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Saudi Center for Disease Prevention and Control

A GUIDE TO MEDICAL RESPONSE DURING RADIATION EMERGENCIES

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A GUIDE TO MEDICAL RESPONSE DURING RADIATION EMERGENCIES

Prepared for use by Radiation Protection Officers,
Medical Doctors, Nuclear Medicine Technologists,
ER Team and Allied Health Personnel

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INTRODUCTION

Different uses of ionizing radiation increase with various technical advancements and it the risks of exposure associated with the uses also increase. International and national regulatory agencies require strict implementation of radiation safety policies and practices to prevent incidental exposures and prevent hazardous biological effects. Effects of radiation accidents/incidents may affect a small number of people however the impact of the exposure may be from low to serious.

The purpose of this document is to have available and adequate medical program for the care of potentially injured individuals due to incidental exposures to radiation. It shall provide specific and practical guidance for emergency response that, if implemented, will develop awareness and capability on basic assessment and immediate response needed to protect the public and the workers in the event of different types of radiation accidents consistent with international and national guidance.

OVERVIEW

Radiation incidents/accidents can happen anywhere and at any time. They may happen in:

- Hospitals where there are facilities for radioisotopes and radiation services. These include primary isotopes used in Nuclear Medicine Department (^{99m}Tc,^{131}I, ^{67}Ga, ^{51}Cr ^{137}Cs, ^{32}P, ^{90}Y), isotopes used in Radiotherapy & Oncology Department (^{60}Co,^{192}Ir, ^{125}I).
- Factories, work places, research centers and education facilities involving the usage of radiation and radioactive substances.
- During the transportation of radioactive materials .
- Theft or loss of radioactive materials Radiation can take place in,

Radiation incident can be on a small or large scale and can happen at any time. For both, exposures to radiation can result to exposure to ionizing radiation. The individual or group of individuals may be exposed externally to radiation either the whole body exposure or part of the body. The individual or group of individuals can also in be radioactively contaminated through inhalation or through entry to body opening such as wounds.

Medical care providers are expected to deliver care to individuals who have been exposed to and/or contaminated with radioactive materials or potentially injured by radiation. Healthcare

providers should be able to provide the necessary medical management of the exposed individuals. The most important consideration in the medical evaluation of people involved in a radiation incident is the medical stability of the affected individuals. The relative magnitude of the situation and the resources needed to address the emergency are also important considerations.

The Radiation Protection Officer and/or the Radiation Protection Expert shall identify the possible sites and types of accidents upon responding to emergencies.

When a contaminated person requires treatment by a physician, the following points must be remembered:

- Medical emergencies are the priority and must be attended first .
- Radiation injuries are rarely life threatening to the victim and the attending person .
- There is negligible risk of radiation injury to persons treating radiation accident victims, provided they are guided accordingly .
- Practice the concept of distance, shielding, time and containment of spread of contamination .

Immediate response to radiation incidents and accidents reduces radiation doses to patients and staff and avoids any biological effect. The table below lists the biological effects at certain total dose values due to external irradiation.

RADIATION EFFECTS	Gy
Hematopoietic syndrome	3-8
Gastrointestinal syndrome	10
Cerebrovascular syndrome	100
Dose that is lethal to 50% of those exposed without medical intervention	3-4

DEFINITION OF TERMS

Contamination	The presence of radioactive substances or materials on surfaces, or within solids, liquids or gases (including the human body), where they are unintended or undesirable. Fixed contamination: Contamination other than non-fixed contamination.
Emergency plan	A document describing the organizational structure, roles and responsibilities, concept of operation, means and principles for intervention during an emergency.
Large-scale incidents	Those involving relatively large quantities of radioactive materials. There is potential exposure and/or contamination of large numbers of people. These incidents include public exposure due to theft or loss or radioactive materials and large-scale nuclear power plant disasters.
Radiation Protection Officer	Certified by KACARE in radiation protection
Radiation Emergency Room	A dedicated room where all potentially radioactive and/or irradiated persons are brought as they reach the Hospital for the initial assessment.
Small-scale incidents	Those that involve small amounts of radioactive materials with the potential to expose one or more individuals. These incidents occur in laboratories.

RADIATION INJURIES

There are two categories of causes of radiation accidents:

- External radiation exposure is irradiation from a source distant or in close proximity to the body .
- Contamination is the presence of radioactive material in or on the body .

Internal contamination can result from *inhalation, ingestion, direct absorption* through the skin, or penetration of radioactive materials through open wounds.

These two categories may occur in combination.

Radiation injuries are caused by exposure to external irradiation and/or contamination. Radiation injuries are classified as follows:

TYPE OF IRRADIATION	RADIATION INJURY
External exposure	Partial and Whole body
Contamination	External and Internal
Combined	External with contamination and with trauma

Condition of patients arising from irradiation are classified as:

