Radiological Preparedness & Emergency Response
Session V

Clinical Evaluation of Acute and Subacute Radiation Injuries 1
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 contamination occurred
  - Characteristics 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

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>KI (potassium iodide)</td>
</tr>
</tbody>
</table>
| 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

<table>
<thead>
<tr>
<th>Retention (% of Uptake)</th>
<th>Control</th>
<th>Treated with DTPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>14.0</td>
<td>0.47</td>
</tr>
<tr>
<td>Skeleton</td>
<td>57.0</td>
<td>5.9</td>
</tr>
</tbody>
</table>
DTPA decorporation of $^{239}\text{Pu}$ (in rats):
Decline in efficacy with delay to treatment

<table>
<thead>
<tr>
<th>Time to treatment</th>
<th>Liver</th>
<th>Skeleton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 24, 48 hours</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>7 - 11 days</td>
<td>22</td>
<td>46</td>
</tr>
</tbody>
</table>

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 interrupts enterohepatic circulation.
Cesium-137

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (Years)</th>
<th>Insoluble Prussian blue dose (grams/day)</th>
<th>No. of Pts.</th>
<th>During Insoluble Prussian blue Treatment - $^{137}\text{Cs T}_{1/2}$</th>
<th>Off Insoluble Prussian blue Treatment - $^{137}\text{Cs T}_{1/2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>&gt; 18</td>
<td>10</td>
<td>5</td>
<td>$26 \pm 6$ days</td>
<td>$80 \pm 15$ days (all 21 adult patients)</td>
</tr>
<tr>
<td>Adults</td>
<td>&gt; 18</td>
<td>6</td>
<td>10</td>
<td>$25 \pm 15$ days</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>&gt; 18</td>
<td>3</td>
<td>6</td>
<td>$25 \pm 9$ days</td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td>12 - 14</td>
<td>&lt; 10</td>
<td>5</td>
<td>$30 \pm 12$ days</td>
<td>$62 \pm 14$ days</td>
</tr>
<tr>
<td>Children</td>
<td>4 - 9</td>
<td>&lt; 3</td>
<td>7</td>
<td>$24 \pm 3$ days</td>
<td>$42 \pm 4$ days</td>
</tr>
</tbody>
</table>

Half life decreased between 43 & 60%

*PB treatment inverts the feces/urine $^{137}\text{Cs}$ 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.
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

131I

THYROID

131I

131I

131I
SSKI®
Potassium Iodide Oral Solution, USP (saturated) 1 g/ml
1 FLUID OZ (30 ml)
Rx only 6/04 calibrated dropper enclosed

UPSHER-SMITH

LOT 20741 EXP 6/04

PIMA Syrup
potassium iodide, not USP
Rx Only

Fanning and Company
Fenton, MO 63026
Efficacy of KI is time dependent

Thyroid Uptake, %

Time of administration post-exposure, hours

6  12  18  24
Dose depends on age, special considerations (pregnant, lactating), and dose to thyroid gland.

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Predicted Absorbed Dose to the Thyroid [Gy (rad)]</th>
<th>KI Dose (mg)</th>
<th>Number of 130 mg Tablets</th>
<th>Number of 65 mg Tablets</th>
<th>KI Solution 65 mg mL⁻¹ (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults &gt;40 y</td>
<td>≥5 (500)</td>
<td>130</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Adults 18 – 40 y</td>
<td>≥0.1 (10)</td>
<td>130</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pregnant or lactating women</td>
<td>≥0.05 (5)</td>
<td>130</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Adolescents 12 – 18 y</td>
<td>≥0.05 (5)</td>
<td>65</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Children 3 – 12 y</td>
<td>≥0.05 (5)</td>
<td>65</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 month – 3 y</td>
<td>≥0.05 (5)</td>
<td>32</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Birth – 1 month</td>
<td>≥0.05 (5)</td>
<td>16</td>
<td>0.125</td>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>

aThe protective effect of KI lasts ~24 h. For optimal prophylaxis, KI should therefore be administered daily, until a risk of significant exposure to radioiodines by either inhalation or ingestion no longer exists.

bWithout KI treatment.

cAdolescents 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.
Radiological Preparedness & Emergency Response
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

Psychological Phases of Disaster

- Honeymoon
- Heroic
- Inventory
- Disillusionment
- Recovery

Time

(1 - 3 Days)

(1 - 3 Years)

Public Confusion Level

Threat

Warning

Impact

Event
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?