Radiation Protection

Radiation Protection Standards used in most countries are based on the recommendations of the International Commission on Radiological Protection (ICRP). ICRP recommendations are intended for guidance purposes, and the Standards used in most countries based on the recommendations of ICRP. The standards in each country are set according to respective legislative requirements.

Each state in Australia has legislation relating to protection against exposure to ionising radiations. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), part of the Health and Ageing Portfolio, is a Federal Government agency charged with responsibility for protecting the health and safety of people, and the environment, from the harmful effects of ionising radiation.

The Advisory Council and Committees of ARPANSA consist of Radiation Health and Safety Advisory Council (RHSAC), Radiation Health Committee (RHC) and Nuclear Safety Committee (NSC).

Radiation exposure occurs when human being exposed to radiation or radioactive materials. The exposures are classified as occupational exposure (exposure of a person in the workplace), Medical exposure (exposure of person as a part of medical diagnosis or treatment) and public exposure (exposure other than occupational and medical).

The Dose Equivalent Limit for adults (radiation workers) exposed to ionising radiation during their work is 20 milli-Sieverts (mSv) per year. This is (effectively) a whole body dose, and the dose limit for individual organs (if irradiated singly) may be somewhat higher. No special provision is made for women of reproductive capacity, but once pregnancy is discovered, the embryo or foetus should be afforded the same level of protection as required for members of public. For the member of public 1 mSv per year is the annual limit.

If radiation exposure does not exceed the levels defined above, then the risk to radiation workers and the general public has been estimated to be small and within acceptable limits. As an additional precaution, however, the ICRP has recommended that all exposures be kept as low as reasonably achievable, economic and social factors being taken into account (the ALARA principle). This policy has been adopted in Australian National Health and Medical Research Council recommendations and in various State regulations.
Diagnostic and Therapeutic nuclear medicine imaging or scans involve the administration of small amounts of radioactive material in the form of a radiopharmaceutical.

1. Guidelines for Administration of Radionuclides to Pregnant Women:
Careful guidelines need to be followed while administering radionuclides to pregnant women.

- All female patients of child–bearing age should be screened for pregnancy before the radioparmaceutical is administered.
- If a patient is found to be pregnant, the need for the nuclear medicine procedure should be discussed with the referring physician. In each case, the merit of performing the test should be judged.
    - Pregnancy is not an absolute contraindication to radionuclide studies and if the need arises, a reduced dose of radioparmaceutical may be administered thereby reducing the dose to the foetus.

2. Guidelines for Administration of Radionuclides to Breast-feeding Women:
For *nursing mothers,* small quantities of radioactivity may also be present in the milk of breast feeding mothers and it is preferable that this not be given to the baby. Therefore, breast-feeding should be avoided, and the milk expressed and discarded, for a period of time that will be advised by the Department of Nuclear Medicine.

3. Radiation Protection Website Links:

International and National Organisations
ARPANSA - Australian Radiation Protection and Nuclear Safety Agency
ARPS - Australasian Radiation Protection Society
ARL - Australian Radiation Laboratory

Other Radiation Protection Links:
International Radiation Protection Association (IRPA),
International Atomic Energy Agency (IAEA)
International Commission on Radiological Protection (ICRP)
International Commission on Non-Ionizing Radiation Protection (ICNIRP)
International Commission on Radiation Units and Measurements (ICRU)
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
New Zealand National Radiation Laboratory (NRL)
Australian Nuclear Science and Technology Organisation (ANSTO)
Victorian Radiation Safety Unit
Western Australia Radiation Health Section

Other Major Sources
Radiation and Health Physics - University of Michigan
Radiation Internal Dose Information Center (RIDIC)
Radiation Effects Research Foundation (RERF)
European ALARA Network (EAN)

Other Societies in Australia and/or New Zealand in Related Disciplines
Australian and New Zealand Society of Nuclear Medicine (ANZSNM)
Australian and New Zealand Association of Physicians in Nuclear Medicine (ANZAPNM)
Australasian College of Physical Scientists and Engineers in Medicine
The Royal Australian and New Zealand college of Radiologists.

