Radiation Safety Manual

Jordan University Hospital

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Radiation Safety Manual

All staff is expected to become familiar with the material in this document. Please review, date and sign to confirm that you have read the material.

Name	Signature	Date

Name	Signature	Date

Name	Signature	Date

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A. Introduction

The teaching and research activities at Jordan University Hospital employ a varied sources of radiation in the form of nuclear substances and radiation emitting devices. The policies and procedures described herein are designed to provide a reasonable and practical standard of safety for the use of nuclear substances in hospital and to assist in compliance with all applicable regulations and codes as well as the **ALARA** principle. No set of rules can cover all possible eventualities and workers must exercise sound judgment in all their work.

B. Regulations

The Jordanian Atomic Energy Comission (JAEC) is the organizational body which has jurisdiction over aspects of the use of ionizing radiation. JAEC licenses the acquisition and use of all nuclear substances and radiation emitting equipment. In general the recommendations of the ***International Commission on Radiological Protection (ICRP)*** are used to formulate the rules and conditions under which radiation-emitting devices or nuclear substances are used.

C. Program Organization & Administration

C.1 Administration:

The policies, regulations and procedures of the Radiation Safety program shall apply to all activities involving the use, storage, transportation and disposal of nuclear substances in Jordan University Hospital.

The organization to administer the Radiation Safety Program includes the following:
1. Radiation Safety Committee
2. Radiation Safety Officer
3. Director of Environmental Health & Safety
4. Radiation Users

C.2 Policy Statement:

The Radiation Safety Officer is responsible for the day to day operations of the radiation safety program. He/she reports to the Radiation Safety Committee which has the authority to implement and enforce the radiation safety program encompassing the use, handling, storage and disposal of sources of ionizing and nonionizing radiation in accordance with regulatory requirements of the Jordanian Atomic Energy Agency. All faculty, staff, residents and students are expected to take individual responsibility for safe work practices and procedures so as to safeguard their own individual health and well being as well as that of their colleagues.

RADIATION SAFETY COMMITTEE:

Terms of Reference:

1. Establish and regularly review policies and procedures for the safe use and control of nuclear substances and radiation emitting devices.
2. Assist the Radiation Safety Officer (RSO), where necessary, with the preparation and submission of license applications and annual renewal.
3. Establish and review worker training programs on an annual basis.
4. Receive reports of any incidents or accidents involving sources of ionizing radiation, arrange for investigations where warranted and assist the Radiation Safety Officer with the required reporting to appropriate bodies.
5. Monitor necessary action on any *action item* or *directive* from regulatory agencies.
6. Order appropriate corrective action in accordance with the Jordan University Hospital policy.
7. Advise senior management of the need for additional resources to improve the Radiation Safety programs.
8. Maintain written records of meetings, actions, incidents and unusual occurrences along with recommendations.

Reporting Structure:

The Radiation Safety Committee is accountable to the Director of Jordan University Hospital. Environmental Health and Safety Committee shall be advised of the Radiation Safety Committee's proceedings, and in turn may refer matters to the Radiation Safety Committee for consideration or action.

Chairperson and members:

The Chairperson is the head of Radiology and Nuclear medicine department. Members are selected by chairperson and should include: one radiologist, one nuclear medicine physician, the radiation safety officer, nuclear medicine technologist and maintenance engineer**.**

Meetings:

The Radiation Safety Committee *shall* meet four times yearly: September, December, March and June. Special meetings, however, may be called at any time. The schedule for the year will be established by the chairperson at the March meeting.

Agenda:

Any member may place items on the agenda for discussion. Items for inclusion on the agenda should be received by the Radiation Safety Officer at least one week prior to the scheduled meeting to allow time for distribution of relevant documents to committee members.

Conduct of Meetings:

Meetings will be conducted by the Chairperson. In the absence of the Chairperson, voting members in attendance will select a member as acting Chairperson.

Voting:
The Committee will normally seek to operate by consensus without the need for formal votes. When a member requests a formal vote, a motion will be carried when supported by a simple majority of the voting members.

C.3 Radiation Safety Officer
The Radiation Safety Officer (RSO) is a technically qualified officer experienced in the nature and use of radiation. RSO performs the executive functions of the Radiation Safety Committee. The Radiation Safety Committee will delegate authority to the RSO for enforcement of applying radiation safety procedures. The Radiation Safety Committee will support the RSO when necessary in asserting his/her authority. If the Radiation Safety Committee overrules the RSO, it will record the basis for its action in the minutes of the quarterly meeting.

RSO carries out the following responsibilities:

1. Over-all administration of the Radiation Safety Program.
2. Implementation of approved policies and procedures forming part of the Hospital Radiation Safety Program, including training and dispersal of information.
3. Maintenance of current awareness of developments in the field of radiation protection in order to make appropriate recommendations for modification of the Radiation Safety Program.
4. Liaison with the national authority concerned with radiation safety ;Jordanian Atomic Energy Agency (JAEC)
5. Review all applications for permits to use nuclear substances and other radiation sources prior to submission to JAEC.
6. Insure that all new occupationally exposed workers will participate in the first available Radiation Safety Training course.
7. Arrange periodic surveys of laboratories, facilities and work places for radiation levels and contamination. The RSO has the authority to suspend operations which are considered unsafe.
8. Maintain records, including inventories, permits, personal exposures, an inventory of all portable monitoring devices and a list of all personnel using/handling nuclear substances or radiation emitting devices.
9. Ensure that all staff using nuclear substances and ionizing radiation has been issued and use, a TLD and participate in bioassay programs if required.
10. Advise and consult with members in matters of radiation safety when required
11. Ensure that required personal protective equipment (PPE) is provided and used. PPE includes lab coats and disposable gloves and may also include (if indicated) whole body TLD's, extremity TLD's, and eye protection.
12. Designate specific work and storage areas for nuclear substances and ensure that these areas are kept clean, properly labeled, ventilated, adequately shielded and secure from unauthorized removal of nuclear substances.
13. Ensure that *all* staff using in radiology and nuclear medicine department receives required radiation safety training from the institution and have been informed of the risks associated with exposure to ionizing radiation.
14. Ensure that functional survey instrumentation is available to monitor both for exposure and contamination and that survey meters are calibrated annually as required
15. Ensure that a responsible *designated alternate,* approved by the RSO, is available

16. Any other function assigned by the Radiation Safety Committee

C.4 Director Health & Safety Office

The Director of Health and Safety Office (H&S) has a general responsibility for safety related matters in Jordan University Hospital. The specific responsibility for radiation safety, however, rests with the RSO, who may call on the Director of H&S for assistance, as is often the case when potential radiation hazards occur in combination with other hazards such as biological or chemical hazards. The RSO will inform the Director of H&S of any incident or emergency involving radiation and may request assistance with its management.

D. Licensing and Registration Regulations

The Jordanian Atomic energy Commission (JAEC) is the national organization responsible for licensing all national institutes dealing with radioactive materials or radiation emitting devices according to Nuclear Energy and Radiation Protection legislation:

نظام اسس و شروط منح رخص و تصاريح العمل الاشعاعي /صادر بمقتضى الفقرة ب من المادة(٢٦) من قانون الطاقة النووية و الوقاية الشعاعية رقم ٢٩ لسنة ٢٠٠١

Radiation Safety Committee and Radiation Safety Officer shall be responsible for conforming to the national legislation regulations.

Radiation safety Officer (RSO) is delegated by Jordan University Hospital administration to apply for institutional and personal licenses from JAEC. According to law institutional license is obtained only once. Personal licenses are renewed once yearly.

Jordan University Hospital shall make all efforts necessary to facilitate RSO task with JAEC and is responsible for institutional and personal licenses fees.

E. Radiation Safety Policy

E1. ALARA Statement

ALARA is an acronym for **A**s **L**ow **A**s **R**easonably **A**chievable, means making every reasonable effort to maintain exposures as far below the regulated dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other social and socioeconomic considerations, and in relation to utilization of nuclear energy and license material in the public interest. The current system of radiological protection reflected in the International Commission on Radiological Protection (ICRP) Publication 60 ***"1990 Recommendations of the International Commission on Radiological Protection"*** and the National Council on Radiological Protection (NCRP) Publication 116, ***"Limitation of Exposure to Ionizing Radiation"*** is based on three general criteria:

1) **Justification,** the need to justify any activity which involves radiation exposure on the basis that the expected benefits to society exceed the overall social detriments.
2) **Optimization,** the need to ensure that the benefits of such justifiable activities or practices is maximized for the minimum associated societal detriment, economic and social factors being taken into account.
3) **Dose and Risk Limitation,** the need to apply dose limits to ensure that individuals or groups of individuals do not exceed acceptable levels of risk.

