Radiobiology and Radiation Protection: Chernobyl Nuclear Disaster

Chernobyl

Devastating radiation disasters have occurred throughout the history of mankind including Chernobyl, Three Mile Island, and Fukushima Daiichi. Chernobyl is one of the most widely known nuclear disasters throughout history. People have heard of it and know it existed, but many of us don't know the specifics of what it entails. This event is one that will always be remembered as a crucial part of our history. It has made many lasting impacts on affected people's health and the environment surrounding the area. A disaster like this will help pave the way for new research on how to prevent events like this from happening again in the future.

The Chernobyl nuclear power plant is located about 80 miles north of Kiev and 12 miles south of Belarus. Both of these larger cities are situated in Ukraine, Europe. Two closer towns in relation to plant are Pripyat and Chernobyl, both under 10 miles away. This plant was made up of four Soviet-designed RBMK-1000 nuclear reactors that were built in the late 1900's to create electrical energy. These reactors were composed of a pressure tube design that used U-235 uranium dioxide fuel. This fuel's purpose was to heat water, which created steam and generated electricity to drive the reactors' turbines. According to the World Nuclear Association, most nuclear reactors use water as coolant to remove the excess heat and steam. The RBMK did not use this water as a coolant. It used graphite to moderate reactivity and kept a continuous reaction occurring. This caused the nuclear core to produce more heat and become more reactive ("Chernobyl: Facts About the Nuclear Disaster," n.d.).

On April 26, 1986, at 1:23 a.m. an explosion occurred on reactor four. A routine maintenance check was being organized and operators turned off vital control systems, which was not to be done. The maintenance check was supposed to test the electrical systems, but it caused the reactor to reach unstable and low-power levels. There is disagreement about the cause of the first explosion, but it is believed that excess steam was building up which in turn caused a power surge. This surge was so big that operators could not shut it down. This created an increase in heat and ruptured the pressure tubes containing fuel. This lifted the 1,000-metric-ton cover off the reactor, rupturing more pressure tubes, and caused a second explosion. The second explosion exposed the reactor core to the environment and started a fire that burned for ten days. This fire released large amounts of radiation and radioactive debris into the atmosphere and to the surrounding cities ("Chernobyl: Facts About the Nuclear Disaster," n.d.).

Iodine-131, cesium-134, and cesium-137 were the main types of radiation that people were exposed to following the explosion. Iodine is transferred to humans and taken up by the thyroid gland, but has a short half-life of eight days. Children are sensitive to this radiation because their thyroid is smaller and they have a much higher metabolism. Cesium isotopes have significantly longer half- lives ranging from two years to 30 years. This increases the chance of long-term exposure through normal daily activities such as ingestion of food, inhalation of air, and deposition of radiation into soil ("Chernobyl: Facts About the Nuclear Disaster," n.d.). The evacuation of people started within 36 hours after the accident and more than 20 countries were affected by the fallout due to the winds carrying the radioactive material. People living in Pripyat

and anyone within a 1,000-mile radius were evacuated within 14 days. An average equivalent dose of .12 sieverts per person was received by the 135,000 evacuees. Approximately 400,000 people from those affected countries received some radiation exposure (Haynes, Ritenour, Sherer, & Visconti, 2018).

This long-term exposure caused many health effects among workers at the plant and the general public who were exposed. The deaths of two workers resulted after the first steam explosion. Of the 600 workers onsite, 134 suffered acute radiation sickness and 28 died within the first three months. These workers proposed increased cases of leukemia and cataracts (Nuclear Safety Commission, 2018). The high levels of radioactive iodine were deposited into pastures and eaten by cows. The cows then concentrated the iodine in their milk and it was ingested by many children. In the most contaminated areas, an increase of thyroid cancer was seen in young children and adolescents. Belarus, Ukraine, and Russia have diagnosed nearly 5,000 cases of thyroid cancer in relation to the radiation received. Instances of leukemia and premenopausal breast cancer have also been seen in the most contaminated areas. These findings need significant epidemiological studies to prove they are specifically caused by Chernobyl, which may take many more years of research. Because the radiation dose received is low, no effects on fertility or hereditary defects have been seen nor are they expected to arise. There are many large uncertainties when making projections about future cancer deaths in relation to this nuclear disaster. People were not only experiencing the physical effects of this event, but also the psychological. Many of the people that have lived in those towns had to be relocated and lost all of their economic stability. High levels of stress and anxiety were reported among many of the individuals affected by the accident (“Health effects of the Chernobyl Accident,” 2017).

Not only were people affected by the nuclear disaster, but so was the environment. Many environmental spaces were impacted including urban areas, agricultural areas, forests, and water bodies. Radioactive materials were deposited on open surfaces in urban areas such as parks, roads, and lawns. Wind and rain has been able to decrease contamination since the event. Agricultural areas include plants, grazing animals, and the milk they produce. Radioactivity levels in agriculture decreased quickly after the first few years due to weathering. The levels are still going down, but much more slowly and are now below international action levels. Forest animals and vegetation are of high concern because radioactive caesium is continuously taken up and passed through the ecosystems. Doses received from forest products are expected to remain high since the decrease in caesium is very slow. Water bodies close to the reactor site and areas in Europe were affected. Radioactive material decreased in the water rapidly due to decay, dilution, and absorption by the soil. Fish in the water were directly affected, but it did not lead to significant human exposure (“Chernobyl Nuclear Accident,” n.d.).

Reactors one and two were shut down in the late 1900’s while still continuing their operation of reactor three until December of 2000. In order to secure the damaged fourth reactor, it was enclosed in a concrete sarcophagus, which was intended to contain the remaining radiation. The original sarcophagus was questioned on how effective it was so new construction began to stabilize it. Completed in 2017, the new structure is designed to enclose reactor four for at least the next 100 years. Decontamination of the site to make it safe is expected to be completed by 2028. The plant and the surrounding areas within 1,000 miles are considered exclusion zones, which are restricted to only scientists and government officials. Even though there are many dangers, several people returned to their homes after the disaster (“Chernobyl: Facts About the

Nuclear Disaster," n.d.).

Chernobyl is now filled with a variety of wildlife today. Some radiation effects including stunted trees and animals with high levels of cesium- 137 are known to occur. People are beginning to resettle in areas outside the exclusion zone even though the area has not yet fully recovered. Tourist visitation has jumped to 40 percent and people are continuously visiting. Many significant changes have occurred after this catastrophe: reactor safety increased, remaining RBMK reactors were modified to reduce risk, and research continues to help prevent future nuclear disasters ("Chernobyl: Facts About the Nuclear Disaster," n.d.).

As future radiologic technologists, I think it's important to know and understand what happened in events like Chernobyl. Technologists work in a career that uses ionizing radiation so having a greater level of awareness on related events is crucial. I hope advancing research will help prevent nuclear disasters from occurring and aid in the knowledge to further understand the detrimental effects of radiation on humans.

References

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