Committee on Medical Aspects of Radiation in the Environment

Latest News: COMARE 13th Report: The health effects and risks arising from the exposure to UV radiation from artificial tanning devices

COMARE: Frequently Asked Questions

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What is ionising and non-ionising radiation?

Radiation is defined as energy that is transmitted in the form of rays or waves or particles and can be either ionising or non-ionising.

Ionising radiation is any form of radiation with sufficient energy to remove electrons from atoms, producing charged particles known as ions. It can consist of high-energy particles (electrons, protons or alpha particles) or short wavelength electromagnetic radiation (X-rays and gamma rays). The various types of ionising radiation cause different levels of damaging biological effects, which depend on the energy level, penetration and dose. Exposure may be through skin contact, inhalation or ingestion. The health effects can be broadly grouped into deterministic and probabilistic effects. The severity of deterministic effects (such as cataracts and skin inflammation) is dependent on dose and there may be a threshold dose below which effects are not seen. Probabilistic effects (including various cancers) are not thought to have any threshold and it is occurrence, not severity, which is dependent on dose.

Ionising radiation is used extensively in medicine (for diagnosis and treatment), in industry (for producing electricity and other purposes) and in research.

Non-ionising radiation is found at the long wavelength end of the spectrum where there is insufficient quantum energy to cause ionisations in living matter. Non-ionising radiation ranges from extremely low frequency radiation (ELF), shown on the far left through the radiofrequency (RF), microwave, and visible portions of the spectrum into the ultraviolet (UV) range. The primary health effect from high exposure levels of non-ionising radiation arises from heat generation in body tissue.

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Who is exposed to ionising radiation?

COMARE's chief concern is population exposure to ionising radiation. No-one escapes exposure to ionising radiation although individual doses may vary considerably. All of us receive doses from cosmic rays (especially when we travel by air), from the small amount of radioactivity within our bodies and from radiation coming from the ground. People that live in areas where there are large quantities of radon gas leaching from the underlying rocks receive an above-average dose from this source.

The largest component of man-made radiation exposure is for medical reasons (eg, diagnostic X-rays, CT scans, radiotherapy and nuclear medicine. These are regarded as acceptable because of their clinical benefit and because this benefit is experienced by those actually irradiated. Workers in certain industries and professions (eg, radiographers, nuclear industry workers, submariners) receive small additional doses in the course of their work. Radioactivity has also been allowed into the environment from nuclear power stations, nuclear reprocessing plants, hospitals, research laboratories and certain other sites, and there is, of course, the legacy of radioactivity from nuclear weapons testing and accidents such as Chernobyl. Although the doses from man-made sources are small compared with those from natural sources, we make the prudent assumption that there is no totally safe dose and any unnecessary exposure, whether to natural or man-made radiation should be kept as low as practicable. In addition to ionising radiation, COMARE deals with a variety of non-ionising radiations including ultraviolet radiation from sunlight, electromagnetic radiation and radio waves.

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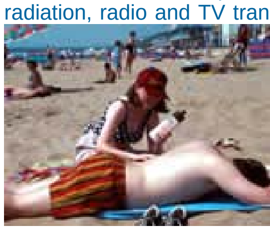
Who Is exposed to non-ionising radiation?



No-one can avoid exposure to non-ionising radiations which include light, ultraviolet radiation, radio and TV transmission waves, and electric and magnetic fields associated with power lines. Of these, only ultraviolet radiation, particularly from the sun, constitutes a known cancer hazard. The way that the other non-ionising radiations interact with living material does not suggest that they should be harmful at the levels to which we are exposed in everyday life. Some published studies have suggested an association between certain frequencies of non-ionising radiation and cancer but overall the evidence is not convincing. There is some reassurance in the fact that there has been no general increase in cancers, etc, over the years when exposure to man-made non-ionising radiations has greatly increased. Nevertheless, COMARE is not complacent and keeps abreast of relevant research.

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How does COMARE work?

Issues are placed before COMARE by UK Government Departments, the Scottish Parliament, the Welsh Assembly or the Northern Ireland Office. Generally, such referrals arise because there is concern over health effects that might possibly be attributed to radiation. COMARE is an independent expert advisory committee with members chosen for their medical and scientific expertise. The committee offers independent medical and scientific advice on the health effects of ionising and non-ionising radiation in the environment, whether natural or man-made. The secretariat is provided by medical, scientific and administrative staff of the Health Protection Agency's Radiation Protection Division (HPA-RPD), formerly NRPB, who are expert in their own fields. It is the secretariat's responsibility to provide the committee with data relevant to the topic under discussion.