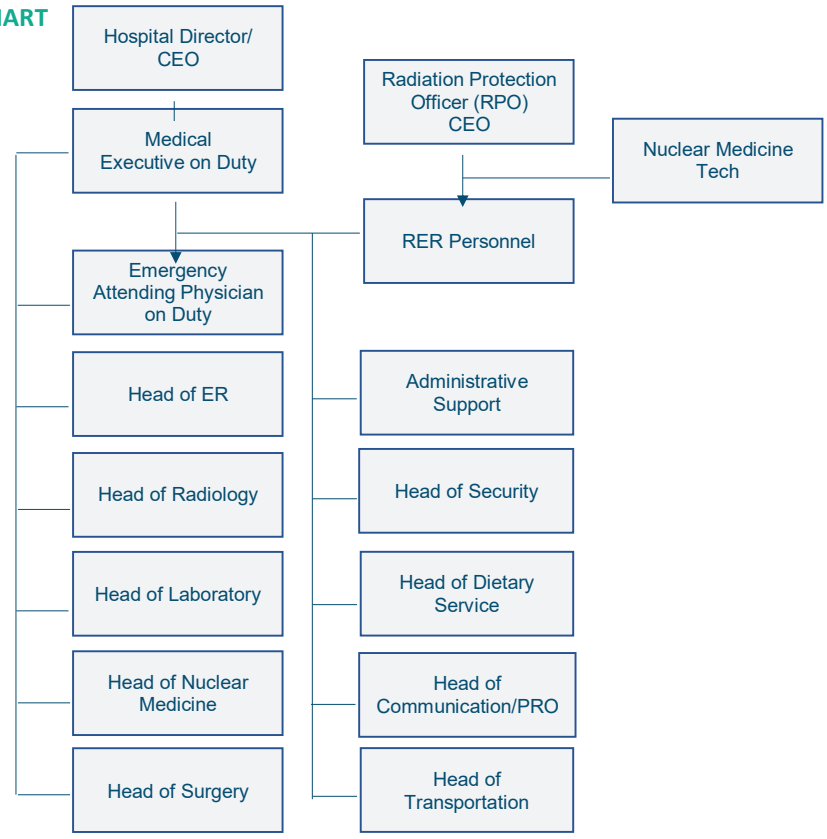
CATEGORY	DESCRIPTION / ACTION
Category A	• No irradiation and no radioactive contamination. • Does not constitute radiation hazard to both attendants and patients. • Should be treated like any other patient with physical trauma.
Category B	• Patient expose to external radiation only. No radioactive contamination. • Exposure can be to a part of the body or whole body. Does not constitute a risk to attendants or public. • Irradiation can occur following an exposure to a radioactive source or as an accidental exposure to X-rays in radiology and radiotherapy departments.
Category C	• Patients with internal contamination only (those patients who inhaled/swallowed radioactive material). • Urgent measures to prevent incorporation of radioactive substance are required. • The inhaled dose is usually not high enough to produce risks to the patient's attendants. Its effect on the patient will depend on the types and activity of radioactive material. There is a need careful examination to access external contaminations. • There is a need for specific measures to minimize the effects of internal contamination.
Category D	• Patients with external contamination of the skin and clothing. • This constitutes a potential risk to both patients and the patient's attendants. • Adequate protective measures need to be taken and the treatment should be in a specially designated area and away from other patients and public. • Immediate protective measures such as removal of clothes and washing of the skin should be done after patient has been stabilized. • Items removed need to be collected in radiation hazard labeled plastic bags and sent to radiation laboratory for analysis.
Category E	• Patients with contaminated wound and possible internal contamination. Like category D there is slight risk to patient's attendants and public. • Procedures similar to those in category D should be carried out. Care must be taken not to cross contaminate the cleaner part of the skin from the wounded areas or-vice versa. Any wound excision/debris should also be sent for analysis. • Measures to minimize the internal contamination and incorporation of radioactive substances are required.

KEY PERSONS IN RADIATION EMERGENCY RESPONSE

Response to radiation emergencies should be well planned and implementation should be smooth to avoid delays in the delivery of care and necessary treatment. The following are important key personnel for administration during the response. Roles and functions are listed in Appendix 1.

- Medical Executive on Duty (MEOD) .
- Emergency Attending Physician (EAP) .
- Radiation Protection Officer (RPO) .
- Radiation Emergency Room Personnel .

ORGANIZATIONAL CHART



RESPONSIBILITIES OF KEY PERSONNEL

Emergency Attending Physician

The Emergency Attending Physician is the responsible physician in charge until the patient is admitted to a service department/unit or released from the RER. He in charge of initiating procedures to prepare for receipt of the radiation emergency case. He is responsibilities are:

- Inform the Head of the emergency department who will subsequently inform the MEOD who will inform the EOD.
- Instruct the Emergency Department's Supervisor to open rooms in emergency department including surgical wards.
- Instruct ER supervisor to prepare and assemble the medical emergency response team (MERT) which will compose of the following:

  - ED doctor
  - Staff nurse (S/N)
  - Health attendant

  The team will be sent to the site for response upon instruction by EAP on call and the RPO.
- Facilitate and supervise preparation for management of patients.

Radiation Protection Officer (RPO)

The Radiation Protection Officer is responsible for:

- Maintaining the necessary radiation and contamination survey instruments and supplies;
- Periodic checking of the emergency locker;
- Keeping his staff trained in emergency procedures;
- Planning and conducting radiation emergency drills with other members of the emergency team;
- Instituting contamination control procedures;

- Surveying for radiation and radioactive contamination;
- Advising the Emergency Team as to contamination and radiation levels and corresponding actions;
- Supervising decontamination and waste disposal;
- Arranging for whole body counting and radioassays;
- Distributing PPE and radiation personal monitor and evaluating doses;
- Performing dose assessment;
- Keeping dose records;
- Preparing report;
- Informing the Head of the emergency department who will subsequently inform the MEOD who will inform the EOD.
- Instructing the Emergency Department's Supervisor to open rooms in emergency department including surgical wards.
- Instructing ER supervisor to prepare and assemble the medical emergency response team (MERT) which will compose of the following:

  - ED doctor
  - Staff nurse (S/N)
  - Health attendant

  The team will be sent to the site for response upon instruction by EAP on call and the RPO
- Facilitating and supervising preparation for management of patients.

Radiation Emergency Room Personnel

The radiation emergency room personnel are responsible for:

- Obtaining as much information as possible about the emergency at the initial contact.
- Receive the persons who are potentially exposed or contaminated from the incident.

