

# TREATMENT OF INTERNAL CONTAMINATION WITH RADIOACTIVE ISOTOPES

## Background:

Exposure to radiation may result from any one or combination of the following: external sources (such as radiation from an uncontrolled nuclear reaction or radioisotope outside the body); skin contamination with radioactive material ("external contamination"); internal radiation from absorbed, inhaled or ingested radioactive material ("internal contamination").

Externally irradiated patients are not contaminated. Patients with skin contamination will need external decontamination measures. Patients with internal contamination may need isotope specific medications to prevent internal biological damage which may lead to long-term effects such as cancer. These medications may decrease the incidence of specific cancers, enhance the elimination of radioactive elements from the body or decrease absorption into the body. Removing radioisotopes is time consuming and of little benefit in the acute setting; life-threatening conditions should have a higher clinical priority. Some patients with internal contamination may need years of chelation to try to remove the internal radioisotopes. All suspected or confirmed cases of internal contamination with radioactive isotopes must be reported to the local department of public health and the Illinois Department of Public Health (IDPH).

## Potassium Iodide:

Potassium Iodide (KI) is used for individuals exposed to radioactive iodine (such as fallout from a nuclear power plant). It is used as prophylaxis to decrease the incidence of thyroid cancer. A one-time dose is usually all that is needed. *Children are the most susceptible to the dangerous effects of radioactive iodine. The FDA and the World Health Organization (WHO) recommend that children from newborn to 18 years of age all take KI unless they have a known allergy to iodine.*

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| Adults                                 | 130 mg tablet                          |
| Children ≥ 150 pounds                  | 130 mg tablet                          |
| Children 3-18 years old ≤ 150 pounds   | One-half of a 130 mg tablet (65 mg)    |
| Children 1 month to 3 years old        | One-quarter of a 130 mg tablet (32 mg) |
| Infants from birth to one month of age | One eighth of a 130 mg tablet (16 mg)  |

Breastfeeding women should take the adult dose and their children should take the recommended infant dose.

Taking extra KI will not add extra protection and may cause severe illness or death in cases of allergy. The high concentration of iodine in KI can be harmful to some people. People should not take KI if they have ever had thyroid disease (such as hyperthyroidism, thyroid nodules or goiter); know they are allergic to iodine (if you are allergic to shellfish, ask your doctor or pharmacist about taking KI); or have certain skin disorders (such as dermatitis herpetiformis or urticaria vasculitis).

## Prussian Blue:

Prussian blue is used to treat internal contamination with particles of radioactive cesium or thallium. Prussian blue works by interrupting entero-hepatic and entero-enteric recirculation and increases fecal excretion of cesium or thallium. It was recently FDA approved and is available through REAC/TS. Consult IDPH or the Illinois Poison Center for assistance in procurement of this antidote.

| Age category              | Initial Therapy (PO)              |
|---------------------------|-----------------------------------|
| Adults and Adolescents    | 3 grams orally, three times a day |
| Pediatrics (2 - 12 years) | 1 gram orally, three times a day  |

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**If you suspect a poisoning exposure from any bioterrorism agent, immediately contact your local county health department, and the Illinois Poison Center at 1-800-222-1222.**

Duration of therapy is controversial; the endpoint has been advocated by some authors as normal radioactive thallium or cesium levels in 24-hour urine or stool collection.

For patients who cannot tolerate swallowing large numbers of capsules, the capsules may be opened and mixed with bland food or liquids. This may result in blue discoloration of the mouth and teeth. If the patient cannot adequately drink the antidote, it may be given via NG tube. For patients who cannot tolerate large doses of Prussian blue, consider decreasing amount to 1-2 grams, three times a day. Prussian blue is effective only in a functioning GI tract. High doses over a prolonged period may lead to obstipation.

**Pentetate Calcium Trisodium Injection (Ca-DTPA):**

Ca-DTPA is indicated for the treatment of individuals with known or suspected internal contamination with plutonium, americium or curium to increase the rates of elimination. Ca-DTPA should be used for the first, initial chelating dose. Chelation is most effective if administered in the first 24 hours after internal contamination has occurred. For additional chelation, further treatment should be with Pentetate Zinc Trisodium Injection (Zn-DTPA).

| <b>Age category</b>    | <b>Initial Therapy (IV)</b>   |
|------------------------|---|
| Adults and Adolescents | 1 gram by either slow IV push (over 3 to 4 minutes) or IV drip mixed with 100–250 mL of D5W, NS or lactated ringer’s over 30 minutes. |
| Pediatrics (<12 years) | 14 mg/kg administered intravenously, not to exceed one gram.  |

**Nebulized solution:**

If the patient was exposed by inhalation only, the solution may be given by nebulized inhalation at a ratio of 1:1 with sterile water or saline. The safety and efficacy in the pediatric population has not been established.

Reported adverse effects include: headache, lightheadedness, chest pain, allergic reaction, dermatitis, metallic taste, nausea and diarrhea, and injection site reactions. Ca-DTPA is associated with depletion of endogenous metals (e.g., zinc, magnesium, manganese). Only a single initial dose of Ca-DTPA is recommended. For additional chelation of internal radioactive contamination, daily doses of Zn-DTPA should be used. Ca-DTPA should be used with caution in individuals with severe hemochromatosis. Exacerbation of asthma may occur with nebulized administration of Ca-DTPA. Ca-DTPA is teratogenic in animals; pregnant patients should be treated with Zn-DTPA.

**Pentetate Zinc Trisodium Injection (Zn-DTPA):**

Zn-DTPA is indicated for the treatment of individuals with known or suspected internal contamination with plutonium, americium or curium to increase the rates of elimination. It may be given if 24 hours have elapsed since contamination (Ca-DTPA and Zn-DTPA are equally effective after 24 hours) or for repeated daily administration with long-term chelation.

| <b>Age category</b>    | <b>Initial Therapy (IV)</b>   |
|------------------------|---|
| Adults and Adolescents | 1 gram by either slow IV push (over 3 to 4 minutes) or IV drip mixed with 100–250 mL of D5W, NS or lactated ringer’s over 30 minutes. |
| Pediatrics (<12 years) | 14 mg/kg administered intravenously, not to exceed one gram.  |

**Nebulized solution:**

If the patient was exposed by inhalation only, the solution may be given by nebulized inhalation at a ratio of 1:1 with sterile water or saline. The safety and efficacy in the pediatric population has not been established.

Reported adverse events include headache, lightheadedness and pelvic pain. Exacerbation of asthma may occur with nebulized administration of Ca-DTPA. Zn-DTPA is associated with depletion of endogenous metals (e.g., zinc, magnesium, manganese). Consider replacement minerals such as zinc with long-term chelation. Zn-DTPA should not be used as a chelator for uranium or neptunium.

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**Sodium Bicarbonate:**

Sodium bicarbonate may be a useful measure to increase the excretion of uranium from the body and to prevent kidney damage from uranium, which is more likely to occur with acid urine.

| <b>Age category</b>    | <b>Initial Therapy</b>  |
|------------------------|---|
| Adults and Adolescents | 4 grams PO initial dose, then 2 grams q4 hours until urine pH of 8 to 9 is obtained and maintained OR<br>2 – 3 amps in 1000 cc D5W at 125 cc/hr. Bicarbonate is potassium-wasting, so replacement therapy will be needed. |
| Pediatrics             | 84-840 mg PO divided every 4 to 6 hours   |

Therapy can be monitored by 24-hour urine and stool collections and analyzing for uranium content.