

HAZARDOUS MATERIALS, CHEMICAL, AND RADIATION EXPOSURE DECONTAMINATION PROTOCOL

*Until the Hazardous material decontamination plan is fully operational, patients contaminated with Hazardous Materials will be decontaminated to best of the hospital ability and supplemented with a FDNY Mobile HazMat unit (911, 718-636-1700). The Chairman of Emergency Medicine (Dr. Michael Lucchesi 718-245-4790) and the Department of Emergency Medicine's Disaster Chairperson (Dr. Bonnie Arquilla 917-760-1454) will serve as liaison to coordinate the decontamination effort between Kings County Hospital and University Hospital of Brooklyn.

PURPOSE:

The purpose of external decontamination is two fold:

1. To remove hazardous materials from the skin and mucous membranes of a victim, thereby eliminating the potential toxic exposure and facilitating both the prevention and treatment of clinical effects.
2. To prevent contamination of the hospital facilities, personnel, and patients by a victim or victims exposed to hazardous materials, chemicals or radiation.

POLICY:

All Kings County Hospital employees will follow the decontamination procedures for their safety as set forth in this document.

PROCEDURE:

1. General Considerations:

Under most circumstances a patient or other individual contaminated with a hazardous material should not be allowed to enter the Emergency Department without prior decontamination.

Under no circumstances should hospital personnel approach or have contact with a patient contaminated with a hazardous material until proper personal protective equipment have been taken to protect themselves (See Instructions).

The New York City Poison Control Center, FDNY, HAZMAT Team, NYPD, Department of Transportation, and/or manufacturer, distributor, or shipper should be contacted in an attempt to ascertain the exact contents and hazardous nature of the material in question. The initiation of these contacts should be through the Emergency Department office.

Until absolute identification of the hazardous material is made, all unknown material will be regarded as highly toxic and therefore life-threatening.

For the purpose of this document, radiation exposures considered to be “hazardous material exposures” under the provisions of this protocol, related to those exposures in which radioactive material is present on the skin or mucous membranes of a patient; rather than the patient who has absorbed radiation from radioactive source without being externally contaminated.

If the number or spectrum of patients, or severity of exposure fall into the designation of an MCI (Mass Casualty Incident) the existing hospital MCI protocols will be used in conjunction with this protocol.

For the purpose of this document all references to the medical control officer will be interpreted to mean the senior attending physician in the Emergency Department or a member of the Disaster Response Team unless otherwise designated during the incident.

2. DECONTAMINATION SUPPLIES:

Adequate supplies of the following decontamination equipment will be available:

A. Tyvek Suits:

Water and hazardous solvent resistant with hood and attached boots, elasticized wrists.

B. Flock-lined Nitrile Gloves:

Resistant to aromatic, petroleum and chlorinated solvents; 0.013 gauge, 13 inch length

C. Panther SAR (Med) - Face mask with O2 attachment and filters:

D. 2 inch wide by 60 yards Solid Color Tape: 3 rolls red, 3 rolls yellow

Other Equipment to be obtained from hospital supply or miscellaneous vendor(s):

A. Decontamination bags, Hazard Bags

B. Standard hospital gowns, gloves, shoe covers, face masks

C. Linens (sheets, towels, patient gowns, washcloths)

D. Soap (liquid)

E. Sponges (several large)

F. Rolls of brown paper for floor covering

G. Rolls of plastic sheeting for floor covering found in the disaster cabinet.

The supplies will be kept in disaster cabinets.

Use of full face respirators (not in use as of 9/03)

- A. Users of respirators will be instructed and trained in their proper use and limitations. Each user shall receive fitting instructions including demonstrations and practice on how the respirator should be worn, how to adjust it, and how to determine if it fits properly. A list of personnel who may be required to wear

respirators shall be forwarded to the Department of Employee Health and Safety and Emergency Preparedness Committee.

- B. Respirators shall be regulated monthly cleaned and disinfected. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

3. **COMMUNICATIONS:**

The Incident Command Center (ICC)/AOD in the hospital shall be responsible for the notification of the following personnel if notified of a hazardous materials/chemical exposure incident prior to patient arrival (If patients present prior to notification, then ED Senior Attending will initiate Disaster Plan as per protocol and will initiate communication with the following parties until relieved by ICO):

- A. Attending Physicians in the Emergency Departments
- B. Director, Surgery/Medicine/Pediatrics
- C. Hospital Police
- D. Emergency Department Charge Nurse and/or supervisor
- E. Environmental Services Supervisor
- F. Safety Control Officer
- G. Radiation Safety Officer
- H. Disaster Coordinator
- I. Director of Facilities Management
- J. Telecommunications (Operators)

4. **DECONTAMINATING ZONE SETUP, MAINTENANCE, TRAFFIC FLOW:**

A. Zone Setup: Personnel from Environmental Services with the Emergency Department Staff will be responsible for outlining and setting up the zones as per this protocol.

- II) The Emergency Department staff will ensure that decontamination supplies are delivered to the appropriate zones.

B. HOT ZONE:

- I) A HOT ZONE (contaminated zone) will be set up according to the attached floor plan of the Emergency Department, referred to as Figure 1. This HOT Zone will be designated by red vinyl tape applied to the concrete and asphalt walkway located at street ambulance entrance behind and including the decontamination unit as indicated in the figure. The red vinyl tape, and therefore the HOT zone, will extend 6-8 feet into the ambulance drive to allow the unloading of potentially contaminated patients directly into the HOT zone. The zone will also be indicated by placing patients directly into the HOT zone.

- II) **Security and Traffic Flow:**

Hospital Police will be placed on station adjacent to the HOT zones as indicated in Figure 1. It will be the responsibility of the police officer to ensure:

- a) Unloading patients (ground transport) and **pre-hospital personnel** attending them **will remain** in the confines of the HOT

zone, unless the triage physician or medical control officer determine otherwise.

- b) All other unauthorized hospital and non-hospital personnel are kept **out** of the confines of the HOT zone.
- c) All other non-contaminated Emergency Department traffic will follow the posted signs and will enter the hospital via ambulatory triage, located outside the D-building entrance (451 Clarkson Ave).

III) **Personnel and Equipment:**

All hospital personnel required to work within the confines of the HOT zone will be appropriately dressed. Unless determined otherwise by the Decontamination Team Leader in concert with the Emergency Department nurse, One health care provider will be dressed in Tyvek suit, full gloves and full- face respirator to stabilize, decontaminate, and triage contaminated patients as per protocol. If additional physician help is required for triage or treatment, one of the Emergency Department physicians will be designated to assist in the decontamination. If additional nursing help is required, it will be the responsibility of the Emergency Department charge nurse to redistribute available resources. The Decontamination Team Leader in concert with the NYPD, HAZMAT/Poison Control can elect to forgo full protective gear and/or increase or decrease the number of personnel in the Hot Zone.

C. **WARM ZONE:**

- I) A WARM zone will be set up according to the attached floor plan of the entrance to the Emergency Department. This WARM zone will be designated by yellow vinyl tape applied to the floor of the Emergency Department directly in front of the decontaminated unit as indicated in Figure 1. Plain brown paper will be applied to the floor of the designated area. The vinyl tape will serve to designate the confines of the WARM zone and to hold the paper floor covering in place. The main entry doors to the Emergency Department will be deactivated and locked. The zone will also be indicated by plain "HAZARDOUS AREA" floor signs.
Access is to be controlled by Police after decontamination.
- II) **Extended WARM zone:** The Decontamination Team Leader is authorized to "extend" the WARM zone to include needed space (as indicated on the floor plan) if a patient's condition warrants immediate intervention without the completion of a formal decontamination sequence.
- III) **Security and Traffic Flow:** One police officer will be placed on station inside of the deactivated and locked Ambulance Emergency Department doors, and one security officer will be placed on station just adjacent to the WARM zone or Extended WARM zone boundary within the Emergency Department, both as indicated in the attached floor plan.

It will be the responsibility of the police officers to ensure:

- a) All unauthorized hospital and non-hospital personnel are kept outside the confines of the WARM zone.
- b) Non-contaminated patients designated for the Emergency Department will follow the usual course and enter the Emergency Department through the aforementioned routes.

IV) **Personnel:** All hospital personnel required to work within the confines of the WARM zone will be appropriately dressed. Unless determined otherwise by the medical control officer in concert with the Emergency Department attending, all personnel will be dressed in standard disposable (paper) hospital gowns, gloves, shoe covers, face masks, and hair covers. If additional physician help is required for triage or treatment, one of the Emergency Department physicians will be designated to assist in the decontamination. If additional nursing help is required, it will be the responsibility of the Emergency Department charge nurse to redistribute available resources.