Australian Institute of Radiography (AIR)
Interventional Radiology Society of Australasia

4. Diagnostic Procedures

For a short time after their nuclear medicine test, patients emit small amounts of radiation. The amount of radioactivity within the patient decreases rapidly with time according to the half-life of the radionuclide, and is also rapidly excreted from the body, mainly in the urine. The radiation exposures from these patients are small and the hazard is negligible.

If you are a female of childbearing age and suspect you are pregnant you should inform the nuclear medicine staff immediately for further advice.

5. Therapeutic Procedures (Radionuclide Therapy)

Radioactive materials (radiopharmaceuticals) are used to treat some diseases. Some treatments may be given as out patients, although the patient may be admitted for other medical reasons. Treatment, such as Iodine-131 therapy, may require the patient to be admitted for radiation safety, depending on the dose that is given. The other common treatments provided are Phosphorous-32 Therapy (treatment of Polycthaemia Rubra Vera and palliative treatment of bone pain), Strontium-89 therapy (palliative treatment of pain associated with metastatic bone disease), Samarium-153 therapy (to relieve the pain caused by bone tumour) and Yttrium-90 SIRsphere therapy (for liver cancer).

a. Radio-Iodine (I-131) Ablation therapy
Iodine-131 therapy is a treatment modality for patients with Graves Disease and thyroid cancer. Iodine-131 has a half life of 8 days. Larger activities of I-131 (more than 1 GBq) are used to ablate thyroid remnants or to treat metastases. These patients require hospitalisation following treatment until radiation level decreases to a safe level. The period of hospitalisation usually varies between 2 to 3 days.

Radiation side effects: Any radiation treatment procedure carries some risk. Your doctor recommends this procedure since the risks are thought to be outweighed by the treatment benefits.

Consultation: Detailed information about the treatment and information on radiation safety are given to the patient. Informed consent is obtained. Pregnancy state is ascertained where appropriate. Interpreters are used whenever necessary in consulting patients with non-English speaking background.

I-131 administration: This includes administration of radioisotope followed by hospitalisation. Nuclear medicine physician and technologists handle the administration of I-131. The treatment room is prepared by nursing staff with assistance from the technologist staff.

Inpatient stay: Monitoring of the patient radiation level is handled by medical physicist. The patient is discharged, when the radiation level decreases to a safe level.

Radiation Safety Instructions for patients after I-131 ablation:
For up to 1 week after your treatment:

1) When you are with people, keep your distance from them as far as practicable (maintain distance at least 2m);
2) Keep the time you are in close contact with people as short as practicable (less than 15min).
3) Avoid public entertainment, places of worship or group gatherings.
4) Avoid sitting, playing or sleeping with young children for prolonged periods.

Thyroid cancer patients may return to work the day after being discharged from hospital as long as they do not interact closely with children and pregnant women. We recommend that you delay returning to work for at least 5 days if you interact with pregnant women.

Radio-iodine is removed from the body by the kidneys and by the bowel. It is also present in saliva, nasal secretions, tears and in breast milk. Here are simple measures to follow for a one week period.

1) Drink 2 litres (6 to 8 large glasses) of water each day.
2) After passing urine, flush the toilet 3 or 4 times.
3) Open your bowels every day / flush the toilet 3 or 4 times.
4) Use disposable tissues when you wipe your mouth, wipe your nose, or wipe your eyes and throw the tissues into the toilet and flush 3 or 4 times.

Travel Recommendation: Avoid travelling in public transport for more than 1.5 hours
For air-travel in near future: Consult the nuclear medicine department for further advice

b. Phosphorus 32 Therapy
Phosphorus-32 is a sodium phosphate [32P] given for treatment of Polycythaemia Rubra Vera. This is also given for palliative treatment of bone pain. P-32 is a pure beta emitter with a half life of 14.3 days.

Radiation side effects: Any radiation treatment procedure carries some risk. Your doctor recommends this procedure since the risks are thought to be outweighed by the treatment benefits.

Excessive radiation from P-32 may lead to medical condition (Pancytopenia) in which there is a reduction in the number of red and white blood cells and platelets.

