



General Guidelines

Healthcare workers should wear a gown, double gloves, shoe covers, mask (N95 preferred), and cap as adequate protection when treating patients contaminated with radioactive material. Reassign pregnant staff to non-radiation areas.

1. Stabilize the patient first, followed by definitive treatment of serious injuries
2. Assess external contamination by use of a handheld detection meter and decontaminate as appropriate
3. Assess internal contamination and administer specific chelator/excretion enhancing agent
Consider if high survey readings persist following decontamination.
High readings around the nose and mouth may reflect inhalation or ingestion of radionuclides
4. Obtain a complete blood count (CBC) with differential as soon as possible, and repeat every 8 hours
5. Approximate dose exposed and manage acute radiation syndrome (ARS)

Assessment of Radiation Exposure and Contamination

Type of Radiation Exposure	Actions
External Exposure: All or part of the body is exposed to an external radiation source.	Approximate the absorbed dose and follow ARS management guidelines (see below). Decontamination not indicated. Chelation/excretion enhancing/uptake blocking therapy not indicated.
External Contamination: Radioactive particles present on skin or clothing, resulting in a continuing external exposure.	Decontaminate by removing external layer of clothing by cutting and rolling clothes away from face and place in a double bag and save. Wash skin and hair with soap and water and avoid splashing. Approximate the absorbed dose and follow ARS management guidelines (see below). Chelation/excretion enhancing/uptake blocking therapy not indicated.
Internal Contamination: Radioactive particles are inhaled, ingested, or absorbed through open wound contamination.	Identify isotope and administer appropriate chelation/excretion enhancing treatment (see right). Perform external decontamination as outlined above if appropriate. Approximate the absorbed dose and follow ARS management guidelines (see below).

Management of Acute Radiation Syndrome (ARS)

Definition of ARS: A combination of clinical signs and symptoms developing over a period of hours to weeks due to a whole or partial body exposure to ionizing radiation > 1 Gray.

Tissues and organs most sensitive to damage include bone marrow, skin, intestinal crypt cells, spermatocytes

Estimate radiation exposure dose to assess prognosis and guide medical management*

Obtain a complete blood count (CBC) with differential immediately. Document time of exposure and onset of vomiting

Dose approximation	<2 Gray	2-4 Gray	4-6 Gray	6-8 Gray	>8 Gray
Onset of vomiting after exposure	>2 hours	1-2 hours	30 minutes -1 hour	10-30 minutes	<10 minutes

% Lymphocyte decrease after exposure (may discontinue Q8H CBCs after 48 hours if no decrease observed)

After 24 hours	0-20%	20-38%	38-60%	60-78%	>78%
After 48 hours	0-33%	33-56%	56-78%	78-96%	>96%

Degree of ARS

	Mild	Moderate	Severe	Very Severe	Lethal
Treatment recommendations**	Supportive Care***, No antibiotics, No cytokine therapy	Supportive Care, Quinolone, Initiate cytokine therapy (G-CSF or GM-CSF or pegylated G-CSF)****	Supportive Care, Quinolone, Initiate cytokine therapy (G-CSF or GM-CSF or pegylated G-CSF)	Supportive Care, Quinolone, Initiate cytokine therapy (G-CSF or GM-CSF or pegylated G-CSF)	Supportive Care, No quinolone, No cytokines.

*Biodosimetry Assessment Tool (BAT) is a software product developed by AFRRRI that may be used to estimate exposure.

For more information on BAT see: http://www.afri.usuhs.mil/www/outreach/expose_assess.htm

**Follow Infectious Diseases Society of America guidelines for febrile neutropenia (ANC <500 x 10³ cells/L)

***Supportive care: 1) Maintenance of vascular and hemodynamic stability through IV fluids & blood products (leukoreduced and irradiated)

2) Keeping a clean patient environment through strict hand washing, scrub attire, gloves, gowns and masks for staff and visitors

3) Encourage early enteral feeding to maintain gut mucosal barrier 4) Consider anti-emetics and anti-diarrheal agents

****Use standard doses as for patients with treatment-related neutropenia, all cytokines listed are pregnancy class C

Agent Specific Treatment Guidelines for Internal Radiation Contamination

The following agents are to be used after internal radiation contamination has been confirmed, and the specific isotope identified. Avoid breastfeeding after any internal contamination

