Radiation Terror 101

Jonathan M. Links, PhD
Johns Hopkins University
Part 3

Radiological Terror
Radiological Terror: Four Main Events

1. **Nuclear device**
   - Stolen state-owned nuclear weapons or weapons components
   - Improvised nuclear devices

2. **Dirty bomb** ("radiological dispersal device")
   - Conventional explosive device bundled with radioactive material
   - Intended to efficiently disperse radioactivity
Radiological Terror: Four Main Events

3. **Attack on fixed nuclear facility**
   - Nuclear reactor
   - Spent fuel storage depot
   - Nuclear fuel reprocessing facility
   - High-level waste site

4. **Attack on radioactive material in transit**
Response to Bomb-Type Attack

- Crisis management
  - Acute response
- Consequence management
  - Long-term effort
Response to Bomb-Type Attack

- Crisis management
  - Acute response
- Consequence management
  - Long-term effort
- Levels of authority
  - Federal
  - State
  - County
  - City
1. Determine that **radioactivity/radiation** is in the environment  
   — First responders
2. Determine the **radionuclide(s)** and **amount(s)**  
   — Radiation strike team
3. Estimate **doses** and **geographic dose distribution**  
   — Radiation strike team + state environment dept
4. Determine need for (and implement) **evacuation**  
   — Radiation strike team + health dept + fire/police
Important First Responders

- **Fire department**
  - Hazmat
  - EMS

- **Police department**
  - Bomb squad
  - Patrol officers

- **Strike team**
  - Health department
  - State Hazmat
  - Radiation experts
NCRP Alarm Levels for First Responders

- **Alarm Level 1**
  - 10 mrem/hour
  - Lifetime cancer fatality risk (per hour) = \(5 \times 10^{-6} = 5\) in a million chance

- **Alarm Level 2**
  - 10 rem/hour or 10 rem total
  - Lifetime cancer fatality risk per 10 rem = \(5 \times 10^{-3} = 5\) in a thousand chance

- **Population limit (for comparison)**
  - 100 mrem/year

Notes Available
Medical Issues

- **Acute**
  - “Usual” medical problems for bomb-type attack
    - Injuries, burns
  - Acute radiation syndromes
  - Patient internal contamination

- **Delayed**
  - Radiation carcinogenesis

- Note: must consider both acute and delayed effects of in utero irradiation
External contamination

- Radioactive atoms are on clothing or skin
- Irradiated by penetrating radiation (X rays and gamma rays)
- “Carry” contamination away from site on surface
- **Internal contamination**
  - Radioactive atoms enter the body by eating or drinking, breathing gases or aerosols, absorption through skin or wound
  - Irradiated by non-penetrating radiation ($\alpha$ and $\beta$) emitted *within* the body
  - “Carry” contamination away from site within body
General Countermeasures

- **External radiation exposure**
  - Sheltering in place
  - Evacuation/relocation
  - Control of access to ground zero site

- **Internal contamination**
  - As above
  - Stable iodine (only when radioiodine present)
General Countermeasures

- **External radiation exposure**
  - Sheltering in place
  - Evacuation/relocation
  - Control of access to ground zero site

- **Internal contamination**
  - As above
  - Stable iodine (only when radioiodine present)

- **Internal contamination due to ingestion**
  - Control of food and water
  - Use of stored animal feeds
Order of Medical Management

- Treat and stabilize life-threatening injuries
- Prevent/minimize internal contamination
- Assess external contamination and decon
- Contain contamination to treatment area
- Minimize external contamination to medical personnel
- Assess internal contamination
- Assess local radiation injuries/burns
Triage

- Separate injured from non-injured
- Decontaminate both groups
  - Remove clothing and double-bag
  - Wash head and hands
- Only injured allowed in the emergency department (ED)
  - If the ED becomes a decontamination site, it is no longer an ED!
Skin Changes

- 300 rem: epilation in 2–3 weeks
- 1,000 rem: erythema in hours to weeks
- 2,000 rem: moist desquamation, ulceration
- 2,500 rem: ulceration
- 3,000 rem: blistering, necrosis at 3 weeks
- 10,000 rem: blistering, necrosis at 1 week
## Lymphocyte Count

<table>
<thead>
<tr>
<th>Lymphocyte Count (10^3 mL⁻¹)</th>
<th>Absorbed Dose (Gray)</th>
<th>Lethality w/o Rx (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0–0.25</td>
<td>0</td>
</tr>
<tr>
<td>1.2–3</td>
<td>0.25–2</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>0.4–1.2</td>
<td>2–3.5</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>0.1–0.4</td>
<td>3.5–5</td>
<td>50–99</td>
</tr>
<tr>
<td>0–0.1</td>
<td>&gt; 5</td>
<td>100</td>
</tr>
</tbody>
</table>

Notes Available
Therapy for Internal Contamination

- **I-125 or I-131**
  - Thyroid blockage
  - SSKI or potassium iodide
- **Cs-137**
  - Reduction of GI absorption
  - Prussian blue
- **Unknown**
  - Reduction of absorption
  - Emetics, lavage, charcoal, or laxatives in cases of ingestion
Acknowledgements

**Johns Hopkins Bloomberg School of Public Health**
- Lynn Goldman
- Tom Burke
- Robert Lawrence
- Tara O’Toole
- Ken Brenneman

**Baltimore City Health Department**
- Peter Beilenson
- Ruth Vogel
- Dawn LaForce
- Dan Barnett
Acknowledgements

Baltimore City Fire Department
Ken Hyde
Ron Addison

Baltimore City Police Department
Rodney Giacomelli
Kevin Forrester
Chuck Schneider
John Skinner