- Assist the physician and the RPO if required.
- Assist in the transfer of persons who are not contaminated.

FACILITIES REQUIRED FOR RADIATION EMERGENCY RESPONSE

Radiation Emergency Room (RER)

The RER is a designated room for receiving the potentially exposed or contaminated persons.

The RER should have the following features:

- Access from more than one side (direct access from the outside is a useful convenience).
- Has convenient access to equipment for washing both ambulatory and injured persons.
- Has a floor plan that will permit convenient decontamination work with minimal opportunity for cross contamination of clean areas in the building.
- Location of this room should be such that access and egress could be made freely and conveniently without any hindrance or obstruction, and isolation from the rest of the hospital could be easily implemented whenever necessary.

Emergency Clinic

This particular clinic has the responsibility of providing radiation emergency training to the attending physician in conjunction with the Radiation Safety Office training program.

Decontamination facility

Dedicated facility includes sink for washing contaminated hands and instruments and dedicated bathroom. Eye decontamination facility must be available.

Radiation Emergency Kit

The radiation emergency kit should always be available and could be accessed at any time. It have the following:

- Radiation survey meters for low and high energies
- Contamination meters
- Absorbent pads with plastic backing
- Active personal radiation monitors
- Ropes
- Radiation signage
- Paper towels
- Cotton tip applicators
- Plastic bags for radioactively contaminated wastes and other materials
- Wipe papers
- Decontamination solution
- Disposable gloves
- Disposable gowns
- Shoe covers
- Mild soap bars
- Paper and pencil for recording
- Hospital Radiation Safety Manual

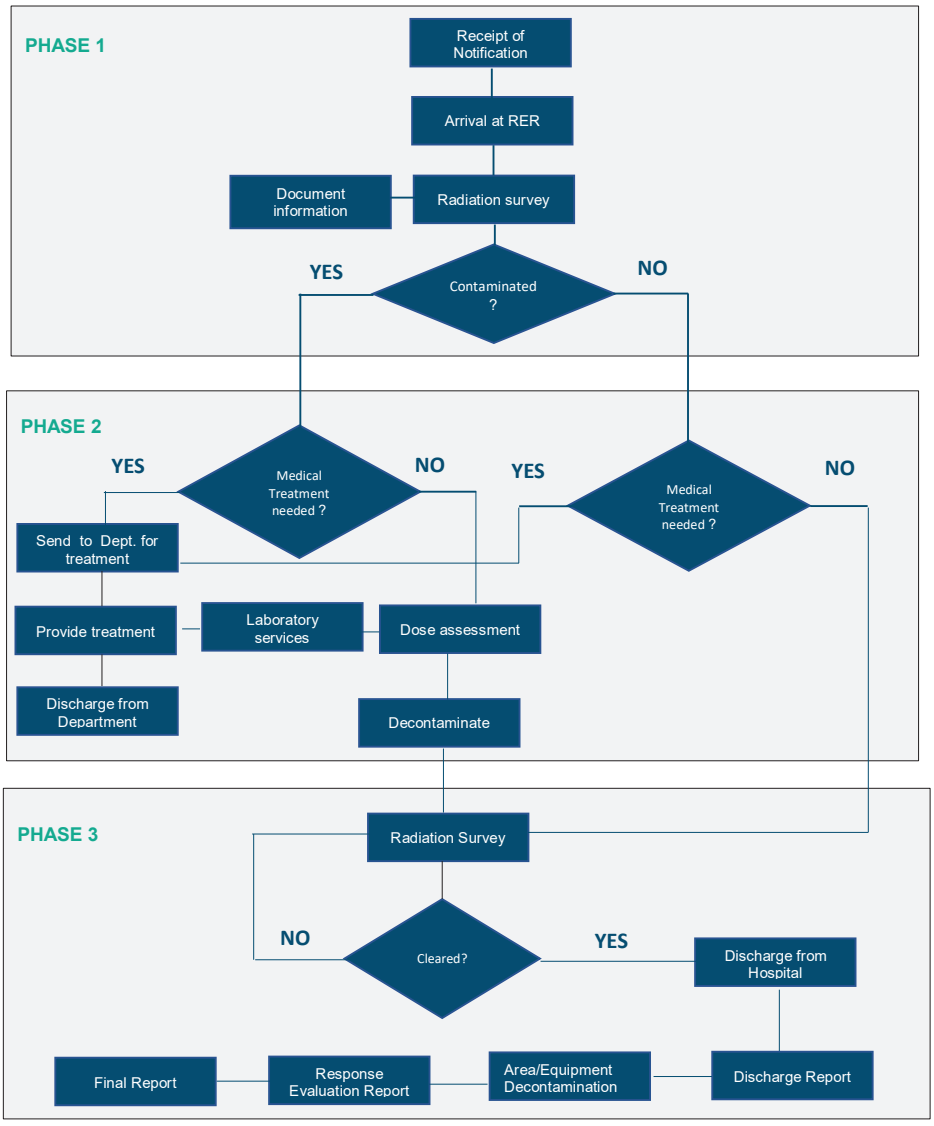
GENERAL PLAN FOR LARGE SCALE RADIATION EMERGENCY

Response to large scale emergencies requires participation of more hospital departments and personnel. Management of radiation injured persons vary with the extent and amount of radiation exposure.

This document divides the response actions into three phases:

Phase 1	Receipt of the request for accepting radiation injured persons and arrival at the RER.
Phase 2	Medical management and treatment of radiation injured persons and decontamination of persons, equipment and areas.
Phase 3	Clearing of persons, equipment and areas, evaluation of response and report submission.

