiple failures in safety systems that had the reactor to cool down	0	2
Feb. 26, 2010	Mayapuri, New Delhi, India	An AECL Gamma cell 220 research irradiator owned by Delhi University was auctioned to a scrap metal dealer	1	4
March 11, 2011	Fukushima, Japan	A tsunami flooded and damaged the plant's 3 active reactors,	1 and 3+ labour accidents; plus a broader number of primarily ill or old people from evacuation stress	7

Table 2 Effects of radiation on body

Head and Neck	<ul style="list-style-type: none"> · Fatigue · Hair loss · Mouth changes · Skin changes · Taste changes · Throat changes, such as trouble swallowing · Less active thyroid gland
Pelvis	<ul style="list-style-type: none"> · Diarrhoea · Fatigue · Hair loss · Nausea and vomiting · Sexual problems (men) · Fertility problems (men) · Sexual problems (women) · Fertility problems (women) · Skin changes · Urinary and bladder changes
Rectum	<ul style="list-style-type: none"> · Diarrhoea · Fatigue · Hair loss · Sexual problems (men) · Fertility problems (men) · Sexual problems (women) · Fertility problems (women) · Skin changes · Urinary and bladder changes
Stomach and Abdomen	<ul style="list-style-type: none"> · Diarrhoea · Fatigue · Hair loss · Nausea and vomiting · Skin changes · Urinary and bladder changes

Acute radiation syndrome: The three classic ARS Syndromes are:⁸

- i. Bone Marrow Syndrome –may occur with a dose between 0.7 and 10 Gy. Mild symptoms may occur as low as 0.3 Gy or 30 rads. The cause of death is the destruction of the bone marrow, leading to infection and hemorrhage.
- ii. Gastrointestinal Syndrome –may occur with a dose between 10 and 100 Gy. Survival is extremely unlikely. Destructive and irreparable changes within the alimentary canal may occur. Death usually happens within two weeks.
- iii. Cardiovascular (CV)/ Central system nervous (CNS) syndrome, the complete syndrome will usually occur with a dose greater

than 50 Gy though some symptoms may occur as low as 20 Gy or 2000 rads. Death due to the collapse of the cardiovascular system occurs within three days. The basal cell layer of the skin is broken by radiation. Hair follicles could also be damaged causing hair loss.

Radiation protection

The best prevention for radiation syndrome is to scale back the exposure dose or to chop the rate through increasing the space from the area and time reduction.

Distance: Increasing distance from the radiation source will reduce exposure. Distance can sometimes be effectively increased by

means as simple as handling a source with forceps and not fingers or evacuation of the people to safer distant areas.

Time: The longer humans are subjected to radiation, the larger the dose absorbed. The exposed person should be taken out of the place of disaster as early as possible.

Prevention of adverse effects⁹

Prevention of adverse effects can be done through the following measures:

I. General precaution and safety measures

- i. Find out and respect the regulations regarding production, transport, handling and storage of radioactive substances.
- ii. Keep family emergency kit ready. It includes identity papers and private medicines.
- iii. Plan and organize your probable stay in protection shelter or basement especially if living during a neighbourhood of a atomic power plant.
- iv. Keep calm and don't panic.
- v. Listen to radio/ T.V. and respect the recommendations.

II. When the extent of radioactivity increases

- i. Keep calm and don't panic.
- ii. Listen to radio/ T.V. and respect the recommendations.
- iii. Stay in house/ shelter/ basement.
- iv. Close the air vents, door and windows and switch off the air conditioner.
- v. If outside, protect your mouth and nose with a wet cloth and seek refuge within the nearest shelter.
- vi. Don't use phones to avoid the overloading the telecommunication system.
- vii. Eat only stored food.
- viii. Bottled water could also be used.
- ix. Avoid going into the stricken area.
- x. Don't use vehicles so as to not slow the relief operations/ ambulance services.
- xi. If an atomic explosion occurs- take shelter behind a solid wall if you're outside.
- xii. Lie in a ditch facing the bottom and protect your face together with your arms.

III. After the incident

- i. First, two days after the explosion is most dangerous.
- ii. Stay in a shelter as long as fortnight.
- iii. Take for brief trips with protective measures if needed.
- iv. Evacuation could also be needed.
- v. Help to arrange evacuation with civil and military personnel.
- vi. Help neighbors, injured, sick, children, pregnant women and aged.

IV. Preparing a secure haven

- i. The entire city or neighborhood could become endangered by radiological hazards.
- ii. Plan a haven at your residence.
- iii. Select an inner room with the smallest amount number of windows and doors.
- iv. The space should be large with the attached bathroom.
- v. Close all doors, windows and air vents with plastic sheets (6 mm minimum) and seal with pressure-sensitive tape.
- vi. The water-soaked cloth should be wont to seal gaps under doors.

V. Safe haven equipments

- i. Protective equipment – mask, waterproof clothing, long-sleeved shirts, long trousers, raincoats, boots, gloves, etc.
- ii. Food and water system for 3 days.
- iii. Emergency equipment – flashlights, battery operated radio, extra batteries, care kit, plastic, tape, soap, etc.
- iv. Miscellaneous items – prescribed medicines, eyeglasses, blankets, important papers, etc.

Conclusion

Apart from nuclear disasters, radiation is additionally getting used within the health sector within the X-ray imaging, computerized tomography scans, diagnostic and therapeutic medicine. Radiation medicine has been revolutionized within the sort of brachytherapy, the gamma knife, and linear accelerators, technologies that are utilized in diagnosis and treatment. On the opposite hand, radiation's benefits for human health are often measured in thousands of lives saved and even greater numbers of persons whose quality of life has been improved annually by these technologies. Albeit the utilization of radiation in medicine offers enormous benefits, however, it also poses potential risks to patients, medical personnel, and therefore the general public. We should always use radiation in medical sciences judiciously taking all the precautions and medicine. Sustained Information, Education and Communication (IEC) activities should be administered vigorously to sensitize the people of health hazards of radiation exposure which will occur within the health sector or due to nuclear fallout which will be accidental or intentional.

Funding

None.

Acknowledgments

None.

Conflicts of interest

The author declares that there was no conflict of interest.

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