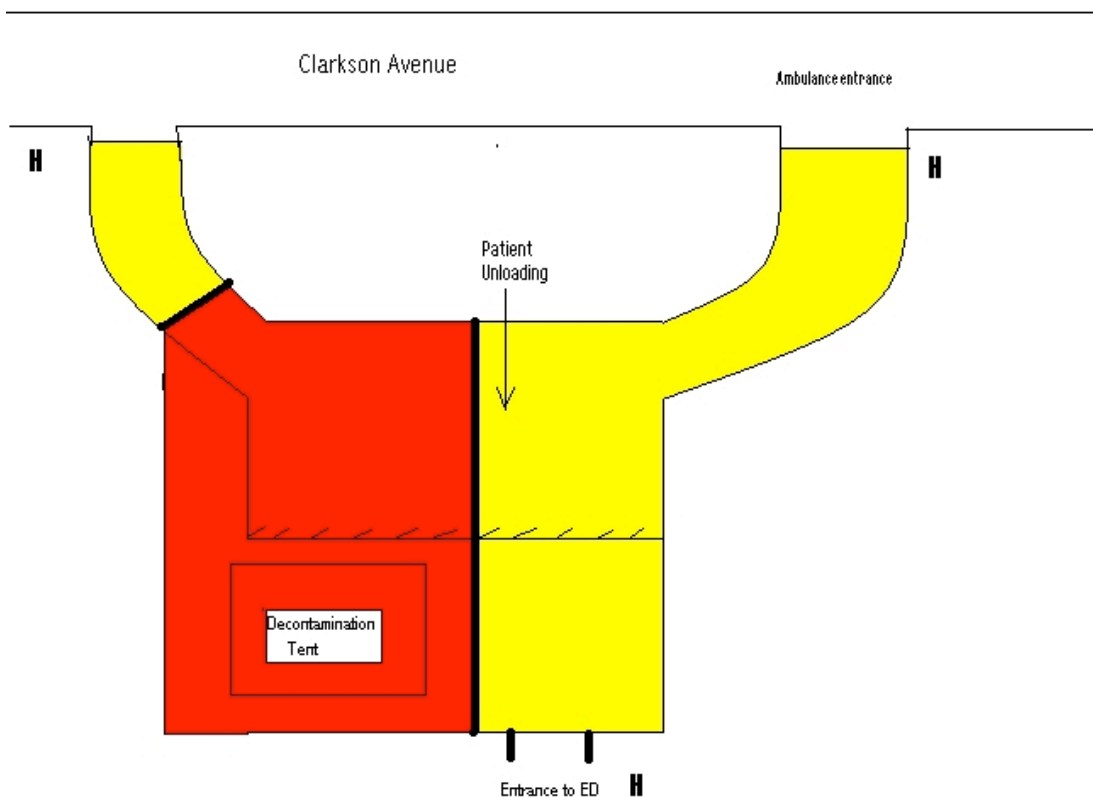


Figure 1. Ambulances will enter from Clarkson avenue the designated entrance. Patients will be unloaded from the edge of the Warm Zone (yellow) directly into the Hot Zone (red) as marked on the map with an arrow and will be ushered into the decontamination tent. Diagram

key: **H** designates a Hospital Police post. The red area is the Hot Zone and yellow area is the Warm Zone.

5. **PATIENT TRIAGE:**

a. **Stable Patients**

- I) If FDNY/Rescue/NYPD personnel do not perform initial external decontamination, the decontamination sequence will precede entry into the Emergency Department through the HOT zone.

b. **Unstable Patients**

- I) If FDNY/Rescue/NYPD personnel do not perform initial external decontamination, the decontamination sequence through the HOT zone will precede entry into the Emergency Department. Alternately, in a life-threatening situation, resuscitative equipment and supplies could be brought into the decontamination area if external decontamination prior to Emergency Department entry is required due to hospital contamination risk.
- II) If FDNY/Rescue/NYPD personnel perform initial external decontamination, the triage physician may elect to allow entry of patient into resuscitation area for stabilization and subsequent secondary decontamination.

c. **Post-Decontamination Triage:**

- I) After completion of the decontamination sequence, patients will proceed to the designated areas of the Emergency Department for secondary care, as determined by the triaging officer using previously established Emergency Department guidelines.

6. **DECONTAMINATION SEQUENCE:**

- a. A "HOT zone" or sphere of contamination will be set up and enforced into which all patients and pre-hospital personnel (if they wish to enter the hospital) shall proceed through. All initial patient decontamination will take place in the decontamination unit within this zone. Equipment and personnel working within this zone shall not leave the zone until they are decontaminated to prevent the spread of contamination.
- b. The patient is stripped, including jewelry and washed twice with soap and water (careful attention to hair and fingernails. If eye exposure is a consideration, irrigation should be instituted. Emergency Department/NYPD/Poison Control will advise if the decontamination procedure requires specific treatment not outlined in this general protocol.
- c. Upon completion of the initial external decontamination, the patient is transferred to a clean stretcher in the WARM zone (at the inside door of the decontamination unit) whereupon secondary evaluation and triage to the appropriate section of the Emergency Department will take place. With severe exposures, or upon advice from the decon team leader in

concert with the Emergency Department attending, a second round of dermal decontamination may take place within the WARM zone.

- d. Patients will be transferred to a clean stretcher or wheel chair upon exiting the WARM zone boundary on their way to the appropriate section of the Emergency Department. All equipment (e.g. stretcher, wheelchair) originally within the WARM zone will remain in the WARM zone until decontamination.
- e. All equipment and supplies will always flow from a clean area to a more contaminated area (e.g. Emergency Department to WARM zone, WARM zone to HOT zone) **never** in the opposite direction. If additional personnel are required in a particular zone, the same sequence will be followed. Personnel may enter a more contaminated zone at will but cannot enter a cleaner zone without first performing the appropriate decontamination.

7. **PERSONNEL DECONTAMINATION:**

If personnel are appropriately dressed, he or she may proceed to the boundary of the lesser contaminated area after full personal decontamination (HOT to WARM, WARM to EMERGENCY DEPARTMENT). Personnel upon entry into normal environment should immediately wash hands and face with soap and water.

8. **EQUIPMENT AND AREA DECONTAMINATION:**

Equipment and hospital facilities will be decontaminated with appropriate cleansers as per Environmental Services Department protocols following completion of the patient decontamination sequence. Environmental Services personnel within the hospital shall be notified of the toxic potential and other particulars relating to the toxin in question. Environmental Service personnel will also wear appropriate decontamination gear during cleanup.

- 9. Ventilators will be cleaned and disinfected after each use. The units will also be inspected by the Hospital Safety Coordinators and worn or deteriorated parts replaced.

Chemical Agents and Treatments

The following is an overview of possible chemical agents that could be expected to be involved in a Mass Casualty Incident involving NCB terrorism. This section is divided up by specific agents, clinical affects, antidotes, and required decontamination. As stated in the hazardous material section of the manual, it is expected that any event that required activation of the hazmat section of the Emergency Management Plan the entire MCI plan would be activated. It is also expected that the hazardous material and decontamination plan would be followed for all chemical agent exposures. The clinician must remember that the most important aspect of decontamination and treatment is to assure that no hospital personnel are placed in danger and that the hospital does not itself become contaminated: **METICULOUS DECONTAMINATION IS THE MOST IMPORTANT PART OF ALL TREATMENT.**

In addition, don't forget to report **ALL cases of suspected chemical agent exposure** to the **New York City Poison Control Center (212-POI-SONS)**. Expert Toxicologists are waiting to help you and you should use all of the resources available.

Specific HAZMAT CHEMICAL AGENTS

NERVE AGENTS	TABUN, SARIN, SOMAN, VX
BLOOD AGENTS	HYDROGEN CYANIDE, CYANOGEN CHLORIDE
CHOKING AGENTS	PHOSGENE, CHLORINE, AMMONIA
BLISTER AGENTS	MUSTARD, LEWISITE
RIOT CONTROL AGENTS	MACE, PEPPER SPRAY

NERVE AGENTS:

(Class of chemicals called organophosphates– Insecticides)

Overview:

- These are the most toxic of the expected chemical agents
- They are easily absorbed through skin, eyes, and mucous membranes
- They are liquid at normal ambient temperatures

Signs and Symptoms of Nerve Agent Exposure

A. INCREASED SECRETIONS (MUSCARINIC EFFECTS)

- Salivary Glands (saliva)
- Lacrimal glands (tears)
- Nasal glands
- Bronchial glands
- Gastrointestinal glands
- Sweat glands

B. SMOOTH MUSCLE STIMULATION (MUSCARINIC EFFECTS)

- Miosis
- Bronchoconstriction (shortness of breath)
- Gastrointestinal hyperactivity (nausea, vomiting, and diarrhea)

C. SKELETAL MUSCLES (NICOTONIC EFFECTS)

- Fasciculations
- Twitching
- Weakness
- Flaccid Paralysis

D. CENTRAL NERVOUS SYSTEM

- Loss of consciousness
- Seizures
- Apnea
- Psychological effects

E. OTHER

- Tachycardia (Bradycardia may also be seen due to muscarinic (vagal) effects)
- Hypertension

Types of Nerve Agents Exposures

A. Nerve Agents in Vapor Form

Exposure tends to lead to immediate symptoms with no delayed symptoms.

Symptoms:

1. Minimal Exposure

- Miosis (dim vision, eye pain)
- Rhinorrhea
- Shortness of breath

2. Large Exposure

- Immediate LOC, seizures, apnea, and flaccid paralysis

B. Nerve Agents in Liquid form

Liquid nerve agents may have an 18-24 hour delay in onset of action. The clinician should assume that all nerve agent exposures are liquid and prepare for prolonged observation.

Symptoms:

1. Minimal Exposure

- Localized sweating
- Fasciculations

2. Moderate Exposure

- Gastrointestinal effects

3. Large Exposure

- Sudden loss of consciousness
- Seizures
- Apnea
- Flaccid paralysis
- Death

Decontamination

(Use AHLS Manual)

1. Removal of clothing and jewelry (decontamination at scene prior to evacuation is preferable and FDNY protocol at this time)
2. Patient should be washed with soap and water. Decontamination should never be delayed if sodium hypochlorite or soap are not immediately available. If necessary, copious water is adequate for decontamination in most cases.
3. Patients arriving at the Emergency Department with an unclear exposure history who are symptomatic from nerve agent exposure should be fully decontaminated with soap and water or sodium

hypochlorate before entering treatment areas.

Treatment

1. Airway and ventilation can be very difficult because of increased secretions therefore atropine should be administered before other measures are attempted. Positive pressure ventilation and frequent suctioning of secretions will be necessary.
2. Patients should be given eye ointment for relief of pain to eyes
3. All patients must be observed for 18 hours for latent symptoms
4. Antidote administration
 - a. Atropine sulfate: IV, IM or ET—2mg every 5 to 10 minutes until secretions decrease. Up to 20 mg may be needed. Even more atropine may be required if organophosphate pesticides, rather than true nerve agents, are used.
 - b. Pralidoxime chloride (2-PAM): 1-2 g in 100 mL of 0.9% NaCl given IV over 15-30 minutes initially. This may be repeated in 1 hr if weakness/fasciculations are not relieved and thereafter every 3-8 hours. Alternatively, a continuous infusion of 500 mg/hr may be started after the initial dose.
 - c. Diazepam: to treat seizure activity, 5 –10 mg IV.
 - d. Age related considerations for nerve agent antidotes
 - i. Children: 0.02 mg/kilogram atropine; 20-40 mg/kg of Pralidoxime chloride (2-PAM) followed by 10-20 mg/kg/hr
 - ii. Elderly: frail, hypertensive or renal disease- give half the usual dose of 2-PAMCI
 - iii. If hypertension is significant with 2-PAM, use phentolamine to control BP (5mg IV in adults and 1mg IV children)

BLISTER AGENTS OR VESICANTS

- Sulfur mustard
- Lewisite

Blister agents cause injury via inhalation and liquid contact to eyes, skin, airway and some internal organs. There is a delayed action and exposure may result in blisters on the skin, temporary blindness, respiratory distress and bone marrow damage. There is no specific therapy.

