NRL
National Radiation Laboratory

The Source

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Going in to bat for the IAEA in South Africa

Vere Smyth was recently sponsored by the International Atomic Energy Agency (IAEA) to present a paper at the Conference of the South African Association of Physicists in Medicine and Biology (SAAPMB), at Bloemfontein. The paper presented the merits of a new Code of practice for radiotherapy dosimetry based on absorbed dose standards, just published by the IAEA (Technical reports series 398), of which Vere is one of the authors. It is intended to replace the older Code TRS 277 which is based on air-kerma standards and is more complicated to use. One of the reasons for writing the new Code was to make therapy dosimetry simpler and more accurate for developing countries with limited technical and scientific expertise.

Previously the SAAPMB has endorsed the dosimetry Code used in North America (TG-21) and has indicated an interest in a new Code (TG-51) developed by North America in competition with the new IAEA Code. However, the South African medical physics community provides extensive IAEA-sponsored assistance to other less developed African nations, and the IAEA was keen to see their new Code adopted throughout the African continent, including South Africa.

The effort bore fruit. News has arrived that the SAAPMB will adopt TRS 398.

Footnote: NZ currently uses the IAEA Code TRS 277. NRL will be recommending the adoption of TRS 398.

Nuclear safeguards: accounting for and control of nuclear material

The primary aim of nuclear safeguards is to prevent the diversion of nuclear material from peaceful uses to nuclear weapons or other nuclear explosive devices.

Cris Ardouin recently attended a training course, funded by the Australian Agency for International Development, on the practical implementation of IAEA nuclear safeguards at state level. The course was run jointly by the International Atomic Energy Agency (IAEA) and the Australian Safeguards and Non-Proliferation Office (ASNO).

Participants came from North Korea (DPRK), South Korea, Indonesia, China, Australia and New Zealand. The course was primarily designed to provide technical assistance to DPRK in setting up systems that comply with IAEA protocols for nuclear safeguards. Topics covered included relevant legislation, accountancy methods, verification, containment, surveillance and reporting techniques necessary to establish nuclear safeguards systems at state and facility level. The course was largely practical, involving plant inspections at the Lucas Heights reactor, group workshops and presentations.

New Zealand has a strong commitment to international co-operation on Northeast Asia security issues and nuclear non-proliferation. As a demonstration of this commitment, New Zealand was one of the first countries to agree to an Additional Protocol with the IAEA for strengthened nuclear safeguards in 1998. Also, while it does not have sufficient nuclear material to require formal declaration under IAEA safeguards, a state nuclear materials accounting system has been established in NZ by the Ministry of Foreign Affairs and Trade and verified by the IAEA.

International Agency for Research on Cancer reviews power frequency fields and cancer risk

A recent International Agency for Research on Cancer (IARC) review into the possible carcinogenicity of extremely low frequency (ELF) magnetic fields from power lines and other electrical equipment finds only limited evidence that they may be associated with cancer. Although some population-based studies have shown a weak but reasonably consistent association between prolonged exposure to relatively strong magnetic fields and the risk of childhood leukemia, laboratory research, including several studies on animals exposed over their lifetime, is inadequate to suggest that the fields have any effect. Data on other cancers were inadequate for forming any conclusion.

This finding supports those of other reviews published recently in the UK, Netherlands and the USA. Those reviews concluded that the data did not justify any aggressive regulatory actions or changes in exposure limits.

A recent study of childhood leukemias in New Zealand found that none of the 86 cases reported over a four-year period was exposed to high levels of magnetic fields.

The IARC classifies agents into groups according to their potential carcinogenicity. Group 1 (carcinogenic) includes alcoholic drinks, benzene and asbestos. Group 2A (probably carcinogenic) includes diesel exhaust, sun lamps and PCBs. Group 2B (possibly carcinogenic) includes car exhaust, coffee and pickled vegetables. The IARC Working Group of 21 scientific experts from ten countries concluded that because of the limited evidence of a carcinogenic effect of ELF fields, they fall within Group 2B.

In New Zealand the Ministry of Health recommends the use of exposure guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a scientific body recognised by the World Health Organisation as having expertise in this area. The ICNIRP guidelines are based on a review of the research data, including most of the work included in the IARC review. Exposures in New Zealand houses and public areas are, at most, a few percent of the ICNIRP limit, and normally less than one percent.

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Responding to emergencies: the Radiation Incident Response Plan

In consultation with the New Zealand Fire Service, NRL is carrying out a review of the arrangements for responding to radiation incidents throughout New Zealand.

