Radiological Preparedness & Emergency Response

Session V

Clinical Evaluation and Management of Internal Contamination

Objectives

- Discuss the diagnosis of internal contamination.
- Describe the health effects of internal contamination.
- Discuss the management principles of internal contamination.
- Describe the use of principle therapies in internal contamination.

Clinical Consequences of Internal Contamination

- Acute and subacute
  - End organ damage
  - Acute Radiation Syndrome
  - Multiorgan failure
- Chronic
  - Solid tumors
  - Leukemias

Radionuclides of Concern

- Transuranics
- Cesium-137
- Strontium
- Cobalt-60
- Polonium-210

Nasal Swabs

- A swab is collected from each nostril of individuals who have potentially inhaled radionuclides in the form of particulate matter.
- Each swab gets tested for the detection of radiation.
- The radiation present in the nasal cavities will reflect the presence of radionuclides in lower air spaces and subsequent internal contamination.

In Vivo Measurements

- Whole body counters.
- Chest counters for Plutonium and Uranium.
- Wound monitoring instruments.

Diagnosis By Excretion (Bioassay) Sampling

- Collect urine or feces to measure excretion rates.
- Challenging interpretation
  - Time when contaminationoccured
  - Charcteristics of inhaled or internalized radionuclides

Management Strategies

- Supportive care.
- Decreasing absorption.
- Decorporation and enhanced elimination.
- Long term monitoring.

REAC/TS Should be Contacted for Assistance

Internal Contamination

Radionuclide	Medication
Iodine	KI (potassium iodide)
Transuranics such as Plutonium & Americium	Zn-DTPA Ca-DTPA
Uranium	Bicarbonate
Cesium Rubidium Thallium	Prussian Blue* [Ferrihexacyano- Ferrate (II)]
Tritium	Water

Transuranics

- Used for Transuranics such as Plutonium and Americium.
- First dose should be Calcium DTPA followed by Zinc DTPA.
- Duration of therapy will be guided by urine or feces transuranic concentrations.

DTPA Treatment of ^{239}Pu

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

DTPA decorporation of ^{239}Pu (in rats): Decline in efficacy with delay to treatment

	Radioactivity as Percent of Control	
Time to treatment	Liver	Skeleton
1, 24, 48 hours	7	10
7 - 11 days	22	46

from Catsch, 1964

Cesium-137

- 46 Goiania pts contaminated with Cs-137 treated with Prussian Blue.
- Less than 1% is absorbed.
- Exchanges a cation and binds Cesium or Thallium.
- Decreases GI absorption and interruts enterohepatic circulation.

Cesium-137

Table 2: Cesium-137 Effective Half-life During and After Treatment with Insoluble Prussian blue (In Days, by Age, and Dose of Insoluble Prussian blue)

Group	Age (Years)	Insoluble Prussian blue dose (grams/day)	No. of Pts.	During Insoluble Prussian blue Treatment - ^{137}Cs $T_{1/2}$	Off Insoluble Prussian blue Treatment - ^{137}Cs $T_{1/2}$
Adults	> 18	10	5	26 ± 6 days	80 ± 15 days (all 21 adult patients)
Adults	> 18	6	10	25 ± 15 days	
Adults	> 18	3	6	25 ± 9 days	
Adolescents	12 -14	< 10	5	30 ± 12 days	62 ± 14 days
Children	4 - 9	< 3	7	24 ± 3 days	42 ± 4 days

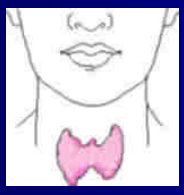
Half life decreased between 43 & 60%
PB treatment inverts the feces/urine 137Cs ratio for 1:4 to 4:1

Radiogardase®

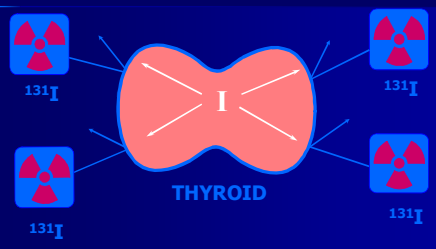
- Insoluble form FDA approved in 2004. Available in CA or REAC/TS.
- Duration of therapy guided by feces Cs content.
- AE: Constipation and blue stools, sweat, teeth.