Jordan University Hospital is committed to maintaining radiation exposures to staff, students, and the public, resulting from the use of nuclear substances and radiation emitting devices in diagnostic, therapeutic and research procedures, as low as is reasonably achievable. The Radiation Safety Committee and the Radiation Safety Officer will advise and assist in all matters of radiation safety. The Committee will recommend to hospital administration policies and procedures to be required for maintaining radiation exposures ALARA.

E2. ALARA Policy

Administration Commitment:
The administration of Jordan University Hospital is committed to the program described herein for keeping individual and collective doses as low as reasonably achievable. In accord with this commitment we hereby describe an administrative organization for radiation protection and will develop policies, procedures and instructions to foster the ***ALARA*** concept. The organization will be comprised of a Radiation Safety Committee and a Radiation Safety Officer (RSO).

Obligations of Licensees
a) Ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the national regulations issued by Jordanian Atomic Energy Commission (JAEC).

b) Train workers to carry on the licensed activity in accordance with the JAEC regulations
c) Take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security
d) Provide the devices required by JAEC regulations and maintain them within the manufacturer's specifications
e) Require that every person at the site of the licensed activity uses equipment, devices, clothing and procedures in accordance with the JAEC regulations
i) Instruct the workers on the physical security program at the site of the licensed activity and to their obligations under that program
j) Keep a copy of the JAEC regulations and this radiation safety manual readily available for consultation by the workers

Obligations of Workers:
a) Use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation in a responsible manner and in accordance with JAEC regulations.
b) Comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation
c) Promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be:
    1) A significant increase in the risk to the environment or the health and safety of persons
    2) A threat to the maintenance of security or incident with respect to security
    3) A failure to comply with the JAEC regulations
d) Observe and obey all notices and warning signs posted by the licensee in accordance with the JAEC Regulations
e) Take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of security.

E3. Radiation Safety Training Policy

Radiology medical residents and technologists working in nuclear medicine or radiology department shall attend Radiation Safety training course taught by the Royal Scientific Society on the safe use of x-ray machines and radioactive sources and pass a Radiation Safety exam. Exemptions to this training requirement is be given to certified technologists and consultant radiologists. It is the responsibility of RSO to make sure that all newly appointed radiology medical residents and technologist apply for the earliest available course and exam.

All personnel will attend orientation to the radiology and nuclear medicine department under the supervision of the Chief radiology technologist and radiation safety officer. Hospital orientation shall include, but not be limited to:

- Orientation to hospital policy and procedure
- Patient rights and responsibilities

- Personnel policies
- Safety
- Infection control and Standard Precautions
- Emergency management plan
- Hazardous materials
- Electrical safety
- Fire safety
- Orientation to hospital departments
- Computer orientation

Any technician working on any equipment installed in radiology and Nuclear medicine department after the date of approval of this document should be trained and certified by regional dealer of the installed machine.

F. NUCLEAR MEDICINE RADIATION SAFETY PROCEDURES

F1. Duties and Responsibilities
a) Nuclear Medicine Specialist:

The Nuclear Medicine Specialist, being the person who fulfils the role of the medical practitioner (radiation) specified and who approves the diagnostic or therapeutic nuclear medicine procedure, needs to be satisfied that the procedure is justified. The ultimate decision to perform or reject each individual nuclear medicine procedure resides with the specialist responsible for overseeing the nuclear medicine exposure. This decision should be based on the specialist's knowledge of the hazard associated with the nuclear medicine exposure and the clinical information supplied by the referrer.
Accordingly, the specialist may need to liaise closely with the referrer about the merit of performing a particular procedure. Any decision to proceed, or not to proceed, with a diagnostic procedure should be made after consideration of the timely availability of alternative tests, which involve less or no exposure to ionizing radiation. This is particularly pertinent in cases when a nuclear medicine procedure for a pregnant woman, or where pregnancy status is uncertain, is being contemplated. The implications of delaying a diagnostic test on patient management in order to confidently exclude pregnancy should be weighed against the potential detriment associated with the increased radiation burden to the patient that would arise from a test involving ionizing radiation. Nuclear medicine specialist should also provide counseling for the patient (or guardian) on the potential radiation-related risks prior to commencing a therapeutic procedure.

b) **Referrer**
A written referral that states the procedure/treatment requested and provides sufficient relevant clinical information be provided to the nuclear medicine specialist before the procedure is performed. The referral will contain suitable patient identifying information (name, date of birth, age, sex and hospital ID) and adequate referrer contact details for consultative purposes. The referral should state a provisional diagnosis for investigation or a medical condition for treatment.

c) **Nuclear Medicine Technologist**

- Ensure that the correct procedure will be performed. If there is a concern about the relevance of the procedure indicated on the request form, then this issue should be taken up with the nuclear medicine specialist.
- The procurement, storage and preparation of radiopharmaceuticals
- Use protective equipment designed to reduce radiation exposure (syringe shields, syringe carrier) and wear TLD.
- Following the administration of a radiopharmaceutical, the nuclear medicine technologist should comply with imaging protocols to ensure adequate imaging/data collection and analysis are performed for reporting purposes.
- Report any instance of accidental, abnormal or unplanned exposure to RSO

d) Nursing Staff:

- Identify the patient correctly. Identification should be established by the name, date of birth, patient hospital ID number.
- Take a suitable intravenous access for all procedures except for radioactive iodine uptake test
- Provide patients with verbal and or written instructions post examination precautions.

e) Administration staff:

- Insert patient data in hospital information system
- supervise non injected patient waiting room

F2. Optimisation of Protection for Medical Exposures

a) General Considerations

Diagnostic Nuclear medicine: Once clinically justified, each diagnostic examination should be conducted so that the dose to the patient is the lowest necessary to achieve the clinical aim. The quality of the images and the complexity of the examination should be sufficient for the intended purpose of the procedure. The optimization process necessarily requires a balance between administered activity (and thus patient radiation dose) and image quality.
It is important to plan the examination to fit the clinical problem. This ensures that the investigation has the best opportunity to address the diagnostic question at hand and minimize the need for any repeat tests. Repeat procedures may be necessary due to the poor quality of the radiopharmaceutical, incorrect administration of the radiopharmaceutical, technical problems with the imaging equipment or if the image does not provide the clinical information required. A comprehensive quality assurance program which includes equipment quality control, should highlight any systematic errors or problems and ultimately lead to a lower repeat rate. In any event, repeat procedures should not be undertaken simply because the images may not be of the highest quality. If the images contain the required information then a repeat procedure should not be performed. Therapeutic nuclear medicine on the other hand, requires special consideration because of the high dose of radiation involved. The level of radiation constitutes a much greater hazard to the patient, staff, the patient's care giver and the general public. In therapeutic nuclear medicine, the radionuclides used often differ from those in diagnostic nuclear medicine; they are usually beta emitters with longer physical and biological half-lives.

b) Procedures for the Preparation of Radiopharmaceuticals

HOT LABORATORY PROCEDURES
Consignment arrival
On arrival, packages containing radioactive materials should be inspected for signs of damage.

Daily schedule
Nuclear medicine technologist should be designated to review the schedule of diagnostic and therapeutic procedures to be performed in the nuclear medicine department and ensure that appropriate radiopharmaceuticals are available.

Preliminary activities
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. Identifying labels with a dated batch number should be affixed to radiopharmaceutical vials and shielding containers prior to the preparation of patient doses.

Reconstitution of 'cold-kits'
Radiopharcameuticals used in nuclear medicine should be prepared according to good manufacturing practice standards. The amount of radioactivity required for reconstitution of kits is based on the number of patient doses for the day. The appropriate volume of generator eluate should be withdrawn and diluted if necessary. The withdrawal of the required activity and subsequent reconstitution of the kit should be performed behind a lead glass screen, preferably using a shielded syringe. Calculations should be checked, and the activity, volume and time recorded.
Where possible, visual inspection of the preparation through a lead glass shield should be performed to confirm that the appearance complies with the manufacturers specification. The total activity of the vial should be measured and the activity, calibration and expiry times calculated and recorded.

DISPENSING

The following rules should be observed in hot lab when working with radioactive materials:

- Laboratory coats and disposable gloves should be worn at all times. Gloves should be changed at regular intervals in order to minimize 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.
- All working surfaces should be covered with absorbent paper that has an impermeable plastic coating – facing the bench-top.
- Radioactive materials should be kept in closed, sealed vials within shielding containers at all times.
- All shielding containers and vials should bear a label identifying the radiopharmaceutical, the total radioactivity, the volume and the time and date of calibration.
- Small spills that present no radiological hazard to persons should be cleaned up as soon as possible. More serious spills may require evacuation of the area before cleanup is undertaken and need to be reported immediately to the RSO.
- Eating, drinking, smoking, or the application of cosmetics are prohibited in areas where radioactive materials are handled or stored.
- In order to demonstrate confinement of radioactivity, a suitable electronic radiation detector should always be available when radioactive materials are manipulated.
- Appropriate radioactive waste management (storage and disposal) should be followed.
- Hands, shoes and clothing should be monitored for contamination in a low background area, allowing sufficient time for instrument response, before leaving the hot laboratory.