The *Radiation Incident Response Plan* will specifically cover incidents in public places (eg, transport accidents, damage to containers, discovery of suspected radioactive substances, etc) and incidents on premises that are not already covered by existing contingency arrangements.

The aim of the plan is to provide emergency services (primarily Fire Service) with expert radiation protection advice in a timely manner, including where appropriate, rapid advice and assistance at the scene. For example, it may be necessary to carry out radiological measurements to determine the extent of the hazard, help set up contamination control procedures, advise on handling of contaminated casualties and so on. In the most common scenarios the real radiological hazard will be low and a rapid response will prevent the incident from escalating.

Before the plan is finalised there will be a process of consultation with interested parties. It is also anticipated there will be a training programme for participants and emergency exercises to demonstrate the procedures and effectiveness of the plan.

Although radiation incidents are very infrequent in New Zealand (typically one or two a year), there is still a need to provide the best possible response to ensure the protection of the emergency services and the general public.

For more information contact Cris Ardouin (Cris_Ardouin@nrl.moh.govt.nz)

Is there a topic you would like to read about in The Source? Let us know and we'll try to oblige.

New equipment at NRL

New x-ray plant

NRL has recently installed a new 320 kV x-ray system in its x-ray calibration laboratory. The system is a Pantak HF 320/160 switchable unit, and it replaces a similar but ageing unit that was becoming increasingly unreliable and difficult to maintain. The x-ray plant forms part of the system that is used to calibrate various types of radiation measurement equipment operated by people involved in industry, medicine and research.

Liquid scintillation counter

The routine measurement of alpha and beta emitting radionuclides in NRL's Environmental Laboratory is currently performed by gas flow proportional counting. However, the problem of sample self-absorption and the high demand for maintenance and quality control have created the need for a better method of performing alpha/beta measurements.

NRL has recently purchased a Wallac 1414-003 Low Level Guardian Liquid Scintillation Counter (LSC) with alpha and beta discrimination capabilities. The LSC enables the simultaneous measurement of both alpha and beta events in an organic based liquid cocktail (scintillant). The LSC technique is based on the detection of light pulses generated from the interaction of alpha and beta events with the scintillant. It offers the additional capability of producing a spectrum for individual radionuclide identification and automated sample counting, allowing for the provision of a wider range of services. The LSC has an automated quality control system and complies with the requirements of ISO 17025:1999.

Rural GP licence conditions

The last issue of *The Source* noted the development of new standard licence conditions for rural GPs who hold a licence to use x-rays in medical diagnosis.

Information for rural General Practitioners wishing to offer a limited x-ray service, NRL matters no. 11, August 2001, has now been sent to relevant GPs. The document explains the process for a rural GP wishing to apply for a licence, including referral to the Medical Licensing Advisory Committee (MLAC), and conditions that may be placed on the licence. It also includes information on the special knowledge requirements for rural GPs and guidelines for auditing extremity radiographs.

NRL matters no. 11 is available on the web site or by contacting Chris Moir (Chris_Moir@nrl.govt.nz)

NRL wipe test kit now available

Wipe tests to check for possible radioactive contamination of surfaces are required by radiation protection legislation in certain circumstances, or are sometimes undertaken when contamination is suspected, such as when a radioactive source is inadvertently dropped.

Using the NRL Wipe Test Kit on a caesium-137 source holder

The *NRL Wipe Test Kit* is designed for use with alpha, beta and gamma emitting contaminants and is especially suitable for wipe testing of sealed radioactive sources. It consists of equipment and instructions to perform a wipe test. Analysis of the sample by the Environmental Laboratory at NRL is part of the package. The kit contains two differently shaped wipes (a pad and a swab) to allow wiping on all kinds of surfaces even in restricted areas. Impervious gloves are provided to ensure protection of the operator. Once completed, the supplied data sheet and sample are sent to NRL for analysis using the prepaid envelope provided. The activity of the wipe sample is determined at the Environmental Laboratory by counting it in a standard geometry with calibrated pancake GM detectors. All test reports can be used to show compliance with the *Radiation Protection Act* and the *Radiation Protection Regulations*. For further information contact Nikolaus Hermanspahn (Nikolaus_Hermanspahn@nrl.moh.govt.nz)

Supervision and instruction in medical practice

The *Radiation Protection Act* restricts the use of radioactive material or irradiating apparatus to people who are licensed under the Act or "acting under the supervision or instructions of a person so licensed". The exact meaning of "supervision or instructions" has been debated for a long time and is clearly very important for establishing legal responsibilities. In order to clarify the application of the terms in the area of medical practice a position paper is being prepared by the Radiation Protection Advisory Council (RPAC). The Council has previously ruled that any fully qualified professional who uses radiation as part of their professional duties, and who cannot be construed to be genuinely acting under the supervision or instructions of another licensed person must have a licence.

