

RADIATION ACCIDENT PLAN

Managing the Emergency Care of Patients

Contaminated with Radioactive Materials

- Notification and Accident Verification
- The Radiological Emergency Response Team
- Goals of Contamination Control
- Techniques of Contamination Control
- If Radioactive Contamination Is Discovered After Patient Has Been Admitted
- Response Team Preparation
- Treatment Area Preparation
- Hospital Emergency Care of the Radiation Accident Patient

Notification and Accident Verification

When the facility receives a call that a radiation accident victim is to be admitted, a planned course of action should be followed. The individual receiving the call should get as much information as possible, including the following:

1. Number of accident victims
2. Each victim's medical status and mechanism of injury
3. If victims have been surveyed for contamination
4. Radiological status of victims (exposed vs. contaminated)
5. Identity of contaminant, if known
6. Estimated time of arrival

If any doubt about contamination exists, assume the victim is contaminated until proven otherwise. Advise ambulance personnel of any special entrance to the emergency department for the radiation accident victim. If the accident notification comes from a source other than usual emergency communications, get a call-back number and verify the accident prior to assembling the radiological emergency response team and preparing for patient admission.

The Radiological Emergency Response Team

Each member of this team should be familiar with the hospital's written plan and be required to participate in scheduled drills. More frequent drills (quarterly or semiannually) should be considered by subgroups such as decontamination, triage, or radiological monitoring. Special training must be instituted to accommodate staff turnover. Training should also be part of the hospital inservice program and should include EMTs and paramedics since they play an important role in assisting the emergency department staff through notification procedures before arrival and proper transport of radiation accident victims.

Radiological Emergency Response Team	
Personnel Role	Function
Team coordinator	Leads, advises, and coordinates
Emergency physician	Diagnoses, treats, and provides emergency medical care; can also function as team coordinator or triage officer
Triage officer	Performs triage
Nurse	Assists physician with medical procedures, collection of specimens, radiological monitoring, and decontamination; assesses patient's needs and intervenes appropriately
Technical recorder	Records and documents medical and radiological data
Radiation safety officer	Supervises all aspects of monitoring and contamination control
Radiation safety personnel	Monitors patient and area and advises on contamination and exposure control; maintains survey equipment
Public information officer	Releases accident information to public media
Administrator	Coordinates hospital response and assures normal hospital operations
Security personnel	Secures the radiation emergency area and controls crowds
Maintenance personnel	Aids in preparation of the radiation emergency area for contamination control
Laboratory technician	Provides routine clinical analysis of biological samples

**The Goals of Contamination Control are to Prevent the Spread
of Radioactive Materials From:**

A. The patient

In most circumstances the victim will be the source of the contamination; however, in rescue and extrication, some contamination may have been transferred to others.

B. The rescue personnel

C. The gurney and equipment used in patient care (stethoscope, BP cuff, etc.)

D. The ambulance

This contamination can be transferred to:

1. Care providers as they touch or move the patient to correct the medical problem
2. The equipment used to assess the patient's condition and to treat the medical emergency
3. The surrounding area (treatment gurney, floor, etc.)
4. In rare cases where dust or powders are present, the air could contain radioactive particles

Techniques of Contamination Control

1. Set up a controlled area large enough to hold the anticipated number of victims.
2. Prevent tracking of contaminants by covering floor areas and monitoring at exits of controlled areas.
3. Restrict access to the controlled area.
4. Monitoring *anyone* or *anything* leaving the controlled area.
5. Use strict isolation precautions, including protective clothing and double bagging.
6. Use a buffer zone or secondary control line for added security.
7. Control waste by using large, plastic-lined containers for clothing, linens, dressings, etc.
8. Control ventilation.
9. Change instruments, outer gloves, drapes, etc., when they become contaminated.
10. Use waterproof materials to limit the spread of contaminated liquids; for example, waterproof aperture drapes.

If Radioactive Contamination Is Discovered After Patient Has Been Admitted

1. Continue attending to the patient's medical needs.
2. Secure entire area where victim and attending staff have been.
3. Do not allow anyone or anything to leave area until cleared by the radiation safety officer.
4. Establish control lines, and prevent the spread of contamination.
5. Completely assess patient's radiological status.
6. Personnel should remove contaminated clothing before exiting area; they should be surveyed, shower, dress in clean clothing, and be resurveyed before leaving area.

