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Does Radiation Make Superheroes?

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Radiation is all around us. It is in the air we breathe, the food we eat, and the devices in our homes. But what is radiation, and how does it affect our bodies? Radiation is energy or particles that travel through space or other objects. It includes particles and electromagnetic waves emitted by certain materials. (ANSTO, 2020)

A TED-ED episode (Anticole, 2016) explains that electromagnetic radiation is pure energy. It consists of interlocking electrical and magnetic waves which oscillate through space. These waves have different widths, and therefore frequencies. The longer waves give us things like radio waves and then visible light followed by gamma rays as they become longer. We use electromagnetic radiation often in our everyday world. Electromagnetic radiation enables us to download things from satellites onto our phones, and call others. Only the highest energy waves, in unusually large doses, can harm a person.

The other type of radiation is nuclear radiation. This begins in the atomic nucleus, which is made of protons and neutrons, when the protons begin to repel each other. The 'strong nuclear force' struggles to keep the protons close to hold nucleus together. Certain combinations of protons and neutrons, release matter and energy in an effort to stay stable; this is called nuclear radiation.

We can break nuclear and electromagnetic radiation down into ionising and non-ionising radiation. Ionising radiation is able to produce charged particles, also known as ions (ANSTO, 2020). All nuclear radiation is ionising. A high dose of ionising radiation can have severe effects on the body.

Radiation is measured in either sieverts (Sv), or grays (Gy). Sieverts measure ionising radiation. The background radiation we experience annually is only 6 millionths of a sievert. However, occasionally people receive higher dosages in a short period of time. An exposure to 1 sievert can cause nausea within hours, and 4 sieverts is often fatal. Grays are similar to sieverts, yet they measure the amount of radiation that is absorbed by the body.

Ionising radiation has a large effect on the body. Dr Kazzi (CDC) states that once a cell has been damaged by ionising radiation it can either repair itself, the damage may be repaired incorrectly causing an alteration, which might result in cancer, or the cell may die. 'Mutated cells' are created when DNA becomes damaged or altered leading to issues in the genetic code. (IRSN, 2013) These cells may be identified by the body or survive without lasting consequences. However, other times there are large amounts of cell death, resulting in the shutdown of an organ, or the faulty cell can become cancerous. It is harder to determine whether an individual will suffer from cancer due to radiation. This is because it differs from person to person, and certain individuals have a higher chance of a cell becoming cancerous due to a wide range of factors such as body size and the part of the body being hit. Cell death is easier to predict as the effects are more systematic among people (IRSN, 2013). This can be caused either from a high dosage of radiation at once, or frequent low-level exposure. The people who have the highest risk of health effects associated with radiation are children and young adults. They have a longer lifespan ahead of them, which gives time for cancer to grow and damaged cells can spread faster as the rate of cell division is faster.

A YouTube clip (Seeker, 2017) explains one of the risks of an acute exposure to high levels of radiation - 'acute radiation poisoning' (ARP). This comes in four phases. The first phase is the prodromal stage, consisting of the initial symptoms; vomiting, diarrhoea and anorexia. These are often not life threatening, and sometimes people take little notice of them. This worsens with increased exposure. These symptoms can come merely minutes or days after the radiation exposure.

The second stage of ARP is the latent stage, where the body seems to recover. However, the body is actually becoming sicker.

Weeks later, the poisoning manifests. If the radiation dosage isn't too severe then the patient is likely to recover, however this leaves them at a higher risk of many cancers. If the exposure measures 1-10 Gy the radiation has penetrated tissue, and kills bone marrow by damaging DNA. This is dangerous as bone marrow creates white blood cells, which combat infection; red blood cells to transport

oxygen; platelets, which help heal injuries. This often leads to death from infection or blood loss. It is possible to get a bone marrow transplant, however this only gives you a 50/50 chance of surviving. If the exposure measures 10 Gy or more, cells in the stomach and intestines are killed. This means that the body can't absorb any nutrients, causing imbalances in electrolytes and dehydration. Once these organs shut down nothing can be done to save a person, they have no chance of surviving. After an exposure of 20 Gy, it is not clear what would happen to the body. Scientists predict that the cardiovascular and nervous system would swell with fluid. In less than 3 days the brain would not be able to control the body anymore because so many cells would have been killed.

The fourth and final stage of ARP poisoning is recovery or death. Because radiation affects DNA at the atomic level it is hard to treat a person with ARP. There are ways to treat some of the mild symptoms though, for example those that come with a death in bone marrow cells. If a person gets an infection due to a loss in white blood cells, doctors are able to treat it, through methods like administering antibiotics.