The particular problem with medical use is the wide diversity of types of use. There is no difficulty in the case of consultant radiologists using x-rays for medical diagnosis. They cannot be considered to be under anyone else's supervision or instructions and they must hold individual licences. The situation is more complicated however in the case of a radiology registrar who is almost fully qualified, and is no longer really under any formal supervision, or in that of a surgeon who may wish to use fluoroscopy only occasionally.

At its 9 May 2001 meeting the RPAC worked through each category of medical use of radiation and made recommendations on what particular circumstances of acting under supervision or instructions could be considered to satisfy the regulatory requirements. It is expected that a position paper will be completed and signed off at its next meeting on 23 November 2001. The details will be communicated to all medical licensees through an *NRL matters* and will be discussed in the *Guidance notes* issued as companion documents to NRL *Codes of safe practice* C3, C5, and C12 when they are next revised.

NRL Codes of safe practice and Guidance notes

The current status of development and revision of *Codes of safe practice* is as follows:

- NRL C16 *Code of safe practice for the use of x-ray security and inspection systems* and NRL C17 *Code of safe practice for the use of x-ray analytical equipment*, are now being published along with *Guidance notes* designed to assist with compliance. These will shortly be sent to appropriate licensees along with licences amended to include compliance with the new *Codes* as a condition.
- NRL C14 *Code of safe practice for the use of sealed radioactive materials for brachytherapy* and its companion *Guidance notes*, has undergone further revision following the consultation period and is currently being prepared for publication.
- Since the public consultation phase ended, work has continued on the revised veterinary code (NRL C8) and *Guidance notes*. During a recent meeting at NRL, the NZ Veterinary Association agreed to further develop the *Guidance notes*.
- A little further back, work has now begun on a revised edition of the code for unsealed radioactive materials (C1) and a new code for non-medical irradiating apparatus (C18). This last will cover the use of x-ray equipment for industrial, research and testing purposes not already included in the scope of other codes.

Dental drill: doses to patients III

The previous two issues introduced entrance surface dose as the measure of the amount of radiation incident upon the dental patient and equivalent dose as a measure of how much radiation is absorbed by a given organ or tissue. In this final article on patient doses a third dose quantity is introduced.

Effective dose

To properly describe "the dose" from a dental x-ray you need to take account of all the equivalent doses to the various tissues and organs in the body. Obviously this is difficult as it involves a large number of tissues and organs with widely varying equivalent doses. A third type of dose is used for this purpose – namely, effective dose. Effective dose is the equivalent uniform whole body dose that would produce the same ensuing radiation harm (cancers and hereditary effects) as the actual dose distribution in the body. Calculation of effective dose takes into account not only the equivalent doses to particular tissues and organs but also their relative radiosensitivities. The unit for effective dose is the sievert (Sv).

The use of effective dose for a bitewing x-ray, for example, enables a single value to characterise the x-ray exposure rather than specifying a whole lot of equivalent doses to various tissues. This single number can then be used to estimate the risk of radiation harm. It may seem odd to convert a head-region exposure into a whole body exposure, but most of the radiosensitive tissues are in the trunk and it is the doses to these tissues that effectively determine the likelihood of radiation harm.

Typical patient effective doses for dental x-ray examinations are in the range of 2 to 20 µSv for a pair of bitewings and 5 to 20 µSv for a panoramic film. In other words, the actual doses from a pair of bitewings has the same effect as if the whole body (and hence every organ and tissue in the body) received an equivalent dose of 2 to 20 µSv. The wide range of doses for the same examination arises because there are a large number of technical and technique factors that affect patient effective dose. These will be discussed in future articles.