Response actions are shown in the flowchart below.



RECEIVING NOTIFICATION OF RADIATION INJURED PERSONS

The receiver of the notification should document all information regarding the potential or radiation exposed persons. He shall:

Record all the information needed in Appendix 2. The data gathered will serve as the initial information before the reception to the hospital. The information shall be forwarded to the RPO if the receiver in another staff in the Emergency Room.

The RPO upon receipt of the notification shall:

- Obtain as much information as possible about the nature of the accident and the likelihood of contamination.
- Notify additional personnel if warranted.
- Meet all concerned in the emergency clinic for briefing
- Assemble required supplies and instruments.
- Proceed to the RER.
- Distribute personal dosimeters to RER personnel.

RECEPTION OF A CONTAMINATED AND INJURED PATIENT

The earlier the notification the more time the Hospital has to prepare the RER for the reception of the patient.

In case an unannounced contaminated person arrives to the Hospital, the following should be followed:

- Call the RPO.
- If there is any reason to suspect radioactive contamination before the patient is brought to RER, the RPO should go to the ambulance (or other means of transport) and check the patient's type and level of contamination and medical condition.
- The patient should remain in the ambulance until the RER is prepared.
- If possible, when external contamination is involved, save all clothing and bedding from ambulance for radiation and contamination survey of the RPO.
- Prepare for receiving contaminated person(s). A floor area adjacent to the table should be covered with absorbent paper. This area should be adequate for stretcher-cart and professional attendants.
- If the patient has already been admitted to the Emergency Room before contamination was suspected or detected, then that area of the

Emergency Room should be immediately isolated. The patient should be immediately surveyed, and if contaminated, transferred to the RER.

- All personnel, equipment, and supplies that were in the area must be surveyed, and if necessary, decontaminated under the supervision of the RPO personnel.

The RPO shall:

- Assist emergency team. Check integrity of contamination control at this time.
- Establish a checkpoint and monitoring station for entry and exit from the contamination control area.
- Survey patient(s) and advise physician in charge on external radiation levels to personnel and on patient contamination.
- Survey personnel equipment and facilities and designate those that must be restricted for contamination.
- Supervise decontamination of personnel and facilities and release areas that are not contaminated.
- Direct handling of radioactive waste.
- Arrange for whole body counting and radioassays of clothing, urine, etc. as required.
- Perform instrument and wipe survey before releasing ambulance. If possible, when internal contamination is involved, save all blood, urine, stool and vomitus.
- If neutron exposure is involved, save all metal objects (e.g. jewelry, belt buckles, dental plates, etc.).
- Label with name, date and time. Mark container “Radioactive - Do not discard”

MANAGING PATIENTS ARRIVING AT THE RER

Emergency Attending Physician and RER personnel shall:

- Upon receiving the notification must wear full Personal Protection Equipment (PPE). This PPE include head cover, goggles, mask, gown, apron and shoe cover.
- Notify the RPO of the arrival of the radiation injured person for radiation and contamination survey.
- Ensure that contaminated patients declared by the RPO or are

managed in RER. This area is a restricted area.

- Assist the RPO in the initial assessment and survey.
- If seriously injured, give emergency life-saving assistance immediately.
- Handle contaminated patient and wound as one would in a surgical procedure, i.e. gown, gloves, cap, mask, etc.
- The physician, if confronted with a grossly contaminated wound with dirt particles and crushed tissue, should be prepared to do a preliminary simple wet debridement. Further measurements may necessitate sophisticated wound counting detection instruments and should be referred to the RPO.
- If internal contamination is suspected after external contamination, request a whole body count as soon as patient's condition permits.
- Ensure that no decontamination is done inside the RER but only in the designated decontamination areas. room of Emergency Department is used for this area
- Arrange for the immediate transfer of patients to the department where immediate treatment is needed after the radiation survey.

Staff Protection

The RPO shall:

- Provide instructions on handling contaminated patients.
- Provide PPE and personal monitors.
- Advise physicians, nurses and other staff on the estimated doses and instruct on ways to reduce exposure
- Require attending staff to immediately ask for frisking and radiation at any instances of contamination.
- Require the staff to immediately report any contamination in the room.

Large amounts of beta-gamma emitting contaminants may present a radiation hazard to physicians, nurses and other attendants. The potential exposure situation can always be evaluated rapidly with portable beta-gamma survey instruments. Improvised shielding may be necessary if a special shielded decontamination facility is not available. In order to estimate the skin exposure on the hands of the surgeon, Thermoluminescent dosimeters can be taped at a location on the palmar side of the hand that will not interfere with tactile

sensation or grip. If the contaminant is a weak beta emitter such as 3H or ‘4C, double gloves should provide sufficient protection.

The IAEA provide the total effective dose guidance for radiation workers responding to emergencies as listed below:

TASK	DOSE GUIDANCE (mSv)
Lifesaving actions.	< 500
Prevent serious injury. Avert a collective dose. Off-site ambient dose rate monitoring (gamma dose rate).	< 100
Short term recovery operations Implement urgent protective actions monitoring and sampling.	< 50
Longer term recovery operations work not directly connected with an accident	Occupational dose limit*

*This dose can be exceeded if justified but every effort shall be made to keep dose below this level and certainly below the thresholds for deterministic effects. The workers should be trained on radiation protection and understand the risk they face. They must be volunteers and be instructed on the potential consequences of exposure.

