Radiation Surge Preparedness Annex

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FOREWARD

Radioactive substances and other sources of ionizing radiation are used to assist in diagnosing and treating diseases, improving agricultural yields, producing electricity, and expanding scientific knowledge. The application of radiation sources is growing daily; consequently, the need to plan for radiological accidents is growing. While the risk of such accidents cannot be eliminated, experience shows that most of the radiation exposure cases that have occurred could have been prevented, as they are often caused by human error.

Radiological accidents such as the victims of the Tokyo Sarin gas attack, many victims of a terrorist event will arrive at area hospitals by private vehicle and therefore not be decontaminated. Coupled with this fact, the minimum time for response and set-up following a HAZMAT incident is approximately one hour (BDLS). Therefore, hospitals must be prepared to have the necessary equipment and trained personnel to provide gross decontamination on on-site modified Level C protection (including a full-face Powered Air Purifying Respirator (PAPR) is the PPE chosen by the Regional Healthcare Preparedness Coalition as meeting and/or exceeding hospital decontamination needs and is the PPE supplied to regional acute care hospitals via the Hospital Preparedness Program.

Demonstrated the importance of adequate preparation for dealing with such emergencies. Medical preparedness for radiological accidents must be considered an integral part of general emergency planning and preparedness and established within the national framework for radiation protection and safety.
This annex outlines the roles and tasks of health authorities and hospital administrators in emergency preparedness for radiological accidents. Health authorities may use this document as the basis for their medical management in a radiological emergency, bearing in mind that adaptations will almost certainly be necessary to consider the local conditions. This annex also provides information relevant to integrating preparedness into emergency plans.

Radiation Surge Preparedness Annex

Purpose:

To provide an effective, safe, and coordinated response to a radiological agent occurrence and to provide optimal management of acute radiation sickness.

General Assumptions:

Responding agencies will follow the Incident Command procedures/guidelines set forth in their Emergency Preparedness Plan.

BACKGROUND:

A radiological accident is an unintended, unexpected, responsible, or intended event occurring with a radiation source or during a practice involving ionizing radiation, which may result in significant human exposure and/or material damage. It includes accidents with reactors, industrial sources, medical facilities, nuclear attacks, and other radiation-emitting sources. Although radiological accidents in industry, medicine, research, teaching, or agriculture are more limited in their environmental impact, they occur much more frequently than reactor accidents and can have serious health consequences.

Not only workers but also members of the public, including children, have suffered radiation injuries due to radiological accidents over the past few years. These accidents not only involved external irradiation but occasionally included internal and skin contamination.

A comprehensive study of the causes and consequences of radiological accidents is a recurrent theme in several fields of International Atomic Energy (IAEA) and World Health Organization (WHO) activities under the programs on radiation safety and the prevention of radiation health hazards. These include occupational radiation protection; assessment and treatment of radiation health effects; emergency planning and preparedness; and safety of radiation sources. Each of these is concerned with a different facet of a radiological accident and approaches it from a different angle. Nevertheless, they are all crucial in reducing the likelihood and severity of such accidents.

Over the past few years, the IAEA (https://www.iaea.org/) has issued publications that give information on the nature of radiation health effects and general recommendations to physicians for the diagnosis and treatment of radiation injuries resulting from a nuclear or radiological accident, as well as safety guides providing general recommendations for emergency preparedness, including some medical aspects and guidance on radiation protection criteria for reducing health consequences. This Safety Report outlines the roles of health authorities and hospital administrators in emergency preparedness and is considered a logical supplement to these publications.

OBJECTIVE:

The purpose of this Radiation Surge Annex is to provide practical information to regional health authorities responsible for medical planning for and medical response to a radiological accident. As was demonstrated by the victims of the Tokyo Sarin gas attack, many victims of a terrorist event will arrive at area hospitals by private vehicle and, therefore, not be decontaminated. Coupled with this fact, the minimum time for response and set-up following a HAZMAT incident is approximately 1one hour (BDLS). Therefore, hospitals must be prepared to have the necessary equipment and trained personnel to provide gross decontamination-site. Modified Level C protection (including a full-face Powered Air Purifying Respirator (PAPR) is the PPE chosen by the Regional Healthcare Preparedness Coalition as meeting and/or exceeding hospital

decontamination needs and is the PPE supplied to regional acute care hospitals via the Hospital Preparedness Program.

SCOPE:

This annex informs health authorities on the medical and public health aspects of dealing with radiological accidents. Small-scale accidents usually involve a small source term and a small number of individuals and often come to light from observations by primary care physicians. Large-scale radiological accidents usually involve a significant source term, and large numbers of persons may be irradiated and/or contaminated, requiring specialist treatment in both primary and secondary medical facilities. Large-scale accidents can also lead to widespread public health actions undertaken to mitigate the effects of radioactive contamination. This report does not discuss those actions, which include the distribution of stable iodine tablets, individual monitoring, and reassurance and counseling, as these are covered in policy and procedures by healthcare entities. Nevertheless, in some small-scale accidents, public health actions such as the issue and administration of stable iodine and the restriction of public access may be required.

Depending on the severity of the accident, the level of medical aid to persons irradiated or contaminated will include the following:

(a) First aid provided at the place of the accident (without a physician or nurse necessarily in attendance).
(b) Initial medical examination (triage will be required if many persons are exposed), detailed clinical and laboratory investigations, and medical treatment in a general hospital.
(c) Complete examination and treatment in a specialized radiation medical center when there is evidence of serious irradiation or internal contamination.

In view of the infrequent occurrence of radiological accidents and the capability of existing large general centers to deal with such accidents, it is not the purpose of this radiation surge annex to encourage the proliferation of medical centers specifically equipped and staffed for the sole purpose of treating victims of overexposure to radiation.