Both COMARE and HPA-RPD have access to a very large variety of sources of information including industry, Government Departments, green organisations, pressure groups and many independent researchers as well as the usual resource of published scientific and medical research data. COMARE is also served by assessors, who represent Government Departments, regulatory bodies and research organisations, and who provide appropriate information as required by the committee. All sources are referenced in published COMARE or HPA-RPD/NRPB reports.

For major problems, COMARE examines each situation in detail, often carrying out its own independent analyses and publishes its findings as reports. Smaller matters are published as statements on the web site and/or as answers to parliamentary questions. COMARE is always prepared to revisit past reports when new information becomes available, a recent example being COMARE's 6th Report reconsidering the implications of the radioactive particles around Dounreay.

Particularly in its early years, it was found that the issues brought before COMARE were often insufficiently researched and, following discussion by the members, COMARE has made several recommendations for further research. This research is subsequently carried out, usually under the auspices of the Department of Health, and when completed and published, is evaluated in the context of all the research available, an example being COMARE's 7th Report on cancer in the offspring of irradiated parents. Another outcome of a recommendation for research is an evaluation of work on the precise distribution of child cancer in England, Wales and Scotland (COMARE's 11th Report). This enabled the incidences of childhood cancer around nuclear installations and other sources of radiation to be seen in an overall context for the first time.

COMARE's current Work Programme is shown on the website, as are the dates of its meetings. Minutes are not published since reports of all significant activities are published in full as soon as they are completed.

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What is epidemiology?

Epidemiology is the study of the distribution of disease in populations and of the factors that affect this distribution. In contrast to clinical medicine where the emphasis is on the individual , epidemiology involves the examination of patterns of disease in groups of individuals. While epidemiology originated from investigations of epidemics of infectious diseases in the 19th Century, epidemiological research in western countries is now directed largely at chronic diseases, such as heart disease and cancer. Indeed, epidemiology has played a vital role in identifying and quantifying the health risks of cigarette smoking and exposure to agents such as asbestos, as well as radiation. Epidemiologists investigate reported disease clusters of any kind, including potential cancer clusters. Knowledge of diseases, lifestyle factors, environmental science and biostatistics is used to determine whether a suspected cluster represents a valid disease excess.

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Why do different epidemiological studies come to different conclusions?

Uncertainty is a fact of life common to all areas of science. Experiments done in the laboratory can usually be designed and controlled so that the uncertainty is minimised and the results can be regarded with confidence. With epidemiology, however, we are dealing with people in the real world and things are not that easy. When looking for possible effects of radiation, the fundamental statistical limitation is determined by (a) the numbers of people exposed to significant doses and (b) the numbers of cases of cancer, mutations, etc. The power of the study is a statistical estimate of the smallest effect that could be expected to be detected with confidence. If the numbers of cases or number of people are too small, even in a well-designed study, there is a high probability that chance will lead to the wrong conclusion and the study cannot be relied upon. Furthermore, almost all epidemiological studies are subject to bias in their design, ie, it is not always possible to find a group of people with whom the exposed group may be legitimately compared (known as the control group). Obviously, researchers try to overcome this, but it always seems impossible to remove bias totally. In addition, there are many factors that may differ between the exposed group and the control group. Some of these confounding factors may be estimated and allowed for, others may not be known and may lead to false results. Because of these uncertainties, not all studies are of equal value.

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How does COMARE evaluate inconsistent epidemiological studies?

When a particular topic is evaluated by COMARE, all the available evidence from epidemiological studies has to be considered. The published studies are looked at individually and examined for the quality of data and the rigour of the analysis. Questions to be considered include, what was the power of the study? Was it seriously flawed by bias in its design, was the effect of possible confounding factors adequately addressed? One of the major problems with human studies is that no two people will have received exactly the same radiation exposure. Sometimes the exposure is not known at all and some surrogate measure has to be used, such as the number of years of work in proximity to a source or the distance of residence from that source. The total available evidence is then weighted according to its quality and an overall assessment is made. Greater weight is given to studies where the radiation exposure is more accurately known and particularly to those studies where there is a quantitative relationship between exposure and effect. In addition, COMARE likes to be able to give an indication of the degree of confidence or uncertainty and to indicate where further work is desirable.

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How does COMARE determine radiation dose?

