Radiopharmaceuticals and cremation

Radioactive materials have been used for medical treatments ever since they were first discovered. Some of the materials used have short half-lives so they can be permanently located in the area of the body requiring treatment, and they deliver their dose while they decay away. The materials may be taken by the patient either as a radiopharmaceutical that finds its own way to the treatment site (such as iodine-131 which is naturally taken up by the thyroid and is commonly used for treating hyperthyroidism) or sealed in small metal capsules and injected (such as iodine-125 "seeds" used to treat prostate cancer). The therapeutic process will continue for days or weeks depending on the material. The patient is given instructions on any precautions that may be necessary during this time to ensure everyone is safe from the radiation.

What if the patient dies and is to be cremated?

One of the treatments, for example, uses strontium-89 (^{89}Sr), to ease the pain from cancer metastases in the bones, as it can be effective when other pain control measures do not work. The usual activity given is 150 MBq, the half-life is 50 days, and sadly it is inevitable that some patients will die while there is still a high activity of ^{89}Sr in their body. This is because the strontium is taken up in the bones (which is why it is effective). When a body is cremated most of the bone mass remains in the ash. It is not unusual for the ash to be so radioactive that it would be neither safe nor legal to release it to relatives to dispose of as they wish, but must be kept shut away under regulatory control in a secure place for as much as two years. Nor is the problem unique to ^{89}Sr. For example, the iodine-125 seeds used to treat prostate cancer would remain intact in the ashes after cremation. The difficulty arises then if the cultural requirement is that the corpse should be cremated, while radiation safety dictates that burial is preferable.

Regulatory requirements

It is quite clear in the *Code of safe practice for the use of unsealed radioactive materials in medical diagnosis, therapy, and research, NRL C3*, that the licensed clinician who prescribed the treatment is responsible for managing subsequent safety. The disposal of any radioactive material must use an approved method if the activity is above a prescribed limit. Controlled burial (either conventional burial or burial of the ashes) is generally acceptable. Storage until the activity is below the limit may be acceptable. In any case a solution should be found that meets the approval of both NRL and the relatives.

NRL's advice to the licensee responsible

- When a patient has a limited life expectancy, discuss the issue with the relatives before giving the treatment
- If at all possible conventional burial should be used
- If cremation is essential then the ashes should be buried
- Storage of the ashes should be discouraged because of the difficulty in maintaining regulatory control
- If a treated patient is to be cremated, the staff at the crematorium and funeral director must be instructed on the safe handling of the ashes
- Do not lose contact with patients after they have been treated; get them to use an alerting method such as a card or bracelet to be carried or worn until the risk is over

For further information contact Vere Smyth (Vere_Smyth@nrl.moh.govt.nz)

ReSources

Items of interest in radiation safety and protection received recently at the NRL library.

Books with a particular emphasis on quality issues include the following IPEM (Institute of Physics and Engineering in Medicine, UK) reports: *Physics aspects of quality control in radiotherapy* (Report no. 81, 1999) and *Quality control in magnetic resonance imaging* (Report no. 80, 1998). Quality issues are also addressed in the *Chiropractic radiography and quality assurance handbook* (CRC Press, 2000) and *Achieving quality in brachytherapy* (IOP Publishing, 2000).

The British Institute of Radiology has recently published *The safe use of ultrasound in medical diagnosis* (a revision of their 1991 text), *Teleradiology: an introduction and definition*, and *Radiation shielding for diagnostic x-rays.*

Useful International Atomic Energy Agency (IAEA) publications include the following titles in their Safety reports series:

Radiation protection and safety in industrial radiography (no. 13)
Assessment of doses to the public from ingested radionuclides (no. 14)
Calibration of radiation protection monitoring instruments (no. 16)
Lessons learned from accidental exposures in radiotherapy (no. 17)

Titles also from the IAEA dealing with occupational exposure are part of the Safety standards series and include:

Occupational radiation protection (RS-G-1.1)
Assessment of occupational exposure due to intakes of radionuclides (RS-G-1.2)
Assessment of occupational exposure due to external sources of radiation (RS-G-1.3)
Indirect methods for assessing intakes of radionuclides causing occupational exposure (SRS 18)

Most of these items can be borrowed on interloan through your library.

