INEA and the problem of LNT

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The nuclear energy industry offers a proven and safe means for generating most of the electricity we need at a reasonable cost, with minimal damage to the environment. Other uses of nuclear science and technology in industry and in medicine also provide enormous benefits to society.

However, for many people, fear of radiation – essentially the mistaken belief that there is no safe radiation dose – is a significant deterrent to the wider use of these technologies. This misconception stems largely from the early recommendation by the International Commission of Radiological Protection (ICRP), adopted by authorities in most countries, that the carcinogenic and mutagenic risks from exposure to ionising radiation should be assumed to be proportional to the dose without a threshold – the "linear no-threshold (LNT) model" – which is based on extrapolation to zero dose and to low dose rates from risks observed at high doses that were incurred from the explosion of atomic bombs.

For low doses, there is abundant evidence that conflicts with the LNT model. This includes some of the data from studies of atomic bomb survivors themselves.

Even after the worst nuclear plant accidents, no member of the public and very few workers in this industry have been exposed to anything remotely approaching the radiological conditions of an atomic bomb explosion. For the most highly exposed members of the public, total doses have been comparatively low and have been spread over prolonged periods of time. Public exposures have mainly been within the range of naturally occurring radiation, to which the human race (indeed, all life on Earth) has been exposed throughout evolution and to which our bodies would necessarily have adapted.

The rate of exposure is a vitally important factor. A dose greater than 1 Sv (1000 mSv) incurred in a short space of time, as in an atomic bomb explosion and for some workers during the Chernobyl reactor accident, causes a very nasty sickness called "acute radiation syndrome" (ARS). At 5 Sv, there is about 50% probability of death within a few weeks from ARS and an estimated 50% excess cancer risk later in the lives of survivors. A dose of 5 Sv spread uniformly over a lifetime, as occurs in some areas of high natural background radiation in some parts of the world, causes no discernible harm.

There is no reason, apart from the LNT assumption itself, to suppose that natural background radiation is harmful. In fact, it appears to be essential for normal life and health. Like most (perhaps all) potentially harmful agents to which we are exposed in our environment, radiation exhibits thresholds to its harmful effects. Incidences of cancer, other diseases and genetic damage are not elevated due to the high levels of ionising radiation that occur naturally. If anything, the reverse occurs. The dose rate from natural background radiation at Ramsar in Iran ranges up to at least 100 times the global average and no significant detrimental effect, such as increased incidence of cancer, has been observed amongst the resident population. Ramsar is a spa resort where people actually go for the good of their health.

Fundamental research and experiments on animals have shown that different biological responses to radiation predominate at doses and dose rates that are substantially lower than those at which risks have been observed. We now know that health benefits instead of risks can and do occur at low levels of exposure. This has been explained as being due to the stimulation of the body's protection systems, not just against radiation but against all potentially carcinogenic and mutagenic damage, including

that which occurs every day in our normal lives. More research is needed but enough is known for us to say that the LNT model is wrong and can be seriously misleading.

Recommendations

For all of the above reasons, it is recommended that use of the linear no-threshold (LNT) model be abandoned and replaced by a more realistic approach to the estimation of radiological risks. A new model to replace LNT should be based on thresholds below which risks are considered to be zero. In accordance with present knowledge and data, thresholds are considered to be within the following ranges depending on circumstances. These figures are proposed as a basis for further discussion:

- Within the range 50-300 mSv for acute single doses to adults;
- Within the range 100-700 mSv per year for continuous chronic exposures; and
- Within the range 50-200 Bq/m^3 for naturally occurring radon in the air breathed in confined spaces, which causes about half the exposure to background radiation for many people.

Thresholds also need to be developed for the sum totals per year, per month or per week of intermittent and protracted exposures, and for acute single doses to embryos, foetuses and infants.

Risks might be assumed to depend on, or be proportional to, the incremental dose or dose rate over limited ranges above the relevant threshold. Simple explanations of the meaning and level of actual risk and benefits should be developed.

Health benefits that might be derived from exposure to ionising radiation are a matter for the medical profession to pursue. As a professional body itself, the International Nuclear Energy Academy is concerned with the appropriate control of potential adverse health effects and the advancement of science and technology in the service of humankind.