SESLHD PROCEDURE COVER SHEET

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SUMMARY	Procedure to limit the risk to health of staff and members of the public arising from exposure to radiation from Nuclear Medicine at any facility within SESLHD.

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Protection of Staff and the General Public in Nuclear Medicine

SESLHDPR/557

1. POLICY STATEMENT

South Eastern Sydney Local Health District (SESLHD) is committed, through a risk management approach, to protecting employees, contractors, students, volunteers, patients, members of the public and the environment from unnecessary exposure to radiation arising from systems and processes which use radiation apparatus and radioactive substances, whilst maintaining optimum diagnostic and therapeutic quality, therapeutic efficacy and patient care.

This document provides procedures necessary to ensure compliance in relation to the protection of staff and the general public in departments performing diagnostic or therapeutic Nuclear Medicine.

2. BACKGROUND

Nuclear medicine uses small amounts of radioactive materials (radiopharmaceuticals) to diagnose and treat disease.

In diagnostic Nuclear Medicine, radiopharmaceuticals may be injected, inhaled or swallowed. Radiation emitted from the patient is then detected in order to provide information about structure and function.

In therapeutic Nuclear Medicine, radiopharmaceuticals may be administered orally, intravenously, or into a cavity in order to treat disease, or provide palliative pain relief.

2.1 Nature of the Hazard

Radionuclides commonly used for diagnostic studies in Nuclear Medicine are mostly gamma emitters with short half-lives (from hours to several days). A few beta emitting radionuclides are used for therapy, both systemic (administered orally or by injection) and intracavity (injection). Alpha emitting radionuclides are also used for therapy and are administered intravenously. Therapeutic radionuclides usually have longer half-lives ranging from days to months.

With all unsealed sources, there is a potential for both external and internal exposure. Sealed sources of long lived radionuclides, primarily Cobalt-57, Barium-133, Caesium-137 and Gadilinium-153 are used for testing instrumentation. These are primarily an external exposure risk.

2.1.1 External Exposure

Exposure to staff occurs mainly from radiopharmaceutical preparation, dose administration and directly from patients to whom a radiopharmaceutical has been administered. Exposure from most sources can be reduced by shielding. The principal source of external exposure to staff is the patient. While providing nursing care or positioning the patient for imaging, reducing exposure depends mainly on working as quickly as possible.

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2.1.2 Internal Exposure

Internal exposure of staff is very unlikely in routine practice. However it can occur as a result of contact with a spill of radioactivity arising from, for example:

- A leak during administration of a radiopharmaceutical
- Body fluids from the patient, especially urine, saliva or vomitus
- A dropped or damaged source container
- Contamination in areas in which unsealed sources are handled

Airborne activity may be released when a vial containing an Iodine-131 capsule is opened, or when Technetium-99m in the form of Technegas is used for lung ventilation studies. Studies have shown that, in normal practice, inhaled Technetium-99m usually contributes less than a few percent of staff annual radiation exposure.

2.2 Area Designation in Nuclear Medicine

In Controlled Areas, employees are required to follow specific procedures aimed at controlling exposure to radiation. There is usually restricted access marked by appropriate signage, and no eating or drinking is permitted in these areas.

Generally in the Nuclear Medicine Department, the Hotlab and Radiopharmacy, Therapy rooms and injection and scanning areas will be designated as controlled areas.

Corridors adjoining rooms where activity is present are also usually designated controlled areas and should not provide public thoroughfare to other areas of the hospital.

In *Supervised* areas working conditions are kept under review but special procedures to control exposure to radiation are not normally necessary.

Generally in the Nuclear Medicine Department, the waiting areas and patient toilet are designated as supervised areas.

3. RESPONSIBILITIES

3.1 The Radiological Medical Practitioner (The Nuclear Medicine Specialist)

- Is responsible for the clinical management of the patient undergoing a diagnostic or therapeutic nuclear medicine procedure. This includes the decision to proceed with a Nuclear Medicine procedure based on the specialist's knowledge of the potential risks and benefits of the procedure, taking into account the clinical information, and the sensitivity and specificity of the procedure.
- Must ensure that all radiation exposures are justified
- Must make information on the benefits and risks associated with a procedure available to the patient or their representative
- Must not authorise a procedure unless a written request is provided

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3.3 The Operator (usually the Nuclear Medicine Technologist, but sometimes the Nuclear Medicine Specialist):

- Needs to comply with the centre's operating procedures on how to identify the patient (See NSW Health Policy Directive PD2017_032 - Clinical Procedure Safety prior to commencing the treatment).
- Needs to:
  - Be trained in intravenous injection and cannulation
  - Use protective equipment designed to reduce radiation exposure (e.g. syringe shields, lead pots) and wear an approved personal radiation monitoring device when handling radioactive materials
  - Ensure that only persons necessary to the procedure are present when performing administrations
  - Report any instance of accidental, abnormal or unplanned exposure to the RSO, and where required also in accordance with SESLHDPR/558 Handling, Investigation and Reporting of Radiation Incidents.