Core Elements:

- ✓ Indicators/triggers and alerting/notifications of a specialty event.
- ✓ Initial coordination mechanism and information gathering to determine impact and specialty needs.
- ✓ Documentation of available local, state, and interstate resources that can support the specialty response and key resource gaps that may require external support (including inpatient and outpatient resources)
- ✓ Access to subject matter experts (SMEs) – local, regional, and national
- ✓ Prioritization method for specialty patient transfers (e.g. which patients are most suited for transfer to a specialty facility)
- ✓ Relevant baseline or just-in-time training to support specialty care
- ✓ Evaluation and exercise plan for the specialty function

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General Assumptions:

Responding agencies will follow the Incident Command procedures/guidelines set forth in their Emergency Preparedness Plan.

Detection of Exposures:

Ionizing radiation exposures may be known and recognized or may be covert as in:

- Large radiation exposures, such as a nuclear weapon or catastrophic damage to a nuclear power plant
- Small radiation sources emitting continuous gamma radiation, producing chronic intermittent exposures, such as those found from medical treatments or industrial devices
- Skin contamination (external contamination) with radiological material
- Internal radiation (internal contamination) from absorbed, inhaled, or ingested radioactive materials.

Types of radiation injuries include damage from exposure to external radiation; internal radiation from ingested or inhaled radioactivity; and surface radioactivity contamination by liquids and dust, both with and without surface wounds.

Rapid response to a radiological-related event requires prompt identification and treatment. Because of the rapid progression to illness and the potential for dissemination of some of the contaminant's agents, it may not be practical to await definitive confirmation. Instead, it will be necessary to initiate a response based on the recognition of presenting syndromes. Each type of radiation is listed in this plan and includes a description and typical combination of clinical features that should alert healthcare practitioners to the possibility of a radiological-related event.

Hazard Assessment:

Cross-contamination of hospital staff and/or facilities may pose a threat when responding to a radiological disaster. Healthcare facilities should consider employing the following mechanisms to ensure the safety of the staff and patients and preserve the structure of buildings upon recognition or alert of a potential radiological event:

a. Anticipate the number, acuity, and potential needs of incoming patients (i.e., medications, treatment modalities, fluid, oxygen, ventilators, etc.).
b. Decompress current patient load in Emergency Department
c. Formulate a plan for decontamination as needed.
d. Formulate a plan for additional surge capacity.
e. Plan for large numbers of "self-presenters."
f. Notify Security to assist in securing the perimeter and access into facilities.
g. Utilize PPE if applicable.
h. Anticipate and cooperate with outside investigating agencies if the event relates to an actual or perceived terror attack.
i. Ensure staff protection and safety first. Immediately report any and all adverse reactions by staff to the immediate supervisor.

All patients suspected of radiation exposure will be treated appropriately with the Radiation Safety Officer (RSO) involved in the decontamination and treatment. In the event of radiological exposure, the RSO must deem the involved individual and encountered staff "clear" or "safe" prior to them leaving the decontamination area. This may require the individual to undergo multiple passes through the decontamination area. Special attention should be paid to maintaining patients' warmth and stable hemodynamic status.

Three basic principles allow the limitation of radiation exposure to healthcare personnel, staff members, and victims:

- Time
- Distance
- Shielding

Clinical Findings:

Acute radiation syndrome follows a predictable pattern after substantial exposure or a catastrophic event. Specific syndromes of concern, especially when presented with a 2–3-week prior history of nausea and vomiting, include:

- Thermal burn-like skin lesions without documented heat exposure
- Immunological dysfunction with secondary infections
- A tendency to bleed.
- Bone marrow suppression
- Hair loss

Triage:

Patients presenting to regional hospitals following a radiological-event will be categorized as follows:

Radiation exposure:

The individual has been involved in a radiological incident but does not become contaminated with radiation. The individual has presented or been transported to the hospital as a precautionary measure. This individual does not require decontamination or further treatment. Collect patient data as requested by jurisdictional authorities. The collected information should include location and duration of exposure.

External contamination:

The individual has been involved in a radiological incident and external contamination of the body surface and/or clothing by radioactive material is present. Decontamination is required to protect other patients, staff, and the hospital environment.

Note: Removing the patient's clothing will remove most of the external contamination. If clothing is grossly contaminated, moistening the clothing before removal will decrease the amount of possible airborne shedding of the material.

Internal contamination: The individual has been involved in a radiological incident, and subsequent contamination results from inhalation or ingesting radioactive material. While this patient is usually no hazard to personnel, other patients, or the environment, external contamination of skin, hair, and clothing must be considered with inhalation of radioactive material. This patient may require external decontamination.

Monitoring and Decontamination Considerations:

Exposure to a beam of radiation does not contaminate an individual. Patient contamination results from contact with radioactive particles that may arise from an explosion or a breach of a radioactive source. Treating individuals before decontamination may result in contamination of the facility. If the patient presents with no life-threatening injuries, decontaminate before treating. If the patient presents with life-threatening injuries, treat the life-threatening injuries, then decontaminate. To minimize the spread of contamination, wrap the patient in a clean sheet prior to bringing them into the facility. (Guidelines for the care of a radiologically contaminated patient in the Operating Room and guidelines for the care of the radiologically contaminated patient in the hospital are outlined in this plan.)

Evaluation of the extent and degree of contamination must be done before and following the decontamination process. Adequate records of contamination and decontamination must be kept. In decontamination, except for contaminated skin breaks, decontamination of areas with higher contamination levels shall be performed first.