The determination of doses is the special expertise of the Health Protection Agency's Radiation Protection Division (HPA-RPD) (formerly NRPB), and COMARE uses the HPA-RPD whenever a dose assessment has to be made. Wherever possible, estimates are based on results from measurements on environmental materials. Both the behaviour of radionuclides in the environment, and their behaviour in the human body can be computer modelled. In both cases, these are checked where possible by comparison with actual measurements. Generally, it is found that the environmental modelling is conservative, ie, it tends to overestimate rather than underestimate exposures. When COMARE is involved in an assessment, it likes to examine the factors built into the model and identify those about which it is least confident. COMARE then asks HPA-RPD to recalculate the doses with slightly different assumptions about these factors. In this way it can gauge the likelihood of a gross error in assessment. This is known as a sensitivity analysis and a good example is found in COMARE's 4th Report on the population of children living in Seascale.

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How are risks from ionising radiation estimated?

If the dose of radiation to which people have been exposed is known, then it is possible to calculate the probability that harmful health effects would ensue. This is done using risk factors and our primary source of risk factors is the population that survived the A-bombs in Hiroshima and Nagasaki. These have been exhaustively studied and, although we do not know the exact radiation dose which each individual received, the risk factors for different cancers and other end-points are now known with a reasonable degree of accuracy. A-bomb survivors are not our only source of information, however. There are many other studies involving people who have received high doses (such as patients given radiotherapy), moderate to low doses (such as patients given certain diagnostic procedures and radium dial painters), and low doses spread out over long periods (such as workers in the nuclear industry). These studies involve exposure to radiations of different types. In addition to these epidemiological (human) studies carried out over more than 50 years, there is a monumental amount of information from laboratory work with animals and cells, which is taken into account in the derivation of risk factors. From all this it is clear that cancer induction is the main risk to those exposed to radiation. Radiation-induced genetic effects (mutations) leading to disease in the descendants of exposed individuals have not been demonstrated in humans (even in the A-bomb survivors), and our risk factor for these is based on work carried out with mice.

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What are cancer clusters?

A cancer cluster can be defined as a greater than expected number of cancer cases occurring within a group of people living in a particular geographical area over a specific time period. The complex patterns of occurrence of cancer make it difficult to identify and interpret cancer clusters. All types of cancer can occur in clusters by chance for purely statistical reasons; this type of clustering occurs when the incidence of cancer is not affected by any external factors, or when there are external factors causing cancer but they are ubiquitous among the population.

There are statistical approaches that enable the recognition of clustering which is over and above that due to chance, ie, that make it possible to determine whether clusters exist that are due to the localised influence of a risk factor. This type of approach was used in COMARE's 11th Report of the distribution of childhood cancer in Britain that is being carried out with particular reference to concerns about possible clusters in the vicinity of nuclear sites. As expected, it has shown that the main type of childhood leukaemia can occur in "genuine" clusters over and above those due to chance. Surprisingly, it seems that other types of childhood cancer can also occur in "genuine" clusters. This may help in the identification of as yet unknown risk factors. Unfortunately, even where there seems to be "genuine" clustering, there is no obvious way to determine in such cases which particular clusters have a localised cause and which are due to chance.

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Why has COMARE extended its remit to include medical exposures to radiation?

Medical exposures account for over 97% of the annual dose to the UK population from artificial sources of radiation, and constitute approximately 14% of the average annual dose to the UK population, although obviously there will be marked variations in the doses received by individuals in the UK depending on their unique exposure characteristics. The Department of Health's (DH) radiation protection concerns increasingly centre on medical exposures. As a consequence of this concern DH in 2005 instructed COMARE to include within its sphere of interest radiation protection from medical practices.

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What is CT Scanning?

CT stands for Computed Tomography. CT scanning images are used to identify and diagnose disease or health problems. CT Scanners use x-rays to take detailed images of cross sections of the body called ‘slices’. The scanners can have different numbers of detectors. Generally the greater the number of detectors, the increased amount of data that is acquired leading to more detailed images of the body. The images are stored in a computer and are interpreted by a radiologist, or appropriate trained specialist.

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What is the difference between scanning and screening programmes?

Scanning is the term applied to a number of radiological examinations including MRI, Ultrasound, Nuclear Medicine and CT. In medicine, the term "screening" refers to a national or regional programme looking for medical conditions in a person showing no symptoms, but having some risk factors, in the hope of identifying problems early when treatment should be most effective.

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