

Handbook

Treatment for Internal Contamination

**KIRAMS
National Radiation Emergency
Medical Center**

Preface

With the increased use of radionuclides in all fields of science and technology ; research, medical applications, nuclear power, and industrial processes, it suggests that there is also a concomitant increase in the probability of human exposures to internally-deposited radionuclides. It is important that such exposures be minimized to use appropriate medication as soon as possible.

This handbook provides information on some medications that are effective in the treatment or the prevention of persons internally contaminated with radionuclides. Even though some

problems exist to use those medications as the literature on medications of such cases is scattered and sparse or only experimental studies have been approved, they are very useful under an emergency situation.

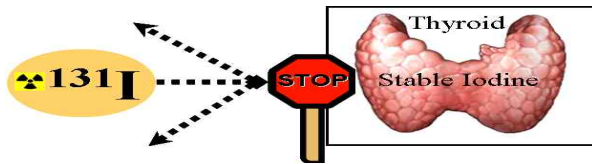
Therefore, this handbook will be intended as an aid and guide to find quick reference of treatment for medical personnels; physicians, nurses, physics, ambulance attendants, rescue squads, and paramedic personnels and other resources as well; police officers, fire fighters, military officers, authorities and etc....

KI(Potassium Iodine)

KI?

- A Thyroid Blocking Agent as preventing uptake of radioiodine
- It is the ingredient added to table salt to make it iodized salt. Approximately 76.5% iodine.
- When KI is available in the blood before any radioactive iodine, the thyroid gland becomes saturated with non-radioactive iodine. When saturated, the thyroid can absorb only about 1% as much additional iodine, including radioactive forms: then it is said to be blocked. Excess iodine in the blood is rapidly eliminated by the action of the kidneys.





Radioactive Iodine

- Released iodine in fission products

I-129 1.57×10^7 years

I-131 8.04 days, common cause of internal contamination

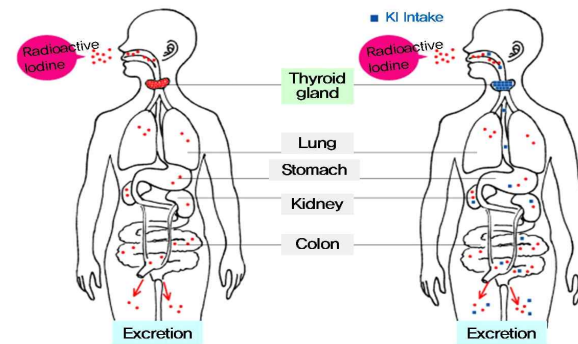
I-133 20.8 hours

I-134 52.6 minutes

- I-131 in human via inhalation/ingestion

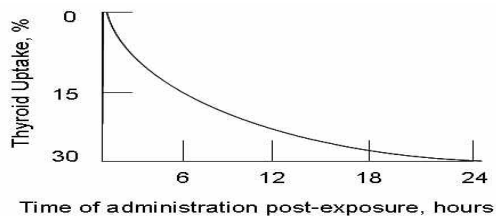
- Iodide ions form in the blood
- saturated in the thyroid gland
10-30%(max) within 24hours
- retained in salivary gland/stomach
mucosa/mammary gland
- eliminated by respiratory tract, urine/feces

How KI Works



Indications

- After exposure to radioiodine in the air; highly recommended KI to administrate ASAP or within 6 hours
- Effectiveness
 - within 15minutes: 90-95%
 - within 6 hours: 50%
 - after the first 12 hours: little



Dosage and Administration

- KI 130mg immediately, then 130mg daily for 7-14days

※WHO Guidelines for Iodine

Age Group	iodine (mg)	KI (mg)	KIO3 (mg)	100mg
Adults and Adolescents	100	130	170	1
Children(3-12years)	50	65	85	1/2
Infants (1month to 3years)	25	32	42	1/4
Neonates (birth to 1month)	12.5	16	21	1/8

Guidance Doses for Population Protection

Sheltering in place	10 mSv
Evacuation	50 mSv
Iodine Prophylaxis	100 mSv
Temporary Relocation	30 mSv/the first month, 10 mSv/followed by the next month

