Radiation Health Series

No.6

IONISING RADIATION

Radiation Health Division

Department of Health

Radiation

Radiation is a fact of live. We live in a sea of radiation. Light and heat from the sun are natural forms of it that are essential to man's existence. There are also other forms that are generated by man, for example, microwaves for cooking, radiowaves for communication, radar for navigation and X-ray for medical investigations. The emissions of radioactive substances are further examples of the different forms of radiation. Some of these substances occur naturally throughout the environment, other have been produced by man.

From the point of view of the effects that radiation produces on matter, there are two classes of radiation: ionising and non-ionising radiations. Ionising radiation include cosmic rays, X-rays and the radiations emitted by the radioactive decay of radioactive substances. Non-ionising radiations include light, heat, radar, and radiowaves and microwaves (Table 1).

Table 1

Examples of uses
Ionising Radiation
Medical diagnostic and treatment, nuclear power, industrial radiography, safety signs and smoke detectors, sterilisation of medical equipment, archaeological dating, baggage inspection
Non-ionising Radiation
Light, heat, lasers, sun-beds, radar, mobile phones, radio, electric power

Radiation Units

Ionising radiation is a form of energy travelling either as electromagnetic waves (X-rays and gamma rays) or particles (alpha, beta, neutrons etc.) They transmit energy to materials they encounter. Faster or heavier particles deliver a harder punch. The unit of absorbed radiation dose is the **gray (Gy)**.

However, while the energy delivered by different particles may be the same, the effect on living cells can be quite different. Alpha particles and neutrons are approximately ten times as damaging as beta particles and gamma rays for the same amount of energy deposited. So the equivalent dose, the **sievert (Sv)**, is the important unit to assess the effects of ionising radiation on living cells, especially human beings. It does not measure the same thing as the gray.

The radiation dose you received from radioactivity depends not only on the biological effectiveness of the radiation, but also on the strength of the source, its distance from you, the effect of any

shielding and your exposure time. The strength of a radioactive source is determined by the number of disintegrations of its radioactivity per second. The unit is **becquerel (Bq)** which is one disintegration per second. This is a very small unit and usually larger units such as kilobecquerel (kBq) or megabecquerel (MBq) are used.

Questions and Answers

1. What is the difference between radiation and radioactivity?

A radioactive atom is unstable because its nucleus is unstable. When this atom 'decays' to a more stable atom, it releases energies as ionising radiation.

2. Is there more than one kind of ionising radiation?

Yes, in addition to X-rays, three are common: they are the alpha, beta and gamma. Alpha rays (helium nuclei) may be stopped by a piece of paper, beta rays (high speed electrons) are stopped less easily, and gamma rays (like X-rays) may need lead or concrete to stop them.

3. Will these ionising radiations make me radioactive?

No, just as light will not make you glow in the dark, a chest X-ray will not make you radioactive.

4. If ionising radiation does not make things radioactive how do items become radioactive in reactor?

In a reactor there are billions of free nuclear projectiles called neutrons. When absorbed in a material they make it radioactive. i.e. it emits its own radiation. (This is how radioisotopes are made.) There are very few free neutrons in the environment.

5. But surely radiation builds up in the body until it gets to a point where it kills you?

No, ionising radiation does not 'build up' in your body any more than light which falls on you builds up. All radiation will eventually disperse. However, radiation effect may appear, following exposure to large amounts of radiation, just as you get sunburnt from too much exposure to sunlight.

6. Well, if radiation does not build up in the body, how does it harm a person?

All radiation carries energy which may damage living cells. This damage may cause cells either to die or to change their structure and function.

7. So if I get a dose of radiation I will be killed?

Very unlikely, since it would take a very large dose to kill sufficient numbers of your cells to cause your death.

8. How much is this large dose of radiation?

Typically several thousands times as large as the radiation dose you receive normally each year from the environment. Note also that to cause your death, you would need to be exposed more or less in one hit, not spread out over a year. (Compare with sunlight: spread out over a year it gives you suntan, but in one day of sunbaking it could cause your death by sunstroke).

