RADIATION IN MEDICINE AND RADIATION IN NUCLEAR POWER PLANTS : THE SAME BUT VERY DIFFERENT !!

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I have been asked to explain as diagnostic radiologist briefly the difference between radiation used in diagnostic x-ray and nuclear medicine studies and the radiation being emanated from a failing nuclear power plant as is unfortunately now happening in Japan.

Different types of ionizing radiations

Radiation is called Ionizing because it can harm the cell nuclei in living tissues, cause disease and even death depending on the dose. Radiation occurs naturally in certain rocky areas in the world and is being emitted by certain substances called radioactive isotopes . The most powerful of those ionizing radiations is Gamma radiation which is used for diagnostic x-ray and for radiotherapy but also in nuclear power plants for electricity production.

Radiation in medicine

As Gamma radiation can penetrate tissues, it has the advantage - if used with caution and in reasonably small dosages - to make the inner organs of the human body visible. This is done in two ways: either by using an x-ray tube to send Gamma-rays through the body or by injecting into the body very small doses of a short lived radioactive radioisotope, usually Technetium. The information compiled through the use of computers will be transmitted via Xray films or CT sensors or gamma cameras to give information about different organs and measure accumulation of Technetium or other radioisotopes in the body. Being short lived, all injected radioactive material will have disintegrated and been eliminated by the patient within minutes or hours. Whether using external radiation in x-ray machines or CT Scanners or whether injecting radioactive substances in nuclear medicine studies, radiologist always use minute doses which are known not to harm the patient. Every patient seen by them needs a diagnosis and radiation may be used if medically justified: the risk of missing a patient's serious disease is much higher than the risk potentially induced to him by the burden of ionizing radiation. Occasionally other non-radiological methods, i.e. non ionizing , such as ultrasound or magnetic resonance imaging , can also be used to render a diagnosis.

Radiation in the nuclear power industry

In a nuclear power plant radiation effects occur in so called fuel rods made by Uranium. Uranium exists in different forms and breaks down in the fuel rods by emitting Gamma rays just like in medicine. But this radiation is much stronger and is used to heat water which then produces steam in order to propel a steam turbine which in turn produces electricity. As long as the radioactive fuel roads are covered by water this process occurs in a controlled manner and the water keeps on being heated and produces steam. So far this was considered an elegant although expensive way to produce electricity. However, there are safety issues involved and this makes nuclear power a potentially risky method to produce electricity. If the radioactive fuel rods are not persistently kept cool, they start to heat up and increase the temperature and pressure in the innermost location of the power plant. This so called core or inner containment may break under pressure if the cooling is not maintained. The fuel rods then disintegrate

and a large amount of radioactivity will be blown out into the atmosphere. Radioactive isotopes in the fuel rods, such as Uranium, Plutonium and Caesium, are much longer lived than the radioisotopes used in medicine. They will continue to send out harmful radiation as long as they are around. These particles can be blown as clouds over oceans and continents, but once they land somewhere, they still will emit radiation and will do this sometimes for many years e.g. the Strontium and Cesium isotopes for about 50 years , yet Plutonium 40'000 years and Uranium over 400'000 years. As these radioisotopes can penetrate the ground, they will accumulate in the water and will be ingested by humans or animals through plants: once inside the body, they will build up in inner body organs, just like the short lived isotopes used in nuclear medicine studies. However, due to their much longer life, these isotopes may submit the body or a particular organ e.g. the thyroid gland, to continued harmful radiation. Through this process, the cells in the body could experience genetic damage, heart disease and malignant tumours. Today it is known that even small doses or so called low level radiation, if ingested repeatedly as by the people living in radioactive contaminated regions , can be harmful and lead to disease.

Extremely helpful and extremely harmful

In summary one can say that radiation used in the core of a nuclear power plant is dangerous, obviously more so when set free in an accident: it is produced by highly radioactive corpuscular substances which are long lived. As the radiation comes from particles, these may be blown over large distances and can potentially be ingested , unnoticed by humans, and lead to chronic radiation diseases including cancer. On the other hand, the radiation produced by an x-ray tube affects the body for milliseconds to minutes and that used in nuclear medicine disappears from the body within minutes to hours. Radiation used in medicine has the beneficial effect of allowing early detection of a serious disease, whereas radiation from the power plant accident had a high chance to produce serious disease and death, depending on the doses experienced. In conclusion, radiation is of the SAME type in medicine and nuclear power but very DIFFERENT: small doses are used in a controlled way in medicine and dangerous long lived radioisotopes are blown into the atmosphere in an uncontrolled way in a nuclear accident.

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