Radioactive Iodine Exposure

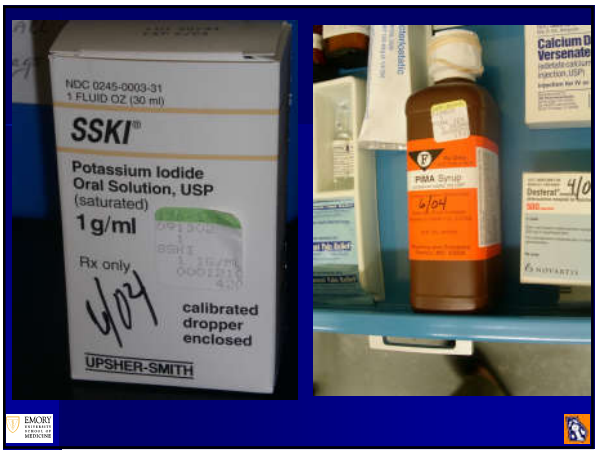
- Iodine Prophylaxis and Treatment
  - Potassium iodide (KI) is an effective, inexpensive thyroid-blocking agent.



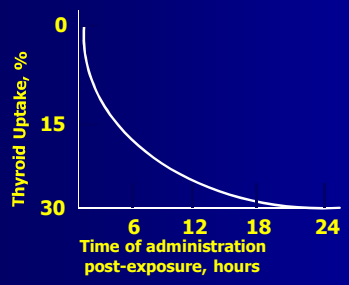
Radioactive Iodine Exposure



Saturate the Critical Organ with the Stable Isotope



Efficacy of KI is time dependent



Dose depends on age, special considerations (pregnant, lactating), and dose to thyroid gland.

TABLE 12.14—*Threshold thyroid radiation doses and recommended doses of KI for different risk groups (adapted from FDA, 2001).*[a]

Age Category	Predicted Absorbed Dose to the Thyroid (Gy (rad))[b]	KI Dose (mg)[c]	Number of 130 mg Tablets	Number of 65 mg Tablets	KI Solution 65 mg mL^{-1} (mL)
Adults >40 y	≥5 (500)	130	1	2	
Adults 18 – 40 y	≥0.1 (10)	130	1	2	
Pregnant or lactating women	≥0.05 (5)	130	1	2	
Adolescents 12 – 18 y[d]	≥0.05 (5)	65	0.5	1	1
Children 3 – 12 y	≥0.05 (5)	65	0.5	1	1
1 month – 3 y	≥0.05 (5)	32	0.25	0.5	0.5
Birth – 1 month	≥0.05 (5)	16	0.125	0.25	0.25

[a]The protective effect of KI lasts ~24 h. For optimal prophylaxis, KI should therefore be administered daily, until a risk of significant exposure to radioiodine by either inhalation or ingestion no longer exists.
[b]Without KI treatment.
[c]Adolescents approaching adult size (>70 kg) should receive the full adult dose (130 mg).

If Exposure to 131-I Longer than 1 Day

- Additional protective actions should be prioritized for children and pregnant or lactating women.
- Repeat doses of KI may have to be given up to 10-14 days.
  - May need to check thyroid hormone levels in certain high risk populations.

Psychological Impacts

Psychological Issues Following Radiation Disasters

- Unique because of the public's intense fear of radiation, strong sense of fatalism, and social stigma attached to persons exposed or contaminated.

Main Issues

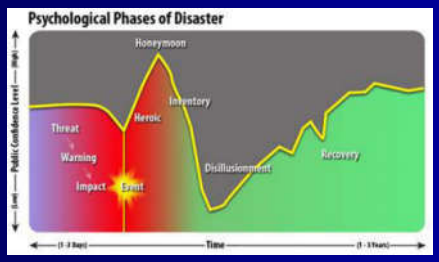
- Food and water contamination concerns.
- Patients may become volatile and agitated.

Shelter-in-Place or Evacuation

Psychological Issues Following Radiation Disasters

- The largest impact of a radiation disaster may be psychosocial.
- Psychological first aid assists survivors to keep risks in perspective.

Different Phases



Summary Points

- Internal contamination with radionuclides can lead to acute and long term health effects.
- Removing the radionuclide or decreasing absorption are the mainstays of therapy.
- The specific therapy depends on the radionuclide in question.


Any Questions?
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