DECONTAMINATION

Decontamination should start if medical status permits with cleansing and scrubbing the highest contamination first. If only an extremity is involved, the clothing may serve as an effective barrier and only the affected limb may need to be scrubbed and cleaned. If the body as a whole is involved, and if the clothing is generally permeated by contaminated material, showering and scrubbing will be necessary. Give special attention to hair parts, body orifices and body folds. Remeasure with survey instrument and record measurement after each washing or showering. If wound is involved, prepare and cover wound with a gauze bandage.

In the event of a major contamination where the level is more than 20,000 dpm, the RPO shall be called.

Decontamination of Patients

Decontamination of injured patients should be properly managed in hospitals where they are brought. Appendix 3 lists some ways of hospital management.

- As soon as the patient's condition permits, and prior to showering or washing of face, nasal swab samples should be obtained. The sample should be collected on a moist, clean, cotton-tip applicator or on moist filter paper on a swab stick. Use a separate swab for each nostril and place in a separate test tube or plastic bag labeled with patient's name, sample collection time and date and send to counting laboratory

- A specific room shall be designated as a decontamination facility. The room's floor shall be covered with absorbent paper with plastic backing.

- Thorough washing of the patient with mild soap and water and gentle brushing of the skin shall be done.

- The addition of a chelating agent (e.g. 1% Na EDTA or Ca EDTA) helps bring the contaminant in a complex as it is freed from the skin.

- The use of abrasive soap or abrasive granules helps remove contamination held by skin protein or remove a portion of the outer layer of the skin if needed. The use of sodium hypochlorite (household bleach) is useful in some difficult areas.

Handling of Contaminated Wounds

- Report to ER all wounds requiring medical attention.

- Clean with mild detergent and flush with isotonic saline or water. If necessary, a topical an aesthetic, such as 4% lidocaine, can be used to allow a more vigorous cleansing. After a reasonable effort, there is no need to attempt to remove all contamination since it will probably be incorporated into the scab.

- Whenever radionuclides have entered the skin via a needle or sharps, induce the wound to bleed by "milking" it as a cleansing action, in addition to the use of running water.

- Perform radiation survey at the surface.

Handling of Contaminated Eye

Where eye contamination is found, the eye should be flushed profusely with isotonic saline or water. Refer to the EAD if there are signs of eye irritation .

Handling of Contaminated Hair

If hair is contaminated, try up to three washings with liquid soap and rinse with water. Prevent water from running onto face and shoulders by shielding the area with towels. Perform a radiation survey.

Handling of Contaminated Skin

- Remove any contaminated clothing before determining the level of skin contamination. Levels below 0.1 mR/hr are considered minimal hazards. Nevertheless, mild decontamination procedures should be initiated when possible.

- If there is gross skin contamination, it shall be given attention first. Wipe with cotton swab moistened with water and liquid soap and held using forceps. Place all swabs in a plastic container for later radiation level measurement.

- If able, the person should have a 10-minute shower. Dry the body with a towel in the shower room and monitor the radiation level over the whole body. Do not allow any water to drip on to the floor outside the shower room for there might be a spread of contamination.

- Place all the towels and any other contaminated clothing in a plastic bag for later monitoring of radiation level and proper disposal.

- Specific hot spots on the skin should be localized with a survey meter or an appropriate contamination monitor including those for H-3, C-14, S-35, etc.

    - Clean the specific areas with mild soap and warm water. Avoid using detergents or vigorous scrubbing, for they might damage the skin. The use of a soft brush is adequate.

    - Wash for 1-2 minutes, rinse and dry. Pay particular attention to fingernails and areas between fingers. Monitor, repeat if contamination is still present.

    - For stubborn contamination, covering a contaminated area with plastic film or disposable cotton or latex gloves over a skin cream will help remove the contamination through sweating.

Protection of Personnel and Facilities During Decontamination Procedures

- Personnel shall wear surgical scrubs, surgical caps and gowns, disposable rubber or plastic gloves, disposable face masks and shoe covers.
- The team leader should be able to recognize the need for masks, respirators or supply air packs due to high alpha or beta radionuclide contamination.
- Those performing patient decontamination with liquids shall wear plastic or rubber laboratory aprons.
- If required, air-conditioning units or forced air heating systems should be turned off so that radioactive particulate are not carried into the duct systems or other rooms.
- Floor shall be covered with absorbent materials with plastic backing to prevent the spread of contamination and to make the clean-up easier.
- All contaminated clothing shall be placed carefully into plastic bags with the appropriate radiation sign and label for later monitoring and proper disposal.
- Splashing of solutions used in decontamination shall be avoided.
- Patients and potentially contaminated personnel shall move to clean (non-contaminated) areas only after the radiation survey has been done on them and results show satisfactory decontamination. Similarly, all passage of persons or transfer of property from contaminated to clean areas shall be done only after the radiation survey and monitoring results show acceptable levels.
- Supplies shall be passed from clean to contaminated areas.
- Contaminated wastes shall be placed in the designated waste container with the label: “CAUTION – RADIOACTIVE MATERIALS”. The container should be lined with a clear plastic bag. This shall be provided by the RPO.
- Personnel dosimeters shall be supplied by RPO to all persons working in decontamination area. Personnel with an effective dose of 20 mSv shall be pulled out.
- Entry of non-essential personnel including family, visitors and administrative persons shall not be allowed.

Decontamination of Tools and Equipment

Techniques for the removal of contamination from facilities are generally subject to consideration of the value of the contaminated items and the durability of the surfaces, which are contaminated. Where the half-life of the radionuclide is short, it may be desirable to store tools and glassware for decay of activity rather than to attempt decontaminating them.