Response Team Preparation

Protective clothing

The purpose of protective clothing is to keep bare skin and personal clothing free of contaminants. Members of the radiological emergency response teams should dress in surgical clothing (scrub suit, gown, mask, cap, eye protection, and gloves). Waterproof shoe covers also should be used. All open seams and cuffs should be taped using masking or adhesive tape. Fold-over tabs at the end of each taped area will aid removal. Two pairs of surgical gloves should be worn. The first pair of gloves should be under the arm cuff and secured by tape. The second pair of gloves should be easily removable and replaced if they become contaminated. A radiation dosimeter should be assigned to each team member and attached to the outside of the surgical gown at the neck where it can be easily removed and read. If available, a film badge or other type of dosimeter can be worn under the surgical gown. A waterproof apron can also be worn by any member of the team using liquids for decontamination purposes.

This protective clothing is effective in stopping alpha and some beta particles but not gamma rays. Lead aprons, such as those used in the x-ray department, are not recommended since they give a false sense of security -- they will not stop most gamma rays.

Preparing the Treatment Area for Contamination Control

If possible, select a treatment room near an outside entrance. Clear the area of visitors and patients. Remove or cover equipment that will not be needed during emergency care of the radiation accident victim.

Several large plastic-lined waste containers will be needed. The treatment table should be covered with several layers of waterproof, disposable sheeting. Plastic bags in all sizes will be needed and should be readily available.

Survey instruments should be checked and ready for use before the patient arrives. Background radiation levels should be documented.

The treatment team should be prepared to meet the patient at the ambulance where the patient can be transferred to the prepared treatment gurney.

Covering floor areas

Rolls of brown wrapping paper or butcher paper three to four feet wide can be unrolled to make a path from the ambulance entrance to the decontamination room. Ordinary cloth sheets or square absorbent pads can be used if paper is unavailable. Whatever the floor covering, *it should be taped securely to the floor*. This route should then be roped off and marked to prevent unauthorized entry. The floor of the decontamination room or treatment area should be covered in a similar way if time allows. This will make cleanup of the area easier.

A control line should be established at the entrance to the decontamination room. A wide strip of tape on the floor at the entrance to the room should be marked clearly to differentiate the controlled (contaminated) from the non-controlled (uncontaminated) side.

Control ventilation

While it may be desirable that the room, or rooms, have either a ventilation system that is separate from the rest of the hospital or a means of preventing the unfiltered exhaust air of the radiation emergency area from mixing with the air that is distributed to the rest of the hospital, there is very little likelihood that contaminants will become suspended in air and enter the ventilation system. Hence, no special precautions are advised. (Ref.: AMA. A Guide to the Hospital Management of Injuries Arising from Exposure to or Involving Ionizing Radiation. 1984).

Patient arrival and triage

Meet the radiation accident victim at the ambulance or at a triage area established near the treatment area. Instruct EMS personnel to stay with their vehicle until they, their vehicle, and equipment are surveyed and released by a radiation safety officer.

During triage, consideration is given to medical and radiological problems. **Serious medical problems always have priority over radiological concerns** and immediate attention is directed to life-threatening problems. Radiation injury rarely causes unconsciousness or immediate visible signs of injury and is not immediately life threatening; therefore other causes of injury or illness **must** be considered.

Noncontaminated patients are admitted to the usual treatment area. **Contaminated** patients are admitted to a specially prepared area. When in doubt, a critically injured patient should be taken immediately into the prepared area. If the victim's condition allows, an initial, **brief** radiological survey can be performed to determine if the victim is contaminated. Any radiation survey meter reading above background radiation levels indicates the possibility of contamination. A more thorough survey will be performed once life-threatening problems are addressed.

The victim's contaminated clothing should be removed before arrival at the hospital (at the accident scene), if this can be accomplished without causing harm or delay. Otherwise, the clothing should be removed as promptly as possible (without compromising life or limb), using care to avoid spread of any contaminants embedded in or on the clothing. Clothing, and any accompanying sheets, blankets, etc. should be placed in a plastic bag. Care-givers should change gloves after handling clothing or other potentially contaminated items.

Assessment and treatment of the noncontaminated patient

Noncontaminated individuals can be cared for like any other emergency case. A specially prepared treatment area is not needed. Following attention to medical needs, question the patient to determine the possibility of radiation exposure from an external source. Remember, the victim of exposure without contamination poses no radiological hazard to anyone. If exposure is known or suspected, a stat CBC should be ordered with particular attention given to determining the absolute lymphocyte count. Be sure to record the time the blood sample is taken. For differential diagnosis, refer to acute radiation injury.