3.4 The Nuclear Medicine Technologist

- Is responsible for performing nuclear medicine procedures as prescribed by the nuclear medicine specialist in accordance with the centre's written standard protocols. This will include one or more of the following duties:
  - Perform imaging and in vitro protocols to ensure optimal data acquisition and analysis
  - Prepare, dispense and administer radiopharmaceuticals
  - Perform quality assurance procedures for radiopharmaceuticals, instrumentation and image quality.
- May include the responsibilities of the operator and the person preparing radiopharmaceuticals.

3.5 The Radiopharmaceutical Scientist

- Needs to develop systems for the:
  - Procurement of radionuclides/radiopharmaceuticals
  - Storage and waste management of radionuclides/radiopharmaceuticals
  - In-house reconstitution of radiopharmaceuticals
  - Development of safe procedures and practices for the preparation and manipulation of radiopharmaceuticals, in consultation with relevant staff
  - Implementation of a quality assurance program for radiopharmaceuticals.
- Plays, in addition to the above duties, a central role in the:
  - In-house manufacture of radiopharmaceuticals
  - Production of cyclotron radionuclides and derived radiopharmaceuticals
  - Implementation of a comprehensive quality assurance program for radiopharmaceuticals
  - Provision of advice on the safe and efficacious use of radiopharmaceuticals.

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3.6 The Nuclear Medicine Physicist

- Is required to be available for consultation on optimisation of medical exposures, including clinical dosimetry and quality assurance, and to give advice on matters relating to radiation protection.
- Works closely with the nuclear medicine specialist and technologists in the optimisation of clinical studies – through image acquisition, analysis and display optimisation and ongoing oversight of the quality control of equipment.
- Is required to provide Human Research Ethics Committees with a radiation dose estimation and risk assessment for any research studies that involve the research participants receiving an exposure from ionizing radiation, in accordance with the requirements of ARPANSA RPS-8 Code of Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes (2005).

3.6 The Radiation Safety Officer (RSO)

- Will oversee and provide advice on radiation safety within the Nuclear Medicine Department.

3.7 Compliance of Workers

All occupationally exposed workers must comply to the best of their ability with:

- The radiation management plan
- Any legitimate instructions they are given relating to radiation protection
- Participation in training related to radiation protection
- Proper application of this training
- Proper use of PPE and monitoring equipment
- Reporting of any matter they are aware of that may compromise radiation protection

4. PROCEDURE

4.1 General Procedural Considerations

- Gloves must be worn whenever handling unsealed radioactive sources.
- Eating and drinking in Controlled Areas is strictly prohibited and neither food nor drink may be stored in a refrigerator used for storing radioactive materials.
- Any cut or break in the skin should be covered with a waterproof dressing before a person enters an area where unsealed radioactive materials are handled.
- Radioactive materials should be received, handled, and stored at the specifically designated controlled location. Vessels containing radioactive materials should be labelled with the radionuclide name, chemical form, activity, and date and time of calibration, and should be properly shielded while in use and in storage.
- All containers used for radioactive materials to be clearly labelled with the radionuclide, form, activity, time, date and when appropriate, a note as to the sterility/ expiry time or otherwise.
- All such containers are to be adequately sealed and shielded at all times. Except for very small activities, containers are not to be handled directly and if possible, long handled tongs or syringe shields should be used.

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- Equipment provided specifically for the safe handling of unsealed radioactive materials should always be used and should not be removed from the work area. Pipettes should never be operated by mouth. Recapping of syringe needles, if absolutely necessary, should be performed using a suitable recapping device.
- Shielding should always be considered for any radioactive source. The prior risk assessment should identify the shielding that is required and what type and form it should take. Appropriate shielding may be obtained using a variety of materials such as tungsten, lead, lead glass, aluminium or Perspex, depending on the characteristics of the radionuclide to be shielded.
- Lead syringe holders should be used to transport syringes containing radioactive materials. Syringe shields should be provided for ready use during radiopharmaceutical preparation and administration whenever practicable. It should be noted that any additional time spent in manipulating the syringe when adjusting the activity to be administered to a patient can result in additional dose to the hands of the administering person.
- All work surfaces where unsealed radioactive substances will be used must be covered with absorbent paper.
- All staff handling radioactivity are to be familiar with contamination and decontamination procedures.
- Personal radiation monitors are to be worn by designated staff at all times when working in the department. Designated staff include; all nuclear medicine technologists, physicians, physicists, radiochemists, nursing staff and porters.
- Finger radiation monitors are to be worn with the chip facing the radioactivity on the non-dominant hand by technologists and radiopharmaceutical scientists, when any radioactivity or radioactive patients are being handled.
- Packaging, containers, lead pots etc. which no longer contain radioactive material and which are to be disposed of MUST have any radiation warning labels removed or covered before disposal.
- A long-sleeved gown must be worn when administering Technegas to a patient.
- During imaging in the scanning rooms, the staff should remain behind the lead glass shielded control areas as much as possible.