Clinical Signs and Symptoms

- No immediate pain, no immediate skin discoloration, no immediate eye irritation.
- Clinical effects range between 2 to 48 hours. Usually 4 to 8 hours.
- Patients usually present with upper airway irritation, hoarseness, dyspnea and cough.
- Pulmonary edema is rare.

Decontamination (AHLS Manual)

- Remove clothing
- Thoroughly wash skin with soap and water.
- Must be done as quickly as possible. Damage can occur if agent is in contact with skin for as little as one minute.

Treatment

- Basically supportive there is no antidote
- There is some evidence that Betadine solution applied to affected areas may decrease the ultimate extent of the injury
- Soothing cream/lotion
- Frequent irrigation
- Topical antibiotics
- Systemic analgesics
- Do not overhydrate; not a thermal burn

Care for Eye Injuries

- Irrigation
- For severe injuries topical mydriatics
- Oral pain medication
- Topical antibiotics and Vaseline should be applied to lids to prevent them from adhering
- Early ophthalmologic care is important

Treatment of Pulmonary Injuries

- Steam, cough suppressants for mild injuries
- Oxygen
- Assisted ventilation
- Early intubation: PEEP may be necessary

- Bronchodilators (steroids)
- Antibiotics **AFTER** organism identified

Lewisite

Is rapidly absorbed by eyes, skin and lungs and is highly irritating on initial exposure.

Clinical Signs and Symptoms:

SKIN

Lewisite causes greater skin damage than sulfur mustard. A gray area of dead skin can progress to blisters and severe tissue necrosis and sloughing.

LUNGS

Since Lewisite causes immediate irritation to the nose and sinuses. Pseudomembrane formation is common.

Treatment for Lewisite Exposure

Decontamination

(Use AHLS Manual)

Soap, water.

Antidote

British anti-Lewisite (dimercaprol or **BAL**) is used IM to reduce systemic effects. **Has no effect on skin and eyes.** Dosage must be adjusted to weight: 0.5 cc's per 25 pounds bodyweight up to a maximum of 4 cc's. IM injections should be repeated at different sites at 4, 8, and 12 hours for a total of 4 equal doses. For severe pulmonary symptoms or hypotension the interval between the first and second injection may be shortened to two hours. BAL may also be applied topically to treat ocular or dermal injuries.

Cyanide

Signs and Symptoms:

Low Concentrations

- victims become anxious
- hyperventilate
- develop headache, dizziness and vomiting
- skin may be flushed or “cherry red” color
- symptoms improve when victim is removed from the source

High Concentrations

- 15 seconds – anxious and hyperventilate
- 30 seconds- seizures
- 3 to 5 minutes – breathing ceases
- 6 – 10 minutes – asystole-death

Decontamination

(Use AHLS Manual)

- Remove from area
- Remove clothing
- Mild exposure, conscious and breathing-O2, IV fluids and observe
- Severe exposure, unconscious-give antidotes

Antidote

Prior to administration, oxygen supplementation, IV hydration and if necessary sodium bicarbonate to reverse metabolic acidosis

Utilize Commercial Cyanide Kit

- Amyl nitrite pearls (a temporizing measure to be used only until IV access is obtained)
- Sodium nitrite 3% solution
300 mg (10 cc amp) over 5 min, hypotension
Injected over 2 to 4 minutes
Pediatric dose 0.2 cc/kg not to exceed 10 cc's
- Sodium thiosulfate 25% solution
12.5 g (50 cc amp) over 5 minutes IV
Pediatrics 0.4 mg/kg or 1.65 cc's/kg of a 25% solution.

Choking Agents

- Phosgene
- Chlorine
- Ammonia

Phosgene

- Causes transient irritation to eyes, nose, sinus and throat
- Penetrates slowly
- Patient symptom-free 2 – 24 hours
- Attacks alveolar capillaries causing leakage, hypoxia and apnea
- Patient is volume depleted
- Odor of freshly mown hay

Decontamination

(Use AHLS Manual)

- Remove clothing
- Wash away all residual liquid with copious amounts of water

Treatment

- ABCs
- Supportive
- Intubate
- Hydrate
- Keep patients quiet do not allow to ambulate
- Transport by stretcher
- Life threatening lung damage can be accelerated by physical exertion of any type
- Lasix is contraindicated

Ammonia

Clinical Signs and Symptoms

Eyes

- Burning, tearing, severe pain, injury of the cornea and lens
- No latency (immediate symptoms after exposure)

Lungs

- Cough, SOB, chest pain, wheezing and laryngitis with mild exposure
- Hypoxia, chemical pneumonia, hemorrhage with moderate-severe exposures
- No latency (immediate symptoms after exposure)

Skin

- Pain, blister formation, deep burns

Gastrointestinal (ingestion)

- Severe mouth pain, cough and abdominal pain
- Nausea and vomiting
- Edema to lips and mouth (leading to airway obstruction)
- Esophageal strictures and perforation

Decontamination

(Use AHLS Manual)

- Remove clothing
- Wash with soap and large amounts of water for 15 – 20 minutes
- Eyes should have continuous irrigation
- Early intubation for airway protection is recommended

Chlorine

- Is a significant irritant to eyes and respiratory and gastrointestinal tracts.
- Initial respiratory distress of coughing, wheezing, chest pain and sputum production.
- Is followed in 12-24 hours by non-cardiogenic pulmonary edema.

Decontamination (Use AHLS Manual)

Treatment

- Remove from source of exposure
- ABCs
- Flush skin and eyes with water
- O2, cool mist, bronchodilators
- Airway management (intubation, PEEP)
- Hydration

RIOT CONTROL AGENTS

- Irritating agents to eyes, nose, mouth and lung
- Effects last about 30 minutes
- Agents can include
 - CN (Mace)
 - CS (Tear gas)
 - OC (Oleoresin capsicum, capsaicin, pepper spray)
 - DM (Adamsite)

Decontamination

Most likely do not need full Kings Count Hospital DMC Emergency Preparedness Hazmat/ Decon

Treatment

Eyes

- Irrigate
- Remove Contact Lenses
- Check for foreign body
- Check eye pH
- Follow-up with ophthalmologist

Lungs

- bronchodilators
- oxygen therapy

Skin

- **DO NOT USE BLEACH**
- Soap and water
- Soothing ointment or cream

Biohazard Preparedness (BP) Plan

PURPOSE: To enable the hospital and its staff to respond appropriately in the event that a Biologic agent with the potential to cause widespread disease and panic is released into the community. The BP Plan is part of the overall Kings County Hospital Center Disaster Plan. It is made up of three components:

- 1) Resource assessment and allocation
- 2) Education
- 3) Response

In all instances the Office of the Hospital Epidemiologist (OHE) or designee will provide input, guidance and coordinate activities with the general oversight of the Chief Executive Officer of the Hospital, the Medical Director of the Hospital, and the Kings County Hospital Disaster Plan Committee.

The plan recognizes that each activity will differ based upon the pathogen in question and the scale of the emergency. The plan also recognizes that in the event of such an emergency overall direction of the plan may be altered at the discretion of the local authorities.

Review of the most likely pathogens:

- 1) **Anthrax-** is a non-contagious disease state caused by the gram positive bacillus *Bacillus anthracis*. It may cause either a severe inhalational disease, cutaneous disease or gastrointestinal disease. It is treatable provided antibiotics are started early after exposure or onset of disease. No special isolation precautions are necessary for patients with this disease. It is the most likely agent to be used in a bioterrorist event. Diagnostic tests include routine bacterial culture and gram stain.
- 2) **Smallpox-** is a highly contagious viral infection not seen in the United States for decades. It causes a characteristic rash and systemic symptoms. The entire population is considered non-immune to this agent. There is a 30% mortality rate for naive populations. Strict airborne isolation precautions must be taken for individuals with this infection. Although in vitro studies suggest some antiviral agents may be useful for the treatment of individuals with this disease this should be considered highly experimental. There is therefore no widely available active antiviral agent for the treatment of smallpox.

Smallpox vaccine is available in only very limited quantities and is controlled by the US government. Supplies are expected to increase over the next two years. In the event of a smallpox case smallpox vaccination may be reinstituted.

- 3) **Pneumonic plague**- is caused by the bacteria *Yersinia pestis*. It is most often seen as a sepsis syndrome associated with the bite of an infected flea. Plague can be aerosolized to be used as a bioweapon. In this setting it can cause a severe pneumonia and life threatening sepsis syndrome. Plague pneumonia is transmissible in droplet form. It may be treated with aminoglycosides such as streptomycin and gentamycin. Tetracyclines and fluoroquinolones can be substituted.
- 4) **Botulinum toxin**-This product is one of the most powerful toxins found in nature. Its primary effect is to impair the release of acetylcholine from nerve endings. This results in a classic descending bulbar and flaccid paralysis. Toxin can be detected using a bioassay. Equine derived anti-toxin is available through the CDC via the NYC Poison Control Center.

Resource Assessment and Allocation:

- 1) **Pharmaceuticals**- The Hospital Epidemiologist in conjunction with the Director of Pharmacy will be responsible for determining the adequacy of pharmaceutical supplies (i.e. medication, vaccines etc) to deal with the most likely biohazard events. Decisions about such stocks will take into account current events and recommendations from the public health authorities. Decisions will also take into account the scale of expected biohazard events, treatment of the acutely ill from the community and the prophylaxis of hospital employees. Access to supplies from the national antibiotic stockpile and from outside vendors will be assessed.
- 2) **Ventilators**- The Hospital Epidemiologist in conjunction with the Director of Respiratory Therapy will assess the inventory of respirators available to the institution in order to respond and care for individuals with respiratory failure as a result of a biohazard event.
- 3) **Personal Protective Equipment**- In conjunction with the Director of Central Supplies the Hospital Epidemiologist will assess the adequacy of the inventory of gloves and masks appropriate to the care of varying numbers of individuals who are victims of a biohazard event.