Isotope	Agent	Dose/Route/Schedule	Contraindications/Side effects/Comments
Americium Curium Plutonium	Ca-DTPA ** (Calcium diethylenetriaminepentaacetate)	Adults: 1g IV once, Children <12 years: 14mg/kg not to exceed 1g IV once. Continued chelation based on contamination assessment, switch to Zn-DTPA for additional chelation therapy (see below).	No known contraindications. Pregnancy category C (use Zn-DTPA). More effective than Zn-DTPA during the first 24 hours after exposure. Causes mineral deficiency, monitor serum electrolytes including zinc and magnesium. Use with caution in patients with hemochromatosis. Avoid breastfeeding during treatment.
Americium Curium Plutonium	Zn-DTPA ** (Zinc diethylenetriaminepentaacetate)	Adults: 1g IV QD, Children <12 years: 14mg/kg not to exceed 1g IV QD. Continued chelation based on contamination assessment	No known contraindications. Use for continued therapy after Ca-DTPA used during first 24 hours after exposure, or as first line for pregnant patients and when Ca-DTPA is unavailable. Avoid breastfeeding during treatment.
Cesium Thallium	Prussian Blue [ferric hexacyanoferrate (II)], (Radiogardase)**	Adults: 3g PO TID, Children ages 2-12: 1g PO TID. Treat for a minimum of 30 days then re-assess contamination	No known contraindications. Side effects may include constipation and electrolyte abnormalities (monitor serum electrolytes). May color feces blue. Taken with food will stimulate biliary secretion and enhance isotope elimination. No data on safety among neonates and infants. Avoid breastfeeding during treatment.
Cobalt	GI lavage and purgatives (charcoal, laxatives). Consider penicillamine* for high dose/potentially fatal exposures.	See footnote	Penicillamine as a cobalt chelator is not FDA approved, but could be considered in high dose exposure cases (>5Gy). Consult with a health physicist and Physician's Desk Reference (PDR) for indications and dosing. Side effects include leukopenia, thrombocytopenia, nephrotic syndrome. Contraindicated in pregnancy (category D). Avoid breastfeeding during treatment.
Iodine	Potassium iodide (KI)**	Age 12-40 years: 130mg PO QD, 3-12 years: 65 mg PO QD, 1 month-3 years: 32 mg PO QD, <1 month: 16 mg PO QD. Treat daily until exposure risk no longer exists.	Used to prevent thyroid cancer. Contraindicated for iodine hypersensitivity. May cause thyrotoxicosis in overdose. Follow TSH in neonates to avoid transient hypothyroidism. Repeat dosing not recommended for infants unless exposure persists. Treatment not recommended for patients older than 40 unless very high levels of exposure (>5 Gy). Pregnant and breast feeding women are to receive only one dose.
Strontium	Aluminum Phosphate* Magnesium Sulfate* Calcium IV*	See footnote	
Tritium	Oral fluids (water)	Oral water to tolerance all patients	Administer oral water to tolerance and avoid water intoxication. Follow serum electrolytes.
Uranium	Sodium Bicarbonate* (NaHCO3)	Adults: 4g PO initially, followed by 2g PO Q4H until urine pH between 8 and 9. Pediatric doses: 84-840 mg/kg PO in divided doses Q4-6H until urine pH in desired range. IV: 2 ampules (44.3meq each; 7.5%) in 1000cc normal saline @ 125cc/hr until desired urine pH obtained.	Maintain urine pH between 8 and 9. Follow serum BUN/creatinine for signs of renal toxicity.

*Agent not FDA approved for treatment of internal radiation contamination. For non-FDA approved agents, clinicians are advised to consult with health physicist and hospital pharmacist for dosing and schedule recommendations.

**Agent included in the managed inventory of the Strategic National Stockpile (SNS)

Order agent directly from the Radiation Emergency Action Center/Training Site (REAC/TS): 865 576 3131 or coordinate request through the Philadelphia Department of Public Health at 215 685 6741, after hours: 215 686 1776

For more information on additional isotopes see: http://www.afri.usuhs.mil/www/outreach/pdf/nrcrp65section2_may2005_1.pdf

For more general information see: <http://www.bt.cdc.gov/radiation/>

or call the Armed Forces Radiobiology Research Institute (AFRRRI) at 301 295 0530.