For procedures specifically relating to Preparation and Dispensing of Radiopharmaceuticals, see Section 4.5 below.

4.2 Facilities required

The radiopharmacy facility should be located, designed, constructed and maintained to suit the operations to be carried out. The layout and design should be such as to minimise the risk of errors and to permit effective cleaning and maintenance, the avoidance of cross contamination, the build-up of dust or dirt and any other influences that may adversely affect the quality of radiopharmaceuticals. Additionally, the facility needs to be designed to give proper radiation and contamination protection to personnel.

Construction features of a laboratory area should include:

- Floors: smooth, continuous, non-absorbent, washable, no penetrations. eg. welded sheet vinyl coved up the walls

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- Walls: shielded, free of dust collecting ledges and pipework. eg. concrete, masonry, plasterboard with lead lining, high gloss paint, sheet vinyl, laminate
- Bench Tops: resistant to chemicals, hard wearing, strong supports, lipped and coved. eg. high grade laminate on water resistant board, polymer resins, stainless steel
- Plumbing: draining direct to main sewer, traps for monitoring. eg. shower, toilets for patient, shower, toilets, handbasin, eyewash for staff; sink, cleaners sluice, pan steriliser
- Air handling: controlled temperature and humidity, exhaust ventilation for waste store, I-131.
- A shielded store for waste: this should be designed such that the dose rate on the external surface does not normally exceed 10 μSv/hr.

(AS/NZ 2982.1 Laboratory Design and Construction Part 1 General Requirements)

4.3 Equipment required

Radiopharmacies, laboratories and other work areas where unsealed radioactive substances are handled should be provided with radiation protection equipment kept specifically for this purpose. This equipment may include:

- Lead barriers (fixed or mobile) with lead glass windows for work with photon emitters
- Perspex barriers for work with beta emitters
- Syringe shields
- Shielded containers
- Drip trays to contain any spillage
- Tongs or forceps to maximise the distance of the worker from the source
- Radiation and contamination monitoring equipment
- Dose calibrators
- Fume cupboards
- Biohazard cabinets
- Shielded transport containers
- Equipment and materials to deal with spills.

4.4 Personal Protective Equipment

Protective clothing is to be used in work areas where there is a likelihood of contamination, both to protect the body or clothing of the worker and to help prevent contamination to other areas. The clothing should be monitored and removed before leaving designated areas, e.g. when visiting the staff room.

The clothing may include:

- Laboratory coats or protective gowns
- Waterproof gloves
- Face masks where there is a risk of airborne droplets.

Overshoes are not routinely required but may be needed in radiopharmacies handling greater than 200 GBq of technetium-99m and should be included in the decontamination kit, to be worn when cleaning up a major spill.

The following uses of personal protective equipment are suggested:

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Gloves	Unpacking radionuclide packages Administering diagnostic injections Handling closed waste containers Administering I-131 capsules Preparing low activity samples for counting
Gloves, gown	Milking Molybdenum-99 generator Preparing radiopharmaceuticals Dispensing injections Nursing sweaty or incontinent patients Changing contaminated bed linen Administering lung ventilation radiopharmaceuticals Preparing Technetium-99m sources for gamma camera QC
Gloves, gown, plastic apron	Emptying bed pans, bottles, catheter bags
Gloves, gown, eye protection	Giving therapy injections or oral liquids, e.g. Strontium-89, Yttrium-90, Iodine-131, (I-131 MIBG, or I-131 iodide) Labelling blood cells
Double gloves, gown, overshoes	Cleaning up spills

In certain circumstances staff may need to wear a protective lead apron. This may be necessary if staff need to be in close contact with patients containing greater than 800 MBq of Technetium-99m, such as during myocardial perfusion studies or gated cardiac blood pool studies. Protective aprons should preferably have a thickness of 0.5 mm lead equivalence. Preferred designs are those comprising a separate vest and skirt that wrap around fully, as open back designs are not recommended. All protective clothing should be examined under fluoroscopy at least annually to confirm the integrity of the protection.

Lead aprons provide little or no protection for higher energy photons and should not be used for radionuclides such as gallium-67 or iodine-131 or for positron emitters.

Staff leaving designated areas should remove protective clothing, wash their hands and monitor their hands, clothing and body as appropriate.