- 4) **Isolation and Cohorting Facilities**- In conjunction with the Director of Nursing Services and the Chief of Facilities, the Hospital Epidemiologist will be responsible for assessing the adequacy of isolation rooms in the hospital in the event of a need to place victims of a biohazard event in respiratory isolation. If isolation facilities are not adequate to the scale of the number of patients requiring care, then efforts will be made to cohort patients in varying size spaces depending upon the number of cases. The safety of the use of such spaces and physical plant issues such as ventilation will be considered in such a decision.

Education

The OHE/Infection Control will be responsible, with the support of Hospital Administration, to coordinate education activities in the institution as they relate to a biohazard event. The OHE will maintain close contact with public health authorities and will provide information to all sectors of the hospital community on an ongoing basis regarding the latest information on expected or actual biohazard events. This will be done through a variety of means including letters, web publications, lectures, videos etc.

Response:

- 1) The response to any biohazard event will be determined by the scale of the event and the pathogen involved.
- 2) An **internal biohazard event** (i.e. a single or limited number of cases identified after hospitalization) will be managed as would any infectious etiology requiring disease or condition specific isolation precautions. It would not require implementation of the hospital disaster plan except in certain unusual circumstances. An internal BH event might involve any of the agents listed above but could include other agents as well. It will be the responsibility of the epidemiologist, in consultation with Hospital Administration, to see that the NYC-DOH is notified regarding any suspicious or verified BH event.
- 3) In the event of an **external BH event** the OHE (MCO for BH) will be notified. The need for implementation of the Hospital Disaster Plan will be determined after consultation with Hospital Administration. The need to activate the Hospital Disaster Plan will be determined almost entirely by the scale of the event. If a BH event results in implementation of the Hospital Disaster Plan:
 - a) hospital lock down will occur

- b) access will only be provided through the ED and designated supply screening entrances.
- c) the MCO will confer with the ED Director regarding the screening and triaging of incoming patients and employees.
- d) The MCO will confer with Hospital Administration, Director of Nursing Services and FM&O regarding the allocation of hospital beds and the need to cohort patients based on their presumptive diagnosis.
- e) The MCO, Director of Pharmacy and the Director of Employee Health Services will confer regarding the provision of prophylactic antibiotics to hospital staff.

Anthrax- not contagious therefore no special measures for isolation or cohorting will be necessary except as it relates to the ease of management. Universal standard precaution will be followed. Decontamination will not ordinarily be necessary since patients who are ill with anthrax will likely have been exposed many days before presentation. The clinical microbiology laboratories should be notified at the first indication of anthrax so that safe specimen processing Under bio-safety level 2 conditions can be undertaken. Laundry should be bagged as biohazard material and laundered in soap and water.

Smallpox- negative pressure, airborne pathogen isolation measures will be necessary. All staff will be considered at risk of exposure to individuals with the rash of smallpox (except in the circumstance of recent vaccination). Patients arriving at the ED will need to be rapidly screened outside of the ED and if infected moved rapidly to isolation facilities. In consultation with public health authorities consideration should be given to isolation of patients at home. Contacts should be identified for surveillance. These people will be defined as those in the same household as well as those who have had face to face contact. In consultation with public health authorities plans should be made for the vaccination of exposed health care workers as well as those enlisted to care for patients who are sick. Staff caring for these patients will need to wear latex gloves and N95 (or higher filtration) respirators (fit testing will be necessary). Disposable gowns should also be worn and left in the room. Staff and others inadvertently exposed to smallpox case will need to be observed for 17 days. This can be done at home or in the facility. Temperature elevation will signal the onset of the rash within 48-72 hours and will require isolation. In the event that not enough negative pressure airborne isolation rooms are available, cohorting may be done (i.e. 2 patients per room). In the event that this is not enough, regular hospital rooms with portable HEPA filters may be used. If this is not enough then a

common large space whose air supply can be vented properly through HEPA filtration with doors that can be closed will be used. All laundry and waste should be placed in biohazard bags and autoclaved before being laundered or incinerated. Laboratory examination requires high containment BL-4 facilities and should not be undertaken at Kings County Hospital Center. All bedding and clothing of smallpox patients should be bagged in biohazard containers, autoclaved and laundered in hot water with bleach. Standard hospital disinfectants are effective for cleaning contaminated surfaces.

Plague- Pneumonic plague may be spread through respiratory droplets. Patients with known or suspected plague should be triaged from the emergency area with a disposable surgical or other face mask to the hospital ward promptly. There they should be placed on droplet precautions. Prophylaxis should be considered for all close contacts. Those refusing prophylaxis should be monitored for the development of fever or other signs of infection. Patients should remain in isolation for 48 hours after the initiation of treatment and until clinical improvement is noted. Patients requiring transport should wear surgical face masks. Standard procedures for cleaning of bedding and environmental surfaces should be followed. The clinical microbiology laboratory should be alerted when specimens are sent with presumed *Yersinia pestis*. Specimens should be processed in a BL-2 facility.

Botulinum toxin- Since exposure might result in illness within hours, it is necessary that patients presenting as victims of an intentional release of botulinum toxin have their clothes removed and washed and their skin washed with soap and water. Contaminated surfaces may be cleaned with 0.1% hypochlorite bleach solution. Medical personnel caring for patients with suspected botulism should use standard universal precautions. Isolation is not necessary.

RADIATION ACCIDENTS

It is possible that patients may be brought to the hospital as a result of a radiation accident. In considering the medical problems of a victim of a radiation accident, one must keep in mind three situations. The first is contamination, in which a radioactive material in the form of dust, solid particles or liquid, becomes physically attached to the victim's skin or clothes. This can be detected by proper monitoring of the patient and may consist of alpha, beta or gamma emitters, depending on the type of isotope in the contaminant. This type of accident requires physical decontamination as outlined in the **"Emergency Procedures for Patients Contaminated with Radioactive Isotopes."**

The second situation is incorporation, in which a radioactive material, in the form of dust, solid particles, or liquid, is inhaled or ingested or contaminates an open wound. This is a true emergency because the radioactive material will be able to irradiate internal tissues, causing much more extensive cellular damage. Many radioactive elements such as uranium pose a toxic threat, as do non radioactive heavy metals. Such a situation demands immediate decorporation as described in the **"Emergency Procedures for Patients who have ingested, inhaled or Incorporated Radioactive Materials."**

The third situation is irradiation, in which the patient has been subjected to a high flux of gamma rays or x-rays. As such, he is not radioactive and no radiation will be detected on his body or his clothes. Any tissue damage he has sustained happened instantaneously and will manifest itself in time. The irradiation may be local, such as exposure of a hand, or total body. The latter situation may give rise to the "radiation syndrome." Although the details of the "radiation syndrome" are not relevant to emergency department care, emergency department personnel should be familiar with the early symptoms and note them on the patient's chart.

The gastrointestinal system represents a handy and reliable "dosimeter" which allows the emergency physician to gauge the dose of radiation received by the patient. Low levels of radiation will produce anorexia and nausea. Vomiting, if it occurs, may be delayed for five or more hours. If vomiting begins within one to five hours, it is usually a sign of significant irradiation, with possible serious sequelae. If vomiting begins within one hour, it is indicative of a near lethal irradiation dose; if it begins within minutes of exposure, it is probably a sign of a lethal dose. Thus information on gastrointestinal signs and symptoms – from feelings of anorexia and nausea to vomiting – should be noted on the chart along with the time each began.

The lymphocyte count is a more sensitive "clinical dosimeter" wherever round-the-clock laboratory facilities are available. Consequently a complete blood cell and differential count should be obtained as soon as possible so that subsequent changes can be monitored. Decrease in the absolute lymphocyte count, if it is to occur, is apparent within 24 hours. If the count does not decline below $1200 / \text{mm}^3$ within 24 hours, the patient will receive no clinical support; if it falls below $500 / \text{mm}^3$, a severe course can be anticipated; if the lymphocytes disappear within six hours, the dose of radiation was fatal.

To minimize the amount of contamination with radioactive materials to hospital personnel, facilities and equipment during the treatment of patient involved in a radiation accident, the following procedures have been established for the Emergency Service:

- **Emergency Care For Patients Exposed To Radiation, Policy# 48B**
- **Emergency Procedures For Patients Contaminated With Radioactive Isotopes, Policy# 48C**
- **Emergency Procedures For Patients Who Have Ingested, Inhaled Or Incorporated Radioactive Materials, Policy# 48D**

A copy of the procedures listed above is available in the Policy and Procedure Manual of Department of Emergency Medicine.

EMERGENCY CARE FOR PATIENTS EXPOSED TO RADIATION

A. BACKGROUND:

Radiation is a general term describing the transmission of energy in the form of wave or fast moving (energetic) particles which can travel through space (including vacuum) or through a medium. Radiation that carries sufficiently high energy to cause changes (ionization to be precise) in atoms or/and molecules in matter is called ionizing radiation. Examples are: x-rays, gamma rays, beta and alpha radiation. Ionizing radiation can alter or kill some of cells in living tissues because of the ionization by radiation. If the number of the cells affected by radiation is large enough and the natural repair mechanism of the body can not repair the damage, then some biological damage may develop. Ionizing radiation is dangerous in that it cannot be seen, felt or heard and medical symptoms appear some time later. Persons exposed to harmful radiation may be unaware of the exposure until instruments, such as a Geiger counter or ion chamber, are employed to detect the radiation. The units of exposure measurement commonly used are roentgens for exposure and roentgens per hour for exposure rate. The absorbed dose is commonly used to measure the energy per unit tissue mass that patient absorbed. The absorbed dose is more closely related to the effect of radiation on patients. Its common unit is Rad. Radiation commonly referred in this document and other emergency protocols is that of Ionizing Radiation.