There are two broad classifications of materials: corrosive and non-corrosive. It is always desirable to use the non-corrosive method of decontamination whenever possible. Simple washing with detergent and water may be effective. If this fails, more aggressive techniques such as the examples given below may be tried:

- The use of acid on metal tools may corrode them although it is effective in cleaning. However, it may cause greater difficulty in future decontamination procedures. Some elements (e.g. iodine) may become volatile upon reaction with acids; therefore, this work should be done inside a fumehood.

- Metal objects may be decontaminated with dilute nitric acid, a 10% solution of sodium citrate or ammonium bifluoride. When all other procedures fail or for stainless steel, use hydrochloric acid. This is a good decontaminant, in that it removes some of the surface contamination. However, polish is an excellent decontaminant for brass.

- Glass and porcelain articles may be cleaned with nitric acid, ammonium citrate, trisodium phosphate, glass cleaning solution or ammonium biflouride. When the glaze is broken on porcelain, or when active solutions are heated to extreme dryness in glass, decontamination is very difficult and usually, it is more convenient to replace them.

- Plastics may be cleaned with ammonium citrate, dilute acids or other appropriate solvents. Some plastics may be damaged by this technique. It should be noted that the effectiveness of a decontaminating process is, for all practical purposes, complete at the end of the second repetition of the process. If necessary, other methods should be considered for further decontamination.

The decontamination of equipment are listed in Appendix 4.

Water used for decontamination will need to be considered as active liquid waste and the potential arrangements for disposal of such waste will need to be addressed in emergency planning. Arrangements will normally need to be agreed with the relevant regulatory authority for liquid waste. However, if there is an urgent need for flushing of contaminated surfaces, then keeping below the following levels will probably be acceptable.

- Discharges to sewers : 20 MBq per 5000 litres.
- Discharges to waterways : 2 MBq per 5000 litres.

DISPOSAL OF RADIOACTIVE WASTES

Once the emergency situation is stable, and survey activities have been completed, assess the need for removal of waste materials.

- Location the radioactive storage room of the hospital. If there is no designated room, request for a possible temporary storage room preferably in the basement of the hospital or away from busy areas.
- Survey each waste container for radiation level
- Categorize wastes by type (solid or liquid), level of activity and volume.
- Label the package with the radiation level, radioisotope and date of disposal
- Determine the appropriate means to transport the wastes from the emergency scene to the designated storage room.
- Volume and packaging will dictate the size and type of vehicle(s) required for transfer for the final depository site. The need for in-transit security should also be considered for transfer of radioactive wastes.

The RPO shall always be in command for the disposal of the radioactive wastes.

CONCLUSION OF EMERGENCY PROCEDURES GUIDELINES

Upon completion of emergency procedures, patient should be handled according to the following guidelines:

- Decontaminated and no injuries requiring hospitalization - Discharge.
- Decontaminated and injured – Admit to designated room.
- Irradiated - Admit to designated room for radioactive patients.
- Serious radiation exposure, serious internal contamination, and/or external wound contamination not responsive to decontamination
  - Admit to designated room for radioactive patients with special contamination control procedures.

Post-Emergency Phase

Once the emergency is over:

- Obtain dose assessment from the radiological assessor,
- Ensure continued medical follow-up of persons sent to hospital(s),
- Inform the media and the public,
- Inform all organizations that have been activated that the emergency is under control.

Ensure that all actions, decisions and/or recommendations have been registered. Save all records, maps, status board, etc. See Appendix 5.

Reconstruct the Education, accident, evaluate the response and sum up lessons learned. If needed update the response plan accordingly.

Submit a final report (Appendix 6)

SMALL SCALE RADIATION INCIDENT

SPILL OF RADIOACTIVE MATERIALS

If a radioactive material is spilled or released to the atmosphere, or a sealed source ruptures, or if a survey indicates significant contamination, the person in charge shall promptly notify the RPO and immediately initiate the following remedial measures:

- Perform a radiation and contamination survey to determine the degree and extent of contamination.
- Isolate the contaminated area to avoid spread of contamination. No person shall be allowed to enter the room.
- Rapidly define the limits of the contaminated area. Immediately confine the spill by covering the area with absorbent materials with plastic backing. If the spill is a dry material, place dampened absorbent material over the contamination to prevent the spread. Masking or adhesive tape may be used to remove loose contaminants. Then, ordinary water and detergent may be used. A heavy coating of wax may also be used. Any remaining contamination may be removed by stripping off the wax. This shall be done with the supervision of the RPO.
- Use gloves, shoe covers, lab coat and other appropriate clothing.
- First remove the “hot spots” and then scrub the area with absorbent materials, working towards the center of the contaminated area. Special decontamination chemicals (e.g. Rad-Con) may be used in the case of a severe spill.
- All personnel shall be surveyed to determine contamination, including their shoes and clothing. If the radioactive material is relatively hazardous and appears to have become airborne, the nostrils and mouth of possible contaminated persons should

be swabbed and the sample shall be evaluated by the RPO.

- Shut off ventilation if possible and appropriate.
- A contaminated individual may shower in the designated decontamination facility as directed by the RPO. Disposable footwear and gloves shall be worn in transit.
- If significant concentrations of iodine have been involved, subsequent thyroid uptake measurements should be made on potentially exposed individuals.
- Monitor the decontaminated area and all personnel leaving the area after the cleanup Particular attention should be paid to checking the soles of shoes and hands.
- All mops, rags, brushes and absorbent materials shall be placed in the designated waste container and should be surveyed by the RPO. Proper radioactive disposal shall be observed.

The RPO shall provide the final radiation survey and advice. He shall report the incident and the subsequent actions undertaken to the Chairman of the concerned department and the Radiation Safety Committee and, if of sufficient magnitude or concern, to the Administration.

The cause of the accident shall be investigated and recommendations shall be made to avoid the recurrence.