- Activity administered to each patient should be within limits of annex I

c) RADIONUCLIDE THERAPY PROCEDURES

Confirmation of absence of pregnancy

All female patients of childbearing age who are to be administered therapeutic radionuclides need to have pregnancy excluded by a definitive biochemical test (serum β-HCG) within 24 hours before the commencement of the treatment. However, a careful clinical history is necessary at all times to facilitate accurate interpretation of these laboratory investigations

Avoidance of conception

Advice is to be given to females and males concerning the avoidance of conception after therapeutic administrations, if appropriate to the particular radionuclide therapy. The ICRP has recommended that a woman not become pregnant until the potential fetal dose would not exceed 1 mGy (ICRP 2000a). The female patient should be advised to avoid pregnancy according to Table 1.

Although there is no evidence that preconceptual irradiation of males can cause any abnormality in their offspring, it may be prudent to advise males receiving radionuclide therapy to avoid fathering children for a period of 4 months, which is greater than the life of a sperm cell.

Table 1: Periods for avoiding pregnancy after radionuclide therapy to ensure that the dose to the fetus will not exceed 1mGy

Nuclide and form	For treatment of	All activities up to MBq	Avoid pregnancy (months)
I-131 iodide	Thyrotoxicosis	800	4
I -131	Thyroid carcinoma	6,000	6
P-32-phosphate	Polycythemia	200	3
Sr-89 chloride	Bone metastases	150	24
Y-99 colloid	Arthritic joints	400	0

Patient information

Prior to radiopharmaceutical administration

The arrangements for the treatment should be fully discussed with the patient prior to the administration of the radiopharmaceutical. In addition to discussing the clinical issues and possible side effects of the radiopharmaceutical administration, the following should be discussed: the manner and place of administration; whether an in-patient stay will be required; the precautions that the patient should follow to limit the amount of exposure to family and friends while in hospital and subsequently at home. These precautions should be given verbally and confirmed in writing; whether the patient (he or she) is involved with close care of a child; any restrictions that may apply if the patient is returning to work. The restrictions will vary depending on the type of work and whether the patient is in close proximity to other workers; and how long any restrictions or precautions should last.

After radiopharmaceutical administration

The patient and/or their care giver 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 activity including travel home; and how long the restrictions or precautions should last. The period of time during which patients (and their family and friends) should observe the restrictions will depend on the initial external dose rate from the patient and the rate of clearance of the radionuclide from the body.

Tables 2 to5 provide information on recommended restriction periods in the case of radioiodine (iodine-131) therapy. The recommended values are based on data from Woodings (2004) and the European Commission (EC, 1998) using a **dose constraint** of 1 mSv, and 5 mSv for partner/care giver.

Written instructions for radioiodine (iodine-131) therapy, based on recommendations from the European Commission (EC, 1998) are also provided (annex II).

Table 2. Periods of restriction for patients receiving radioiodine (iodine-131) therapy for thyrotoxicosis

Dose Equivalent Rate at a distance of 1 metre from the patient	Corresponding to an administered activity of	Recommended periods for following instructions		
		Close contact with children under age of 5 years#	Close contact with children over age of 5 years	Sleeping with non-pregnant partner
<30 µSv/h	<600 MBq	20 days	14 days	9 days
<20 µSv/h	<400 MBq	16 days	11 days	6 day
<10 µSv/h	<200 MBq	10 days	4 days	1 day
<5 µSv/h	<100 MBq	4 days	1 day	1 day
<3 µSv/h	<60 MBq	2 days	1 day	None

It is recommended that a family member other than the patient (for example, the partner, or a grandparent) look after children under 3 years of age for at least the first 5 days – in the family home, or in separate accommodation.

Table 3. Thyrotoxicosis patients: Periods of restriction for return to work

Administered Radioactivity	Office worker 2 hours at 1 m.	Close Worker 8 hours at 1 m.	Child Care 2 hours 0.1 m. 6 hours 1 m.
600 MBq	1 day	4 days	21 days
400 MBq	1 day	1 day	17 days
200 MBq	1 day	1 day	11 days
100 MBq	None	None	8 days
60 MBq	None	None	6 days

Table 4. Periods of restriction, after discharge, for patients receiving radioiodine (iodine-131) therapy for thyroid cancer

Dose Equivalent Rate at a distance of 1 metre from the patient	Corresponding to a residual activity of	Recommended periods for following instructions		
		Close contact with children under age of 5 years#	Close contact with children over age of 5 years	Sleeping with non-pregnant partner
<30 μSv/h	<600 MBq	5 days	3 days	2 days
<20 μSv/h	<400 MBq	4 days	2 days	1 day
<10 μSv/h	<200 MBq	2 days	1 day	1 day
<5 μSv/h	<100 MBq	1 day	1 day	1 day
<3 μSv/h	<60 MBq	1 day	None	None

It is recommended that a family member other than the patient (for example, the partner, or a grandparent) look after children under 3 years of age for at least the first 5 days – in the family home, or in separate accommodation.

Table 5. Thyroid cancer patients: Periods of restriction for return to work

Discharge radioactivity	Dose Equivalent Rate at 1 metre from patient	Office worker (2 hours at 1 metre)	Close worker (8 hours at 1 metre)	Child care/nursery worker (2 hours at 0.1 metre and 6 hours at 1 metre)
600 MBq	30 µSv/h	1 day	1 day	6 days
400 MBq	20 µSv/h	1 day	1 day	4 days
300 MBq	18 µSv/h	1 day	1 day	3 days

Administered activity
The administered activity should not vary from the prescribed activity by more than 10%. However, for logistic reasons, there may be considerable variation between the activity of the radiopharmaceutical originally ordered, and the activity available at the time of administration. If the delivered activity varies by more than 10% from the intended activity, a decision needs to be made on whether to administer the total available activity or, if the delivered activity is greater, to only administer a part.
Where practicable, and provided it is clinically appropriate, it is recommended that, in order to minimize radiation exposure of staff, the amount of the radiopharmaceutical. It is recommended that iodine- 131 capsules are not broken prior to administration.

Administration of therapeutic radioactive substances
Treatments should be administered in a Hot Lab within the nuclear medicine department for activities equal or less than 30 mCi (1110 MBq) or in the patient's own room on the ward for activities more than 30 mCi as indicated JAEC regulations. If the administered activity is such that the patient needs to be isolated after receiving the dose, the administration should be performed in the patient's own room.

Procedures in wards used by patients receiving radionuclide therapy
If the following guidelines and maximum daily times are adhered to, nursing personnel can adequately care for Iodine- 131 therapy patients and still remain well below acceptable limits of exposure to ionizing radiation:
Iodine-131 therapy patients must remain in their room.
Radiation warning sign (Controlled Area), needs to be displayed on the door of the treatment room.

a) The nursing staff should be made familiar with the implications of the treatment procedure, time and date of administration and any relevant instructions to visitors.
b) The nursing staff should be instructed that only essential nursing procedures should be carried out and that these should be done as rapidly as is consistent with good nursing practice
c) No blood or urine specimens can taken after the I-131 therapy dose has been given unless authorized nuclear medicine physician
d) Patients are allowed non-pregnant visitors over 18 years of age. Visitors must sit in the at least 2 meters from patient, foe not more than 30 minutes per day
e) Nurses known to be pregnant should not work with these patients
f) Nurses should know that Iodine-131 liquid given orally is absorbed very quickly into the blood stream and carried to thyroid tissue where it is concentrated. Also, a large amount of the radioactive iodine is excreted in the urine during the first 24 hours; smaller amounts are present in the stomach contents, saliva, and perspiration. Because of the possibility of radioactive contamination from these fluids, it is important to wear plastic gloves and gowns when handling patient excretions. The used gloves, linen, and disposable waste must be kept in the room, special receptacles are placed in the room for this purpose.
g) In the event of a spill (urine or vomitus), ensure that patient care issues are addressed, then restrict the area immediately and call RSO and nuclear medicine department.