However, radiation is very useful, and is used in hospitals to test and treat patients. Radiation is used in X-rays, which help doctors to identify broken bones. It is also used in radiation therapy, to treat patients with cancer. Due to the risks of radiation, it is very important for doctors to use appropriate precautions while using these.

X-rays are a type of electromagnetic radiation that are used to create image of structures, such as bones, inside the human body. These X-rays are able to pass through less dense tissues, so that there is a contrast. Doctor use the resulting image to diagnose a patient with many illnesses and injuries such as bone fractures, dental problems, and sometimes pneumonia, without requiring surgery. X-rays have a very small amount of radiation, yet this can have accumulative effects. To counteract this, doctors shield body parts not needed to be seen in the X-ray. X-rays and other types of imaging that use radiation can affect pregnant women, so doctors use different means of imaging if they need to see the pelvis or abdomen (NIBIB, 2020). Children are also at a higher risk of damage from ionising radiation, and although there is an extremely low risk from X-rays, doctors often adjust their machine settings for children (ACS, 2015).

Radiation therapy is used to treat many types of cancers and tumours, such as breast cancer, cervical cancer and gastroenteropancreatic neuroendocrine tumours. High doses of radiation are aimed at cancerous cells and tumours inside the body, with the purpose of either killing them or slowing their growth. This is caused by the radiation damaging their DNA. This is not an instant fix though. It can take days or weeks of radiation therapy treatment before the DNA is damaged to the extent that the cells will die. After this time it can take months until the cancer cells are gone. There are two main types of radiation therapy; internal radiation therapy and external beam radiation therapy. Internal radiation therapy is where a source of radiation is placed inside the body near the tumour. External beam radiation therapy is where the radiation is aimed from a machine at a certain part of the body. As radiation therapy exposes the body to a large amount of radiation, the same area cannot undergo radiation therapy twice. Radiation therapy does have the side effect of healthy cells near the cancer or tumour dying, however these recover in the months after treatment (NCI, 2020a). The effects of radiation therapy differ depending on the part of the body that is being treated. For example, if the pelvis is the targeted area, there are the side effects of fatigue, hair loss, diarrhoea, nausea, changes in the bladder, and infertility. During external beam radiation therapy the patient wears protective clothing to avoid radiation effecting healthy tissue. During internal radiation therapy patients are often asked to remain in the hospital and cannot be visited by pregnant women or children (NCI, 2020b).

Radiation has its benefits and its downfalls. It is slowly becoming more and more valuable in medicine, and there are many innovations making it safer for patients. However, high exposures must be avoided to stay alive. Does radiation really make superheroes though? You'd have to survive it to find out.

Bibliography (In order of date accessed)

Ansto.gov.au. 2020 Radiation | What Is Radiation? | ANSTO. [online] Available at: <https://www.ansto.gov.au/education/nuclear-facts/what-is-radiation> [Accessed 27 June 2020].

ANSTO News, 2017. What Is Radiation?. [video] Available at: <https://youtu.be/FC9x7fTNmIg> [Accessed 28 June 2020]

Anticole, M., 2016 Is Radiation Dangerous?. [online] Ted. Available at: <https://www.ted.com/talks/matt_anticole_is_radiation_dangerous/up-next?language=en> [Accessed 30 June 2020].

Centres for Disease Control and Prevention (CDC), 2015. Biological Effects Of Radiation. [video] Available at: <https://youtu.be/EuKzl3g5ra4> [Accessed 11 July 2020].

Seeker, 2017. What Does Radiation Poisoning Do To Your Body?. [video] Available at: <https://youtu.be/hhUuFCrDOIw> [Accessed 11 July 2020].

Institute for Radiological Protection and Nuclear Safety (IRSN), 2013. *The Effects Of Radiation On Our Health*. [video] Available at: <https://youtu.be/tq6FDyFeCN0> [Accessed 12 July 2020].

National Institute of Biomedical Imaging and Bioengineering (NIBIB). 2020. *X-Rays*. [online] Available at: <https://www.nibib.nih.gov/science-education/science-topics/x-rays> [Accessed 12 July 2020].

American Cancer Society (ACS). 2015. *Medical Radiation*. [online] Available at: <https://www.cancer.org/cancer/cancer-causes/radiation-exposure/x-rays-gamma-rays/medical-radiation.html> [Accessed 12 July 2020].

National Cancer Institute (NCI). 2020a. *Radiation Therapy Side Effects*. [online] Available at: <https://www.cancer.gov/about-cancer/treatment/types/radiation-therapy/side-effects> [Accessed 13 July 2020].

National Cancer Institute (NCI). 2020b. *Radiation Therapy For Cancer*. [online] Available at: <https://www.cancer.gov/about-cancer/treatment/types/radiation-therapy> [Accessed 13 July 2020].