MINISTRY OF HEALTH
MANATŪ HAUORA

For further information contact: National Radiation Laboratory
PO Box 25-099, Christchurch, N.Z. Phone: (03) 366 5059, Fax: (03) 366 1156
E-mail: enquiry@nrl.moh.govt.nz, Web page: http://www.nrl.moh.govt.nz

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Safety of sunbeds and sunlamps

A recent TV3 *Target* programme in which NRL featured, commented on the poor practices followed by commercial sunbed operators and highlighted the need for greater awareness from operators and clients of the potential hazards involved.

While sunbeds and sunlamps are not regulated, in common with most dermatologists, NRL discourages their use. Every year people suffer burns through sunbed and sunlamp use, and there can also be long term effects such as premature ageing of skin, and increased risk of skin cancer. it is debatable whether sunbeds offer the "protective tan" which some users seek. NRL and the Ministry of Health have published an information sheet for users *(An important message regarding sunlamps from the Ministry of Health), and a booklet for operators (Guidelines for operators of ultraviolet tanning lamps).*

Operators should take responsibility for advising people with fair or sensitive skins not to use sunbeds. They should also assist in keeping track of tanning sessions, providing goggles to protect the eyes, and ensuring their sunbeds are properly maintained.

NRL is currently working with Standards New Zealand and Standards Australia to develop a Standard for sunbeds and their operation.

Contact NRL (enquiry@nrl.moh.govt.nz) for a copy of either the information leaflet or booklet mentioned above. More information can also be found on the Cancer Society web site (www.cancernz.org.nz)

Test Ban Treaty monitoring stations officially opened

During July 2000 NRL hosted a visit by six members of the Preparatory Technical Secretariat of the Comprehensive Test Ban Treaty Organisation (PTS/CTBTO) including Dr Joachim Schulze, the Head of the Radionuclide Section. The purpose of the visit was to carry out an extensive evaluation of the recently installed radionuclide monitoring stations located at Kaitaia, Chatham Islands, and Rarotonga in order to ensure that their performance was consistent with PTS/CTBTO specifications. As a result of these successful audits, the PTS/CTBTO will shortly certify the three stations and officially incorporate them into the international monitoring network prescribed in the Comprehensive Nuclear Test Ban Treaty.

These three stations will be the first radionuclide stations in the world to be accorded such status.

During the certification audit of the Kaitaia station the PTS/CTBTO members were welcomed by the Ministers of Health (Annette King) and Disarmament (Matt Robson) who also officially opened the station on behalf of the New Zealand Government.

More information on the purpose and operation of these stations can be found in Issue 1 of *The Source* and on the NRL web page.

Environmental radioactivity in New Zealand and Rarotonga - annual report 1999

The latest and last in dedicated annual reports of environmental radioactivity data has just been published. Since 1960, NRL has monitored environmental radioactivity levels in New Zealand and the South Pacific. Monitoring was initially conducted for radioactive fallout from nuclear weapons tests in the Northern Hemisphere and then for fallout from the French testing programme; first from atmospheric tests and later to detect any venting from underground tests. During 1999, artificial radioactivity in the environment in NZ and Rarotonga was at trace levels only. This is typical of recent years during which there has been no significant change in the radioactivity status of the environment.

From next year the information reported in this publication will be included in an NRL Annual Report.

Unsporting use of a laser pointer

The June issue of *The Source* contained an item on the potential hazards associated with the misuse of laser pointers. On 12 August in a Tri-Nations Test match held at Jade Stadium in Christchurch, the Springbok goalkicker Braam van Straaten was targeted with such a pointer, just as he was lining up a penalty attempt. While the laser pointer was not a factor in him missing the kick, such misuse is irresponsible. NRL reiterates its advice that laser pointers are potentially hazardous and should be used with care. In particular pointers should not be given to children as toys.