Adverse Reactions

- Skin Rash
- Swelling of the salivary glands
- Iodism: metallic taste, burning mouth & throat, sore teeth & gum bleeding, symptoms of a head cold, stomach upset & diarrhea
- Allergic reaction with serious symptoms: fever & joint pains, or swelling of parts of the face and body, at times severe SOB(shortness of breath) requiring immediate medical attention

- Rare : overactivity of the thyroid gland, underactivity of the thyroid gland, or enlargement of the thyroid gland(goiter)

Ca-DTPA(Trisodium calcium-diethylenetriaminepentaacetate)

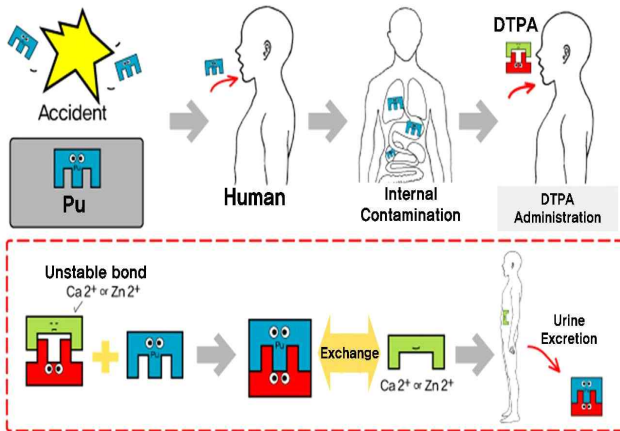
Ca-DTPA?

- Calcium salt of DTPA (1g/amp)
- The Powerful chelating agent as forms stable complexes with plutonium or transuranic metals
- Effectively exchanges calcium for another metal of greater binding power and carries it to the kidneys
- The plasma half life of DTPA is 20-60 minutes; almost the entire administered dose is excreted in 12 hours.
- Ca-DTPA is rapidly distributed throughout the extracellular fluid space.



- Ca-DTPA is approximately 10 times more effective than Zn-DTPA for initial chelation of transuranics; therefore, it should be used whenever larger body burdens of transuranics are involved.
- Ca-DTPA can deplete the body of Zn or Mn with repeating dosing.

How DTPA Works



Indications

- Treatment of internal contamination with transuranium ions (plutonium, americium, curium, berkelium, californium)
- Effectiveness
 - Good for internal contamination with the soluble plutonium salts; however, chelation is highly dependent not only on the actual metal, but also on the chemical & physical characteristics of the compound.
 - As the efficiency of chelation decreases with time, DTPA should be given within 6 hours of exposure, if possible.

※ DTPA treatment of ²³⁹Pu Intake

	Retention (% of Uptake)	
	Control	DTPA Treated
Liver	14.0	0.47
Skeleton	57.0	5.9

Dosage & Administration

- IV Injection of DTPA 1g/4ml with 6ml saline over 5-10 minutes
- IV infusion of DTPA 1g with 100~250ml D5W/NS/Ringers Lactate over 1hour, but less than 2 hours
- Aerosol: 1:1 dilution with water or saline via hand-held nebulizer; inhalation takes 10-15 minutes

Contraindications

- Minors(under 18YOA), pregnant women, patients with nephrotic syndrome, in patients with bone marrow depression; use zinc-DTPA

Precautions

- pre-existing serious kidney disease or depressed myelopoietic function (e.g.,

leukopenia or thrombocytopenia)

- Kidney function should be normal; Urinalysis should be normal prior to each use. If proteinuria, hematuria or casts developed during use; discontinue drug administrations.
- Fractionation of the recommend 1g dose is not recommended.
- Blood pressure should be monitored closely during drug infusion.
- Discontinue the drug if diarrhea occurs.

Adverse Reactions

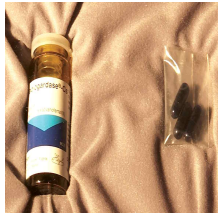
- No serious toxicity in human has been reported in recommended doses. When given repeatedly, with short intervals for recovery, Ca-DTPA treatment may cause nausea/vomiting/diarrhea/chills/fever/pruritus/muscle cramps in the first 24 hours.