Mobile shielding barriers may be required for therapeutic nuclear medicine procedures using gamma-emitting radionuclides.

4.5 Procedures for the preparation and dispensing of radiopharmaceuticals

The following rules should be observed when preparing or dispensing radiopharmaceuticals:

- Eating, drinking, smoking, or the application of cosmetics are prohibited
- All preparation and dispensing of radiopharmaceuticals must be carried out behind suitable lead or lead-glass shielding

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- Disposable gloves should be worn at all times and preferably laboratory coats or gowns
- Safety glasses should be used if the work is of a hazardous nature to the eyes
- Gloves should be changed at regular intervals in order to minimise the spread of contamination
- Personal dosimeters are to be worn at all times when handling radioactive materials or working in areas where they are handled or stored
- Packaging and containers for radioactive material must be observed for contamination on opening
- The receipt of all radioactive material must be recorded in the Radionuclide Register
- The work area should be prepared and set up by covering surfaces with plastic-backed absorbent material and laying out needles, syringes, shields, forceps, diluents, gloves and other necessary items
- Radioactive materials should be kept in closed, sealed vials within shielding containers
- For reconstituted vials, a radiopharmaceutical record should be maintained that includes the batch numbers, manufacturer, date received, expiration time/date, the name of the person preparing the radiopharmaceutical, and any quality assurance tests performed. Identifying labels with a dated batch number should be affixed to radiopharmaceutical vials and shielding containers prior to the preparation of patient doses. These should identify the radiopharmaceutical, the total radioactivity, the volume and the time and date of calibration
- Each individual patient dose which is prepared must be recorded in the register and the staff member preparing the dose must be recorded electronically or by signature
- Small spills that present no radiological hazard to persons should be cleaned up as soon as possible. Major spills may require evacuation of the area before clean-up is undertaken and need to be reported immediately to the RSO. See section 5.6
- Mouth pipetting of any radioactive substance is **TOTALLY PROHIBITED**
- Interruptions to the preparation or dispensing of radiopharmaceuticals should be avoided
- In order to demonstrate confinement of radioactivity, a suitable electronic radiation detector should always be available when radioactive materials are handled
- Hands, shoes and clothing should be monitored for contamination in a low-background area, allowing sufficient time for instrument response, before leaving the radiopharmaceutical laboratory
- A radiation survey for contamination and sources must be done at the end of the working day in the radiopharmacy dispensing bay and Hot Lab, paying particular attention to the waste bins.

4.6 Special procedures for therapy administration

Therapeutic nuclear medicine requires special consideration because the high doses of radiation involved are at a level where a biological effect is produced. The levels of radiation constitute a much greater hazard to the patient, staff, the patient's carer, and to the general public. In therapeutic nuclear medicine, the radionuclides used are often different from those used in diagnostic nuclear medicine; they are usually beta emitters

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with longer physical and biological half-lives. Therapy radionuclides may require different facilities to radionuclides used for diagnostic procedures, to ensure the safe preparation and administration of the radiopharmaceutical.

Preparation of therapeutic radiopharmaceuticals should be performed in a controlled area with entry restricted to essential staff only. Careful consideration should be given to the amount of shielding required and to the measures to be taken to avoid radiation exposure from internal contamination. A laminar flow cabinet should be used where there is a risk of airborne contamination of the operator.

The interaction of high energy beta particles with high atomic number materials (e.g. lead) will lead to the production of high energy X-rays (bremsstrahlung). Materials of low atomic number (e.g. plastic or aluminium) should be used for shielding pure beta emitters; and there may be high dose rates near the surface of open solutions of beta emitters. Where possible, tongs should be used for handling.

Written protocols for each therapeutic radionuclide procedure should include:

- Indications for therapy
- Type of radionuclide
- The range of activity of the radionuclide generally used
- The method of administration
- The radiation hazard
- The radiation safety procedures
- Whether treatment is as an inpatient or outpatient.

For example, each Nuclear Medicine Department should have separate local procedures for:

- Administration of Iodine-131 Therapy Doses up to 600 MBq
- Administration of Iodine-131 Therapy Doses Above 600 MBq
- Instructions for Nursing of Inpatient Iodine-131 Therapy patients
- Instructions for visitors of Inpatients undergoing Iodine-131 Therapy
- Discharge of Iodine-131 Therapy Inpatients.

4.6.1 Design of treatment areas and wards

Where there is a risk of significant exposure from external radiation arising from the patient, or from any associated radioactive contamination, it may be necessary to admit the patient to a dedicated treatment facility. Advice should be sought from a medical physicist and/or the relevant regulatory authority on:

- The design of these facilities, including the need for extra shielding in the walls, ceiling or floors
- The precautions for the protection of staff and visitors, including comforters and carers
- A suitable waste management system; and any necessary radiation monitoring requirements.