Pregnancy: This medication is not recommended to be used in the pregnancy.

Risks for others: Since P-32 is a Beta emitter, there is no external radiation hazard.

Procedure on treatment day: On the treatment day, you will attend the Nuclear Medicine department at Liverpool Hospital. The physician will explain the procedure to you. A needle or thin tube will be inserted in one of your veins, the P-32 pharmaceutical will be injected and flushed through with saline.

Prior to the treatment you will require a blood test to establish a baseline measurement for parameters such as red & white blood cells and platelets.

You need to be well hydrated before the administration of radioparmaceutical.

Stay in the hospital: Usually after the administration you will be discharged immediately. It is imperative that you should follow the following procedure:

1) Avoid prolonged, close contact with young children and pregnant women.
2) It is recommended to sleep in a separate bed with your partner or children for few days after you return home.
3) P-32 is excreted via urine up to 19 days. It is important that you should have personal hygiene to avoid any external contamination.
4) If you are incontinent and require therapy, you will be hospitalised for a period of two to three weeks.

c. Strontium (Metastron) therapy: Metastron is a radioactive form of strontium (strontium-89) which is given for the palliative treatment of pain associated with metastatic bone disease. Strontium-89 is chemically similar to calcium and concentrates in the diseased areas of the skeleton. Strontium-89 emits beta particles, which travel about a millimetre in bone.

Radiation-side effects from this procedure: Any radiation treatment procedure carries some risk. Your doctor recommends this procedure since the risks are thought to be outweighed by the treatment benefits. Metastron has been proved to be effective in pain palliation without causing severe side effects. You may experience a small increase in bone pains for a short period in the first few days after treatment.

Pregnancy: This medication is not recommended to be used during pregnancy.

Breast Feeding: Strontium chloride may pass into the breast milk. This medication is not recommended to be used during lactation. If you are breast-feeding an infant, be sure you have discussed this with your doctor because it will be necessary to cease breast-feeding.

Risks for others: Since the radiation from strontium-89 lodged in bone is confined to the painful area, the patient does not pose any radiation hazard.

However during the first two days after the administration of strontium-89, a significant amount of strontium-89 will be excreted, mainly through the urine. It is necessary that the patient should adopt a high level of personal hygiene to prevent any contamination from radioactive urine. Due to the presence of high activity in the urine in the first two days after the treatment, it is advisable for the patient to use a separate toilet to the one used by others, especially young children, to avoid any possible contamination.

Procedure on treatment day: On the treatment day, you attend the department of Nuclear Medicine at Liverpool Hospital. The physician will explain the procedure to you. A needle or thin tube will be inserted in one of your veins, the strontium-89 pharmaceutical will be injected and flushed with saline.

Incontinent Patients: Following the treatment your urine will be radioactive for the first two days. If you are likely to have an incontinence episode, the doctor will advise you about precautions to avoid contamination. The doctor may prefer you to be hospitalised at least for the first two days after the administration of the radiopharmaceutical.

Stay in the hospital*:* Usually after the administration you will be discharged immediately. It is imperative that you should follow the following procedure

- The toilet should be flushed twice after use.
- Any spilled urine should be wiped off with a tissue and flushed away.
- Ensure that hands are always washed after using the toilet.

Immediately wash linen or clothes which become stained with blood or urine. These should be washed separately from other clothes and rinsed thoroughly.

d. Samarium (Quadramet) therapy

Quadramet is a drug, which is used to relieve the pain caused by bone tumour. It is not a therapy and therefore not a cure for cancer. Quadramet is taken up particularly strongly in bone affected with cancer. The half life is 47 hours.

Radiation side effects from this procedure: Any radiation treatment procedure carries some risk. Your doctor recommends this procedure since the treatment benefits are thought to outweigh the risks.

Risks for pregnant or breast-feeding women: There is no evidence on the safety and effectiveness of Quadramet in pregnant women, nursing mother and children (below > 18). Therefore, this treatment should not be given to pregnant women as it may cause harm to foetus. As the drug has a potential to harm breast-fed infants, it should not be used for lactating patients.