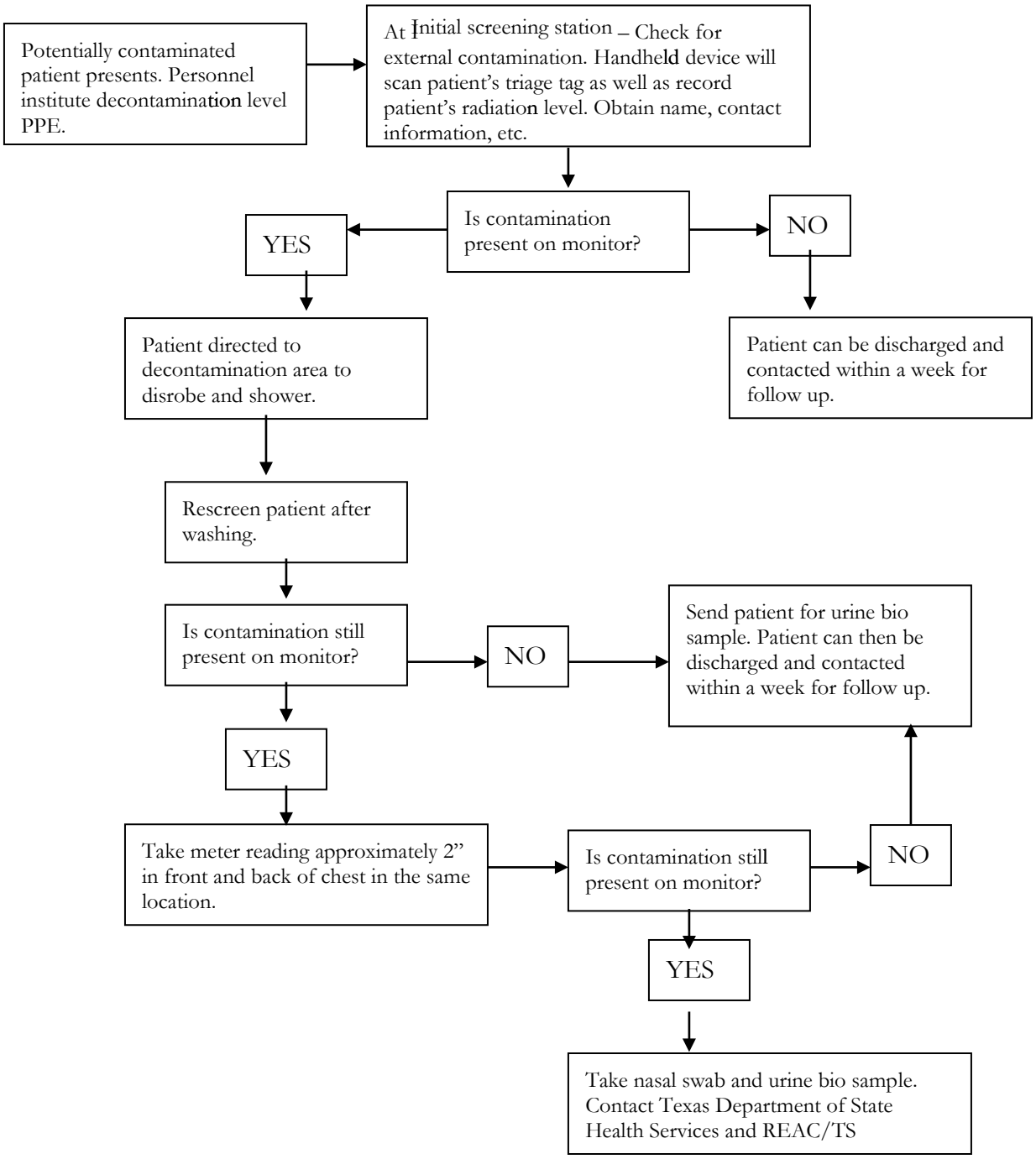
Identification and containment of contaminated areas with drapes and tape shall be done to prevent the spread of radioactive nuclides to "clean" areas or areas of lesser contamination. Areas not being immediately decontaminated should be covered and protected.

Reagents and equipment used in decontamination should be monitored closely for radioactive contamination and replaced as needed.

Hand-held Gamma radiation detection devices should be covered with a non-sterile glove which is replaced between each patient reading to avoid misleading readings due to possible accumulation or contamination of the instrument. DO NOT cover Alpha or Beta radiation detection devices.

Screening and Triage

The following algorithm should be followed at regional hospitals for the purpose of screening and triaging potential radiological exposure victims:



Contamination Control Measures

The goal of contamination control is to prevent the spread of radioactive materials from the patient, care providers, rescue/EMS crew, and/or equipment used in patient care. Contamination can be transferred to care providers as they touch or move the patient, from contaminated equipment used on the patient to provide care, or from the surrounding area.

- If possible, decontamination and triage areas should be outside the main entrance of the Emergency Department. Clear the area of visitors and patients. Remove or cover any 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 and stretcher should be covered with several layers of waterproof, disposable sheeting.
- Survey instruments should be checked and ready for use before the patient arrives. Background radiation levels should be documented.
- The Facility Decontamination team and Radiation Safety Officer should be prepared to meet the patient at the ambulance, where the patient can be transferred to the prepared treatment stretcher.

Defining a Control Line

- 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.
- 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 area. Ordinary cloth sheets or square absorbent pads can be used if the 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 similarly if time allows. This will make cleanup of the area easier.

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).

Techniques of Contamination Control

- Set up a controlled area large enough to hold the anticipated number of victims.
- Prevent tracking of contaminants by covering floor areas and monitoring at exits of controlled areas.
- Restrict access to the controlled area.
- Monitoring anyone or anything leaving the controlled area.
- Use strict isolation precautions, including protective clothing and double bagging.
- Use a buffer zone or secondary control line for added security.
- Control waste by using large, plastic-lined containers for clothing, linens, dressings, etc.
- Change instruments, outer gloves, drapes, etc., when they become contaminated.

Emergency Department Response:

Anticipate the number, acuity, and potential needs of incoming patients (i.e., decontamination, medications, isolation, etc.). Refer to Attachment A for assistance.