Often these patients need to be accommodated in a single room with their own toilet, washing facilities and, perhaps, food preparation area. Ensuite toilet facilities are essential when significant amounts of radioactivity will be excreted in the urine or faeces

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(e.g. the use of ^{131}I-iodide for the treatment of thyroid cancer). Radioactive excreta should not be stored in containers, as this is likely to result in unnecessary exposure of staff and would also create a biological hazard. In most cases, excreta may be disposed of directly via the sewer system (ICRP 2004), although the relevant regulatory authority may require the use of delay tanks in certain circumstances.

4.6.2 Arrangements for appropriate isolation of hospital in-patients undergoing treatment with unsealed radioactive sources

Therapeutic nuclear medicine requires special consideration because the high doses of radiation involved are at a level where a biological effect is produced.

Therapy doses of up to 600 MBq of Iodine-131 may be administered within the Department of Nuclear Medicine. Therapy doses above this level must be administered in an isolation room,

Special procedures for Medical Emergencies Involving Patients Undergoing Radionuclide therapy can be found in Section 4.8.2.

4.6.3 The discharge of patients undergoing treatment with unsealed radioactive substances

The ARPANSA publication RPS-4 Recommendations for the Discharge of Patients Undergoing Treatment with Radioactive Substances, provides guidance on the conditions which should be met for the discharge from a hospital or clinic of a patient who is undergoing treatment with a radioactive substance, and the conditions for treatment as an outpatient.

The recommendations take into account the dose rate external to the patient and the potential for the spread of contamination from an unsealed radioactive substance excreted by the patient.

The Responsible Person needs to be able to demonstrate that the effective dose received by the carer is unlikely to exceed 5 mSv per treatment episode and the dose to children and members of the public is unlikely to exceed 1 mSv per annum. Carers are individuals who are not normally occupationally exposed, who are appropriately informed of the radiation risks, and who consent to being exposed. Carers may be relatives and friends over the age of 18 years who are not pregnant.

When individual patient risk assessments cannot easily be made it is recommended that, in order to comply with the above criteria, the ambient dose equivalent rate at a distance of 1 metre from a patient who is undergoing treatment with a radioactive substance should not exceed 25 μSv/hour at the time of the patient's discharge from hospital.

Prior to discharge, the patient and/or their carer should receive written information on:

- The type and radioactivity of the radiopharmaceutical administered
- The date of administration
- Any specific radiation safety precautions
- Any restrictions on activities including travel home
- How long the restrictions or precautions should last.

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Recommendations relating to restriction periods in the case of radioiodine (^{131}I) therapy and other advice relating to return to work, public transport, avoidance of conception and patient instructions can be found in the ARPANSA Safety Guide Radiation Protection in Nuclear Medicine, Radiation Protection Series Publication No. 14.2.

4.6.4 Procedures relating to administration of Strontium-89, Samarium-153 and Yttrium-90

These radionuclides emit beta radiation, i.e. charged particles, with a small amount of x-radiation induced by the interaction between the beta particles and the container. The major radiation hazard is not this radiation but contamination from the injectate. With Strontium-89, there is also a significant contamination hazard from the patient's urine for the first two to three days.

Patients must be given the appropriate information sheet concerning the therapy before the administration, and given time to read the sheet and to ask any questions before receiving treatment. It is particularly important that patients receiving Strontium-89 are aware of the need to wash their hands following toilet use, cleaning up any spilt urine, flushing toilets, washing of clothes which may be urine contaminated. The instructions should also include contact names and phone numbers in case of emergency.

In administering these doses, the following procedure should be followed:

- Injections must only be performed in the Procedures room.
- Injections must always be performed by a medical officer. When Yttrium-90 is used for radiation synovectomy, the injection will usually be performed by the Rheumatology Physician. Occasionally, for other joints such as the shoulder, the administration will be given under fluoroscopic control by a Radiologist.
- As a precaution against spillage, the physician should wear gloves and a long sleeved gown and safety goggles to protect the eyes.
- When drawing up the dose, all bubble removal, volume adjustment etc. must be performed with the needle in the vial. **UNDER NO CIRCUMSTANCES** may this be done in the open. The syringe must be placed inside the Perspex syringe shield once the dose has been drawn up.
- Following the administration, the syringe, needle and swabs must be placed into a labelled sharps container and stored in the Waste room. Gloves and any other material that may have come into contact with the radioactivity must be placed in a labelled plastic bag, securely sealed and stored in the Waste room for disposal.
- If a spill of the injectate has occurred, or is suspected, the Department RSO must be called at once. Do not attempt to clean the area.
- The physician who has administered the dose must be monitored for contamination at the end of the procedure.
- There is no danger to staff, the patient, or his/her family from the radioisotope once it has been injected.