B. FOUR TYPES OF IONIZING RADIATION:

1. **Alpha Particles (Rays)** – Alpha particles are composed of two protons and two neutrons and heavy particles with a positive charge of two electrons. Their typically ranges are only a few centimeters in the air and only a few micrometers in tissue. Consequently, they can not penetrate skin. The contamination of alpha-emitting materials, therefore, is not a hazard to intact skin, but is a hazard to open wounds or when inhaled or ingested.

2. Beta Particles (Rays) – Beta particles are energetic electron or positrons emitted from the nucleus. Their typical ranges are several meters in the air and a few millimeters in tissue. Consequently, they pose a biological threat both internally and externally.
3. Gamma Rays – Gamma rays are high energy electromagnetic waves emitted from nucleus. Their typical ranges are much larger, i.e., many meters in air and many centimeters in the tissue. They are dangerous and can pass through the body to cause cell damage and ionization in tissue.
4. X-rays – Similar to the Gamma rays, x-rays are high energy electromagnetic waves, but are produced by x-ray machines and not by radioactive material. And like Gamma rays, they are dangerous and cause ionization

Alpha, Beta and Gamma emitting materials can enter bodies through inhalations, eating or open wounds and are harmful until they decay or are removed

C. RADIATION EFFECTS ON THE BODY:

Cellular changes resulting from radiation may stop or impair biological functions, therefore cause sickness or even death. Their effects are depending on the energy and the intensity of radiation, the time and extent of the exposure, and the distance to the radiation source. The greater the distance to the source, the smaller the exposure would be. The greater the energy, the greater the dose would be.

D. RADIATION ACCIDENTS:

1. One type of radiation accident that may be encountered is radiation release at a power station, laboratory, or industrial plant where the radioactive materials are carefully controlled. This type of accident might be classified as "*CLEAN*."
 - a. After the victim is exposed, the source is probably shielded or secured to reduce the possibility that other persons will be affected.
 - b. A radiological monitoring team usually monitors the area and takes steps necessary to prevent contamination before the arrival of the ambulance or rescue squad.
 - c. The patient, who did not ingest or inhale or was not contaminated by any radioactive materials, is transported to a medical facility with little or no danger to the emergency personnel and little or not additional damage to the patient-self.
2. Accidents in the transport of radioactive materials may be encountered in the Emergency Room. This type of accident is classified as "*DIRTY*," the radioactive source may be unshielded when emergency personnel arrive on the scene, and as such, present a radiation hazard to everyone in the area. If a vehicle is on fire and the radioactive source is involved, the smoke may carry radioactive particles for

some distance. If a "*DIRTY*" accident occurs both the patient and rescuing personnel may carry contaminating radioactive materials on clothes and parts of the body. All such individuals should be confined to a small area, and they should be provided with facilities to shower all parts of the body with soap and water. Outer clothing, shoes and any equipment used during the rescue should be placed in an isolated area until it can be monitored.

E. EMERGENCY CARE FOR PATIENTS EXPOSED TO RADIATION:

1. Patients who have received whole or partial body external radiation may have received a lethal dose, but present no hazard to the staff, other patients, or the environment.
2. Patients who have suffered internal contamination through inhalation or ingestion likewise present no hazard to others. After cleansing away minor amounts of contaminated material deposited on the body surface during airborne exposure, the course of treatment used for chemical poisoning should be followed.
3. Patients who have suffered external contamination of the body surface and/or clothing by liquids or dirt particles should be managed by surgical isolation techniques to confine the potential hazard and protect others.
4. Patients who have external contamination complications by a wound should have the wound and surrounding surfaces cleaned separately and sealed off to avoid cross-contamination.

F. GENERAL RULES FOR HANDLING RADIATION ACCIDENT PATIENTS:

1. Give life-saving emergency assistance if needed.
2. Determine if physical injury or open wounds are involved, cover any open wound with a clean dressing held in place with a bandage (do not use adhesive tape).
3. Cover the stretcher, including the pillow, with an open blanket, and wrap the patient in the blanket to limit the spread of contamination.
4. Secure pertinent information, including rough radiological measurement, from those present, if possible.

G. DOCUMENTATION:

1. Strict decontamination procedures should be followed after exposure to radioactive material, whatever the source is.

2. Remove, isolate and save all clothing.
 - a. Do not burn clothing since contaminated particles could be released into the air in the form of radioactive smoke.
 - b. Do not bury clothing since it might be dug up at some later time.
3. Shower immediately, paying close attention to open wounds, the hair, body orifices and body fold areas.

H. EMERGENCY PROCEDURES FOR PATIENTS CONTAMINATED WITH RADIOACTIVE ISOTOPES:

1. Summon Nuclear Medicine Physician and Radiation Safety Officer as soon as possible:
Nuclear Medicine Ext. 3695 & 3696 at KCHC; 270-1632, 33 0r 34 at SUH.
Radiation Safety Officer Ext. 3258 at KCHC; 270-1423 at SUH.
For evening and night emergencies, notify the switchboard operator to call the Nuclear Medicine physician and Radiation Safety Officer on an emergency basis.
2. If the patient is injured, immediate first aid should be administered following the rules in (3) to avoid spreading the contamination. It is invariably more important to attend to conventional injuries of the patient than to be concerned about the radiation complications.
3. *Radioactive contamination is spread by contact!* It can be removed but not destroyed. *Avoid direct contact* and wear gloves and gown. *Cover or contain* all items with which the patient may make contact using impervious plastic if possible.
4. The radiation Safety Officer will determine the extent of contamination using appropriate instrumentation.
5. If the patient is or is believed to be externally contaminated, remove the clothing and put it in a plastic bag. Decontaminate the skin carefully or the situation may be made worse. Avoid destroying the integrity of the skin by too vigorous scrubbing. Running water and mild soap are best. Swabbing may also be effective. Dip clean swabs into clean water, swab a small area then discard the swab.
6. If the patient is believed to have swallowed radioactive material, emetics may be effective if used soon after the ingestion. Wash out mouth area. If the intake occurred some time previously strong laxatives should be given unless contraindicated medically. In either case, collect saliva, urine and fecal samples. The detailed protocols in “**Emergency Procedures For Patients Who Have Ingested, Inhaled Or Incorporated Radioactive Materials**” are to be followed to treat the patients.

7. If the patient has been exposed to an intact source of radiation, he is not considered contaminated and is not a hazard to others. He should be treated as a normal casualty pending expert advice.

I. RADIOACTIVE CONTAMINATION PROTOCOL:

1. All personnel should wear protective outer wear and gloves before approaching the contaminated patient.
2. The contaminated patient are put in a decontaminating area; all their clothes are removed; and the patient or patients are washed with soap and water thoroughly.
3. Radiation Safety Officer and Hematology notified of the contaminated.
4. All personnel in contact with the patient, who did not have protective outerwear, should be evaluated by the Radiation Safety Officer.
5. The detailed protocols in “**Emergency Procedures For Patients Contaminated With Radioactive Isotopes**” are to be followed to treat the patients.

EMERGENCY PROCEDURES FOR PATIENTS CONTAMINATED WITH RADIOACTIVE ISOTOPES

A. NOTIFICATION

When the emergency department receives notification that a radiation accident has occurred and that a possibly contaminated victim is en route, there must be an orderly routine for the notification of essential personnel. The Director of the Emergency Medicine (or the person in charge at that time) must decide whether to activate the radiation accident plan. If he activates the plan, he is responsible for seeing that other essential people are notified.

1. Summon Nuclear Medicine Physician or Radiation Safety Officer as soon as possible.

Nuclear Medicine, Ext. 3695, 3696 or 3697 at KCHC

270 - 1632, 1633, or 1634 at SUH.

Radiation Safety Officer, Ext. 3258 or 3257 at KCHC

270 - 1423 or 1424 at SUH.

For evening and night emergencies, notify the switchboard operator to call the Nuclear Medicine physician and Radiation Safety Officer on an emergency basis.

2. Notify Director of Nursing that additional nursing staff will be needed.
Nursing Director, Ext. 3983 Page# 395 - 4162
3. Notify Hospital Police Department, because they will be needed to keep all nonessential persons out of emergency department and to be sure no one goes in or out of area without being monitored for radiation contamination.
4. Notify Hospital Administration and Regulatory Agencies - The Executive Director of KCHC or the senior hospital administrator on duty (AOD) should be notified immediately and they should then inform the New York City Bureau of Radiological Health and other officials, such as community and/or State Health Departments, police and fire departments as indicated.

Hospital Administration:

Daytime: Ext. 3100, Evenings/Weekends: call Page Operator

NYC Bureau of Radiological Health:

(212) 676-1580, 81 (X-ray)

(212) 676-1570, 72 (Radioactive material)

(212) 676-1558 (Director & off hours)

B. OBTAIN ON-SITE INFORMATION

1. Number and condition of victims
2. Type of radioactive material involved
3. Type of radiation accident:
 - a) irradiation
 - b) contamination
 - c) incorporation

On receipt of information that a victim of a radiation accident will arrive at the emergency department, the director or a designated person should keep in constant communication with the on-site emergency personnel to obtain as much advance information as possible.

If monitoring has been done at the accident site, the number of contaminated and non-contaminated victims is probably known. If the accident occurs in a laboratory or nuclear power facility, the type of isotope involved may be known. All trucks carrying radioactive material must, by law, also carry papers describing the type of radioactive material being carried. Such information is important, for example, partially processed uranium ore poses much less of a radioactive hazard than that fission product waste with its high level of radioactivity.

Finally information should be obtained about whether the accident involved only exposure to high level gamma rays or x-rays radiation or potential contamination with radioactive materials. If the former is the case, the emergency department need not prepare to receive contaminated patients; if any doubt exists, however, the radiation accident protocol should be activated and the following preparatory steps taken.

C. EMERGENCY ROOM PROCEDURES

1. Evacuation of Area

All patients or others near the route from the ambulance entrance to the decontamination rooms should be moved to other areas as following:

- a. Patients with non-critical problems to waiting rooms or other suitable areas.
- b. Patients with critical problems to another section of emergency department with continued medical supervision and care.
- c. All pregnant or potentially pregnant women to areas free of possible contamination.