- Decompress current patient load in Emergency Department
- Anticipate and plan for personal protective equipment for staff
- Notify Radiation Safety Officer (RSO) immediately
- Surgical intervention should not be delayed while awaiting/performing decontamination
- Based on the type of release (single spill versus terrorist or explosion) anticipate associated injuries requiring additional care.
- Ensure staff protection and safety first.
- Maintain accurate records of all patient's identities, valuables, care, and disposition.
- Anticipate and cooperate with outside investigating agencies if the event is related to an actual or perceived terror attack.

  If possible external contamination is involved, save all clothing and bedding from the ambulance, blood, urine, stool, vomit, and all metal objects (i.e., jewelry, belt buckle, dental plates, etc.). Label with name, body location, time, and date. Save each in appropriate containers marked clearly "RADIOACTIVE—DO NOT DISCARD."

Preparation for the arrival of victims:

- Floors of rooms will be prepared by placing the tape on the floor at the entrance to the decontamination side from the non-contaminated side.
- Route from the ambulance entrance to the decontamination room will be covered with a roll of plastic, paper, or with sheets. Covering will be secured to the floor with tape.

- The above route will be taped off, if necessary, and marked "Radioactive" until cleared by the RSO.
- Nonessential equipment will be removed from the room or covered with plastic.
- If outside, the decontamination corridor, from the ambulance drop-off point to the entrance to the ER will be taped off. The route will be marked "Radioactive" until cleared by the RSO.
- Large plastic or metal containers with plastic bags shall be provided to receive discarded contaminated clothes, gauze, supplies, etc.
- The RSO, along with decontamination team members, will begin setting up the decontamination corridor.

(1)***The first priority*** is the treatment of life-threatening injuries (shock, bleeding, thermal burns, fractures, etc.) by whichever type of specialist is appropriate for the condition.

(2)***The second priority*** is assessing the extent and magnitude of contamination and decontamination as necessary. Any person with external contamination requires special and separate (isolated) treatment. The most effective decontamination procedure is washing, subject to control by monitoring.

(3)***The third priority*** is that if there is suspected internal contamination, a quick assessment of its nature and degree should be made so that appropriate measures to reduce the contamination may be started as soon as possible. In handling internally contaminated persons, the following procedures are essential:

— a collection of appropriate samples, such as nasopharyngeal swabs, for clinical evaluation. It may be important to continue collecting samples of urine and feces for further analysis.
— continuation of external decontamination, if necessary.

— special tests such as whole-body monitoring and/or direct thyroid counting depending on the radionuclides involved.
— decontamination therapy, including excision of contaminated wounds.

IMPORTANT LABORATORY SAMPLES ARE TO BE TAKEN IN THE HOSPITAL FOR SUBSEQUENT ANALYSIS

Blood, approximately 20–30 mL for the following analyses:

- Full blood count
- Cytogenetic analysis (24 h after exposure is the optimum time)
- Biochemical analysis (serum amylase)
- Analysis of radionuclide content

Urine

- Routine analysis
- Biochemical (creatin Uria)
- Analysis of radionuclide content
- Stools (for estimation of radionuclide content)

EXAMPLES OF SUBSTANCES THAT SPEED UP THE ELIMINATION OF RADIONUCLIDES FROM THE HUMAN BODY

Substance	Target radionuclides
Prussian blue	Cesium
Alginate	Strontium
Aluminum phosphate	Radium
Isotonic sodium bicarbonate	Uranium
CAD-TPA	Plutonium and in general, the transuranic, lanthanides, manganese, iron, cobalt, zirconium, ruthenium
Calcium glauconite	Calcium, strontium, barium, radium
Cobalt glauconite	Cobalt
Strontium glauconite or lactate	Strontium
Potassium iodide	Iodine
Aluminum phosphate	Strontium, radium
Barium sulfate	Strontium, radium
Magnesium sulfate	Strontium, radium

In addition, medicaments of the following groups may be needed in the decontamination area: anti-emetic agents; analgesics; cardiac stimulants; anti-intoxicant agents; antibiotics; homeostatic; and desensitizers.

Operating Room Safety Guidelines

A victim of a radiation accident who requires either emergency surgery or surgery at a later date and has been exposed only to external radiation but no contamination requires no special care in the operating room.

For those victims that require emergency surgery and who might be externally or internally contaminated with radioactive materials, the staff of the operating room should take the following precautions to minimize the spread of contamination:

- ✓ A conventional operating room can be used, provided that there is adequate room to accommodate additional personnel along with the standard operating room staff.
- ✓ Everything within the operating room (i.e., operating table, back tables, and floor) should be covered with disposable plastic coverings.
- ✓ Protective clothing should be instituted to ensure adequate protection of the operating room staff against contamination. The purpose of protective clothing is to keep bare skin and personal clothing free of contaminants. Staff members of the OR team 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 in 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.
- ✓ Unless otherwise instructed by the radiation safety officer (RSO), there is no danger of contamination to the anesthesia and breathing equipment. Other items (i.e., surgical equipment and instruments, and gloves) should be frequently changed to avoid the spread of contamination. An adequate supply of surgical equipment should be present (i.e., triplicate).

Equipment should be monitored, surveyed, and wipe-tested by the RSO or his/her designee after use. Contaminated items should be placed in a container and stored in the nuclear medicine department. Body areas with gross contamination will be delineated and, if possible, covered with a plastic covering before surgery.

Suppose an area of bodily contamination is to be surgically incised. In that case, it should be washed with normal saline, Betadine, and/or hydrogen peroxide (according to the preference of the attending
surgeon). For persistent contamination, consultation with the RSO might be appropriate regarding using diethylenetriaminepentaacetic acid (DTPA) (1 ampule of DTPA per 100 mL of water) or another chelating agent.

