Medicine for Managers

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Radiation Sickness

Anyone under the age of seventy will have been brought up with fear, or at least anxiety, about nuclear war and the consequences of the explosion of nuclear weapons. Everyone will have seen pictures of Hiroshima and Nagasaki after the American nuclear attack on those Japanese cities. Parts of a beautiful country laid waste with absolute devastation and huge loss of life.

On August 6th 1945 a B-29 bomber dropped the first nuclear bomb on Hiroshima, killing 90% of the population, some 80,000 people, instantly.

Three days later another B-29 dropped a second bomb on Nagasaki, this time killing 40,000 people.

However unspeakably terrible the acute loss of life, tens of thousands were to die slow, painful deaths from what has come to be known as **radiation sickness**.

The bombings brought to an end World War II in the Pacific with Japan's unconditional surrender but those affected by the radiation would provide the horror of lingering remembrance of what Emperor Hirohito called "a new and most cruel bomb".

Since the second world war, radiation damage has generally occurred after nuclear accidents, such as that at Chernobyl in 1986 or the tsunami that followed the earthquake which damaged Fukashima nuclear power station on the east coast of Japan in 2011.

Radiation sickness is damage to the body caused by exposure to radiation, often over a short period of time.

The amount of radiation must be above a certain level and is influenced by a variety of factors; the nature of the radiation, the amount of radiation absorbed, the distance between the individual and the source of the radiation, whether the exposure is to the whole body or just to a part and the degree of sensitivity of the individual body tissue to the irradiation.

When an individual is exposed to a high level of radiation, it results in illness which may occur rapidly.

It may produce local effects such as burns and sloughing of skin or systemic affects such as vomiting and diarrhoea, bleeding, dizziness, headache and fever. The higher the dose sustained the greater the damage and potentially any bodily system can be disrupted.

If the individual's dose of radiation is not too high and he or she survives long enough, they will experience weakness and fatigue within four weeks and such effects as hair loss, skin ulceration, bloody vomit, infections, poor wound healing, anaemia, heart failure and low blood pressure.

Other complications occur over the medium to long term in survivors.

Absorbtion of radiation is measured in units called ***millisieverts (mSv)***.

To give some sort of perspective to the measurement:

- Diagnostic test using radiation e.g. a single chest X-ray – 0.02 mSv.

- A mammogram – 2 to 5 mSv

Someone working in an environment with radiation such as a nuclear power station – 20 mSv, which is the UK limit of exposure set by the Ionising Radiations Regulations.

A dose of 100 mSv doubles the risk of cancer within twenty years.

To put the exposure into perspective, we are all subject to radiation from natural sources and the average annual dosage received by an individual is 2.2 mSv.

Radiation comes from Radon, a naturally occurring radioactive gas present in the atmosphere, cosmic rays emanating from space, the earth which contains various radioactive rocks and food and water which contain minute traces of radiation in things such as meat, potatoes, nuts and bananas.

Some may have seen the unit of radiation called the ***gray (Gy)***.

The milliSievert and the Sievert (1,000 times the dose) are used to measure the effects of low levels of ionising radiations on the human body and as a predictor of cancer genesis and genetic damage.

The gray is used with higher dosages and, for the physicists, is defined as the deposition of a joule of radiation in a kilogramme of tissue.

A Sievert is a gray weighted by the effectiveness of a particular type of radiation at causing damage to tissues.

The Sievert represents the equivalent biological effect of the deposition of a joule of radiation energy in a kilogramme of human tissue.

The fundamental question is ‘what happens when radiation reaches a body cell’. In simple terms radiation is composed of rapidly travelling electrons which may be highly charged.

When these electrons penetrate the cell, they cause scattering of cellular molecules and the most serious damage is breakage of the DNA strand (the genetic code of the cell). You may recall that the DNA molecule is in the form of a double helix.

The effect of the electron bombard may be to break one or both strands of the DNA. The latter is more serious than the former.

The two strands which form each helix are linked across by four proteins.

