

SUMMARY OF ACUTE MEDICAL MANAGEMENT FOR RADIATION EXPOSURES

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)

	<2 Gray	2-4 Gray	4-6 Gray	6-8 Gray	>8 Gray
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:filgrastim or pegylated G-CSF: pegfilgrastim)***	Supportive Care, Quinolone, Initiate cytokine therapy (G-CSF:filgrastim or pegylated G-CSF: pegfilgrastim)***	Supportive Care, Quinolone, Initiate cytokine therapy (G-CSF:filgrastim or pegylated G-CSF: pegfilgrastim)***	Supportive Care, No quinolone, No cytokines.

*Follow Infectious Diseases Society of America guidelines for febrile neutropenia (ANC <500 x 10⁹ 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 doses recommended by Radiation Emergency Medical Management (REMM) <https://www.remm.nlm.gov/cytokines.htm>

Additional cytokines are not FDA approved to treat radiation exposures, and require an FDA Emergency Use Authorization (EUA).

These additional cytokines can be found in the REMM link.

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. Medications in bold are the preferred medications to give.

Isotope	Medication	Dose/Route/Schedule for Preferred Medications	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.
	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	DTPA* ETPA* (ethylenediaminetetraacetic acid)	See above information for DTPA. For Dose/Route/Schedule information for other suggested medications, see link below for additional information on isotopes.	
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 Hydroxide* Calcium IV* Calcium Carbonate* Calcium Phosphate* Barium Sulfate* Sodium Alginate*	Adults: 60-100 mL (1200 mg) Children: 50 mg/kg, not to exceed the adult dose. For Dose/Route/Schedule information for other suggested medications, see link below for additional information on isotopes.	
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* (NaHCO ₃)	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 a health physicist and a hospital pharmacist for dosing and schedule recommendations.

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

Report suspected cases of internal contamination to Philadelphia Department of Public Health (PDPH) at 215-685-6740, after hours: 215-686-4514. PDPH can coordinate ordering of SNS medications through the Office of Emergency Management and the Pennsylvania Department of Health (PA DOH)

For additional information on isotopes, see: https://www.remm.nlm.gov/int_contamination.htm#isotopestable

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

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