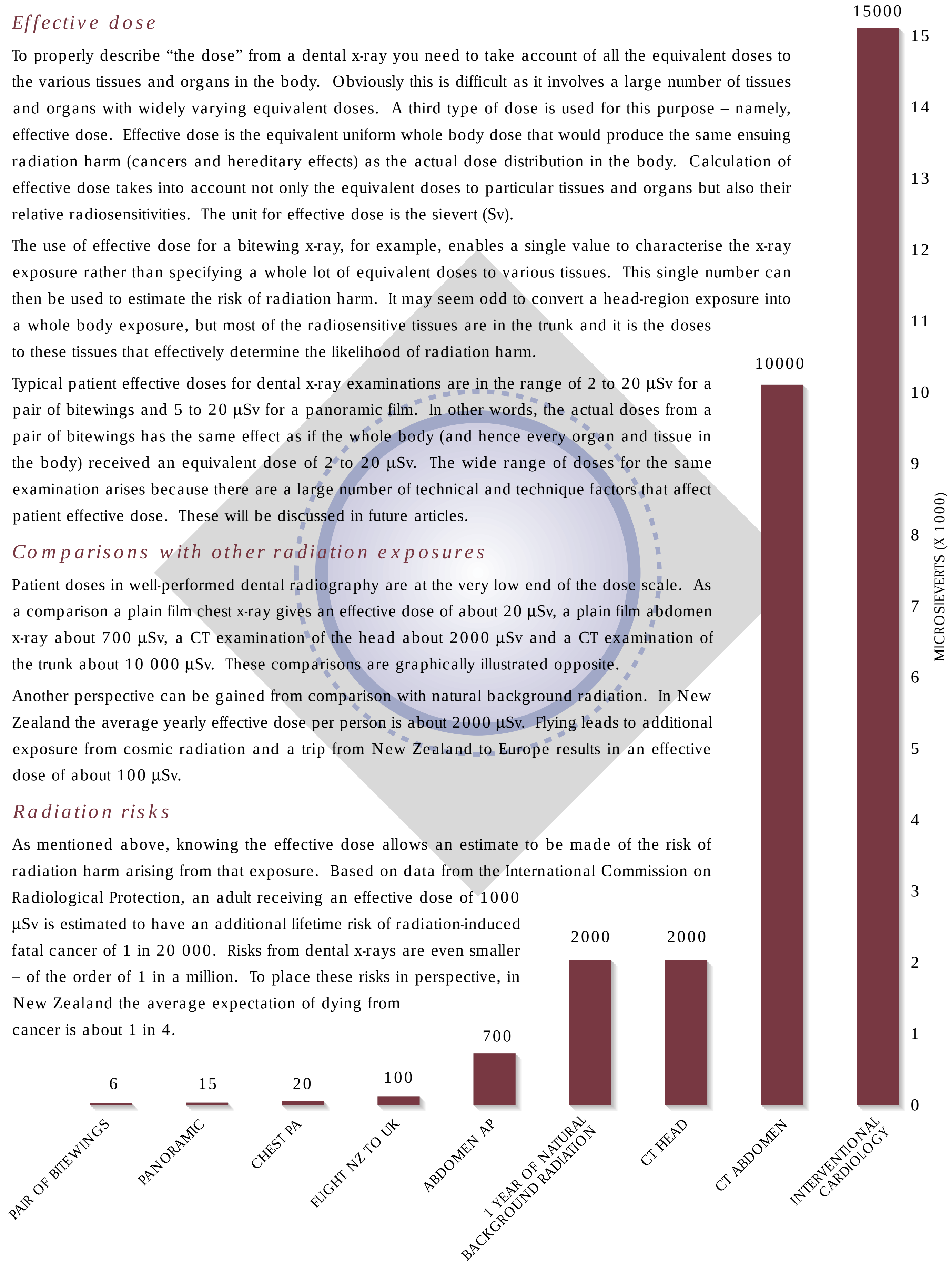
Comparisons with other radiation exposures

Patient doses in well-performed dental radiography are at the very low end of the dose scale. As a comparison a plain film chest x-ray gives an effective dose of about 20 µSv, a plain film abdomen x-ray about 700 µSv, a CT examination of the head about 2000 µSv and a CT examination of the trunk about 10 000 µSv. These comparisons are graphically illustrated opposite.

Another perspective can be gained from comparison with natural background radiation. In New Zealand the average yearly effective dose per person is about 2000 µSv. Flying leads to additional exposure from cosmic radiation and a trip from New Zealand to Europe results in an effective dose of about 100 µSv.

Radiation risks

As mentioned above, knowing the effective dose allows an estimate to be made of the risk of radiation harm arising from that exposure. Based on data from the International Commission on Radiological Protection, an adult receiving an effective dose of 1000 µSv is estimated to have an additional lifetime risk of radiation-induced fatal cancer of 1 in 20 000. Risks from dental x-rays are even smaller – of the order of 1 in a million. To place these risks in perspective, in New Zealand the average expectation of dying from cancer is about 1 in 4.



Typical effective doses (microsieverts) from dental and medical exposures and other activities