Meanwhile, handle all contaminated items with disposable gloves and avoid spreading contamination.

h) Where a patient needs to use a bedpan or urine bottle it should be kept for the exclusive use by the patient, preferably in the toilet, and should not be used by another patient until it has been checked and decontaminated as appropriate

i) Crockery and cutlery used should be disposable items and thrown is special receptacles placed in the room for this purpose

j) The patient's bed linen and/or towels may become contaminated. These items should be stored to allow for radioactive decay, before the items are laundered.

k) Following the discharge of a patient receiving radionuclide treatment, the area of the ward used by the patient should be monitored and, if necessary, decontaminated before further use. This is done by Nuclear Medicine Technologists.

d) MEDICAL EMERGENCIES INVOLVING PATIENTS UNDERGOING RADIONUCLIDE THERAPY

The condition of a patient undergoing radionuclide therapy may deteriorate such that urgent surgery or intensive monitoring in an Intensive Care Unit is required. The RSO should be consulted on any necessary precautions against external radiation and against possible contamination from body fluids. If surgery is not urgent, it should be postponed until the radioactivity in the patient has fallen to a suitable level.

In life-threatening situations, the patient's medical management will always take precedence over radiation safety considerations. 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 2 metres from the patient. If the patient requires ventilation as part of resuscitation, ventilation should be by a mask-bag system, or the patient may be intubated. Mouth to mouth resuscitation should not be used.

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

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.

e) CLASSIFICATION OF AREAS (warning signs and signals)

Relevant areas of a practice should be classified as controlled or supervised.

A **Controlled Area** is any area "in which specific protection measures or safety provisions are or could be required for: (a) controlling normal exposures
(b) preventing or limiting the extent of potential exposures."

Controlled areas are: storage room, Hot Lab , 18-FDG injection area, treatment wards.

A **Supervised Area** is "any area not already designated as a controlled area but where occupational exposure conditions need to be kept under review even though specific protection measures and safety provisions are not normally needed." Supervised areas are:

gamma camera room, and waiting rooms where there are patients who have been injected with radiopharmaceuticals.

F3. Radioactive Waste Management

Jordan University Hospital shall:
(a) ensure that the activity and volume of any radioactive waste that results from the sources for which they are responsible be kept to the minimum practicable, and that the waste be managed, i.e collected, handled, treated, conditioned, transported, stored and disposed of, in accordance with the requirements of the JAEC standards
(b) segregate, and treat separately if appropriate, different types of radioactive waste where warranted by differences in factors such as radionuclide content, half-life, concentration, volume and physical and chemical properties, taking into account the available options for waste disposal.
The criteria for disposal are:
(a) Waiting for decay until disposal is the method used in nuclear medicine, in radioactive waste storage room. The room should be locked, properly marked. Records should be kept from which the origin of the waste can be identified. The process requires grouping (segregation) radionuclides according to the expected time for their decay (initial activity and physical half-life), their physical form and their appearance. Examples of different physical forms are: biological waste which may undergo decomposition, infectious waste requiring sterilization prior to disposal, broken glassware, syringes, etc., requiring collection in separate containers to prevent personnel being injured, radionuclide generators, bed linen and clothing from hospital wards (therapeutic applications). Containers to allow segregation of different types of radioactive waste should be available in areas where the waste is generated.
In practice, it is mainly I-131 and the waste from therapy patients that require special radioactive waste precautions. The majority of diagnostic studies are performed using ^{99m}Tc, which has a physical half-life of 6 h. Following storage of 2.5 days (10 half-lives, i.e. a decay of a factor of more than 1000) most of this waste can be disposed of.
The following summary of practical advice for concrete items used in nuclear medicine can be given:
(a) *Technetium generators*. returned to the supplier after use
(b) *Used syringes and needles*. These can be collected in a shielded container in the rooms used for preparation and injection of radiopharmaceuticals.
When the container is full, it should be sealed and the expected disposal date be marked on it. After this time, the external dose rate can be monitored. The container can be disposed as medical waste when the external ambient dose equivalent rate is the same as the background.
(c) *Vials containing residues of 99mTc, 67Ga, 111In and 201Tl.* The same procedure should be used as for the syringes, but using a different container.
(d) *Gloves and cover paper*. These should be collected in plastic bags in the rooms used for preparation and injection of radiopharmaceuticals. When a bag is filled, it should be sealed. After waiting for decay, they can be disposed of as ordinary waste.
(e) *Patients' excreta, such as urine with 131I,* there is no need for collection of excreta and ordinary toilets can be used this is in accordance to the instruction of JAEC.

F4. POTENTIAL EXPOSURE AND EMERGENCY PLANS

I.GENERAL

On the basis of events identified clinical experience, JUH and nuclear medicine staff shall prepare special emergency procedures. The procedures should be clear, concise and unambiguous and shall be posted visibly in places where their need is anticipated.
An emergency plan shall, as a minimum, list/describe the following:
—Predictable incidents and accidents, and measures to deal with them;
—The persons responsible for taking actions, with full contact details;
—The responsibilities of individual personnel in emergency procedures (for example, nuclear medicine physicians and nuclear medicine technologists);
—Equipment and tools necessary to carry out the emergency procedures;
—Training and periodic rehearsals;
—Recording and reporting systems;
—Immediate measures to avoid unnecessary radiation doses to patients, staff and the public;
—Measures to prevent access of persons to the affected area;
—Measures to prevent spread of contamination.

Emergency kits should be kept readily available for use in an emergency.
These include the following:
—Protective clothing, for example overshoes and gloves;
—Decontamination materials for the affected areas, including absorbent materials for wiping up spills;
—Decontamination materials for persons;
—Warning notices;
—Portable monitoring equipment;
—Bags for waste, tape, labels and pencils.

II: TYPES OF EMERGENCY SITUATIONS

a) Damage to ^{99m}Tc generators

Generators contain a relatively large amount of radioactivity. In the event of a ^{99m}Tc generator being damaged, the measures to be taken are:
—Evacuate the area immediately.
—Inform the RSO, who should confirm the spillage and supervise the decontamination and monitoring procedures.
—Record the event and make a report according radiation safety committe.

b) Spillage of small amounts of radioactivity (<100 mCi for all radioisotopes except for iodine which is <1 mCi)

After such a spillage the following actions should be taken:
—Use protective clothing and disposable gloves.
—Quickly blot the spill with an absorbent pad to keep it from spreading.
—Remove the pad from the spill.
—Wipe with a towel from the edge of the contaminated area towards the centre.
—Continue the cycle of cleaning and use survey meter until it indicates that the spill has been cleaned.

—Use a plastic bag to hold contaminated items. Suitable bags shall be available as well as damp paper towels

c) Spillage of large amounts of radioactivity: >100 mCi ^{99m}Tc or >1 mCi ^{131}I.
After such a spillage the following actions should be taken:
—The RSO should immediately be informed and directly supervise the clean-up.
—Throw absorbent pads over the spill to prevent further spread of contamination.
—All people not involved in the spill should leave the area immediately.
—Monitor all people involved in the spill for contamination when leaving the room.
—If clothing is contaminated, remove and place it in a plastic bag labeled 'RADIOACTIVE'.
—If contamination of skin occurs, wash the area immediately.
—If contamination of an eye occurs, flush with large quantities of water.

d) PERSONNEL DECONTAMINATION
a) Define area on body or clothing that is contaminated.
b) Remove contaminated clothing immediately to prevent spread of contamination and the possibility of internal contamination.
c) If contamination of the skin has occurred, decontamination should not increase penetration of the radioactivity into the body by excessive abrasion of the skin. Therefore, clean with mildest methods first and progress to harsher methods only if fixed contamination persists. Clean from outside area of contamination inward to prevent spread of contamination. The maximum limit on residual contamination of hands, body surfaces, personal clothing and shoes is 0.1 mrad/hr at 2 cm.
d) Methods of skin decontamination are listed below starting with the mildest and progressing to harsher methods: flush with water, soap and warm water, mild abrasive soap with soft brush and water or detergent.
e) The procedure for decontaminating personnel follows; each cleaning should be monitored with a survey meter to assess effectiveness:
- Flush with water
- Wet gloved hands and work cleaning agent into a good lather before applying to contaminated area
- Wash lather into contaminated area 2 to 3 minutes
- Rinse with warm water
- Repeat the process three or four times
- Progress to a more aggressive method if radiation is still excessive
- Apply skin cream after clean up to prevent chapping

f) Finally, a contamination victim should take a shower and clean the entire body with special attention to hair, hands and fingernails

e) Medical emergencies involving radioactive patients
This is particularly important for therapy patients containing large amounts of radioactivity. Medical personnel should proceed with emergency care (for example, when a patient has suffered a stroke), while taking precautions against spread of contamination and minimizing external exposure.

The staff should avoid direct contact with the patient's mouth, and all members of the emergency team should wear impermeable protective gloves.

f) Need for urgent patient attention, including surgery

Radiation protection considerations should not prevent or delay life saving operations in the event that surgery on a patient is required. The following precautions should be observed:

—Notify the operating room staff.