2. Floor

- a. The route from the ambulance entrance to the decontamination room to be covered with roll of plastic or paper or with sheets, the covering to be secured to floor with tape.
- b. Above route to be marked off with ropes and marked "radioactive" until cleared by Radiation Safety Officer.

3. Decontamination Room – External Set up Tent.

If the patient was brought inside, the any patient room:

- a. Turn off ventilation (call Hospital Facility Management).
- b. Floor to be covered smoothly with plastic or paper floor covering (or sheets) secured to floor with tape.
- c. Strip of tape on the floor at the entrance to the decontamination room to delineate the contaminated side from the non-contaminated side.
- d. Radiation Safety Officer to designate a person (or persons) with counter to stay at entrance to monitor all personnel, equipment, and samples leaving decontamination room.
- e. Nonessential equipment to be removed from room or covered with plastic.
- f. Light switches and handles on cabinets and doors to be covered with tape.
- g. The nurse in charge to designate person to stand outside to obtain supplies for medical and decontamination teams.

- h. Place contamination tray on stretcher or make trough on decontamination table as follows:
 - i. Roll two sheets lengthwise and place along edge and head of table.
 - ii. Place plastic sheeting over rolled sheets, tucking it under the sides and head.
 - iii. Form ends of plastic sheet at the foot of table into a trough that empties into a large plastic container or wastebasket lined with a heavy plastic bag.
 - iv. Elevate head of table or stretcher so that all water runs into container.
- i. Provide large plastic or metal containers with plastic bags to receive discarded contaminated clothes, gauze, supplies, etc.

D. PREPARATION OF DECONTAMINATED TEAM

- *Physician*
- *Nurses*
- *Radiation Safety Officer*

The decontamination team should be outfitted with protective clothes outlined in the protocol. However, if the patient arrives before that is possible and has life threatening injuries that must be attended immediately, the team can treat him as soon as they have put on surgical gloves, gowns and masks. Rarely is a patient so contaminated that the level of radioactivity is a threat to the medical team. The main goals of precautions taken during decontamination are to prevent the radioactive material from internally contaminating the patient through oral ingestion, inhalation, or open wounds, and to prevent spread of contamination throughout the emergency department and the hospital. When time and the patient's condition permit it, the decontamination team should prepare as follows:

1. Use rest room.
2. Attach film badge to clothes. The badge should be labeled with the name.

3. Don full surgical dress:
 - a. Surgical trousers and pull-shirt;
 - b. Surgical hood;
 - c. Waterproof shoe covers;
 - d. Surgical gown;
 - e. Surgical gloves-tape gloves to sleeves and cuffs to shoe covers;
 - f. Second pair of surgical gloves;
 - i. Do not tape.
 - ii. Change as needed if torn or contaminated.
 - g. Surgical Mask.
4. Attach outside dosimeter.
 - a. Attach at neck level so it will not become contaminated easily.
 - b. Read at intervals during decontamination: report readings to Radiation Safety Officer.

E. FOR AMBULANCE PERSONNEL

If contamination is suspected, prepare space in ambulance by covering the floor area.

1. Give life saving emergency assistance if needed.
2. Determine if physical injury or open wounds are involved. Cover wounds with clean dressing; use elastic bandage to hold wound cover in place, do not use adhesive.
3. Remove victim's clothes and leave at accident site. A major portion of contamination is usually found on them. Cover stretcher, including pillow, with open blanket; wrap victim in blanket.
4. If clothes were not removed at accident and the victim is contaminated and the patient's condition permits, remove clothes inside ambulance.
5. If victim needs immediate medical attention, he is taken directly to the decontamination room. When a choice must be made, the care of life threatening conditions must always take priority over containment of contamination.
6. Perform survey of clothing, ambulance, etc. on arrival at hospital before undertaking further activity.
7. If contaminated, discard clothing in a metal trash container with lid and plastic liner marked "**Radioactive-Do Not Discard.**" Cleans oneself by washing and/or showering as appropriate.

8. If in contaminated area, rescue squad personnel must be surveyed by radiation survey meter; measurements must be recorded. Cleansing must continue until responsible physician indicates person may leave.

F. PATIENT CARE

The emergency physician in charge and the Radiation Safety Officer should meet the ambulance at the entrance to the emergency suite. The physician's primary task at this point is to determine whether the victim has injuries other than potential radiation injuries and, if he is so injured, how critical those injuries are. While the physician is doing that, the Radiation Safety Officer can determine whether the victim is contaminated. If the victim is contaminated, the physician must decide if the victim's condition permits removal of the clothes inside the ambulance because it, presumably, is already contaminated. If the victim needs immediate medical attention, he is taken, clothed, directly to the decontamination room. When a choice must be made, the care of life-threatening conditions must always take priority over containment of contamination.

The following procedure should be implemented when the patient arrives:

1. Physician and Radiation Safety Officer to examine patient in ambulance on arrival.
 - a. Physician determines if patient is critically injured, then he goes directly to decontamination room whether or not his clothes have been removed. If patient is not critically injured, his clothes are removed in the ambulance.
 - b. Radiation Safety Officer determines if patient is contaminated. If the patient is contaminated and is not critically ill, he goes to decontamination room after his clothes are removed in ambulance. If patient is not contaminated, he goes, still dressed, to regular trauma section of emergency department.
2. Stretcher with decontaminating tray or improvised trough is brought to the ambulance to receive contaminated patient. Patient is transferred to stretcher and patient is covered with plastic or cloth sheet.
3. Ambulance attendants stay by the ambulance until they and the ambulance are monitored for contamination. If non-contaminated, follow Radiation Safety Officer's instructions for decontamination.

G. DECONTAMINATION OF PATIENT

It is essential that care of serious medical problems take precedence over any attempts to decontaminate the patient. The physician and nurse must do a complete physical examination and attend immediately to the basics of resuscitation and preliminary studies. Only when the patient's condition is stable should they turn to decontamination.

The first priority in the decontamination procedure should be given to decontaminate the contaminated open wound, for such areas allow for rapid incorporation of radioisotopes. Decontamination procedures should be started (see “**Emergency Procedures For Patients Who Have Ingested, Inhaled Or Incorporated Radioactive Materials**”) and irrigation of the wound should begin with copious amounts of normal saline for at least three minutes. If monitoring shows persistent contamination, irrigation can be continued with normal saline, although substitution of 3% hydrogen peroxide may be more helpful.

The following procedure should be implemented as required:

1. Airway, breathing and cardiovascular status must be attended to first.
 - a. Physical examination done by physician.
 - b. Required laboratory material, electrocardiograms and radiographs obtained as required by patient's condition.
 - c. Procedure, fluid and drug administration done as required by patient's condition.
2. Patient evaluation
 - a. Remove patient's clothes, if not done in ambulance, place them in plastic bag and seal the bag.
 - b. Cotton swab samples of ear canals, naris, and mouth:
 - i. Place each in glass container labeled with patient's name, the site, and the time.
 - ii. Stopper glass container and place in lead container for later analysis.
 - c. Radiation Safety Officer monitors entire patient, including the posterior.
 - d. Circulating nurse notes in record areas and amount of contamination.
 - e. Cotton swab samples of all contaminated areas are obtained and stored as above.

3. Physical decontamination of radioactive areas
- a. Contaminated open wounds (these have first priority):
 - i. Begin decorporation (see **“Emergency Procedures For Patients Who Have Ingested, Inhaled Or Incorporated Radioactive Materials”**);
 - ii. Wash with normal saline for three minutes;
 - iii. Monitor and repeat step *ii.* as needed.
 - iv. If contamination persists:
 - 1) wash with 3% hydrogen peroxide;
 - 2) Consider surgical debridement;
 - 3) Save and monitor all tissue removed.
 - v. After wounds are decontaminated, cover them if other areas need to be decontaminated.
 - b. Contaminated eyes:
 - i. Rinse with water; stream should go in nose-to-temple direction, away from medical canthus;
 - ii. Monitor and repeat step *i.* as needed.
 - c. Contaminated ear canals:
 - i. Rinse gently with small amount of water; suction frequently;
 - ii. Monitor and repeat step *i.* as needed.
 - d. Contaminated nares or mouth:
 - i. Turn head to side or down, as patient's condition permits;
 - ii. Rinse gently with small amount of water; suction frequently;
 - iii. Prevent water from entering stomach as much as possible;
 - iv. Insert nasogastric tube into stomach; suction and monitor contents, If contents are contaminated:
 - 1) Lavage with small amounts of normal saline until contents are clear of contamination;
 - 2) Begin decorporation (see **“Emergency Procedures For Patients Who Have Ingested, Inhaled Or Incorporated Radioactive Materials”**).

- e. Contaminated intact skin:
 - i. wash with soap and tepid water, gently scrubbing with soft brush for three minutes;
 - ii. Monitor and repeat step *i.* as needed;
 - iii. Do not redden or irritate skin with hot water or harsh scrubbing;
 - iv. If contamination persists,
 - 1) Use Lava soap or
 - 2) Use mixture of 1/2 Tide[®] and 1/2 cornmeal.
 - 3) If those fail to remove contamination use Clorox either full strength for small areas or diluted for large areas.
- f. Contaminated hair:
 - i. Shampoo with mild soap for three minutes
 - ii. monitor and repeat step as needed
 - iii. If contamination persists:
 - 1) Clip hair off.
 - 2) Do not shave scalp.

H. EXIT OF DECONTAMINATION TEAM

After the patient has been medically treated and decontaminated, he should be discharged home or admitted to the hospital, for his clinical condition.

If the Radiation Safety Officer finds no contamination when he re-monitors the patient, new floor coverings are placed from the clean line at the door to the stretcher that the patient is on (and from the door to a clean stretcher outside the room unless the area outside the room has already been decontaminated). The clean stretcher is brought in; the patient is transferred to it by new attendants (those involved in the decontamination procedure may now be contaminated); and the stretcher and patient are 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 transferred out of the room on the clean stretcher.