Contaminated tissue removed from the victim should be placed in an appropriately labeled container and stored in the nuclear medicine department or another area of the hospital designated to be appropriate for the storage of radioactive waste. The RSO should be notified of the location and type of stored tissue.
Upon completion of the surgical procedure, the RSO or his/her designee will survey and wipe-test the remaining surgical equipment, surgical garb, and the plastic coverings of the operating room floor to ascertain contamination. Any items that are found to be contaminated will be placed in a container and transported to the nuclear medicine department for storage until adequately decayed. All personnel should be monitored with a standard Geiger-Mueller meter before exiting the operating room suite.

If a Known Radioactive Contamination Patient Has Been Admitted Before Decontamination:
Continue attending to the patient's medical needs.
Secure the entire area where the patient will be admitted.
Notify the Radiation Safety Officer to assist in determining transport routes and special considerations.
Before entering into any potentially contaminated areas, personnel must wear appropriate protective clothing and wear personnel radiation monitoring devices. The purpose of protective clothing is to keep bare skin and personal clothing free of contaminants. Staff members providing direct care to the patient 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 in 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.

- ✓ Upon exit from the decontamination area, the protective clothing must be removed and considered contaminated. It shall be placed in a plastic-lined trash container for subsequent disposal or decay. The bag should be clearly marked “Radioactive – Do Not Discard.”
- ✓ All personnel must survey their hands, feet, and clothing before leaving the area with a survey meter, ensuring that they are not contaminated.
- ✓ Facilities should have an up-to-date and properly calibrated radiation detection device at their facility.
- ✓ Do not allow anyone or anything to leave the area until cleared by the Radiation Safety Officer.
- ✓ Hospitalized victims with persistent contamination should be surveyed daily and assessed for the potential spread of contamination.
- ✓ Bed linen, bedclothes, and supplies will be bagged and surveyed.
- ✓ All contaminated items will be bagged, labeled, and stored in the appropriate storage area under the direction of the radiation safety staff.
- ✓ **No person or equipment shall be allowed to exit from the potentially contaminated area without appropriate monitoring or clearance from the RSO.**

If Radioactive Contamination Is Discovered After the Patient Has Been Admitted

- ✓ Continue attending to the patient's medical needs.
- ✓ Secure the entire area where the victim and attending staff have been.
- ✓ Contact the Radiation Safety Officer
- ✓ Do not allow anyone or anything to leave the area until cleared by the radiation safety officer.
- ✓ Notify the Emergency Management Department to activate Decontamination Team members for patient and staff decontamination.
- ✓ Completely assess the patient's radiological status utilizing the screening method in the above "Screening and Triage" algorithm.

NOTE: Regular checking and periodic calibration of instruments to ensure that they are in good working order is an essential part of good operational practice. If the patient's medical status permits, the hospital Decontamination Team should institute decontamination procedures.

- ✓ Hospital personnel should remove contaminated clothing before exiting the area; they should be surveyed, shower, dress clean, and be resurveyed before leaving the area.
- ✓ The contamination space and other spaces in contact with the contaminated victim will be surveyed and wipe-tested for contamination and decontaminated as needed.
- ✓ Bed linen, bedclothes, and supplies will be bagged and surveyed.
- ✓ All contaminated items will be bagged, labeled, and stored in the appropriate storage area under the direction of the radiation safety staff.
- ✓ **No person or equipment shall be allowed to exit from the potentially contaminated area without appropriate monitoring or clearance from the RSO.**

FIRST AID PROCEDURES:

Details of the medical procedures to be followed in the event of a radiological accident are given elsewhere. However, there are a few simple procedures that can be undertaken by non-medical staff, pending the arrival of medical specialists in the reception area:

- ✓ Normal first aid measures should be taken to deal with life-threatening conditions such as asphyxiation and hemorrhage, irrespective of contamination levels.
- ✓ Surface contamination on undamaged skin can usually be removed by washing with soap and water. Stronger agents or scrubbing should not be used at this stage.

Dosage and Treatment Considerations:

Acute Radiation Syndrome (ARS):
Definitions of Lethal Doses (LD):
LD_{100} dose: The amount of dose in man to cause a 100% probability of death in those contaminated. The LD_{100} for men is approximately 800 rem (or 8 Sievert).

LD_{50} dose: The amount of dose in a man that will produce an acute illness (Acute Radiation Syndrome) followed by death in 30-60 days in 50% of the people exposed. The LD_{50} in man is approximately 400 rem (or 4 Sievert).

Assume a whole-body dose of 400 rem (or 4 Sievert or LD_{50}). This dose almost invariably would be from external radiation. Smaller doses would show an attenuated ARS both in time and severity of symptoms.

Early Phase (1 hour - 2 days)
- ✓ Nausea plus or minus vomiting
- ✓ Malaise plus or minus hyper-excitability of reflexes

Asymptomatic Phase (2 hours - 2 days)
- ✓ The patient feels well, but tissue damage is progressing.
- ✓ White Blood Count (WBC) drops during the first day; first lymphocytes, then granulocytes, to the range of 1000 cells/A drop follows this drop in RBCs and platelets.
- ✓ Internal bleeding
- ✓ Gastrointestinal (GI)
- ✓ Skin

Height of disease (2-3 weeks)
- ✓ Fever 103 - 104 degrees
- ✓ Exhaustion
- ✓ Weight loss
- ✓ Reddened skin
- ✓ Hair loss
- ✓ Hemorrhages in the skin
- ✓ Ulcerated mucous membranes.
- ✓ GI hemorrhages
- ✓ Infection (maybe the ultimate cause of death)
- ✓ Fluid imbalance

Delayed effects in survivors:
- ✓ Hair loss
- ✓ Cataracts

- ✓ Anemia
- ✓ Leucopenia may go on to leukemia.
- ✓ Impaired spermatogenesis
- ✓ Premature aging, shortening of life span.

Acute Radiation Syndrome Treatment Guidelines:
Evaluate as many of the four Acute Radiation Syndrome (ARS) sub-syndromes as you have information for by the degree of severity. (See Attachment C).