—Modify operating procedures under the supervision of the RSO to minimize exposure and spread of contamination.

—Protective equipment may be used as long as efficiency and speed are not affected.

—Rotation of personnel may be necessary if the surgical procedure is lengthy.

The RSO should monitor all individuals involved.

—Measure doses to members of staff.

g) infectious control

radiology and nuclear medicine department should follow infectious control policy at JUH.

h) Fires

The normal hospital drill should be observed, with the safe evacuation of patients, visitors and staff being the most important consideration. When the fire brigade attends, they should be informed of the presence of radioactive material. No one is allowed to re-enter the department or treatment ward until it has been checked for contamination.

F5. QUALITY ASSURANCE IN NUCLEAR MEDICINE
Quality Assurance

ACCEPTANCE TESTING OF NUCLEAR MEDICINE EQUIPMENT
At initial installation, the nuclear medicine equipment needs to undergo a series of acceptance tests to ensure that the performance of the equipment complies with the manufacturer's specifications and is in accordance with NEMA requirments. These tests should be performed by manufacturing company engineer and the results of the acceptance tests should be thoroughly documented. Following acceptance, constancy tests designed to assess the subsequent performance of the equipment, should be performed.

TESTING FREQUENCY: should be performed quarterly for dose calibrator, thyroid uptake system, Geiger muller counters, wall area monitor, hand feet clothing monitor.
Daily gamma camera check should be performed at twice weekly.

RADIOPHARMACEUTICAL QUALITY TESTING

99m Technetium Generator A molybdenum-99 breakthrough measurement needs to be performed on all elutions from each technetium-99m generator and the following records kept of all generator elutions: time of elution; volume of eluate; technetium- 99m activity; molybdenum 99 activity; and radionuclidic purity.
BP specification for molybdenum-99 impurity in sodium pertechnetate eluate is 0.1% or a limit of 1 MBq of molybdenum-99 per GBq of technetium-99m at the time of administration. If this level is exceeded, then the technetium-99m solution has failed quality control and is not to be used in the preparation of radiopharmaceuticals for patient use.

Technetium-99m cold kits
No radiochemistry is available at JUH. All technetium-99m cold kits should be reconstituted in accordance with the manufacturer's instructions. All cold kits should have the GMP certificate. No routine testing for quality control is done. If any problem rises regarding quality control then the radiopharmaceutical is not used any more and shipped back to manufacturing company for testing.

RECORD KEEPING
Data regarding quality control of dose calibrator and gamma camera should be kept in records.

G. RADIOLOGY DEPARTMENT

G1.DUTIES AND RESPONSIBILITIES

The department policy ensures that

(1) No patient be administered a diagnostic medical exposure unless the exposure is prescribed by a medical practitioner

(2) Radiology consultant is assigned the primary task and obligation of ensuring overall patient protection and safety in the prescription of, and during the delivery of, medical exposure

(3) Medical and paramedical personnel be available as needed, and either be health professionals or have appropriate training adequately to discharge assigned tasks in the conduct of the diagnostic procedure that the medical practitioner prescribes

(4) Each individual should take actions within his or her area of responsibility, as established in the radiation protection programme, to prevent inappropriate exposures to patients.

The following describes in details assigned tasks and responsibilities of all employees in radiology department:

a) Referrer

A written referral that states the procedure requested and provides sufficient relevant clinical information should be provided to radiology consultant before the procedure is performed. The referral will contain suitable patient identifying information (name, date of birth, age, sex and hospital ID) and adequate referrer contact details for consultative purposes.

The referral should state a provisional diagnosis for investigation or a medical condition for treatment.

b) Radiology consultant

GENERAL RESPONSIBILITIES

To provide effective, efficient and professional clinical radiology services during contracted sessions. Emergency clinical coverage of the radiology services is shared on weekly rotations between radiology consultants from 5:00 pm till 8:oo am.

CLINICAL RESPOSIBILITIES

- The Radiologist is responsible for reporting full range of radiological procedures at that include general radiology reporting, barium studies, ultrasound, CT, MRI, angiography and interventional radiology.
- The Radiologist will be responsible for ensuring that adequate professional reports are available in a timely manner particularly for inpatients who should receive official written report within 24 hours in working days and 48 hours in weekends and 96 hours in holidays.
- The Radiologist will function as a part of a multidisciplinary team working with radiographers, nurses, clerical and attendant staff in the interests of patient diagnosis and care.
- The Radiologist will liaise with Medical Staff in other departments to ensure that patients are investigated in an appropriate and cost effective manner. This will include taking part in departmental meetings with other disciplines.
- The Radiologist will be aware of the role of patient advocates and patient's rights and ensure informed consent has been obtained in accordance with the radiology department policies and protocols.

- Radiology consultant should be directly involved in managing cases of contrast allergy particularly in emergency situations until CPR team arrives.

TEACHING RESPONSIBILITIES
The Radiologist, when appropriate, will instruct, guide and supervise the work of other staff in the radiology unit, including residents and technologists as part of regular clinical duties.

QUALITY ASSURANCE
The Radiologist will maintain high standards of personal clinical performance and foster the maintenance of high standards of radiological diagnosis within the radiology unit.

c) Radiology resident
   - Residents take thorough and accurate patient medical histories.
   - Assist radiologist by preparing a provisional report of all procedures and exams done in radiology department.
   - Call CPR team when contrast allergy reaction is reported by technologist
   - Assist radiology consultant in managing the contrast allergy emergency case till the CPR team arrives.

d) Radiology technologist
   - Radiologic Technologists, prepares and processes images of designated portions of the body. General job duties for this occupational group include the following activities:
   - Set up examination rooms as required, making sure all necessary equipment is ready. Prepare patients for examination, informing them of the procedure to be performed.
   - Take thorough and accurate patient medical histories regarding allergy for any medication or iodine, asthma and about kidney function prior to CT contrast administration. Technologist should raise any problem and question to radiology radiology resident
   - Take thorough history from patients before MRI examinations looking for metallic foreign objects (stents, prosthesis, plates, screws…etc).
   - Technologists follow written protocols for each radiologic exam.
   - Technologists prepare and administer oral and IV contrasts to patients
   - After positioning patients properly, technologists obtain the correct images for the type of equipment being used. Technologists must constantly monitor the patient's condition and
   - reactions and report any abnormal signs to a radiology resident rand consultant.
   - Technologists prepare a hardcopy of images as required by protocol

e) Nursing staff

Staff nurse
- Check the emergency trolley and the validity of its medications.

- Check the oxygen and suction equipments.
- Make the monthly schedule for the nurses in the radiology department.
- Prepare the daily schedule for the nurses in the radiology rooms.
- Give the sedation for the pediatric patients in the CT and MRI rooms.
- Put the intravenous cannula for the patient in the radiology department.
- Assist the radiologist during the interventional procedures and prepare all his needs previously.
- Requesting all the medications, disposables and materials needed in the radiology department.
- Supervise the nurses' performance during the daily work, and following up the workflow.
- Make sure that all the materials and disposable needs in the interventional procedures ,US ,and CT rooms are available.
- Follow up the coordination and cooperation between the radiographer and the nurse in order to improve and optimize the quality of the work.

Practical nurse

- Clean for the U/S room equipments.
- Supply the radiology rooms with sheets, bed-linens, and gowns.
- Bring the patients from their rooms to the radiology department and return them back.
- Prepare the patients before any radiological procedures.
- Coordinate and cooperate with the radiographer in order to ease and improve the workflow and to avoid any troubles.
- Supply the radiology rooms with all disposable and materials needing.
- Prepare the cotton swab for the rooms.
- Preparing and helping in the interventional procedures.

f) Administration

- Receive patients' request and inserts patient data in JUH IT system.
- Schedule inpatient and outpatient procedure appointments
- Informs radiology technologists about inpatient requests particularly emergency cases

G2. OPTIMIZATION OF PROTECTION AND SAFETY FOR PERSONNEL

a) RADIATION WARNING SIGNS

All devices and equipment capable of producing radiation when operated shall be appropriately labeled to caution individuals that such devices or equipment produce radiation. Rooms or areas that contain permanently installed x-ray machines shall be posted with a sign or signs that bear the words, “CAUTION X-RAY.”

b) OPERATION SIGNALS

Any radiation-producing machine that is located in an area accessible to individuals and is capable of producing a dose rate in excess of 100 millirem per hour, shall be provided with conspicuous visible or audible alarm signal so that any individual at or approaching the tube head or radiation port is aware that the machine is producing radiation. This alarm signal shall be activated automatically only when radiation is produced and is not required for radiographic and fluoroscopic machines used solely in the healing arts.