Each member of the decontamination team then goes to the clean line and begins to remove his protective clothes in the manner described below:

1. Each team member goes to clean line at door and remove protective clothing (placing all of it in a plastic container marked "contaminated"):
 - a. Remove outer gloves first, turning them inside out as they are pulled off.
 - b. Give dosimeter to Radiation Safety Officer.
 - c. Remove all tape at trouser cuffs and sleeves.
 - d. Remove outer surgical gown, turning it inside out; avoid shaking.
 - e. Remove surgical shirt.

- f. Remove head cover.
 - g. Pull surgical trousers off over shoe covers.
 - h. Remove shoe cover from one foot and let Radiation Safety Officer monitor shoe, if shoe is clean, step over clean line, then remove other shoe cover and have other shoe monitored.
 - i. Take off inner gloves.
- 2. Have feet and hands monitored for final time.
- 3. Take shower.

I. RADIATION SAFETY OFFICER'S RESPONSIBILITIES

- 1. Radiation Safety Officer shall monitor:
 - a. Ambulance and attendants.
 - b. Route from the ambulance entrance to the decontamination room.
 - c. Decontamination room, patient and personnel.
- 2. Decontamination of area if found necessary in step 1. above.
- 3. Analysis of all specimens taken of potentially contaminated areas.
- 4. Proper disposal of any contaminated items or water.
- 5. Examination of all film badges and dosimeters and proper follow-up if indicated.

EMERGENCY PROCEDURES FOR PATIENTS WHO HAVE INGESTED, INHALED OR INCORPORATED RADIOACTIVE MATERIALS

A. INTRODUCTION

The procedures for treatment of persons with internally deposited radionuclides are intended to reduce the absorbed radiation dose and hence the risk of possible future biological effects. These aims can be accomplished by the use of two general processes: (1) reduction of absorption and internal deposition; and (2) enhanced elimination or excretion of absorbed nuclides. Both are most effective when begun at the earliest possible time after exposure.

Treatment is most effective if absorption of contaminants into the systemic circulation is prevented. Administration of diluting and blocking agents may also enhance elimination rates of the radionuclide or reduce the quantity of radionuclide incorporated in tissue. Therapeutic measures that use mobilizing agents or complexing drugs are less effective when the radionuclide has already entered the cells of target tissues and organs. The most important considerations in treatment are: (1) selection of the proper drug for the particular radionuclide; and (2) timely administration after exposure.

General guidance concerning factors involved in determining the necessity of treatment is given in Section 5 of the National Council on Radiation Protection and Measurements Report No 65 "Management of Persons Accidentally Contaminated with Radionuclides." There is no numerical exposure value that can be used as an absolute guide for this determination. For relatively risk-free procedures, the need for rapid action will probably preempt the desire to make a more careful evaluation of the exposure. In any event, treatment should be started immediately when the probable exposure is judged to be significant.

The cessation of treatment is another decision that depends on the experience and judgement of the physician-in-charge. This decision rests on the relative risks versus the effectiveness of the particular treatment and will be raised primarily with relation to continuation of the use of mobilizing or chelating agents. These treatments may be of sufficient duration that a judgement of their current therapeutic effectiveness can be based on measurements of the urinary excretion rate of the radionuclide with and without treatment, or possibly on the effective half-life of the radionuclide determined by whole-body counting data. This decision is not as crucial as that relating to initiation of treatment and can be made after due deliberation that includes consultations as desired.

The table at the end of this procedure presents selected generic drugs along with the usual dose instruction for other medical problems and explanatory or cautionary remarks. In cases of emergency and significant radiation exposure risks, higher drug doses with consequent higher risks of adverse drug reactions may be justified. The sparse literature on human therapy for incorporated radionuclides shows that cases warranting treatment have often received an aggressive course of therapy including the employment of agents and doses that are not usual for other medical problems. The decisions to follow this

course have been based on the physician's judgement and on careful clinical management of the case.

The drug schedules listed in this report are in the conventional dose ranges. The drug listings are not intended to be exhaustive. The physician is cautioned to consult additional references in the use of these drugs since it is not possible to include all pharmacological details in this report. A physician should feel free, however, to use any drug approved by the FDA for any use that he or she deems appropriate in his or her professional judgment.

B. DECORPORATION (GENERAL)

A true medical emergency exists when a victim of a radiation accident inhales or ingests radioactive material or has contaminated open wounds. The sensitive internal tissues become irradiated as the material passes through the body, and some of the material becomes incorporated biochemically, which results in permanent radioactivity within body tissues. Therefore, whenever is possible that radioactive material has entered the body, decorporation should be started within one or two hours of the accident.

In most cases, emergency department personnel will not know the exact isotopes involved and isotope identification may take days. Thus certain steps should be taken routinely in an attempt to remove the most commonly encountered radioactive isotopes.

The radioactive actinide isotopes can be chelated effectively subsequently and excreted by the use of DTPA diethylenetriaminepentaacetic acid. To be effective it must be administered within one hour of internal contamination. It should be ordered from any emergency department that has reason to expect that DTPA may be needed because of nearby nuclear reactors, isotope production facilities, nuclear chemistry laboratories, etc. should have on hand both the chemical and instructions on its use.

If DTPA is not available, several procedures can be used to decrease incorporation of common radioisotopes. They should be started as quickly as possible.

Because radioactive iodine is taken up by the thyroid its uptake can be blocked to a great extent by having the patient swallow two or three drops of saturated solution of potassium iodide in a glass of water after gastric lavage has been completed. Antacids will precipitate metals in the stomach as insoluble hydroxides, and cathartics will subsequently shorten their internal transit time. Aluminum phosphate gel (Phosphsjel) reduces by 87% the intestinal absorption of radioactive strontium. Barium sulfate to be obtained from the radiology department will precipitate radium. Again, these should be given as soon as gastric lavage is completed.

Thus emergency department personnel have available a number of agents that lessen the biological incorporation of radioactive isotopes. Once these isotopes have been incorporated, there is little anyone can do except wait for metabolism and excretion, as well as radioactive decay, to occur.

C. PROCEDURES TO REDUCE GASTROINTESTINAL ABSORPTION

Gastrointestinal absorption of radioactive substances can be reduced either by washing out or by use of medications selected for specific elements. These medications combine with the radionuclide so that it becomes less available for absorption and is then eliminated in the stool. Examples of these are the alginates and aluminum-containing compounds that tightly bind radioactive strontium. Other substances act by exchange, e.g., resins that bind the radioisotope in place of another ion. The radioactive substance that has exchanged is subsequently eliminated in the feces. The following procedures can be used for reducing the gastrointestinal absorption of radioactive substances.

1. Stomach-Lavage.
2. Emetic.
3. Purgatives.
4. Ion-exchange resins.
5. Aluminum-containing antacids.
6. Alginates.
7. Barium sulfate.
8. Phytates.

D. BLOCKING AND DILUTING AGENTS

A blocking agent saturates the metabolic processes in a specific tissue with the stable element and thereby reduces the uptake of the radionuclide. The best example of this process is the use of stable potassium iodide to prevent the uptake of radioiodine in the thyroid. To be effective, blocking agents must be administered in a form that is rapidly absorbed.

Isotopic dilution with a diluting agent is achieved by the administration of large quantities of the stable element or compound so that, on a statistical basis alone, the opportunity for incorporation and exposure to the radionuclide is lessened. The best example here is the use of water to reduce the effective half-life of tritium in the body. As with blocking agents, it is desirable to administer a form of the diluting agent that is at least as readily absorbed and metabolized as the compound that contains the radioisotope.

Displacement therapy is a special form of dilution therapy in which a non-radioactive element of a different atomic number successfully competes with the radionuclide for uptake sites.

Some of the examples for blocking and diluting agents or displacement therapy are:

1. Potassium iodide as a blocking agent for radioiodine.
2. Stable strontium as a diluting agent for radiostrontium.
3. Forced fluid to increase excretion to reduce tritium.
4. Calcium to reduce the deposition of radioactive strontium and calcium.

E. MOBILIZING AGENTS

Mobilizing agents are compounds that increase a natural turnover process and thereby induce a release of some forms of radioisotopes from body tissues. This process results in an enhanced rate of elimination from the body. Mobilizing agents are more effective the sooner they are given after the exposure to the isotopes. Many of the mobilizing agents are still effective, however, within about 2 weeks after exposure to the radioisotopes, although they are decreasingly effective after this time interval. The examples are:

1. Antithyroid drug can be used to reduce uptake of radioiodine.
2. Ammonium chloride is an effective mobilizing agent for radiostrontium.
3. Diuretics can be used to decrease the volume of extracellular fluid by enhancing urinary excretion of sodium and water.
4. Expectorants and inhalants.
5. Parathyroid Extract (PTE) injection can increase serum calcium.

F. CHELATING AGENTS

A number of chemical compounds are known that enhance the elimination of metals from the body by chelation, a process by which organic compounds (ligands) exchange less firmly bonded ions for other inorganic ions to form a relatively more stable non-ionized ring complex. The strength of this binding varies with the different chelating agents and with the bonded ion. These agents do not have the ability to form a chelate with only one specification, but they do bond some metals more strongly than others. After chelation, the cation becomes an integral part of a stable ring structure and ceases to act as a free ion. When this complex is soluble it can be excreted readily by the kidney.

1. EDTA - CaNa (2) EDTA.
2. DTPA - CaDTPA.
3. Dimercaprol.
3. Penicillamine.
4. Deferoxamine.

G. SUMMARY OF DRUG THERAPY

The following table is reproduced from the National Council on Radiation Protection and Measurements Report No 65 "Management of Persons Accidentally Contaminated with Radionuclides." Report # 138, and "Disaster Preparedness for Radiology Professionals" ACR publication 2002.

TABLE 2.5 – *Treatment summary for selected elements*

The benefit from therapy recommendations in the Immediate Actions (Col. 2) and Drugs to Consider (Col. 3) columns will be influenced by the route of exposure – ingestion, inhalation, skin absorption or contamination of wounds. The chemical form and solubility of the radionuclide will also change markedly the efficacy of the recommended treatment. This table lists therapeutic procedures or drug therapy that may be helpful for the listed elements in the favorable circumstances. The user is advised to consult the text for details on the influence of these other factors. The numbers in this table refer to sections in the text where additional information is available.