Treatment modality (RC) is assigned to patients based on the highest degree of severity in any subsyndrome. Utilizing the charts and graphs attached, patients admitted with suspected ARS will be evaluated upon arrival and daily thereafter as indicated (See attachments D-F for guidance.)

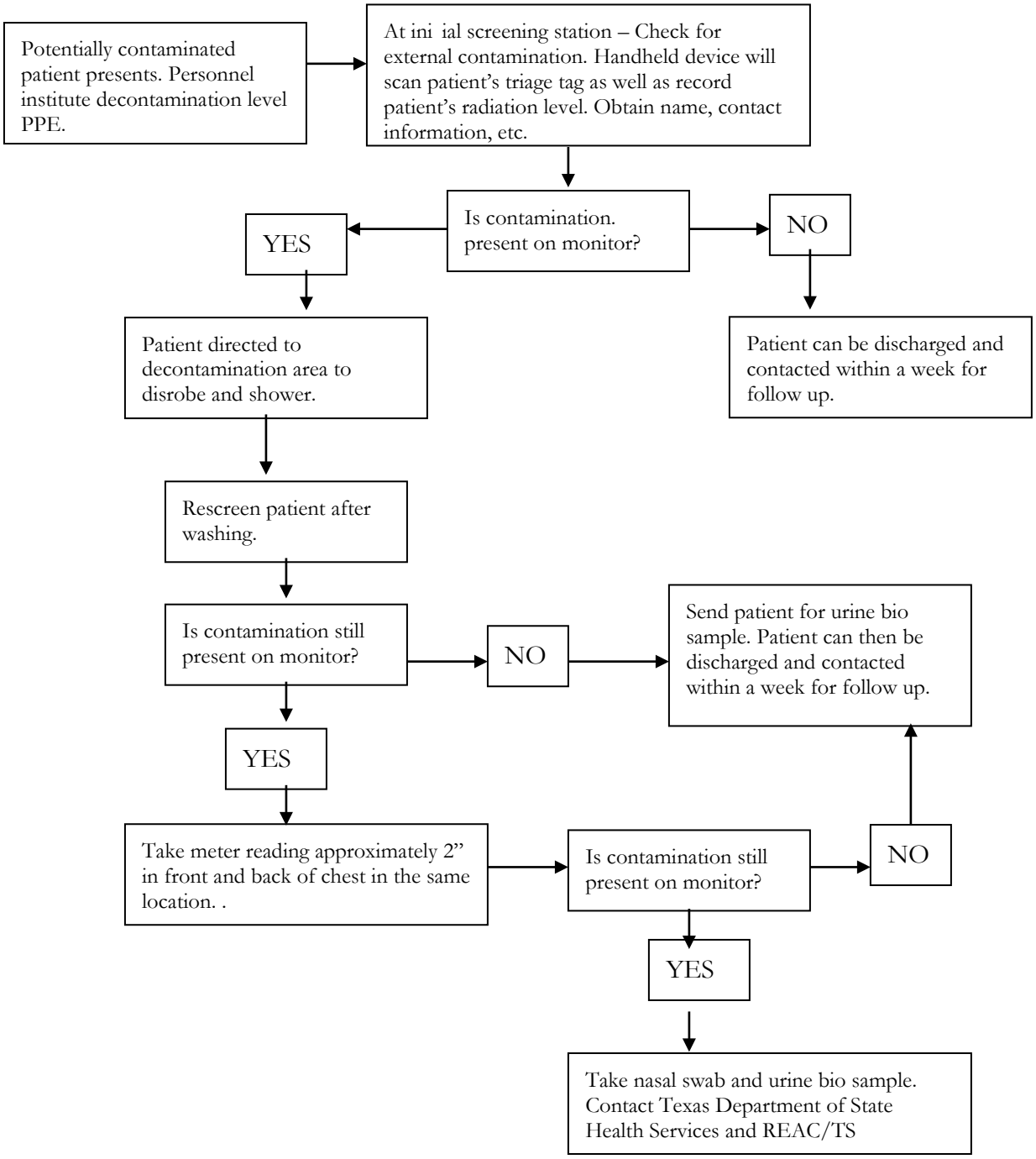
Use of Potassium Iodide:
The Food and Drug Administration has issued guidance on using potassium iodide (KI) to reduce the risk of thyroid cancer in children and adults in emergencies involving the release of radioactive iodine into the environment. Data clearly demonstrates the risks associated with thyroid radiation from radioiodine's that are inhaled or ingested with contaminated food. When such exposures are likely, KI can be used to block thyroid uptake of radioactive iodine species and thus provide safe and effective protection against thyroid cancer caused by such irradiation when exposure cannot be prevented by other measures.

The FDA recommends a standard daily dose of:

- ✓ 16 mg of KI for infants less than one (1) month old.
- ✓ 32 mg of KI for children aged one (1) month to three (3) years.
- ✓ 65 mg of KI for children and teenagers from three (3) to 18 years old.
- ✓ 130 mg of KI for adults, including pregnant, lactating women, and adolescents over 150 lbs.

As a rule, daily dosing should continue until the risk of exposure has passed and/or until other measures (evacuation, sheltering, and control of the food and milk supply) have been successfully implemented. The increased risk of thyroid suppression in the fetus and neonate leads to a specific recommendation that newborns and pregnant women be given priority with regard to these adjunctive measures in order to obviate, as possible, the need for repeat dosing with KI. The guidance also states that the overall benefits of KI far exceed the risks of overdosing, especially in children, though particular attention should be paid to the dose and duration of treatment in infants and in pregnant women.