INVASIVE RADIOLOGIGY PROCEDURES

Interventional radiology (abbreviated **IR** or sometimes **VIR** for **vascular and interventional radiology**) is a subspecialty of radiology in which minimally invasive procedures are performed using **image guidance**.

Some of these procedures are done for purely diagnostic purposes (e.g., angiogram), while others are done for treatment purposes (e.g., angioplasty).

Pictures (images) are used to direct these procedures, which are usually done with needles or other tiny instruments like small tubes called catheters.

The images provide road maps that allow the Interventional Radiologist to guide these instruments through the body to the areas of interest.

Common interventional imaging methods include X-ray fluoroscopy, computed tomography (CT), ultrasound (US), and magnetic resonance imaging (MRI).

Fluoroscopy and computed tomography use ionizing radiation that may be potentially harmful to the patient and, in the case of fluoroscopy, the interventional radiologist. However, both methods have the advantages of being fast and geometrically accurate. Ultrasound suffers from image quality and tissue contrast problems, but is also fast and inexpensive. Magnetic resonance imaging provides superior tissue contrast, at the cost of being expensive and requiring specialized instruments that will not interact with the magnetic fields present in the imaging volume.

Procedure

Common IR procedures are:

- Angiography: imaging the blood vessels to look for abnormalities with the use of various contrast media, including iodinated contrast, gadolinium based agents, and CO2 gas.

- Balloon angioplasty/stent: opening of narrow or blocked blood vessels using a balloon; may include placement of metallic stents as well (both self-expanding and balloon expandable).

- Chemoembolization: delivering cancer treatment directly to a tumour through its blood supply, then using clot-inducing substances to block the artery, ensuring that the delivered chemotherapy is not "washed out" by continued blood flow.

- Drain insertions: placement of tubes into different parts of the body to drain fluids (e.g., abscess drains to remove pus, pleural drains)

- Embolization: blocking abnormal blood (artery) vessels (e.g., for the purpose of stopping bleeding) or organs (to stop the extra function e.g. embolization of the spleen for hypersplenism) including uterine artery embolization for percutaneous treatment of uterine fibroids.

Various embolic agents are used, including alcohol, glue, metallic coils, poly-viny alcohol particles, Embospheres, encapsulated chemo-microsphere, and gelfoam.

- Thrombolysis: treatment aimed at dissolving blood clots (e.g., pulmonary emboli, leg vein thrombi, thrombosed hemodialysis accesses) with both pharmaceutical (TPA) and mechanical means

- Biopsy: taking of a tissue sample from the area of interest for pathological examination from a percutaneous or transjugular approach

- Radiofrequency ablation (RF/RFA): localized destruction of tissue (e.g., tumours) by heating

- Cryoablation - localized destruction of tissue by freezing

- Line insertion: Vascular access and management of specialized kinds of intravenous devices (IVs) (e.g. PICC lines, Hickman lines, subcutaneous ports including translumbar and transhepatic venous lines)

- IVC filters: - metallic filters placed in the inferior vena cavae to prevent propagation of deep venous thrombus, both temporary and permanent.

Inferior vena cava filter

- Vertebroplasty: percutaneous injection of biocompatible bone cement inside fractured vertebrae

- Nephrostomy placement: Placing a catheter directly into the kidney to drain urine in situations where normal flow of urine is obstructed. NUS catheters are nephroureteral stents which are placed through the ureter and into the bladder.

- Radiologically Inserted Gastrostomy or RIG: Placement of a feeding tube percutaneously into the stomach and/or jejunum.

- Dialysis access and related intervention: Placement of tunneled hemodialysis catheters, peritoneal dialysis catheters, and revision/thrombolysis of poorly functioning surgically placed AV fistulas and grafts.

- TIPS : Placement of a Transjugular Intrahepatic Porto-systemic Shunt (TIPS) for management of select patients with critical end-stage liver disease and portal hypertension

- Biliary intervention - Placement of catheters in the biliary system to bypass biliary obstructions and decompress the biliary system. Also placement of permanent indwelling biliary stents.

D. Hazardous materials in radiology department

I) Fixer

A. Principal Components:

Ammonium Thiosulfate, Sodium Sulfite, Acetic Acid

B. Hazards Identification

Appearance and Odor: Clear Blue liquid , slight floral odor

C. Effects of over exposure:

- Eyes: May cause burning or irritation of eyes and mucous membranes.

- Skin: May cause mild irritation and/or allergic reaction.

- Ingestion: Seek immediate medical advise giving full details of amount swallowed and toxicity.

- Inhalation: Prolonged inhalation of fumes may be irritating and may cause headaches.

D. First Aid Measures

- Eyes: Wash eyes immediately for 15 minutes if contact occurs

- Seek medical attention if symptoms develop.

- Inhalation: Remove to fresh air, If breathing is difficult, give oxygen and call a physician.
- Skin: Rinse with water and wash thoroughly after contact with soap and water.
- Remove contaminated clothing and shower if appropriate.
- If irritation persists, seek medical attention.
- In case of ingest ingestion Do not induce vomiting. Seek medical attention immediately.

E. Fire Fighting Measures

Fixer is has low for fire. It is not flammable at ambient temperature in case of fire, JUH fire policy should be applied.

F. Accidental Release Measures:

Spill Response: Wipe or absorb with dry towel.

G. Handling and Storage:

- Do not consume food, drink or tobacco in area where
- contact with product may occur.
- Provide general exhaust in the storage area.
- Keep container tightly sealed. Avoid incompatible substances.
- Avoid unnecessary personal contact.
- Wash thoroughly after handling.

II) Developer

A. Principal Components:

Sodium Sulfite, Hydroquinone,Potassium

B. Hazards Identification:

Appearance and Odor: Clear, Pale Red Liquid

C. Effects of over exposure:

- Eyes: May cause burning or irritation of eyes and mucous membranes.
- Skin: May cause mild irritation and/or allergic reaction.
- Ingestion: Seek immediate medical advise giving full details of amount swallowed and toxicity.
- Inhalation: Prolonged inhalation of fumes may be irritating and may cause headaches.

D: First Aid Measures

- Eyes: Wash eyes immediately for 15 minutes if contact occurs. Seek medical attention if symptoms develop.
- Inhalation: Remove to fresh air, If breathing is difficult, give oxygen and call a physician.
- Skin: Rinse with water and wash thoroughly after contact with soap and water. Remove contaminated clothing and shower if appropriate. If irritation persists, seek medical attention.
- Ingestion: Do not induce vomiting. Seek medical attention immediately.

F: Fire Fighting Measures

Fixer is has low for fire. It is not flammable at ambient temperature in case of fire, JUH fire policy should be applied.

G: Accidental Release Measures:

Neutralize with Sodium Bicarbonate. Spill Response: Wipe or absorb with dry towel

H: Handling and Storage:

- Do not consume food, drink or tobacco in area where
- contact with product may occur.
- Provide general exhaust in the storage area.
- Keep container tightly sealed. Avoid incompatible substances.
- Avoid unnecessary personal contact.
- Wash thoroughly after handling.

E) Infectious control
radiology and nuclear medicine department should follow infectious control policy at JUH.

F) Fires
The normal hospital drill should be observed, with the safe evacuation of patients, visitors and staff being the most important consideration. When the fire brigade attends, they should be informed of the presence of radioactive material. No one is allowed to re-enter the department or treatment ward until it has been checked for contamination

G3. Radiation-Producing Machines (X-Ray)

a) GENERAL REQUIREMENTS FOR THE OPERATION OF RADIATION PRODUCING MACHINES

1. Only personnel who are certified radiology technologists and are employee in JUh and received appropriate training on the specified machine shall operate or supervise the operation of the specified radiation producing machine.
2. When required, dosimeter (TLD) shall be worn whenever the machine is producing ionizing radiation. This dosimetry shall be supplied by and returned to RSO.
3. Personnel who are required to wear lead aprons or other similar radiation protection devices should visually inspect these devices prior to each use for obvious signs of damage. If there

appears to be any damage, the device should be taken out of service immediately and RSO should be called.

4. All individuals are responsible for using the radiation producing machine that they are operating: a. In a safe manner.

b. In accordance with the written protocols safety manual for the machine and this document (|Radiation Safety Manual) in such a manner that their exposure, their fellow workers, and the patient's exposure is as low as is reasonably achievable.

5. Personnel who supervise or operate radiation producing machines are responsible for notifying their fellow workers and their supervision of any unsafe operating conditions and failures of the machine to operate according to specifications.

6. The appropriate department head is responsible for assuring that radiation producing machines are kept in a good state of repair, safety systems are functioning, and the equipment meets specifications.