Insoluble Prussian Blue (ferric hexacyanoferrate, $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$)

Radiogardase® -Cs

Prussian Blue?

■ $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ enhances excretion of isotopes of cesium and thallium from the body by means of ion exchange (0.5g/cap)



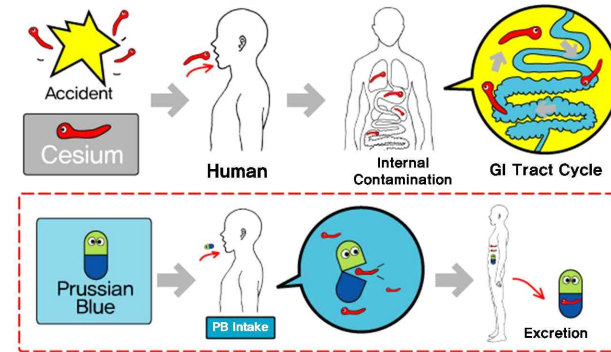
• Cs-137 and Thallium-232 are the most important isotopes.

■ Ions of cesium and thallium are ordinarily excreted into the intestine and reabsorbed from the gut into the bile, and then excreted again into the gastrointestinal (GI) tract.

■ Orally administered PB traps thallium and

Cs in the gut, interrupts its re-absorption from the GI tract and thereby increases fecal excretion.

■ The mechanism of Cs and thallium absorption by hexacyanoferrates is not yet known in full details.



Dosage and Administration

■ Depending on the severity of thallium and Cs incorporation, PB may be given from 3g to 20g, daily in three divided doses.

- For internally deposited radiocesium, the initial dosage is 1g three times daily and the dosage may be increased for more severe cases.
- > 10g daily is preferred in acute poisoning with thallium, and thallium still present in the stomach or the upper part of the small intestine, an initial dose of at least 3g should be given at once.
- Administrated orally with some liquid or dispersed in warm water and drunk as a solution
- the solution may also be administrated via stomach tube following gastric lavage
- If oral ingestion is impossible, PB administration is recommended via a duodenal tube.
- In cases involving decorporation therapy, daily whole body counting and collection of

24-hour urine and fecal bioassay samples will be performed. This will allow proper evaluation of Cs-137 elimination curve.

- The patient should be warned that he/she may experience blue colored stool.

Precautions

- PB is effective only if gastrointestinal motility is intact.
- No known absolute contraindication of the usage of PB when medically indicated; however, given with tetracycline, it may retard the absorption of the tetracycline.
- Blood samples should be collected every 12 hours for the first 96 hours post-accident for serum chemistry, esp., iron, ferritin, and serum electrolytes). CBC should be collected initially and as indicated clinically thereafter.

- In severe cases of internal contamination, hemodialysis and other extracorporeal clearance techniques have been recently proposed to aid elimination of radiocesium.
- Therapy for thallium poisoning is similar to that for cesium, except that an initial loading dose of 3g orally should be used.
- In cases of severe thallium intoxication, additional types of elimination treatment may be necessary.
 - Induced emesis, followed by gastric intubation and lavage
 - Forced diuresis until urinary thallium excretion is less than 1mg/24h
 - charcoal hemoperfusion
 - hemodialysis

Radio-nuclide	medication	Administration	Principle
Iodine	KI	130mg(tabl) stat, followed by 130mg QD×7 if indicated	blocks thyroid deposition
Rare earths Plutonium Transplutronics Yttrium	Ca-DTPA Zn-DTPA	1g DTPA in 150~250 mL D5W (N/S) IV over 60 minutes	chelation
Cesium Rubidium Thallium	Prussian blue	1g with 100~200mL water p.o. TID for several days	blocks absorption from GI & prevention recycling
Uranium	Bicarbonate	2 ampls sodium bicarbonate(44.3 mEq each; 7.5 alternately, oral administration of 2 bicarbonate tabs every 4 hours until the urine reaches a pH of 8~9	alkalization of urine; reduces chance of acute tubular necrosis
Tritium (H-3)	water	force fluids	isotopic dilution

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