Assessment and treatment of the contaminated patient

Contaminated patients can have radioactive materials deposited on skin surfaces, in wounds, or internally (ingested, inhaled, or absorbed). Reassessment of the contaminated patient's airway, breathing, and circulation are done in the decontamination room prior to attention to the patient's radiological status. Level of consciousness and vital signs are assessed promptly and the patient's condition is stabilized. After examining the entire patient and identifying all injuries, a complete radiological survey should be done.

The patient should be questioned about allergies, currently used medications, any history of chronic or recent illness, and **recent nuclear medicine tests**. The patient's level of anxiety should be noted, and psychological support offered. A complete and detailed medical, occupational, and accident history should be taken, and a physical examination completed.

Certain clinical and radiological laboratory analyses (see Radiological and Clinical Laboratory Assessments section below) are essential to the care of the radiation accident patient. These laboratory tests are done to assess the biological effects of radiation injury; to identify abnormalities that might complicate treatment; to locate, identify, and quantify radionuclide contamination; and to provide information useful in accident analysis.

Radiological and clinical laboratory assessments

All samples **must** be placed in separate, labeled containers that specify name, date, time of sampling, area of samples, and size of area samples. It is suggested that blood, urine, feces, or other samples taken in the emergency treatment period be retained for subsequent investigation. Appropriate advice (legal, radiation safety, etc.) should be obtained regarding the storage and disposition requirements of collected samples.

Samples Needed	Why?	How?
<i>In all cases of radiation injury:</i>		
CBC and differential STAT (follow with absolute lymphocyte counts every 6 hours for 48 hours when history indicates possibility of total-body irradiation)	To assess the radiation dose; initial counts establish a baseline, subsequent counts reflect the degree of injury	Choose a noncontaminated area for venipuncture; cover puncture site after collection
Routine urinalysis	To determine if kidneys are functioning normally and establish a baseline of urinary constituents; especially important if internal contamination is a possibility	Avoid contaminating specimen during collection; if necessary, give the patient plastic gloves to wear for collection of specimen; label specimen "Number 1," with date and time
<i>When external contamination is suspected:</i>		
Swabs from body orifices	To assess possibility of internal contamination	Use separate saline- or water- moistened swabs to wipe the inner aspect of each nostril, each ear, mouth, etc.
Wound dressing and/or swabs from wounds	To determine if wounds are contaminated	Save dressings in a plastic bag. Use moist or dry swabs to sample secretions from each wound, or collect a few drops of secretion from each using a dropper or syringe; for wounds with visible debris, use applicator or long tweezers or forceps to transfer samples to specimen containers which are placed in lead storage containers (pigs)
<i>When internal contamination is suspected:</i>		
Urine: 24-hour specimen x 4 days	Body excreta may contain radionuclides if internal contamination has occurred	Use 24-hour urine collection container
Feces x 4 days		

Decontamination of the contaminated patient

Good judgment is essential in determining decontamination priorities. Since some radioactive materials are corrosive or toxic because of their chemical properties, medical attention might have to be directed first to a non-radiological problem if radioactive materials are components of acids, fluorides (uranium hexafluoride-UF₆), mercury, lead, or other compounds.

In general, contaminated wounds and body orifices are decontaminated first, followed by areas of highest contamination levels on the intact skin. The purpose of decontamination is to prevent or reduce incorporation of the material (internal contamination), to reduce the radiation dose from the contaminated site to the rest of the body, to contain the contamination, and to prevent its spread. Please note that frequent glove changes will be necessary.

Treatment of contaminated wounds

In a contamination accident, any wound must be considered contaminated until proven otherwise and **should be decontaminated prior to decontaminating intact skin**. When wounds are contaminated, the physician must assume that uptake (internal contamination) has occurred. Appropriate action is based on half-life, radiotoxicity, and the amount of radioactive material. It is important to consult experts as soon as possible and to initiate measures that prevent or minimize uptake of the radioactive material into body cells or tissues.