7. Records of the use of the radiation producing machine shall be kept. The records shall as a minimum: a. Record the kVp, mA, and if applicable, mA-sec used for each use of the equipment.
b. Names of operators.
c. Patient name or identification
d. Equipment failures.
e. Failure of any safety system (e.g. interlocks, warning lights, etc.).

8. All radiation producing machines shall have periodic Quality Assurance inspections. The purpose of these inspections is to assure that the equipment is operating in a safe manner, in accordance with specifications. These inspections will only be performed by the JUH maintenance engineer who received appropriate training on that equipment and or service engineer of the manufacturing company.

b) RESTRAINT/MANIPULATION OF PATIENTS DURING EXAMINATIONS

No individual shall be regularly employed to hold or support humans during radiation exposures. Operating personnel shall not perform this service except infrequently and then only in cases where no other method is available.

Any individual holding or supporting a person during radiation exposure should wear protective gloves and apron with a lead equivalent of not less than 0.25 millimeters. Under no circumstances shall individuals holding or supporting a person place part of their body directly in the primary beam.

c) SPECIAL REQUIREMENTS FOR THE USE OF FLUOROSCOPY

When personnel use fluoroscopy equipment for treatment and diagnosis, the following special requirements must be met:

1. Whenever practical, shielding (e.g. drapes, screens, etc.) of 0.25 mm lead equivalent thickness should be interposed between the operator and the patient so as reduce the exposure from scattered radiation.

This shielding will not be substituted for the use of leaded aprons and gloves.
2. Aprons must be worn when the fluoroscopy machine is producing radiation. These aprons must have a lead equivalent thickness of at least 0.25 mm. when available a 0.5 mm lead equivalent thickness apron is recommended.

H. Exposure Standards and Dosimetry

EXPOSURE STANDARDS AND DOSIMETRY

A. RADIATION DOSE LIMITS

I. Every effort shall be made to maintain radiation doses by humans to levels that are as far below the appropriate regulatory limits as is reasonably achievable (ALARA). As a guide to assist in maintaining radiation doses ALARA, the following administrative guidelines should not be exceeded.
During a calendar year either a or b will be effective - whichever is most limiting.

a. Total Effective Dose Equivalent	2.5 rem/per calendar year (25 mSv).
b. Committed Dose Equivalent to any organ other than the skin of the whole body or the lens of the eye.)	25 rem/per calendar year (250 mSv)
c. A dose to the lens of the eye.	7.5 rem/per calendar year (75 mSv).
d. Shallow dose equivalent to the skin of the whole body.	25 rem/per calendar year (250 mSv)
e. Shallow dose equivalent to any extremity	25 rem/per calendar year (250 mSv).
f. The radiation dose to a minor (under 18 years of age)	less than 10% of the above guidelines

II. In a situation where the above administrative guidelines have been or are about to be exceeded:
a. The RSO will immediately begin investigating the circumstances by which the radiation dose was received or is about to be received.
b. The RSO must immediately determine the need to issue a "cease and desist order" to prevent an unnecessary radiation dose.
c. Except where such action may cause injury to another human being or reduce the effectiveness of essential medical care, individual users of radiation sources are required to stop work whenever they have good reason to believe that the dose guidelines may have been or will be exceeded.
d. Before work continues, the RSO, the principal investigator, and the individual workers involved will establish a written plan of action such that:
1. Radiation doses can be reasonably expected to be maintained ALARA.
2. The appropriate regulatory limits will not be exceeded.
e. An event report shall be written and reviewed by the appropriate Radiation Safety Committee for each action required under a. through d. above.

III An authorized user who becomes pregnant should notify her supervisor of her pregnancy. Upon notification, the RSO will implement lower dose limits to protect the embryo/fetus.
A "declared pregnant woman" is a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. The radiation dose limits for the fetus of a declared pregnant radiation worker is 500 mrem over the period of pregnancy not to substantially exceed a rate of 50 millirem per month.

IV Radiation fields outside restricted areas shall be controlled such that the following apply:
a. The use of ionizing radiation from all licensed and regulated sources can be reasonably expected to maintain the dose to any member of the public, less than 100 millirem in any one calendar year.
b. For all uses of ionizing radiation, no one member of the public can be reasonably expected to receive a radiation dose greater than 2 millirem in any one hour.

V. Occupancy factors, machine use factors, and other such factors that account for the time radiation fields are present or the time a member of the public is present in the radiation field, may be used in determining compliance with the 100 millirem standard in section IV.a. above.

B. DOSIMETRY

The RSO shall provide a TLD (thermoluminescent Dosimeter) to workers whom careful evaluation establishes a need for the use of this monitoring technique. These devices provide legal records of radiation exposure; therefore, it is imperative that they only be used as prescribed. When prescribed, they must be worn at all times while working with radionuclides or radiation-producing machines. They must be stored away from radiation sources and protected against heat, moisture, or contamination. TLDs are collected and read by RSO quarterly in collaboration with JAEC.
Lost dosimeter must be immediately reported to RSO. If the dosimeter is later recovered, it must immediately be sent to RSO.

C. PERSONNEL EXPOSURE RECORDS

Personnel exposure data shall be part of the permanent records maintained by RSO and copies sent to Health and Safety Office. The exposure records should include information on the general nature of the work involving occupational exposure, and information on doses and the data upon which the dose assessments have been based. Upon written request by the employee Health and Safety office will provide a copy of the individual's exposure history.

D. RECORDS OF PRIOR EXPOSURE

Employees requiring personnel dosimetry will be required to complete a "Statement of Experience" form indicating all locations where previous radiation exposures may have occurred. With the signed consent of the employee, a letter will be sent to the indicated facility requesting the current calendar year exposure history. A reasonable effort will be made to obtain the individual's prior lifetime exposure levels.

E. BIOASSAY REQUIREMENTS

When using I-131 in human therapy applications, personnel preparing therapeutic quantities in liquid form containing more than 30 mCi shall have a bioassay within 24 - 72 hours. Individuals who administer therapeutic quantities of I-131 in bound form are not required to receive a bioassay. Doctors, nurses, and maintenance staff working with I-131 therapy patients are exempt from bioassay requirements under normal circumstances.

F. MEDICAL SURVEILLANCE POLICY

Personnel will be placed under medical surveillance when their potential exposure to ionizing radiation is such that somatic biological effects susceptible to detection by medical evaluation could occur. This situation will only occur for individuals who have exceeded or are likely to have received a radiation dose in excess of 0.2-0.5 Sv or higher to any part of their body. Such appraisal will include an acute and chronic exposure evaluation and will consider many variables (duration, source, type of potential exposure, etc.).

Under normal working conditions, the doses incurred in a nuclear medicine department are low and no specific radiation related examinations are normally required for persons who are occupationally exposed to ionizing radiation, as there are no diagnostic tests which yield information relevant to normal exposure.

G. MEDICAL RECORDS AND EXAMINATIONS

1. Medical records will consist of the following:

a. Information necessary to assess exposure.

b. Personnel dosimetry records.

2. Examinations will be performed on any employee who is suspected of ingesting, inhaling, or absorbing radionuclides at defined levels of activity. Urinalysis, thyroid counting, whole body counting, and eye examinations may be included. Radiation workers must be scheduled to appear at a prearranged time for the measurement.

3. Copies of examination records will be maintained by RSO and Health and Safety Office and coordinated with one's personal dosimetry data.

H. EXCESSIVE RADIATION EXPOSURES

In a situation where the above administrative guidelines have been or are about to be exceeded:

a. The RSO will immediately begin investigating the circumstances by which the radiation dose was received or is about to be received.

b. The RSO must immediately determine the need to issue a "cease and desist order" to prevent an unnecessary radiation dose.

c. Before work continues, the RSO and the individual workers involved and head of department will establish a written plan of action such that:

1. Radiation doses can be reasonably expected to be maintained ALARA.

2. The appropriate regulatory limits will not be exceeded.

d. An event report shall be written by RSO and reviewed by radiation safety Committee for each action required under a. through c. above.

e. A copy of the report and action plan should be sent to health and safety office.

Annex I

Note that the maximal usual activity for each procedure can vary also according to the patients' clinical conditions, the clinical question, and the protocol and instrumentation used. For paediatric patients the dosage should be modified according to age and/or weight.