4.7 Pregnant or Breastfeeding staff

If an occupationally exposed member of the nuclear medicine staff is pregnant then the foetus should be afforded the same level of protection as a member of the public. This

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may be achieved by controlling the exposure of the employee such that the dose received by the foetus is less than the public effective dose limit of 1 mSv for the remainder of the pregnancy. For external irradiation from Technetium-99m or Iodine-131, a dose of 1.3 mSv to the surface of the maternal abdomen has been shown to give rise to a dose of 1 mSv to the foetus. For higher energy photons, such as those from positron emitters, the dose to the foetus may be similar to the dose at the surface of the abdomen.

The likely dose to the foetus of a pregnant employee from each work activity should be assessed. This will usually require an examination of the employee's personal monitoring records and an assessment of the likelihood of incidents leading to either external or internal exposure of the foetus. If the foetus could receive more than 1 mSv over the declared term of the pregnancy a change in work practice should be discussed and agreed to with the employee. It would be prudent to provide an occupationally exposed pregnant staff member with an electronic personal dose monitor.

Pregnant women, or those intending a pregnancy or breastfeeding, should not work with large amounts of radioiodine.

If a member of staff is breastfeeding she should not take part in procedures or work in areas where there is a significant risk of bodily contamination, e.g. cleaning up a large spill of radioactivity. An assessment should be undertaken of the potential radiation dose to the infant resulting from a chance inhalation by the mother of radioactive gases or aerosols arising from her work and appropriate procedures put in place to restrict this dose if necessary.

4.8 Emergency procedures in Nuclear Medicine

4.8.1 Accidental Decontamination Procedures

There are three major causes of contamination by a radioactive material:

- Spillage from a source container
- Leakage during an injection procedure
- From patient excretion such as urine, faeces, sweat, saliva and vomitus.

Spills of radioactive material should not be regarded as an unavoidable hazard in the day-to-day operation of the department. Any spill carries some degree of risk and acceptance of minor spills may lead to a casual approach to major spills. Accidents involving radioactive material must be reported to the Radiation Safety Committee of the Hospital via the Radiation Safety Officer. In cases where personal injury is also involved, even if this is minor, e.g. a scratch on the skin where radioactive material may enter the person's body, an Incident Report Form must also be filled out.

The following procedure should be followed on discovery of a contamination problem:

- All persons involved in the incident are to vacate the immediate vicinity but are not to move freely around the department, as this involves a danger of spreading contamination.
- Notify IMMEDIATELY, the Department Radiation Safety Officer (the medical physicist) and the senior technologist for the area.
- If the contamination is due to a container spill of liquid and the hands are protected with gloves, right the container, and ensure that it is adequately shielded. If the

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problem is due to a leaky syringe or other container, place suspect item in a labelled plastic bag and remove it to the Waste Room.
- Seal off the area involved and in particular ensure that personnel do not walk on any possible contaminated floor area. Discard any clothing which is contaminated and place it in a labelled plastic bag and store in Waste Room. If there is any radioactive material on the skin, flush thoroughly with water.

Decontamination of Personnel

- Wash with soap and water scrubbing lightly with a soft nail brush, avoiding spreading contamination to the eyes and mouth. If the hair is contaminated, it will be necessary for the individual to shower in order to remove this contamination.
- Monitor with an appropriate radiation monitor until the count rate is less than 1000 cps or the dose rate is less than 10 µSv/hr. with the detector at a point close to (but not touching) the contaminated region of skin.
- Eyes which are contaminated should be washed using the dedicated eyewash station. The mouth should be rinsed with water.
- Contaminated wounds should be washed under fast running water and bleeding encouraged. Finally apply a gentle antiseptic and then a first aid dressing.

Decontamination of Work Environment or Equipment.

The following should be performed by a Physicist (RSO), the Chief Technologist or a Senior Technologist:

- Define the area of contamination using an appropriate survey meter and, if appropriate, mark hot spots with a felt tipped pen. Be aware that this pen may become contaminated and must be dealt with accordingly.
- Permit no person to resume work in the area until a survey is made and decontamination procedures have been satisfactorily carried out.
- Decontamination of any contaminated area cannot be performed by a fixed set of rules, but must have regard for the radioisotope form and type of contamination. The decontamination trolley stored in the Hot Lab should be used. The following general information applies in most cases:
  - In cases of spillage during patient injection or drawing up of a dose, a suitably clad (gown, gloves, overshoes) person shall soak up any obvious liquid contamination with blue incontinence sheets or absorbent paper, placing them into a labelled plastic bag for storage. Once this step has been performed decontamination of contaminated surfaces can take place.
  - Swabs or similar absorbent material soaked in decontamination fluid shall be used to swab and scrub small contaminated areas until a minimum decontamination effect is attained. This will in most cases mean that the surface dose rate at the area in question can be reduced to something less than 10 µSv per hour.
  - Where items of equipment have been contaminated it may be preferable to store such items until the activity has been reduced to a safe level.
- Relatively low activity spills of 99mTc (count rate less than 1000 cps) may be handled by technologists in this manner. Areas that have been decontaminated and where the

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dose rate is still at a high level should be avoided until the activity has reached a safe level.