Contaminated wounds are first draped, preferably with a waterproof material, to limit the spread of radioactivity. Wound decontamination is accomplished by gently irrigating with saline or water. More than one irrigation is usually necessary. The wound should be monitored after each irrigation. Contaminated drapes, dressings, etc., should be removed before each monitoring for accurate results. When monitoring contaminated wounds or irrigation fluids, gamma radiation is easily detected while beta radiation may prove more difficult to detect. Without special, highly sophisticated wound probes, alpha contamination will not be detected. Following repeated irrigations, the wound is treated like any other wound. If the preceding decontamination procedures are not successful, and the contamination level is still seriously high, conventional debridement of the wound must be considered. Excision of vital tissue should not be initiated until expert medical or health physics advice is obtained. Debrided or excised tissue should be retained for health physics assessment.

Embedded radioactive particles, if visible, can be removed with forceps or by using a water-pik. Puncture wounds containing radioactive particles, especially in the fingers, can be decontaminated by using an "en bloc" full thickness skin biopsy using a punch biopsy instrument.

After the wound has been decontaminated, it should be covered with a waterproof dressing. The area around the wound is decontaminated as thoroughly as possible before suturing or other treatment.

Contaminated burns (chemical, thermal) are treated like any other burn. Contaminants will slough off with the burn eschar. However, dressings and bed linens can become contaminated and should be handled appropriately.

Decontamination of body orifices

Contaminated body orifices, such as the mouth, nose, eyes, and ears need special attention because absorption of radioactive material is likely to be much more rapid in these areas than through the skin.

If radioactive material has entered the oral cavity, encourage brushing the teeth with toothpaste and frequent rinsing of the mouth. If the pharyngeal region is also contaminated, gargling with a 3-percent hydrogen peroxide solution might be helpful. Gastric lavage may also be used if radioactive materials were swallowed. Contaminated eyes should be rinsed by directing a stream of water from the inner canthus to the outer canthus of the eye while avoiding contamination of the nasolacrimal duct. Contaminated ears require external rinsing, and an ear syringe can be used to rinse the auditory canal, provided the tympanic membrane is intact.

External contamination

Decontamination of the intact skin is a relatively simple procedure. Complete decontamination, which returns the area to a background survey reading, is not always possible because some radioactive material can remain fixed on the skin surface. Decontamination should be only as thorough as practical.

Decontamination should begin with the least aggressive method and progress to more aggressive ones. Whatever the procedure, take care to limit mechanical or chemical irritation of the skin. The simplest procedure is to wash the contaminated area gently under a stream of water (do not splash) and scrub at the same time using a soft brush or surgical sponge. Warm, never hot, tap water is used. Cold water tends to close the pores, trapping radioactive material within them. Hot water causes vasodilation with increased area blood flow, opens the pores, and enhances the chance of absorption of the radioactive material through the skin. **Aggressive rubbing tends to cause abrasion and erythema and should be avoided.**

If washing with plain water is ineffective, a mild soap (neutral pH) or surgical scrub soap can be used. The area should be scrubbed for 3 to 4 minutes, then rinsed for 2 to 3 minutes and dried, repeating if necessary. Between each scrub and rinse, check the contaminated area to see if radiation levels are decreasing. Sodium hypochlorite, diluted 1 to 10 with water, is an effective decontamination agent. A mildly abrasive soap (a 1 to 1 mixture of powdered detergent and cornmeal mixed with water into a paste) can be used for calloused areas. **The decontamination procedure stops when the radioactivity level cannot be reduced to a lower level.** Expert advice might be needed to determine an appropriate stopping point. Contaminated hairy areas can be shampooed several times. Contaminated hair can be clipped if shampooing is ineffective. Shaving should be avoided since small nicks or abrasions can lead to internal contamination. When shampooing the head, avoid getting any fluids into the ears, eyes, nose, or mouth.

Ambulatory patients with localized contamination can be decontaminated using a sink or basin. If extensive body areas are contaminated, the patient can be showered under the direction or with the assistance of a radiation safety officer. Caution the patient to avoid splashing water into the eyes, nose, mouth, or ears. Repeated showers might be necessary, and clean towels provided for drying after each shower. Again, decontamination should be as thorough as practical.

Although it may be desirable that the wastewater from decontamination procedures be retained and analyzed before being discharged into the sanitary sewer, this requirement should not be mandatory. Furthermore, the installation of an elaborate holding system is not likely to be justified because of the infrequency of the event. The welfare of the patient should come first, and the physician should feel free to use whatever facilities are readily available to accomplish that end. Any radiation hazard to the general public will be virtually eliminated when the inherently small and infrequent volume of radioactive waste is mixed with and diluted by other sewage effluents of the hospital and community (AMA, 1984).