9. Where does my annual radiation dose come from?

The major part derives from the decay of natural radioactivity in the earth, most of it from uranium and thorium: they give rise to a radioactive gas called radon in the air we breathe. Radon is present in all buildings. Smaller, and roughly equal, parts of everyday radiation come from cosmic rays and from the natural radioactivity of our food and drink. Some other radiation is 'man-made'.

10. What are the man-made sources of my radiation dose?

Medical uses of ionising radiation are the major items. These include the use of X-rays for radiography and tomography, and radioactivity in nuclear medicine.

11. Can you put some figures on these natural background and man-made radiation doses?

On average you receive 2000 microsievert (symbol μSv) a year from natural background radiation. Your additional dose from medical use of radiation would depend on your medical history. Dental X-ray would be very small, a chest X-ray may be a few percents of annual background, while multiple X-rays in conjunction with a barium enema may be several times annual background. Radiation doses in cancer therapy may be larger still.

12. When you say 'on average' does this mean that some people get more radiation than others?

Yes. Cosmic rays vary with latitude, with height above sea-level, with sun-spot activity. Some rocks (like granite) or beach sands are more radioactive in some parts of the earth than others. Some foods like olives and Brazil nuts accumulate more radioactivity than others. But the most important natural variation is in radon, brought about by difference in building materials, ventilation, and water supplies. It is common for the radon dose to vary by a factor of five, both up and down from the average.

13. Surely it is dangerous for anyone to experience these higher levels of radiation dose?

When whole populations exposed to high doses are compared with those exposed to low doses, difference are not detected. The human race has evolved over millions of years in this radiation environment.

14. Did you suggest earlier that if I get a radiation dose more quickly it will do more damage?

Yes. Over an extended period the body can repair most small damages from almost any cause, including radiation, but if the dose is acute, that is all in one short period, more serious damage may occur.

15. What kinds of radiation damage can occur?

There are two kinds: damage to any of the cells of your body, which may put you at risk (somatic effects), and damage to your reproductive cells, which may put future generations at risk (genetic effects). There are many different somatic effects, but the most important long-term effect is cancer induction.

16. What is my chance of getting a fatal cancer from a dose of radiation?

You have a chance of about 100 in a million of getting a fatal cancer from a radiation dose corresponding to one year of natural background. Very roughly this means that your lifetime dose of natural background might give you a one in a two hundred chance of dying of cancer. Note that your natural chance of dying of cancer from all causes is one in four.

17. What is the chance of radiation causing genetic mutations that are passed on to my children?

Your total radiation dose from natural background up to the time your children are conceived (not after) might result in about a one in 3000 chance of your generating genetic diseases that are passed on. Note that about one in ten of all live-born children carry some type of genetically-related defect.

18. How can I tell when I am being subjected to radiation?

Only by appropriate instruments since none of our five senses, sight, hearing, touch, taste, or smell enable us to detect ionising radiation.

19. How can I protect myself against radiation?

In everyday life we cannot avoid the majority of natural radiation. However, near local sources of radiation you should use distance, time and shielding to provide protection. Staying further away from the source reduces your dose, but if it is necessary to approach a source you should minimise the time spent near it, and if it is strong, you should ensure that adequate shielding is maintained between you and the source.

20. How may I measure my radiation dose, and what are the limits?

All doses should be kept 'as low as reasonably achievable' (ALARA). The Radiation Ordinance (Cap. 303), Laws of Hong Kong, requires that doses received by workers who are employed to undertake any work involving exposure to ionizing radiation are limited to 20 millisievert in a year, and that doses received by members of the public are limited to one millisievert in a year. For this purpose, radiation workers are required to wear a film badge or a thermoluminescent dosimeter (TLD) to record their radiation doses.

21. If I want to get more information, what can I do?

Information on radiation protection can be obtained from:

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28 Tai Hong Street,
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