Need a radiation warning symbol? Trefoils can now be printed from our web page. (Click on What's new? at www.nrl.moh.govt.nz)

Dental drill: the pregnant patient

This third article in the *Dental drill* series considers the implications for the pregnant dental patient and her embryo or foetus, in an area where x-rays are used. In the next issue recommendations for the pregnant dentist or assistant will be discussed.

Scattered radiation and the embryo or foetus

As discussed in the first issue of *The Source*, when a dental patient is x-rayed, as well as the radiation in the primary beam, scattered radiation is also produced. The scatter will either be absorbed in the head or leave the patient via the head. A small fraction of the scatter will be in a direction towards the trunk and its organs. However to reach these organs the scattered x-rays must travel through many centimetres of tissue. This tissue will attenuate the scattered x-rays, so that more distant organs or tissues, such as the developing embryo or foetus, will receive essentially no radiation. The attenuation process is further enhanced by the scattered dental x-rays having low energies.

In addition, for intra-oral dental radiography and panoramic radiography the amount of scatter produced in the first instance is small because the x-ray beam area is small. This in turn helps ensure that little or no radiation reaches the embryo or foetus.

Leakage radiation and the embryo or foetus

A potential source for *in utero* exposure would be from x-ray tube leakage. Any x-rays that emerge from the x-ray tube head, but are not part of the primary beam, form what is called leakage radiation. However New Zealand, in line with the rest of the world, has strict requirements on allowable levels of leakage radiation. Even a dental x-ray tube at the limit of acceptability for leakage would still not cause any measurable amount of radiation to reach the embryo or foetus per exposure. It is also rare for a modern x-ray tube to even approach the allowable limits for leakage radiation.

So how much radiation does reach the embryo or foetus?

To illustrate the above discussion, a calculation of the estimated dose to the uterus for a single bitewing x-ray is zero mSv (to 4 decimal places!) And measurements made at NRL, using sensitive radiation dosemeters, for a large number of consecutive bitewing exposures to an anthropomorphic phantom also gave an embryo/foetal dose of zero (again to many decimal places). In this latter case any contribution from tube leakage would have been included.

Two special situations

- Some dental projections, such as a vertex occlusal, involve pointing the primary beam in a direction towards the trunk of the patient. The potential concern here is that the primary beam or an only partly attenuated primary beam may irradiate the embryo or foetus. This should not happen, but a recommended precaution is the use of a leaded apron for the patient.
- Some dentists use extra-oral radiography for cephalometry. In these cases the x-ray beam is larger but the same arguments apply. The irradiated part is again distant from the womb and although the amount of scatter generated is greater than for intra-oral or panoramic examinations, the dose to the embryo or foetus is still essentially zero. It should be self evident that the dentist must ensure the x-ray beam is collimated to the region of anatomical interest and in any case must be smaller than or equal to the image receptor.

As can be seen from the above discussion, the normal selection criteria for performing dental radiography need not be influenced by pregnancy or the possibility of pregnancy.

Should pregnant patients routinely be given a leaded apron?

The only way that a lead apron can reduce *in utero* doses is if it is positioned to be in the way of x-rays reaching the embryo or foetus. The lead apron will only be effective against scatter that, on leaving the head (where the scatter is produced), has to pass through the apron before it can re-enter the body. Only a proportion of scatter will fall into this category, with another proportion still able to potentially irradiate the embryo or foetus via pathways inside the body.

Protection to the embryo or foetus is afforded by the x-ray being of a distant part of the body, performed with a small beam area and relatively low x-ray energies. The use of a lead apron will have little or no effect on the already zero or near zero embryo/foetal dose, with the exception of some infrequently used dental x-ray projections (such as the vertex occlusal projection) that involve pointing the x-ray tube downwards towards the patient's trunk. For these uncommon projections a lead apron will give some additional protection and their use is recommended practice in the case of females who are or may be pregnant.

If you are unsure about your particular practice or have further queries, please contact John Le Heron (John_Le_Heron@nrl.moh.govt.nz)

Safety of radioactive materials during transport

Onlookers at a traffic accident in New Plymouth were alarmed to see workers casually handling a small drum with a radioactivity warning on its side. The drum was part of some specialised oil and gas well testing equipment housed in a special shipping container that tumbled off the back of a truck. Observers saw two workers, neither wearing protective clothing, shifting the drum with their bare hands.