Guidance levels of activity for procedures in nuclear medicine for a typical adult patient:

Test	Radionuclide	Chemical form[a]	Maximum usual activity per test[b] (MBq)
Bone			
Bone imaging	^{99m}Tc	Phosphonate and phosphate compounds	600
Bone imaging by single photon emission computerized tomography (SPECT)	^{99m}Tc	Phosphonate and phosphate compounds	800
Bone marrow imaging	^{99m}Tc	Labelled colloid[c]	400
Brain			
Brain imaging (static)	^{99m}Tc	TcO_4^-	500
	^{99m}Tc	Diethylene-triamine-penta-acetic acid (DTPA) or glucoheptonate	500
Brain imaging (SPECT)	^{99m}Tc	TcO_4^-	800
	^{99m}Tc	DTPA, gluconate and glucoheptonate	800
Lymph node imaging	^{99m}Tc	Labelled colloid	80
Abscess imaging	^{99m}Tc	Exametazime labelled white cells	400
	^{111}In	Labelled white cells	20
Thrombus imaging	^{111}In	Labelled platelets	20

Test	Radionuclide	Chemical form[a]	Maximum usual activity per test[b] (MBq)
Cerebral blood flow	^{99m}Tc	Exametazime	500
	^{133}Xe	In isotonic sodium chloride solution	400
	^{99m}Tc	Hexamethyl propylene amine oxime (HM-PAO)	500
Cisternography	^{111}In	DTPA	40
Lacrimal			
Lacrimal drainage	^{99m}Tc	TcO_4^-	4
	^{99m}Tc	Labelled colloid	4
Thyroid			
Thyroid imaging	^{99m}Tc	TcO_4^-	200
	^{123}I	I^-	20
Thyroid metastases (after ablation)	^{131}I	I^-	400
Parathyroid imaging	^{201}Tl[d]	Tl^+ chloride[d]	80
Lungs			
Lung ventilation imaging	^{81m}Kr	Gas	6000
	^{99m}Tc	DTPA aerosol	80
Lung ventilation study	^{133}Xe	Gas	400
	^{127}Xe	Gas	200
Lung perfusion imaging	^{81m}Kr	Aqueous solution	6000
	^{99m}Tc	Human albumin (macroaggregates or microspheres)	100
Lung perfusion imaging (with venography)	^{99m}Tc	Human albumin (macroaggregates or microspheres)	160
Lung perfusion studies	^{133}Xe	Isotonic solution	200
	^{127}Xe	Isotonic chloride solution	200
Lung imaging (SPECT)	^{99m}Tc	Macroaggregated albumin (MAA)	200

Test	Radionuclide	Chemical form[a]	Maximum usual activity per test[b] (MBq)
Liver and spleen			
Liver and spleen imaging	^{99m}Tc	Labelled colloid	80
Functional biliary system imaging	^{99m}Tc	Iminodiacetates and equivalent agents	150
Spleen imaging	^{99m}Tc	Labelled denaturated red blood cells	100
Liver imaging (SPECT)	^{99m}Tc	Labelled colloid	200
Cardiovascular			
First pass blood flow studies	^{99m}Tc	TcO_4^-	800
	^{99m}Tc	DTPA	800
	^{99m}Tc	Macroaggregated globulin 3	400
Blood pool imaging	^{99m}Tc	Human albumin complex	40
Cardiac and vascular imaging/probe studies	^{99m}Tc	Human albumin complex	800
	^{99m}Tc	Labelled normal red blood cells	800
Myocardial imaging/probe studies	^{99m}Tc	Phosphonate and phosphate compounds	600
Myocardial imaging	^{99m}Tc	Isonitriles	300
	^{201}Tl	Tl^+ chloride	100
Myocardial imaging (SPECT)	^{99m}Tc	Phosphonate and phosphate compounds	800
	^{99m}Tc	Isonitriles	600
Stomach, gastrointestinal tract			
Stomach/salivary gland imaging	^{99m}Tc	TcO_4^-	40
Meckel's diverticulum imaging	^{99m}Tc	TcO_4^-	400

Test	Radionuclide	Chemical form[a]	Maximum usual activity per test[b] (MBq)
Gastrointestinal bleeding	^{99m}Tc	Labelled colloid	400
	^{99m}Tc	Labelled normal red blood cells	400
Oesophageal transit and reflux	^{99m}Tc	Labelled colloid	40
	^{99m}Tc	Non-absorbable compounds	40
Gastric emptying	^{99m}Tc	Non-absorbable compounds	12
	^{111}In	Non-absorbable compounds	12
	^{113m}In	Non-absorbable compounds	12
Kidney, urinary system and adrenals			
Renal imaging	^{99m}Tc	Dimercaptosuccinic acid	160
Renal imaging/renography	^{99m}Tc	DTPA, gluconate and glucoheptonate	350
	^{99m}Tc	Macroaggregated globulin 3	100
	^{123}I	O-iodohippurate	20
Adrenal imaging	^{75}Se[e]	Selenorcholesterol	8
Miscellaneous			
Tumour or abscess imaging	^{67}Ga	Citrate	300
	^{201}Tl	Chloride	100
Tumour imaging	^{99m}Tc	Dimercaptosuccinic acid	400
Neuroectodermal tumour imaging	^{123}I	Meta-iodo-benzyl guanidine	400
	^{131}I	Meta-iodo-benzyl guanidine	20

Annex II
Written instructions to patients or their legal guardians before leaving the hospital or practice after treatment with iodine-131

You have been treated with radioactive iodine to cure a thyroid problem. Most of the iodine will leave your body through the urine. For several weeks, however, some of the iodine will stay inside your body, which means that you in turn can irradiate other people physically close to you.
It is your responsibility to protect relatives, friends, colleagues and others. The following questions and answers are designed to inform you about simple precautions to be taken.
Your doctor will inform (or has already informed) you how long you should follow these instructions:

1. What is the most important precaution?
Do not sit or stay close to any person either at home or at work. Try to maintain a distance of at least 1 metre. For long periods (more than one hour), stay at least 2 metres away.
Passing someone briefly, for example in the street, or while shopping, is permissible - as is a quick hug. The restrictions above only apply if you are to be in close proximity to another person for more than a few minutes.

2. What about contacts with pregnant women?
Contact with pregnant women should be minimised. Try to stay at least 2 metres away from a pregnant woman.

3. Is it safe to become pregnant / father children?
Some of the iodine will remain in your body for four months. During this time period you should not become pregnant or father children.

4. Can I still see my children and care for them?
If your children are under ten years old, please minimize hugging or holding and avoid prolonged contact for the restriction period.
The risk is higher for young children than for adults, therefore it is prudent to avoid additional unnecessary contact for an additional week on top of the recommended period.

5. What about infants?
Children under two years old should be looked after by someone else. If possible, arrange for them to stay with relatives or friends.

Can I go on with breast-feeding?
Radioactive iodine is passed on in breast milk for quite a long time. Therefore, it is important that breast-feeding be stopped completely!

7**. Can I be in close contact with my partner or other people at home?**
Any close contact such as hugging or sex should be limited to half an hour a day. You should sleep in a separate bed. Beds should be at least 2 metres apart, even if there is a wall separating them. This is because the walls of a house do not provide good protection against the type of radiation emitted by iodine-131.

8. What if my partner is pregnant?
If your partner is pregnant, it is important to avoid close contact with her.

9. Do the precautions apply to those over 60?
For those over 60 years, the risk is much lower than for other people. Special precautions are for that reason less important.

10. Can I receive visitors?
Short visits, less than two hours, create no problem. Keep at a distance of about 2 metres and preferably avoid close contact. You should discourage visits by young children and pregnant women.

11. Can I go to work?
Most people can go to work. If, by the nature of your work, you are within 2 metres of the same individual(s) for more than two hours per day, you should seek advice from your doctor.
You should in any case inform your manager.

12 What if I am a nursery school teacher?
Nursery school teachers, or others who are in close contact with young children during working hours, should stay off work. Your doctor will indicate the required period of time for this restriction.

13. Can I go to the movies or other entertainment?
1756 Avoid visiting cinemas and other social events where you are close to other people for more than one hour.

14. May I use public transport?
For the first week you should restrict public transport to journeys lasting no more than two hours. Longer trips should only be undertaken if unavoidable. In that case, try to find a place where you can sit alone. Ask your doctor for advice if the trip is longer.

15. What about using a taxi?
Sit in the back on the opposite side from the driver. Do not spend more than two hours with any one taxi driver.

16. Can I use the same toilet as other people?
Yes, but spilling of urine needs to be avoided. Therefore, (also for men) pass urine while seated. Always dry your genitals with toilet paper and flush the toilet. It is also important to wash your hands immediately afterwards, even when only urinating.

17. What about cutlery, crockery, bed linen, towel etc?
Radioactive iodine also leaves the body in the saliva and the sweat of patients.
Therefore, cutlery, crockery, towels, bed linen etc. should not be shared with others.
After washing they are completely safe. There is no need to wash them separately.

18. What happens if I have to go to hospital?
If you have to go to hospital unexpectedly, please inform the doctor that you have been treated with radioactive iodine recently. This applies even when it is the same hospital where you were treated.

If in doubt, you should always ask the advice of the doctor treating you.