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Popular Article

Radiation Toxicity in Animals

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Abstract

Humans and animals are usually exposed to varying degrees of radiation from natural and manmade radioactive substances. The effects of ionizing radiation on exposed animal's forms direct damage to organs and tissues. It impairs the performance efficiency of animals and production performance, which leads to contamination of food products for human consumption. So, by proper treatment, housing and management we can protect livestock exposure to ionizing radiation.

Introduction

In veterinary medicine, the greatest potential for acute radiation damage lies in accidents releasing the contents of nuclear reactors, radiation cancer therapy used for dog mammary tumors or a gross miscalculation of irradiation dose needed for diagnostic imaging. Radiation fatalities at the highest dose can affect the CNS, possibly by damaging the BBB. At a lower dose they can damage intestinal epithelium with rapid turnover, causing the GI syndrome and at a still lower level that can damage blood cells causing the hematologic syndrome.

History: In 1895, Wilhelm Conrad Roentgen discovered X-rays and in 1901 he was awarded with Nobel Prize for physics. After this discovery in 1898 Marie Curie discovered Radium.

- 1945 –Nuclear bombs were dropped on Japan.
- 1979 - Nuclear accident in Pennsylvania.
- 1986 - Nuclear disaster in Ukraine.
- 2011 - Radiation hazard after earth quake in Japan.

The US Radium Corporation employed young women to paint radium on watch dials. These women used their lips to point the brushes. Each time they pointed their brushes, they ingested a small amount of radium. The radium thus ingested moved to the bone where it continued to emit alpha radiation. The alpha radiation damaged the cells near the radium particle.

As a result of their exposure to radium, many of these women developed painfully debilitating bone decay and died of cancer. The long half-life of radium combined with it being sequestered in the bone resulted in a lifetime of radiation exposure. During the 1920s, a group of these women sued the Radium Corporation. Many of them were victorious in court and received a small amount of money, becoming the first to receive compensation for occupational injury.

Radiation

Radiation can be ionizing radiation or non-ionizing radiation. Ionizing Radiation is defined as radiation capable for producing ions when interacting with matter. In general, ionizing radiation reduces the rate of metabolism of xenobiotics both *in vivo* and in enzyme preparations subsequently isolated. Non ionizing radiation has less energy and, in general, is less interactive with biological material than ionizing radiation. Sources of non-ionizing radiation include - Ultraviolet light, visible light, infrared radiation, microwaves, radio & television, power transmission (Adam and Wilson, 1995).

Radiation sources:

- X-rays
- Radioactive materials produce alpha, beta and gamma radiation.
- Cosmic rays from the sun and space.
- Depletion of ozone layers.
- Nuclear weapons like Iodine^{131}, Barium^{140} and Strontium89 etc.
- Nuclear power plants, industrial uses, radioactive wastes and diagnostic and therapeutic uses.
- The four main types of irradiations are X-rays, gamma rays, electrons (negatively charged beta particles or positively charged positrons) and alpha particles.

Radiation units:

- The effect of radiation depends on the amount received and the exposure time.
- The amount of radiation received is expressed as a Dose and the measurement of dose is known as Dosimetry.
- The dose per mass of body tissue unit is the Gray (Gy), equal to 1J kg^{-1} and is named in honor of the British physicist Louis Gray.
- The gray is a large dose and for most normal situations we use the milli-gray (mGy) and the micro gray (μGy).
- The absorbed dose is given the symbol D.

- The gray is a numerical unit that quantifies the physical effect of the incident radiation (the amount of energy in joules deposited per kilogram), but it tells us nothing about the biological consequences of such energy deposition in tissue.
- One Gy of α - or neutron radiation is more harmful than 1 Gy of γ -radiation.

Sources for UV rays:

- Sun light.
- Most harmful UV is absorbed by the atmosphere and it depends on altitude.
- Fluorescent lamps.
- Electric arc welding which can damage the cornea of the eye.
- Germicidal lamps.

Effects of Ultra violet and Infra-red radiation:

- Ultraviolet rays kill bacterial and other infectious agents.
- High dose can cause sun burn and there is increased risk of skin cancer.
- Can damage cornea, iris, retina and lens of the eye.

X rays:

- Electromagnetic photons or radiation. Produced from orbiting electrons or free electrons usually machine produced.
- Produced when electrons strike a target material inside and x-ray tube.
- Emitted with various energies & wavelengths.
- Overlap with gamma-rays.
- Highly penetrating extensive shielding required.
- Produces radiation hazard including genetic and non genetic effets.

Tissue Sensitivity to irradiation:

- Very high - White blood cells (bone marrow), stem cells of intestinal epithelium, reproductive cells
- High - Optic lens epithelium, esophageal epithelium, mucous membranes
- Medium - Glial cells of brain, lung, kidney, liver, thyroid, pancreatic epithelium
- Low - Mature red blood cells, muscle cells, mature bone and cartilage

Absorption of Radiation:

- Absorption of radiation is the prime consideration in radiation toxicology.
- Radiation can reach all tissues of the body directly from an external source, but the capacity to penetrate body tissues varies with the type of radiation.
- Radiation may be emitted as particles or as high energy electromagnetic waves such as X-rays or gamma radiation
- Alpha particles released by radionuclide are dangerous if they are taken into the body by inhalation (breathing in) and/or ingestion (eating and drinking).
- Indoor radon exposure can lead to lung cancer.
- Exposure from radon in drinking water is also of toxicological importance
- The depth to which Beta particles can penetrate the body depends upon their energy.
- When ß -emitters are taken into the body they irradiate internal tissues and become a more serious hazard.

Biological effects of irradiation:

- Prodromal syndrome, mediated through autonomic nervous system.
- Neurological syndrome, forms cerebrovascular damage
- Gastrointestinal syndrome causes diarrhea, loss of appetite, loss of fluid and electrolytes, dehydration, gastric retention etc.
- Carcinogenesis
- Severe burn, atrophy of epidermis, sebaceous gland and hair follicle.
- Azoospermia, sterility, pneumonitis, hypothyroidism, growth retardation, cataract.
- Genetic mutation includes stillbirths, congenital defects, sex chromosome abnormalities.
- Frequent effects of radiation exposure in dogs include hematological changes, infertility, and cancer of the bone, liver, lung, and blood (Spatola *et al.*, 2021).

Treatemnt:

- There is no specific treatment for radiation toxicity.
- Treatment is only symptomatic and supportive.
- Antibiotics, fluid therapy, corticosteroids and antihistaminic agents can be used.
- Fresh bone marrow cells transfusion.

- Parathyroid extracts and low calcium diet to increase the rate of excretion of radioactive material.
- There should be proper shade and housing management for the animals to avoid exposure of radiation (Olobatoke and Maththu, 2015).

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