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 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>
<tr>
<td>Transuranics such as Plutonium &amp; Americium</td>
<td>Zn-DTPA Ca-DTPA</td>
</tr>
<tr>
<td>Uranium</td>
<td>Bicarbonate</td>
</tr>
<tr>
<td>Caesium</td>
<td>Prussian Blue* [Ferrihexacyano- Ferrate (II)]</td>
</tr>
<tr>
<td>Rubidium</td>
<td></td>
</tr>
<tr>
<td>Thallium</td>
<td></td>
</tr>
<tr>
<td>Tritium</td>
<td>Water</td>
</tr>
</tbody>
</table>

### 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>
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>Isocladable Precussite Blue dose (grams/day)</th>
<th>No. of Pts.</th>
<th>During Isocladable Precussite Blue Treatment</th>
<th>Off Isocladable Precussite Blue Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>18</td>
<td>10</td>
<td>5</td>
<td>25 ± 6 days</td>
<td>80 ± 13 days (all)</td>
</tr>
<tr>
<td>Adults</td>
<td>18</td>
<td>6</td>
<td>10</td>
<td>23 ± 11 days</td>
<td>23 ± 11 days (all)</td>
</tr>
<tr>
<td>Adults</td>
<td>18</td>
<td>6</td>
<td>6</td>
<td>25 ± 5 days</td>
<td>25 ± 5 days</td>
</tr>
<tr>
<td>Adolescents</td>
<td>12-14</td>
<td>10</td>
<td>5</td>
<td>26 ± 12 days</td>
<td>42 ± 14 days</td>
</tr>
<tr>
<td>Children</td>
<td>4-9</td>
<td>&lt; 10</td>
<td>7</td>
<td>24 ± 3 days</td>
<td>42 ± 4 days</td>
</tr>
</tbody>
</table>

Table 2: Cesium-137 Effective Half-life During and After Treatment with Isocladable Precussite Blue

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.

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>
<thead>
<tr>
<th>Age Category</th>
<th>Desired Model Dose (mg)</th>
<th>Recommended Dose (mg)</th>
<th>Number of Preg Mangels</th>
<th>Number of Lactating Mangels</th>
<th>Dose to Thyroid Gland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants &lt; 6 months</td>
<td>0.5</td>
<td>0.5-2.0</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Infants 6-12 months</td>
<td>0.3</td>
<td>0.3-1.5</td>
<td>1</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Children 1-10 yrs</td>
<td>0.15-0.25</td>
<td>0.15-0.25</td>
<td>1</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Adults 18+</td>
<td>0.15-0.25</td>
<td>0.15-0.25</td>
<td>1</td>
<td>1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

This page includes images of a potassium iodide test kit and a graph showing the efficacy of KI over time post-exposure. A table outlines the recommended doses of KI according to age group.
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?