Low Level Radioactive Waste

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Personal Background

I am a senior medical physicist working in hospital and have over 23 years of experience in the use of radioactive substances and radiological equipment in the medical field. I am writing in the capacity of the chairman of the Hong Kong Association of Medical Physics which is the Association for all the medical physicists working in hospitals in Hong Kong.

Introduction

The question addressed in this paper is the risk to health from exposure to low level radioactive waste. The radiation of concern is ionising radiation.

What is 'Ionising Radiation'?

There are many kinds of radiation in our environment. They include visible radiation (light), radio waves, ultraviolet radiation, and ionising radiation. Ionising radiation is emitted by radioactive atoms. As it can cause damage on our cells and the effects are often dramatised by the media, it often invites public fear - a phenomenon that I would call 'Radiophobia'.

Are we exposed to 'Ionising Radiation'?

Yes, everyone is exposed to the background radiation. On top of that, one may be exposed to artificial sources of ionising radiation, e.g. medical and dental x-ray, testing of nuclear bombs, nuclear power plant, sterilisation of consumer products, etc.

What is 'Backgound Radiation'?

We are exposed to radiation around us all the time. There is ionising radiation from the outer space, which is called cosmic radiation, and showers upon us wherever we go. Other sources of naturally occurring radiation come from rocks and soil, radon in air that we breathe which comes from ground and buildings, the food we eat, the water we drink, and even from inside our own body. Radiation is part of our daily life. The background radiation level in Hong Kong is about 2 to 3 mSv per year. mSv is milli-sievert and is a small radiation unit. The background radiation level varies considerably from place to place. The high background radiation areas in China do not lead to higher cancer rates. In USA, the radiation levels in the Rocky Mountain states are higher than in the Gulf States, yet the cancer rate is lower. We have to bear in mind that there may be confounding factors like smoking, drinking, pollutants etc.

Is radiation hazardous?

Yes, radiation could damage cells, cause sterility, genetic defects, radiation syndromes, induce cancer and if serious, could lead to death. That is why radiation protection is very important.

What is 'Radiation Protection'?

The general principles of radiation protection are:

(i) Justification

All uses of radioactive substances and radiation emitting equipment must be justified by a positive net benefit after considering the risk.

(ii) ALARA

The ALARA principle means the radiation exposure of the people at risk is As Low As Reasonably Achievable after considering the social and economic factors.

(iii) Dose Limits

It is regulated by law that the radiation exposure of the public and the occupational radiation workers could not exceed certain dose limits. The annual dose limit for the public in Hong Kong is 1 mSv. It is believed that people are safe if their dose limits are not exceeded.

Is there a threshold for radiation risk?

Health effects of radiation are divided into two categories:

(i) Deterministic Effects - occur above a certain threshold dose; the severity of injury depends on the dose absorbed which is usually more than hundreds of times higher than the background level. We could hardly observe any health effects below 250 mSv. For an acute dose of 250 - 1000 mSv, we can detect some blood changes; for more than 500 mSv, we may find temporary sterility in males; for more than 1000 mSv, we could see vomiting, diarrhea etc.; for more than 2000 mSv, we begin to see serious radiation sickness; for more than 3000 mSv, we may find permanent sterility in females; for more than 4000 mSv, we could observe acute illness and early death.

(ii) Stochastic Effects - might occur at any level of radiation exposure and have no threshold; there could be very small risks even at very low doses, the risk generally increases linearly with the dose absorbed. Such risks might include hereditary consequences and development of cancer. However, hereditary effects could not be detected even in the offsprings of the large population of A-bomb survivors in the first two generations. The issue of cancer is a complicated one. Only some cancers can be induced by radiation, not the rest. Exposure to a particular dose may cause cancer in one individual but not the other. Cancer like leukaemia has cluster effects. There are many other carcinogenic factors.

It is impossible to predict the health effect of low levels of radiation on any one individual.

Radiation effects on populations

Although the low level radiation effect on an individual cannot be determined, the health effects of radiation on a population can somehow be predicted. According to some studies, 1 mSv might cause 50 additional fatal cancers per one million population.

Why do we have 'Radioactive Waste'?

Radioactive substances, though have associated risks, play a number of important roles in our daily lives. They are used in medicine - both for diagnostic and treatment purposes, industry, power generation, sterilisation of consumer products, etc. The use of radioactive substances will continuously generate radioactive waste that must be managed properly.

What is 'Low Level Radioactive Waste'?

Radioactive waste should be classified on the basis of how much radiation and the type of radiation it emits and the length of time over which it will continue to emit radiation.

Low level waste is usually interpreted as the category that it contains enough radioactive material to require action for the protection of the public, but not so much that it requires shielding during handling, storage or transportation.

This is a catch-all category which is defined in terms of what it is not. The term is somewhat misleading because low level waste is not necessarily low in radioactivity.

Risk of 'Low Level Radioactive Waste'

The danger of exposure to radiation in low level waste varies widely according to the types and concentration of radioactive substances. Low level waste containing some radioactive substances used in the medical field is not particularly hazardous unless inhaled or consumed, and one can stand near it without shielding. Low level waste from processing water at a reactor, on the other hand, could be quite hazardous. In Hong Kong, we have radioactive substances used in hospitals and industry, but there is no nuclear reactor nor nuclear power plant.

How to dispose of 'Low Level Radioactive Waste'?

Low level waste is suitable for near-surface disposal, i.e. can be disposed of in a repository on or below the ground, or a few tens of metres below the earth surface where the final covering is of the order of a few metres thick. Near-surface repositories may be either with or without engineered barriers, and include sub-surface trenches and caverns, and above- and below-ground vaults. The repository design is determined by the geography and geology of the site and the types of waste to be disposed of.

The primary objective of a disposal facility for low level radioactive waste is to isolate the waste from the public and the environment. The waste must be isolated from water (hydrologic isolation). The radionuclides (i.e. atoms that are radioactive) must be prevented from migrating out of the disposal facility. The waste should be stored in a manner which will allow recontainerisation and make continued isolation from the environment possible in the future. The decommissioning of a disposal facility should be facilitated right at the design phase of the facility.

Public involvement is essential at all stages of the development and in the subsequent monitoring of the operation of a disposal facility.

A disposal facility should be properly managed to an extent that it could be a touristic and educational site.

Just a few more words

For low level radioactive waste, we need a clear definition in Hong Kong. The risk to the health of the public would mainly be the stochastic effects of radiation. It could induce additional fatal cancers in the Hong Kong population according to the dose absorbed. However, the risk could be much reduced by prohibiting the movement of the radioactive waste through the environment to the public and by minimising the exposure of the public to additional radiation resulting from the waste. A properly designed disposal facility would be the answer. Public involvement is essential as the issue concerned would affect their health.