Patient comfort and emotional support

A patient involved in a radiation accident needs explanations of procedures and actions being taken (isolation, use of survey meters, taking of samples, decontamination, etc.) in the radiation emergency area. A knowledgeable person should answer the patient's questions and provide reassurance. For example, explain use of protective clothing and surgical masks during treatment. Following initial care and treatment, someone with a knowledge of radiation effects should spend adequate time answering the patient's questions. Preferably, this person should be the attending physician who continues to treat the patient until discharge. Reporters and news-hunters should get their reports from the hospital's public information officer.

Patient safety

Routine precautions for patient safety should not be forgotten. Be especially alert for potential falls or slips on wet floors, excessive heating or chilling, and electrical hazards.

Documentation

In addition to routine medical records, note survey readings, samples taken (and time), descriptions of the accident, and the effectiveness of decontamination. Take care to note pre-existing conditions such as rashes, healing wounds, or scars. This information will be extremely valuable to medical consultants and health physicists in reconstructing the accident accurately and making a prognosis.

Post-emergency patient transfer

A final complete-body survey is performed following decontamination procedures. A new floor covering is laid from the clean area to the patient stretcher. A clean stretcher is brought in, the patient is transferred to it by clean attendants (those involved in the decontamination procedure may now be contaminated), and the patient is wheeled to the door. After the radiation safety officer makes a final check of the patient and the stretcher (especially the wheels), the patient is taken from the room.

Staff exit from the controlled area

Each member of the decontamination team goes to the control line and removes his protective clothes as described below:

1. Remove outer gloves first, turning them inside-out as they are pulled off.
2. Give dosimeter to radiation safety officer.
3. Remove all tape at trouser cuffs and sleeves.
4. Remove outer surgical gown, turning it inside-out -- avoid shaking.
5. Pull surgical trousers off over shoe covers.
6. Remove head cover and mask.
7. Remove shoe cover from one foot and let radiation safety officer monitor shoe; if shoe is clean, step over control line, then remove other shoe cover and monitor other shoe.
8. Remove inner gloves.
9. Do total-body radiological survey of each team member.
10. Take shower.

After staff exit, the decontamination room should be secured and a sign reading "**CAUTION -- CONTROLLED AREA -- DO NOT ENTER**" should be posted. Unless it is needed for emergency medical reasons, the decontamination room remains secured until it can be checked and decontaminated, if necessary, by the radiation safety officer or other health physics expert.

Resources:

Radiation Event Medical Management (REMM) Guidance on Diagnosis & Treatment for Healthcare Providers

<http://remm.nlm.gov>

Radiation Emergency Assistance Center / Training Site

Oak Ridge Operations Office

P.O. Box 2001

Oak Ridge, TN 37831

865.576.1005 (Ask for REAC/TS)

www.orise.orau.gov/reacts

Federal Emergency Management Agency

Region V

536 South Clark Street, 6th Floor

Chicago, IL 60605

312.408.5500

312.408.5222 (fax)

Medical Radiobiology Team

Armed Forces Radiobiology Research Institute

National Naval Medical Center

8901 Wisconsin Ave. Building 42

Bethesda, MD 20889-5603

301.295.0530 (24 hr)

www.afri.usuhs.mil

Michigan State Police

Emergency Management & Homeland Security

Michigan Intelligence Operations Center

4000 Collins Road, P.O. Box 30636

Lansing, MI 48909

517.333.5042

517.333.4987 (fax)

www.michigan.gov/msp/1,1607,7-123-1593_3507-00.htm

Wayne County Emergency Management

434.247.7325

Dearborn City Emergency Management

313.943.5470

Indiana Emergency Management Agency & Department Fire Building Services
302 West Washington Street, Room E-208
Indianapolis, IN 46204-2760
317.232.3980
317.232.3895 (fax)
www.ai.org/sema/index.html

Wisconsin Division of Emergency Government
2400 Wright Street
PO Box 7865
Madison, WI 53707
608.242.3232
608.242.3247 Fax
<http://badger.state.wi.us/agencies/dma/wem/index.htm>

Centers for Disease Control & Prevention (CDC)
800.232.4636
www.bt.cdc.gov/radiation

Reference:

Management of Persons Accidentally Contaminated with Radionuclides, NCRP Report 65
Bethesda, MD
1980

Management of Terrorist Events Involving Radioactive Materials, NCRP Report 138
Bethesda, MD
1980