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1. International Atomic Energy Agency, IAEA-TECDOC-1162 “Generic procedures for assessment and response during a radiological emergency “, 2000.

2. King Faisal Specialist Hospital and Research Center, Radiation safety Manual, 2000.

3. US Environmental Protection Agency, PAG Manual Protective Action Guides and Planning Guidance for Radiological Incidents.

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5. Oak Ridge Institute of Science and Education, The Medical Aspects Of Radiation Incidents, 2017.

APPENDIX 1

Roles and Functions of Involved Personnel

PERSONNEL	FUNCTION
Hospital Director/CEO	Oversee the overall hospital response operation.
Emergency Attending Physician/ Head of ER	Coordinate clinical activities.
Administrative Coordinator	Coordinates hospital non-clinical response and assures normal hospital operations.
Head of Departments	Support clinical needs and expertise
Radiation Protection Officer (RPO)	Leads in technical advices and assists coordination.
Emergency Doctors/ physicians	Diagnose, treat and provide emergency medical care; can also function as team coordinator or triage officer.
Nuclear medicine technologist	Assists in decontamination and clean-up
Triage officer	Performs triage.
Nurse	Assists physician with medical procedures, collection of specimens, radiological monitoring, and decontamination, assesses patient needs and intervenes appropriately.
Public Relation Officer (PRO)	Manages media needs and releases information to public and media based on Hospital Director's instructions.
Chief Pharmacist	Provides pharmaceutical support
Dietitian	Provides food with disposable utensils for patient and emergency team.
Hospital support service	Provides maintenance support
Security personnel	Ensures security at the radiation emergency area

APPENDIX 2

RADIATION ACCIDENT REPORT FORM

1. Information about the Facility					
Facility Name					
Mail box		Postal code		City	
TEL.		Fax		EXT	
Facility type	☐ Government sector			☐ Private sector	
Commercial Register No					
Business type					
License number		License expiration date			
Facility Manager		Mobile number			
Radiation Protection Officer		Mobile number			
License number of the Radiation Protection Officer		License expiration date			
2. Information about the radiological accident					
Place of the accident					
Date of the accident					
Time of the accident					
Type of radioactive source in the incident					
Nature of the accident	☐ Radiological Exposure ☐ Stealing of source ☐ Escape from container		☐ Contamination ☐ loss of source		
Incident site according to the Global System (GPS)					

3. Information on the radioactive source						
#	Radiated source	Radiological activity	Physical state	Emission type	Serial Number	Severity class (IAEA)

4. Devices and tools used in emergency response			
#	Device or tool	Purpose of use	Measurement unit

5. Radiation dose rates for the radioactive source					
#	Radiated source	Radiological activity	Dosage rate		Physical state
			distance (m.)	mSv / (hr.)	

6. Persons exposed by the radiological accident					
#	Name of the exposed	Categorization of the exposed (worker / patient/ public)	Does exposed carry a personal measure instrument?	Effective dose (mSv)	Exposure Level (Normal, Medium, High)

* Exposure Level:

1. Normal = less than < 1 mSv
2. Mean = between 1 mSv and 5 mSv
3- High = greater than> 5 mSv

7. Program of the radiological response to the preparation of this report		
#	24-Hour Time (00:00)	Action
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

8. Government agencies Which has been notified of the radiological incident					
Government Authority	Recipient Notification	Date of notification	Time of notification	Method of reporting	Method of responding

9. Environment surrounding radiation incident		
#	Item	Illustration
1.	The presence of a fire or not near the radioactive source.	
2.	The presence of flammable materials near the accident location.	
3.	The presence of other chemicals.	
4.	The type of radiation hazards expected from the accident.	
5.	Climatic conditions associated with the accident.	
6.	Has there been a leakage of the radioactive material?	

10.	Possible developments of the radiological event
#	
1.	
2.	
3.	
4.	
5.	
6.	
7.	

11.	Recommendations of the Radiation Response Team
#	
1.	
2.	
3.	
4.	
5.	
6.	
7.	

12. Radiation Response Team			
#	The name	Responsibility (Head / Member)	Role
1.			
2.			
3.			
4.			
5.			

13. Head of the Radiation Response Team		
Name	Signature	Date

14. Head of the facility concerned with the radiological accident			
Name	Signature	Date	Stamp of the facility

Radiation Contamination Survey Report

Date: ____________	Time: _____
Institute name: _____	Region:_____
Surveyed by :_____	Surveyor signature : _____

Full Name: _____ ID: _____

Date of birth: _____/_____/_____ Sex: M F

Location(s) during emergency:

_____

Time spent at each location:

_____

Date of exposure: _____________ Time of exposure: _____

Intake pathway (if known): Inhalation Ingestion Skin absorption wound

Person externally decontaminated Y N

Date of measurement: ____________ Time of measurement: _____

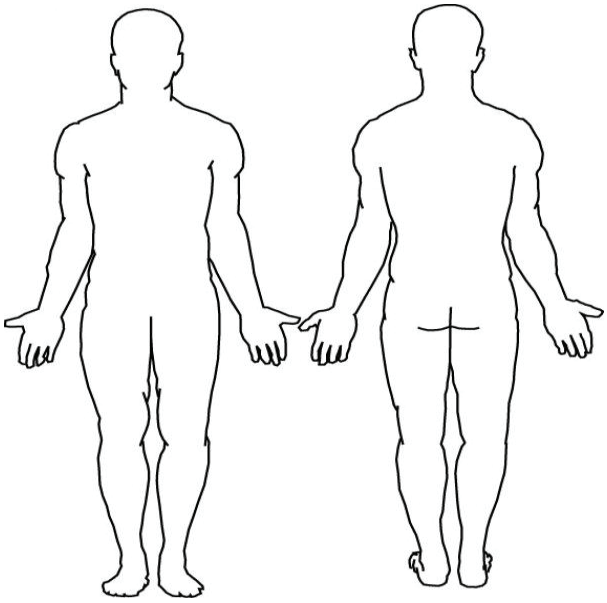
Results of measurement

Instrument type: _____ Model: _____S/N: _____

Background reading: _____ [cps] Detector active Surface: _____ [cm^2]