Element	Immediate Actions	Drugs to Consider	Information and Comment
Americium (Am)	7.3.5.3-DTPA	7.3.5.3-DTPA	See Section 6.1. See Section 7.2 for contaminated wounds. Chelation should be started as soon as treatment decision is made. CaEDTA (7.3.5.2) may be used if CaDTPA is not immediately available.
Arsenic (As)	Consider 7.3.2.2.-Lavage	7.3.5.4-Dimercaprol	Short-lived isotopes. Use of dimercaprol (7.3.5.4) is not indicated except in massive exposures.
Barium (Ba)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	See Comment	Use of sodium or magnesium sulfate with and after stomach lavage will precipitate insoluble barium sulfate.
Calcium (Ca)	Consider 7.3.2.2-Lavage 7.3.2.4-Purgatives, and 7.3.3.6-Calcium	7.3.3.6-Calcium 7.3.4.4-Flurosemide	Massive exposure may warrant use of the <i>sodium</i> salt EDTA (7.3.5.2), but with caution over a 3-4 hour period to avoid tetany. Furosemide (7.3.4.4.) enhances urinary excretion.
Californium (Cf)	7.3.5.3-DTPA Consider 7.3.2.2-Lavages and 7.3.2.4-Purgatives	7.3.5.3-DTPA	See section 6.2. See section 7.2 for contamination wounds. Chelation should start as soon as treatment decision is made. Ca-EDTA (7.3.5.2) may be used if Ca-DTPA (7.3.5.3) is not immediately available.

Carbon (C)		No treatment available	Soft beta rays of ^{14}C not detected by survey instruments; collect samples and smears for special low-energy beta counting in laboratory.
Cerium (Ce)	7.3.5.3-DTPA, Consider 7.3.2.2.-Lavage and 7.3.2.4-Purgative	7.3.5.3-DTPA	See section 6.3 Chelation should start as soon as treatment decision is made. CaEDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available.
Cesium (Cs)	7.3.2.6-Prussian Blue, Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	7.3.2.6-Prussian Blue	See Section 6.4 Ion exchange resins (7.3.2.5) should be as effective as Prussian Blue, but have not been used in humans.
Chromium (Cr)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	No treatment available for anionic forms, 7.3.5.2-DTPA or 7.3.5.6-DFOA for cations	Antacids are contraindicated. Adsorbents (such as charcoal or MgO_2) may reduce intestinal tract absorption.
Cobalt (Co)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	See comment	See section 6.5. Penicillamine (7.3.5.5) may be considered for therapeutic trial in large exposures.
Curium (Cm)	7.3.5.3-DTPA Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	7.3.5.3=DTPA	See Section 6.6. See section 7.2 for contaminated wounds. Chelation should be started as soon as treatment decision is made. Ca-EDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available.
Europium (Eu)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	7.3.5.3-DTPA	
Fission Products (Mixed)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	Depends on major isotope(s) in mixture, which varies with age of the isotope mixture.	Gamma-ray spectroscopy of plant air or swipe samples may identify prominent radionuclide(s) in mixture to determine definitive therapy. Check also for possible alpha emitters. Most important may be iodine, cesium, cerium, and strontium.
Fluorine (F)	7.3.2.7-Aluminum Hydroxide gel	See Comment	Very short half-life. Oral aluminum hydroxide gel will reduce absorption from gastrointestinal tract.

Gallium (Ga)	See Comment	See Comment	Short half-life. Penicillamine (7.3.5.6) can be considered for therapeutic trial.
Gold (Au)		7.3.5.4-Dimercaprol and 7.3.5.5-Penicillamine are possible therapeutic agents.	See Section 6.7. No known therapy for Au in colloidal form.
Hydrogen (H)			See Tritium.
Indium (In)		7.3.5.3-DTPA	Pharmaceutical form of indium is chelated already.
Iodine (I)	7.3.3.2-KI Consider 7.3.2.2.-Lavage	7.3.3.2-KI	See Section 6.8. Success of stable iodine (7.3.3.2) depends on early administration.
Iron (Fe)	Consider 7.3.3.2-Lavage and 7.3.2.10-Phytates	7.3.2.6-DFOA	Materials that reduce GI absorption include phytates (7.3.2.10), egg yolk, or adsorbents. Oral penicillamine (7.3.5.5) also chelates iron.
Lanthanum (La)	Consider 7.3.2.2-Lavage and 7.3.2.4.-Purgatives	7.3.5.3-DTPA	CaEDTA(7.3.5.2) may be used if CaDTPa (7.3.5.3) is not immediately available.
Lead (Pb)	Consider 7.3.2.2-Lavage	7.3.5.2-EDTA	Dimercaprol (7.3.5.2) and penicillamine (7.3.5.5) are less satisfactory alternative drugs.
Mercury (Hg)	Consider 7.3.2.2-Lavage	7.3.5.5-Penicillamine	See Section 6.9. Dimercaprol (7.3.5.4) may be considered for alternative therapy. Gastric lavage with egg white solution or 5 percent sodium formaldehyde sulfoxide; if unavailable, use a 2-5 percent solution of sodium bicarbonate.
Neptunium (Np)		See comment	DTPA (7.3.5.3) may not be effective, but no other drugs are available.
Phosphorus (P)	Consider 7.3.2.2-Lavage and 7.3.2.7 Aluminum Hydroxide	7.3.3.4-Phosphates	See section 6.10. Severe overdosage may be treated with parathyroid extract IM (7.3.4.6) in addition to oral phosphates (7.3.3.4).
Plutonium (Pu)	7.3.5.3-DTPA	7.3.5.3-DTPA	See section 6.11. CaEDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available, but is less effective. Chelation should be started as soon as treatment decision can be made. Desferrioxamine (7.3.5.6) may be used initially if DTPA is not available. See Section 7.2 for contaminated wounds.

Polonium (Po)	Consider 7.3.2.2-Lavage and 7.3.2.5-Purgatives	7.3.5.4-Dimercaprol	See section 6.12. Consider toxicity of Dimercaprol before using in cases of low-level exposure. Penicillamine (7.3.5.5.) is an alternative treatment.
Potassium (K)	Consider 7.3.2.4-Purgatives, 7.3.4.4-Diuretics, 7.3.2.7-Aluminum Hydroxide	7.3.4.4.-Diuretics	Use aluminum hydroxide antacids first to reduce GI tract absorption. Use oral liquid potassium supplements (7.3.3.8) for dilution.
Promethium (Pm)	7.3.5.3.-DTPA Consider 7.3.2.2.-Lavage and 7.3.2.4.-Purgatives	7.3.5.3.-DTPA	Chelation should be started as soon as treatment decision is made.
Radium (Ra)	7.3.2.4.-Magnesium Sulfate Consider 7.3.2.2.-Lavage and 7.3.2.4.-Purgatives	See comment	See Section 6.13. Use 10 percent magnesium sulfate solution for gastric lavage and as saline cathartic. Oral sulfates (7.3.2.9) reduce intestinal absorption. No effective therapy after absorption. Ammonium chloride (7.3.4.3) and calcium (7.3.3.6) may increase urinary excretion slightly. Other agents that have shown little success include thyroid extract, parathyroid extract and I.V. ACTH. Alginates are useful to reduce gastrointestinal absorption.
Rubidium (Rb)	7.3.2.6.-Prussian Blue	7.3.2.6-Prussian Blue	Chemical properties are similar to potassium, but efficacy of similar treatments is unknown.
Ruthenium (Ru)	Consider 7.3.2.2-Lavage and 7.3.2.4-Purgatives	See comment	Chlorthalidone (7.3.4.4.) causes enhanced urinary excretion. DTPA (7.3.5.3) has variable effectiveness.
Scandium (Sc)	Consider 7.3.2.2.-Lavage and 7.3.2.4.-Purgatives	7.3.5.3.-DTPA	EDTA (7.3.5.2) may be used in place of DTPA
Silver (Ag)			Short effective half-life. No therapy.
Sodium (Na)	Consider 7.3.2.2-Lavage	7.3.4.4-Diuretic	Isotopic dilution (1 liter I.V.-0.9 percent NaCl) by I.V. route followed by furosemide or other diuretic agents (7.3.4.4.)

Strontium (Sr)	7.3.2.7- Aluminum Phosphate (7.3.2.4.- Magnesium Sulfate or 7.3.2.8- Alginates are alternatives) Consider 7.3.2.2.- Lavage	7.3.3.3- Strontium or 7.3.3.6 (Calcium I.V.) and 7.3.4.3- (Aluminum Chloride)	See section 6.14. Corticosteroid (7.3.4.7) may be considered, but adverse reactions should be balanced against probable limited effectiveness.
Sulfur (S)	Consider 7.3.2.2.- lavage and 7.3.2.4.- Purgatives	No therapy known	Soft-energy beta rays of ^{35}S not detectable with conventional survey instruments. A thin window survey meter may be used or obtain smears or samples for special low-energy beta counting in laboratory.
Technetium (Tc)			See Section 6.15 Potassium perchlorate has been used effectively to reduce thyroid dose
Thorium (Th)		DTPA (7.3.5.3.) or DFOA (7.3.5.6) useful for soluble compounds	See Section 6.16. Treatment not effective for thorotrast (ThO_2).
Tritium (^3H)	7.3.3.5- Forced Water	7.3.3.5-forced water	See Section 6.17. Soft-energy beta rays of ^3H , not detectable by survey instrument, require samples for special low-energy beta counts in laboratory.
Uranium (U)			See Section 6.18 DTPA must be given within 4 hours to be effective. Sodium bicarbonate protects kidney from damage.
Yttrium (Y)		7.3.5.3-DTPA	CaEDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available.
Zinc (Zn)	Consider 7.3.2.2- Lavage. Phytates (7.3.2.10) may reduce intestinal uptake.	7.3.5.3-DTPA	Zinc sulfate (7.3.3.7) may be used as diluting agent if CaDTPA is not immediately available. CaEDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available. Penicillamine (7.4.5.5.) is a second alternative.
Zirconium (Zr) -Niobium (Nb)	Consider 7.3.2.2- Lavage	7.3.5.3.-DTPA	CaEDTA (7.3.5.2) may be used if CaDTPA (7.3.5.3) is not immediately available.