Attachment A
Screening and Triage:
The following is an example of an algorithm to follow for the purpose of screening and triaging potential radiological exposure victims:



Attachment B
RADIATION CONTAMINATION

Type	Characteristics	Usual Sources	Decontamination Requirements
Alpha	• Alpha radiation is a heavy, very short-range particle. • Alpha radiation is not able to penetrate human skin or clothing. • Alpha emitting materials can be harmful to humans if the materials are inhaled, swallowed, or absorbed through open wounds. • Alpha radiation travels only a short distance (a few inches) in air but is not an external hazard.	• Radium • Radon • Uranium • Thorium •	• Removal of all clothing, jewelry, etc.
Beta	• Beta radiation is a light, short-range particle. • Beta radiation may travel several feet in air and is moderately penetrating. Beta • radiation can penetrate human skin to the "germinal layer," where new skin cells are produced. If high levels of beta-emitting contaminants are allowed to remain on the skin for a prolonged period of time, they may cause skin • injury. Beta-emitting contaminants may be harmful if deposited internally. • Clothing provides some protection against beta radiation.	• Strontium-90 • Carbon-14 • Tritium • Sulfur-35 •	• Removal of all clothing, jewelry, etc. • Soap and water decontamination • Re-evaluate for continued contamination after initial decontamination. and perform secondary soap and water decontamination as needed. • Decontaminate open wounds. first, then cover with clean gauze.

Gamma	• Gamma radiation or x rays are very long range, penetrating electromagnetic radiation. • Gamma radiation or x rays are able to travel many feet in air, and many inches in human tissue. It readily penetrates most materials. • Dense materials are needed for shielding from gamma radiation. • Clothing provides little shielding from penetrating radiation. • Gamma radiation and/or characteristic x rays frequently accompany the emission of alpha and beta radiation during radioactive decay.	• Iodine-131 • Cesium-137 • Cobalt-60 • Radium-226 • Technicium99m •	• Removal of all clothing, jewelry, etc. • Soap and water decontamination. • Re-evaluate for continued contamination after initial decon and perform secondary soap and water decontamination as needed. • Decontaminate open wounds first, then cover with clean gauze.

Attachment C

NEUROVASCULAR SUBSYNDROME				
Sign/Symptom/Test	**Degree 1**	**Degree 2**	**Degree 3**	**Degree 4**
Nausea	Mild	Tolerable	Intense	Excruciating
Vomiting	Occasional:1/day Intermittent	2-5/day Persistent	6-10/day Refractory	>10/day or parenteral nutrition
Anorexia	Able to eat and drink. Reasonable intake	Significantly decreased intake but able to eat	No significant intake	Parenteral nutrition
Fatigue	Able to work or perform normal activity	Able to work or perform normal Activity	Needs assistance for self-care	Prevents daily activity
Headache	Minimal	Minimal	Intense	Intense
Vital signs	Temp < 38 degree C HR > 100 BP > 100/70	Temp 38-40 degree C BP < 100/70 unstable vital signs	Temp > 40 degree C for less than 24 hours; BP < 90/60; transient or intermittent drop or unstable	Temp > 40 degree C for more than 24 hours; hypotension: BP < 80/?
Neurological deficits	No major neurological deficit. Able to perform normal activities	Easily detectable mild neurological deficit; No significant interference with normal activity	Prominent neurological deficit. Significant interference with normal Activity	Life threatening neurological signs. Possible loss of consciousness
HEMATOPOIETIC SUBSYNDROME				
Sign/Symptom/Test	**Degree 1**	**Degree 2**	**Degree 3**	**Degree 4**
24 - 48 HOURS Serial CBCs recommended to improve estimation of severity. (Lymphocyte kinetics and dose, how frequent?)				
Lymphocyte count (109 cells/L)	≥ 1.5	1.5 - 1	1 - 0.5	< 0.5
Granulocyte count (109 cells/L)	> 2	4 - 6, mild agranulocytosis	6 - 10, moderate agranulocytosis	> 10, marked agranulocytosis

Platelet count (109 cells/L)	≥ 100	100 - 50	100 - 50	100 - 50
3 - 7 DAYS Serial CBCs recommended to improve estimation of severity. (Lymphocyte kinetics and dose, how frequent?)				
Lymphocyte count (109 cells/L)	≥ 1	1 - 0.5	0.5 - 0.1	< 0.1
Granulocyte count (109	> 2	> 2	> 5 *	> 5 *
cells/L				
Platelet count (109 cells/L)	≥ 100	100 - 50	50 – 20 *	< 20 *
CUTANEOUS SUBSYNDROME				
Sign/Symptom/Test	**Degree 1**	**Degree 2**	**Degree 3**	**Degree 4**
Erythema (Hours - 30 days)	Minimal and transient.	Moderate. isolated patches <10 cm2; not more than 10% of body surface area (BSA)	Marked. isolated patches or confluent; 10-40% of BSA	Severe. isolated patches or confluent; >40% of BSA;
Altered sensation/ Itching (Hours - 30 days)	Pruritus	Slight and intermittent pain	Moderate and persistent pain	Severe and persistent pain
Edema (5 days - 8 weeks)	Present; asymptomatic;	Symptomatic; tension	Secondary dysfunction	Total dysfunction
Blistering (5 days - 8 weeks)	Rare, with sterile fluid	Rare with hemorrhage	Bullae with sterile fluid	Bullae with hemorrhage
Desquamation (5 days - 8 weeks)	Absent	Patchy dry	Patchy moist	Confluent moist
Ulcer/necrosis (5 days - 8 weeks)	Epidermal only	Dermal	Subcutaneous	Muscle/bone involvement
Hair loss (2 - 8 weeks)	Thinning, not striking	Patchy, visible	Complete and most likely reversible	Complete and most likely irreversible
Onycholysis (2 - 8 weeks)	Absent	Partial	Partial	Complete
GASTROINTESTINAL SUBSYNDROME				
Sign/Symptom/Test	**Degree 1**	**Degree 2**	**Degree 3**	**Degree 4**

Diarrhea - frequency	2-3 stools/d	4-6 stools/d	7-9 stools/d	>= 10 stools/d Refractory diarrhea
Stool - consistency	Bulky or normal	Loose	Very lose	Watery
Blood in stool	Occult	Intermittent	Persistent	Gross hemorrhage
Abdominal cramps / pain	Minimal	Tolerable	Intense	Excruciating
Vomit	See Neurovascular System			
Nausea	See Neurovascular System			

* Note a high granulocyte with low platelets is a poor prognostic sign

Modified from the NIH REMM draft ARS treatment website, which created the original by modifying from Fliedner, TM, Friesecke, I, Beyrer K. Medical Management of Radiation Accidents: Manual on the Acute Radiation Syndrome. Oxford: British Institute of Radiology; 2001.