- Floor surfaces that cannot be completely decontaminated, or where it is uncertain if further activity is present, should be covered with a plastic sheet until the activity has decreased to a satisfactory level. The covering must be marked with brief details such as radionuclide, dose rate and date.

Further advice on Decontamination principles and Decontamination Kits can be found in SESLHDPR/558 - Handling, investigation and reporting of radiation incidents.

4.8.2 Medical Emergencies Involving Patients Undergoing Radionuclide therapy.

In life-threatening situations, the patient's medical management will always take precedence over radiation safety considerations.

Arrest Procedures - Patients Containing Radioactive Material

In the case of cardiac or respiratory arrest only those staff essential for the patient's resuscitation should be involved. All other staff should remain at least two metres from the patient. If the patient requires ventilation as part of resuscitation, ventilation should be by a mask-bag system. Mouth to mouth resuscitation should not be used.

PLEASE REMEMBER THAT THE PATIENT'S WELFARE IS THE FIRST CONCERN. FOR THE RELATIVELY SHORT PERIOD OF TIME INVOLVED, IF THE GUIDELINES ARE FOLLOWED, RADIATION EXPOSURE TO STAFF WILL BE VERY SMALL AND DEFINITELY NOT A CAUSE FOR CONCERN. ARRESTS IN SUCH PATIENTS ARE RARE.

Each patient's situation is different, so consultation with the RSO or a medical physicist will be required (where medical circumstances permit) before a final decision regarding precautions to be taken can be made.

Patients Treated with Iodine-131

These are patients with thyrotoxicosis or thyroid carcinoma being treated with oral Iodine-131, which is absorbed through the gut over a period of some hours, or patients receiving ^{131}I -MIBG therapy or ^{131}I-Lipiodol therapy. These patients may contain a wide range of radionuclide activities. In general thyrotoxicosis patients contain less activity than carcinoma patients, however this is dependent on the administered activity, the time elapsed since administration, and the avidity of target tissue uptake. In the few hours following administration, the gut may contain a significant amount of radioactive material; this tends to decrease rapidly with time. Radionuclide not taken up by the target tissue is predominantly excreted in the urine over two days or more. Hepatocellular carcinoma patients retain the activity for much longer periods of time than do thyroid carcinoma patients, predominantly in their liver and lungs.

Action to be taken:

- Do NOT apply direct mouth-to-mouth resuscitation, but use either an Air Viva or the Concord mask provided to avoid contamination.
- Staff involved in resuscitation should don examination gloves at the earliest possible opportunity.

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- Materials which have come into direct contact with the patient should be, as far as is practicable, kept to one side for examination by the RSO or Nuclear Medicine Department staff. This particularly applies to airways, masks, endotracheal tubes etc.
- Notify the Department of Nuclear Medicine immediately. Out of hours, the RSO on call, is to be notified as well as the Nuclear Medicine physician on call.
- The RSO will advise on subsequent action and safety measures.

Note: lead aprons provide very little protection from the high energy gamma radiation from Iodine-131 and should not be worn. Wearing a lead apron may lead to a false sense of safety and may in fact lead to an increased radiation dose to the staff because procedures may take longer when wearing an apron.

Transfer to ICU or CCU: If transfer is required, the fact that the patient may still contain radioactive material is not to interfere with the patient's management.

- As intubation, catheterisation or a nasogastric tube may be necessary, staff are to be gowned and wear gloves when handling the patient.
- Attempt to contain any urine, gastric contents or any other body fluids by means of absorbent pads, and hold the pads in a contaminated waste bag for examination by the RSO or Nuclear Medicine Department staff.
- Any suction bottles or urine bags used must not be discarded until checked by the RSO or Nuclear Medicine Department staff.
- The RSO will advise staff as to what precautions are necessary, given the amount of radioactive material involved, and the elapsed time since administration.

Patients requiring Surgery or Intensive care

Whenever the medical condition of the patient deteriorates a nuclear medicine specialist should be consulted. If surgery is not urgent, it should be postponed until the radioactivity in the patient has fallen to a suitable level. If urgent surgery or monitoring in an Intensive Care Unit is required, precautions against external radiation and possible contamination from body fluids should be considered.