This introduction to a recent news item raises questions about the safety of radioactive materials during transport. From time to time serious accidents have occurred during the transportation of dangerous chemicals.

Control of radioactive material in New Zealand

The general use of radioactive material in NZ is tightly controlled by the requirements of the *Radiation Protection Act 1965*. Except for very small quantities, it can only be used under the control of persons holding a licence and having all the necessary knowledge and equipment to ensure safety. However, when it is transported, it travels in a less controlled environment. It is handled by people such as airport cargo handlers, courier drivers and truck drivers, who generally have no special knowledge of radiation hazards.

Regulatory requirements for transport

The transport of all dangerous goods is highly regulated. While the detailed requirements for different types of dangerous goods may vary, the principles are similar for them all.

- They must all be labelled with the appropriate labels specified in regulations
- Vehicles must carry placards warning of the presence of dangerous goods
- There must be documentation in the vehicle, in a format that can be understood by emergency services, that describes the dangerous goods and hazards
- In some situations, radioactive materials cannot be transported unless the driver has a driving licence with a dangerous goods endorsement

All these principles apply to the transport of radioactive materials. Packaging, as well as preventing the loss of dangerous contents in an accident, must also ensure the integrity of the shielding limiting the radiation emitted from the package.

In the New Plymouth incident described in the recent news report, there was no impact between vehicles. A heavy offshore well-logging unit was dislodged from a large transporter. A small (less than 15 megabecquerels of cobalt-60) encapsulated radioactive source is used with the equipment and was being carried on the transporter. It was packaged and labelled in full compliance with Regulation 3 of the *Radiation Protection Regulations 1982*. The *Regulations* require packaging to withstand accident situations without loss of shielding of sources. Therefore, although it fell from the transporter, there was no damage to the packaging or to the source encapsulation. Fire service personnel have training in dealing with such hazards and those attending the incident had no concerns about the radioactive source.

For more information contact Murray Robertson (Murray_Robertson@nrl.moh.govt.nz)

Soil erosion studies using caesium-137

Surface erosion by wind and water has been an ongoing problem on grazing and crop land in New Zealand. Assessment of surface erosion is possible using the radionuclide caesium-137 (^{137}Cs). The ^{137}Cs technique is the only method that can be used to make actual measurements, quickly and efficiently, of loss and re-deposition of soil. This information can then be used to develop techniques to conserve the quality of the New Zealand landscape.

Environmental source of caesium-137

The artificial radionuclide ^{137}Cs, with a half life of 30 years, is a product of nuclear fission and was first introduced into the environment as a result of atmospheric nuclear weapons testing in 1945. Such testing results in the release of radioactive debris into the atmosphere with gradual deposition over the following 2 years onto the earth's surface mainly through rainfall. In New Zealand and the South Pacific deposition peaked in 1964. Currently, trace amounts of ^{137}Cs are found in New Zealand, commonly about 4 Bq kg-1 in surface soils. NRL maintains a dedicated low level radiochemistry laboratory capable of measuring these low levels.

The technique and its application

The ^{137}Cs technique relies on the initial accurate estimation of ^{137}Cs deposition levels coupled with present day measurements of surface concentrations, to allow calculation of soil loss or gain and determination of erosion and deposition rates. The estimates are derived from measurements taken at local undisturbed sites and the expected ^{137}Cs fallout levels are derived from NRL's atmospheric fallout monitoring programme that has been in operation since 1960 (see also item on p.1).

Vegetation on grazing land in the Mackenzie Basin is depleted and there are extensive visual signs of soil erosion. A study undertaken to quantify erosion showed a mean soil loss of 2.2 cm in these areas compared to a local undisturbed site. On tussock pedestals results indicated stable or gaining soil conditions.

NRL is currently collaborating with Landcare Research and Environment Canterbury in the use of this technique to measure erosion in the grazing and crop lands of New Zealand.

For more information please contact Rick Tinker (Rick_Tinker@nrl.moh.govt.nz)