Attachment D

RC GRADING

Organ Specific Assessment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Neurological Assessment										
Nausea										
Vomiting										
Anorexia										
Fatigue										
Fever										
Headache										
Hypotension										
Neurological Assessment										
Neuro Grade										
Hematopoietic Assessment										
Absolute Lymphocyte Count										
Absolute Granulocyte Count										
Platelet Count (un-transfused)										
Blood Loss										
Infection										
Heme Grade										
Cutaneous Assessment										

Erythema										
Sensation										
Edema										
Blisters										
Desquamation										
Ulcer/Necrosis										
Hair Loss										
Onycholysis										
Skin Grade										
Gastrointestinal Assessment										
Diarrhea										
Abdominal Pain										
GI Grade										
Overall RC Grade										

Place patient sticker here **Attachment E**

Acute Radiation Syndrome (ARS)

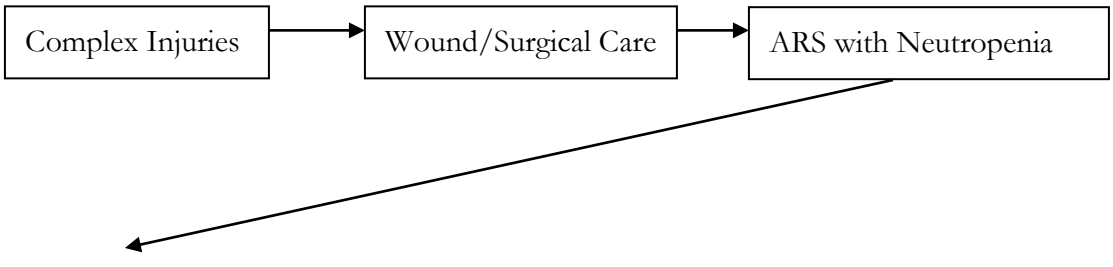
Triaged to hospital with diagnosis of ARS	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**
Case History	**X**									
Physical Examination	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Eval by Surgery, if applicable	**X**									
Eval by Burn, if applicable	**X**									
Appropriate Decontamination	**X**									
Diagnostics										
CBC w/diff	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Reticulocyte Count	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
PT/PTT/INR	**X**		**X**			**X**			**X**	
Type and Screen	**X**		**X**			**X**			**X**	
Chem 20	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
HLA Typing of Patient	**X**									
HLA Typing of Siblings										
Urinalysis	**X**									
Bone Marrow Aspirate and Biopsy	**??**					**??**				

Interventions										
Place Central Triple Lumen Line	**X**									
Chest X-ray	**X**									
EKG	**X**									
Echocardiogram						**X**				
Wound/Surgical care	**X**									
Reverse Isolation	**X**									
NPO	**X**									
Start Fungal Coverage	**X**									
Start Quinolone	**X**									
Start Acyclovir for all	**X**									
Start 5Ht3 Inhibitor	**X**									
Start Proton Pump Inhibitor	**X**									
Start Imodium, if indicated.	**X**									
Skin Care	**X**									
Consider KI Therapy, if indicated	**X**									
Advanced Therapeutics										
Consider Stem Cell Support						**X**				
Start Donor Search, if indicated						**X**				

Attachment F

Supportive Care:

Decisions are to be based on clinical parameters and estimated biological effects. As always, treat complex injuries requiring surgical or wound care first.



Hematopoietic Support
1. Start G-CSF (300

Antimicrobial Support
1. Reverse Isolation

GI Support
1. 5HT3 inhibitor, lorazepam

mcg/m2/d)		for nausea/vomiting
2. Consider PICC line	2. When neutropenic, start fluconazole	2. Proton pump inhibitor
3. Blood product support: irradiated and leuko-reduced (keep Hgb > 7 g/dl, platelets >10,000μL).	3. If HSV+ start Acyclovir	3. Imodium for diarrhea
4. HLA type victim	4. PCP prophylaxis (pentamidine)	
5. Search for donors	5. Start fluoroquinolone[3]	
	6. Consider coverage for skin flora if burns are present	

RADIATION SAFETY OFFICE CONTACTS

The Texas Department of State Health Services - Radiation Control

1100 West 49th Street Austin,
TX 78756.
Emergency 24-hour telephone number: (512) 458-7460.

REAC/TS

Radiation Emergency Assistance Center/Training Site
Oak Ridge Institute
Business hours: 865-576-3131
After-hours emergency contact: 865-576-1005 (Ask for REAC/TS)
For crisis assistance, including access to decor oration agents or guidance on their use call:

REAC/TS: 865.576.1005 (24x7 - Ask for REAC/TS)

Medical personnel caring for a few casualties with exposures in excess of 200 Rad (2 Gy) or with cytopenia should.
call REAC/TS.

The Radiation Emergency Assistance Center and Training Site (REAC/TS) is located outside Knoxville, TN and has been providing crisis response to radiological accidents since 1976. REAC/TS staff include physicians and health physicists. REAC/TS maintains a stockpile of decor oration agents as well (REAC/TS Website: http://orise.orau.gov/reacts).

The Radiation Injury Treatment Network plans for the coordination of care for large groups of casualties with marrow toxic injuries.

RITN
Radiological Injury Treatment Network
E-mail: ritn@nmdp.org
Phone: (612) 884-8276
Fax: (612) 294-4441