Date of calibration: ____________ Background reading: _____ [cps]

Mark location of contaminated areas on the charts below:



Levels following Decontamination:

Body Location Ex(arm, foot, head)	Decontamination Method	1st Attempt	2nd Attempt	3rd Attempt

APPENDIX 3

HOSPITAL MANAGEMENT OF RADIOACTIVELY CONTAMINATED PATIENTS

PLANNING AND PREPARATION

1. Assemble decontamination team to include: physicians, nurses and technologists.

2. Use a pre-selected area suitable for decontamination of patients with the following criteria:

    a. Near outside entry
    b. Showers with hot and cold water
    c. Floor drains
    d. Table suitable for wash down
    e. Ease of room wash down
    f. Ability to isolate air movement from air-conditioning or heating

3. Plan to evaluate medical condition immediately to determine priority of need for medical or surgical procedures, essential diagnostic procedures and decontamination.

4. Move patient as little as possible to minimize spread of contamination. Keep patient in selected area for medical and minor surgical treatment until loose contamination is removed.

5. Have the RPO monitor area entrances and hallways to prevent “tracking” to other areas.

6. Consider the need for monitoring stations at exits. Personnel should not leave the isolated area unless monitored for contamination.

7. Prepare decontamination room supplies and identify the location for rapid use.

APPENDIX 4

Guidelines on Decontamination of Equipment

The decontamination of equipment should follow the following guidelines:

- Contaminated equipment shall not be released from control of the laboratory for repair or any other purpose until the level of activity has been reduced to a safe limit.
- Where the half-life of the contaminating element is short, it may be desirable to store the item for decay of activity rather than to attempt to decontaminate.
- Equipment that is contaminated with long half-life radionuclides and which cannot be decontaminated must be regarded as a radioactive waste and shall only be disposed through the approval and proper guidance of the RPO.
- If it is necessary to dismantle any equipment prior to decontamination, careful survey shall be made during the operation.
- If the items are cheap or can easily be replaced, it may be advisable to dispose such equipment in a recommended manner and replace with new equipment.
- Glass blowing, welding, brazing, soldering, etc., should never be permitted on equipment contaminated with radioactive materials unless it is done in specially ventilated facilities and unless special techniques are used to prevent the inhalation of radioactive fumes and dust.

APPENDIX 5

Immediate Response Action Record

Immediate response action	Time Initiated	Time completed	Remarks
Initial instruction provided			
Responder arrived at scene Medical responder Police Fire service			
First on-scene controller in RER			
Safety perimeter established			
Access/egress control established			
Contamination control established: Staff Public			
Emergency staff protection Personal monitors PPE			
Transfer to other Dept from RER			
Spill Control Confined Cleaning up			
Contamination survey of patients			
Contamination of staff			
Decontamination Patients Areas Equipment			

Recorded by:_____ Date: _____

Designation: _____

Name of Hospital: _____

APPENDIX 6

How to Prepare the Accident Report

A formal report should be prepared for all radiological emergencies. These reports are helpful for documentation of important accident information including the general description, location, date, persons involved, estimates of exposure/contamination, medical actions, environmental aspects, and initial aspects for accident mitigation. These reports may also serve as a basis for accident investigation to determine causes and consequences, as well as, provide useful information to aid in the prevention of future accidents. Reports also provide information to assist experts in assisting the host country with accident mitigation. At a minimum each report should contain the following:

SUMMARY

Brief description of the accident, its causes and consequences, response actions, lessons learned; main conclusions and recommendations (if any).

DESCRIPTION OF THE ACCIDENT

- Initiating events.
- Location of the accident.

Use as many descriptors as needed: country, republic, state, administrative district, city, facility, laboratory, etc.

- Accident date and time.

Event contact
Name, telephone number, fax, e-mail.

Accident environment
Irradiation facility, isotope production, industrial radiography, research, medical diagnosis/therapy, transportation, public domain, military, non-military, nuclear R&D, other (specify).

Source or radiation devices
Critical assemblies, reactors, or chemical assemblies; indicate known or estimated activity, specify transuranics, tritium, fission products, radionuclides eg. Co-60, Cs -137, Ir –192; sealed sources, X ray devices, accelerators, radar generators etc.).

Radiation type
Gamma, beta, gamma-neutron, X ray, alpha.

RESPONSE TO THE ACCIDENT

Initial action upon discovery, protective actions for emergency workers, public; remedial actions.

HUMAN CONSEQUENCES

Nature of exposure.
External exposure, external contamination, internal contamination.
- Number of persons involved.
- Number of injured, exposed, and contaminated.

Medical assistance and medical follow-up (if any)

ENVIRONMENTAL CONSEQUENCES

- Type of contamination.
- Waste disposal.

DOSE ASSESSMENT

Dose estimates for emergency workers and persons involved.

CONCLUSIONS AND RECOMMENDATIONS

Lessons learned, follow-up activities, recommendations for accident prevention, upgrading emergency response.

وقاية
Weqaya
المركز الوطني للوقاية من الأمراض ومكافحتها
Saudi Center for Disease Prevention and Control