They are ***Adenine, Guanine, Thymine*** and ***Cytosine***. Any of the four proteins is found in each strand of the double helix and may be in any order. The proteins are each linked across the helix.

Did you know?

Smokers expose themselves to significant radiation. Tobacco contains traces of polonium-210, one of the most radio-active substances in the Universe. It is only in small quantities but people who smoke 30 cigarettes a day receive a dose of radiation annually equivalent to 300 chest X-rays. American researchers estimate that polonium-210 in cigarettes is responsible for 11,700 deaths a year globally.

Source: NHS Health Library

However, Adenine can only link with Thymine and Guanine can only link with Cytosine. If only one of the two strands is broken then it will have the remaining, undamaged strand to use as a template and may be restored as before.

If there is a double-strand break healing is much more difficult and the result is often erroneous joining of damaged fragments. These ‘mis-repairs’ result in mutations, chromosome aberrations and cell death.

The damage to the DNA explains various post-immediate effects of radiation damage.

Firstly it explains why the damage is most profound on the gut, the skin and hair, the blood and the reproductive organs.

It is because the body cells which are dividing most rapidly are those that line the gut, that replace the skin, that manufacture in the bone marrow and in other locations the various types of blood cells and that prepare the sperm and the female genital tract.

Consequently virtually all people injured by higher doses of radiation will have diarrhoea and vomiting with loss of blood in both, a variety of skin diseases resulting from failure of normal cell maturation and turnover, chronic anaemia, poor infection defence and failure of immune systems with decreased clotting ability and failure of reproduction. Healing is impaired in all affected tissues because of cellular destruction which prevents repair and development of new cells.

The risk of cancer is increased and the level by which it is increased depends on the dose of radiation absorbed and the tissues affected.

The Hiroshima and Nagasaki survivors had an increased incidence of cancers until they died.

Of course it is important not to forget the effects on children which are exaggerated because they are growing rapidly and therefore their body cells are dividing more prolifically and are more vlnerable to radiation damage.

The detonation of a so-called 'dirty bomb' in the UK or anywhere in the world would be unimaginably worse than a conventional bomb of the same size because of the morbidity that would inevitably follow.

Perhaps one of the most difficult aspects in such circumstances is knowing whether a bomb is radioactive. If suitable warnings are broadcast, there are certain procedures which are of benefit.

1. Remove yourself as far from the source of the contamination as possible. Stay indoors and close all windows and doors.
2. Removal of as much external radiation particles as possible by removing all clothing and shoes which will eliminate about 90% of the contamination. Washing with soap and water (without scrubbing) will remove further contamination.
3. If you are not ill, stay where you are.
4. If you are ill, it is likely to be difficult to get medical attention in the post-incident period involving any radiation exposure. There are various drugs that can bind to radiation particles in the body and allow the body to eliminate them. Other medication will be required for supportive treatment, such as to fight infections with antibiotics, treat bleeding etc.
5. For people exposed to very high radiation levels, much will involve end-of-life care, keeping them comfortable without sickness or diarrhoea and pain free. Death may be rapid or much slower depending on dosages and type.

Perhaps for some exposed to radiation, the most profound effect might be on mental health.

Not only would the experience be horrific, but friends would die, symptoms would be sporadic and unpredictable and the individual would have to live with the ever present possibility of developing cancer.

It is always good to conclude an article with encouraging news. In this case it is difficult because information on radiation, whether for business and industry, therapeutic use or for terrorism is very sparse because of the value it has as intelligence and for business competition.

I am sure we are all extremely glad that no ‘dirty bomb’ has been exploded in the UK and, God willing, our defence and intelligence services will continue to ensure that it doesn’t.

I’ll raise a glass for MI5.

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*PS. Some may have heard of the unit of radiation called a **becquerel**. Press reports following the Japanese incident in 2011 made reference to radiation levels in water measured in becquerels. For clarity the becquerel is a measure of radioactivity whereas the milliSievert and the gray are measures of dosage to the body of radiation.*