If the patient requires surgery, the surgical team should plan the procedure in order to minimise any staff radiation exposure. This can be achieved by ensuring that only essential staff are present in the operating theatre, and where possible, staff stand away from any organs containing high concentrations of radioactivity and that close contact with the patient is minimised. The wearing of two pairs of surgical gloves will give some protection to the hands against beta radiation.

After the operation has been completed, the operating theatre, surgical instruments, equipment and surgical drapes, and anaesthetic equipment should be checked for contamination and, if necessary, decontaminated or stored until the radioactivity has decayed to negligible levels. All staff involved in the management of the emergency should be checked for any radioactive contamination and, if necessary, decontaminated before leaving the area.

In all cases of an emergency involving a patient who has received a therapeutic radiopharmaceutical, the RSO should be consulted as soon as possible.

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Patients who have Received Diagnostic Administrations of Radioactive Material

Patients who have had small amounts of radioactive material administered in the Nuclear Medicine Department for diagnostic purposes, do not in general pose any hazards to medical or nursing staff involved in resuscitation. However, as a matter of course, the Department of Nuclear Medicine should be notified as soon as practicable. No out of hours call is necessary.

For procedures relating to corpses containing radioactive material, see SESLHDPR/533 - Death Procedures for Bodies Containing Radioactive Material.

4.9 Miscellaneous Exposure from radioactive patients

On occasions when a patient who has already been administered a diagnostic radiopharmaceutical is then required to undergo another medical procedure a radioactive patient presents a source of radiation exposure to other staff. Therefore as a general rule, it may be prudent to consider performing other procedures before the administration of the radiopharmaceutical.

However, the risk to hospital staff is extremely small, and in practice there are very few requirements for special scheduling of procedures for patients who have been administered diagnostic radiopharmaceuticals. It is important to note that the prior administration of a radiopharmaceutical to a patient is not of itself a contraindication to performing X-ray, ultrasound or other procedures. A decision about what precautions should be adopted (if any) depends upon an assessment of the amount of radiation exposure to others from the patient as a result of the nuclear medicine procedure. The decision to proceed with the other test should be based primarily on clinical need. Social and economic factors should also be taken into account.

When balanced with medical implications of delayed diagnosis, the cost for inpatients incurred by lengthening hospital stays and the inconvenience for patients who must return for the test, special scheduling requirements would very rarely be justified.

With Sonography, due to the potential for extended periods of close contact, there is further advice in the policy directive issued by NSW Ministry of Health PD2019_044 Work Health and Safety - Limiting Staff Exposure to Ionising Radiation.

5. DOCUMENTATION

- Standard Operating Procedures (SOPs) for preparing and dispensing of radiopharmaceuticals
- SOPs for radionuclide administration, for both diagnostic and therapeutic purposes.

6. AUDIT

The following records should be available for audit:

- Records of staff radiation exposures
- Records of contamination monitoring in Nuclear Medicine

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- Records of Radiation Incidents involving Nuclear Medicine

7. REFERENCES

[1] NSW Ministry of Health Policy Directive PD2019_044 - Work Health and Safety - Limiting Staff Exposure to Ionising Radiation

[2] NSW Ministry of Health Policy Directive PD2017_032 - Clinical Procedure Safety

[3] SESLHDPR/533 - Death procedures for Bodies Containing Radioactive Material

[4] SESLHDPR/558 - Handling, Investigation and Reporting of Radiation Incidents

[5] ARPANSA RPS-4 (2002) Recommendations for the Discharge of Patients Undergoing Treatment with Radioactive Substances

[6] ARPANSA RPS 8 (2005) Code of Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes

[7] ARPANSA RPS 14.2 (2008) Safety Guide for Radiation Protection in Nuclear Medicine

[8] AS/NZ 2982.1 (2010) Laboratory Design and Construction Part 1 General Requirements

[9] ICRP Publication 94 (2004). Release of patients after therapy with unsealed radionuclides. Annals of the ICRP, Vol. 34, No. 2.

[10] ARPANSA RPS C-1 (Rev.1, 2020). Code for Radiation Exposure in Planned Exposure Situations

8. VERSION AND APPROVAL HISTORY

Date	Version	Version and approval notes
May 2010	draft	Richard Smart, Area Radiation Safety Officer in conjunction with the Area Radiation Safety Committee
October 2010	Revised draft	Richard Smart, taking into account received comments
February 2011	0	Approved by Combined Clinical Council
January 2016	1	Periodic Review
October 2016	1	Updates endorsed by Executive Sponsor
December 2019	2	Updates endorsed by Executive Sponsor
21 July 2023	2.1	Minor review: introduction of RPS C-1, responsibilities updated. Approved by Executive Sponsor.

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