If there is a possibility you might become pregnant at any time after the injection, there may be other important health issues to consider and you should discuss further with your doctor.

Procedure on Injection day:

- On the treatment day, you will attend the Department of Nuclear Medicine at Liverpool Hospital. The physician will explain the procedure to you.
- Prior to the treatment you would have had your bone scan to determine the severity of the tumour involvement.
- Also you will have had a pre-treatment blood test to establish baseline blood count.
- You need to be well hydrated and you should drink at least 2 cups of water prior to the administration.

Stay in the hospital: Usually this treatment is done as out patient basis. You will be discharged immediately after the administration of Quadramet. If for medical reason if your hospitalised it is advisable that the children and pregnant women not to visit during your stay.

You should follow these precautions for one week after the treatment:

1. Do not share your bed with a pregnant woman or children.
2. Use good personal hygiene – after using the toilet, wash hands carefully and flush the toilet twice.
3. Avoid prolonged, close contact with young children and pregnant women for a week following the treatment.
4. It is recommended to sleep in a separate bed with your partner or children for few days.

e. Yttrium-90 SIRsphere treatment.

SIRspheres are micro-spheres containing the radioactive element Yttrium-90, which emits beta radiation. The Beta radiation has an ability to travel only a few millimetres in the soft tissues of the body. The external radiation exposure to others from the patient is minimal. SIRspheres are implanted through the arterial blood stream to lodge in the liver, where they are targeted to the tumours within the liver. Whilst lodged in the liver the spheres irradiate through the process known as Selective Internal Radiation Therapy (SIRT) which kills the tumour cells. SIRspheres selectively irradiate the tumours directly over a considerable period of time, mostly during the first week after the injection, while the yttrium-90 radioactivity is decaying naturally to a negligible level.

Radiation side effects from this procedure: Any radiation treatment procedure carries some risk. Your doctor recommends this procedure since the treatment benefits are thought to outweigh the risks. This treatment involves killing the cancer cells selectively and damage to the other cells in the liver is minimal. There can be damage to other organs if some of the SIRspheres are carried in the blood stream to other organs than the liver.

In a few patients, a significant part of the blood flow from the hepatic artery bypasses the liver and is shunted via the venous system to lodge in the lungs. Treatment with SIRspheres in such cases could result in irreversible damage to the lungs known as radiation pneumonitis. To determine if this treatment is safe for you, your physician will assess this condition prior to the treatment by performing a nuclear medicine scan.

It is also possible for some of the SIRspheres to be carried in other arteries to parts of the gastrointestinal tract, which could result in radiation damage. To avoid this complication, the SIRspheres are injected under x-ray control to visualize the blood vessels.

Risks for pregnant and breast-feeding women: There is no evidence on the safety and effectiveness of SIR-Spheres in pregnant women, nursing mother and children. Therefore, this treatment should not be given to pregnant women, nursing mothers or children. If you are a female and still able to have children you should ensure that you do not become pregnant for at least three months following the treatment.

If there is a possibility you might become pregnant at any time after the treatment, there may be other important health issues to consider and you should discuss further with your doctor.

Procedure on treatment day: On the treatment day, you will be taken to the Department of Radiology, Liverpool Hospital. You will be taken to the angiogram suite for treatment procedures. An experienced surgical team supervised by the nuclear medicine physician and radiation safety officer will carry out the administration of the SIR-spheres. After the completion of the administration, you will be brought to the department of Nuclear Medicine for imaging to assess the placement of micro-spheres.

A small number of patients may experience pain or nausea after the treatment. The physician may prescribe medication to overcome these side effects.

Can pregnant and small children visit during your stay in the hospital?

Children and pregnant women should not visit you during your stay in the hospital.

Precautions to be taken once discharged

- Avoid prolonged, close contact with young children and pregnant women for a week following the treatment.
- It is recommended to sleep in a separate bed with your partner or children for few days (3 to 4 days) after you return home.
- Yttrium-90 is bound to the SIR-spheres and is not generally excreted in the urine. However it is important to use good hygiene and hand-washing for all visits to the toilet.