Radiation Terror 101

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Part 2

General Radiation Principles, Part II
Exposure Paradigm

- **Agent** = ionizing radiation
  - Alpha and beta particles, X rays and gamma rays
- **Source** = radioactive atoms
  - Emit the ionizing radiation
- **Exposure**
  - External exposure = directly from the radiation
  - Internal exposure = from radiation emitted from radioactive atoms in the body
Exposure Paradigm

- **Vector** = air, water, soil, food
  - Carries the radioactive atoms into the body
- **Routes of entry** = inhalation, ingestion, absorption
Exposure Paradigm

- **Vector** = air, water, soil, food
  - Carries the radioactive atoms into the body
- **Routes of entry** = inhalation, ingestion, absorption
  - How radioactive atoms enter the body
## Ionizing Radiation Exposure (U.S.)

<table>
<thead>
<tr>
<th>Natural Source</th>
<th>Dose Equivalent (mrem)*</th>
<th>Source Contribution to Dose</th>
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<tbody>
<tr>
<td>Radon</td>
<td>200</td>
<td>Radon 55%</td>
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<td>In the body</td>
<td>39</td>
<td>In the body 11%</td>
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<td>28</td>
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<tr>
<td></td>
<td></td>
<td>Medical 15%</td>
</tr>
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<td></td>
<td>Products 3%</td>
</tr>
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<td>Other 1%</td>
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* mrem is a unit of radiation dose
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Ionizing Radiation Effects: Deterministic and Random

- **Deterministic**
  - Severity is a function of dose
  - Threshold exists
  - Examples: skin reddening, mental and growth retardation, cataract formation

- **Random**
  - Risk is a function of dose
  - No threshold
  - Example: cancer
Ionizing Radiation Effects: Acute

- **Acute—deterministic effects**
  - Prodromal syndrome: 100+ rem
  - Hematopoietic syndrome: 100s of rem
  - Gastrointestinal syndrome: 1,000s of rem
  - Central nervous system syndrome: 10,000s of rem
  - Near 100% fatality: 600 rem
Ionizing Radiation Effects: Delayed

- **Delayed—stochastic and deterministic effects**
  - Random: cancer, genetic changes
  - Burns, cataract formation: 100 rem threshold
  - Growth and mental retardation: 10 rem threshold
## ICRP Fatal Cancer Risk

**Baseline (Non-Radiogenic) Fatal Cancer Risk = 25%**

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<tr>
<td>1 mrem</td>
<td>0.01 mSv*</td>
</tr>
<tr>
<td>10 mrem</td>
<td>0.1 mSv</td>
</tr>
<tr>
<td>100 mrem</td>
<td>1 mSv</td>
</tr>
<tr>
<td>1 rem</td>
<td>10 mSv</td>
</tr>
<tr>
<td>10 rem</td>
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*1 mSv = 100 mrem*
Radiation Safety and Protection

- Exposure = intensity x time
- The “Big 3:”
  – Time
  – Distance
  – Shielding
Radiation Safety and Protection

- Time
  - \( \text{Exp}_\infty \text{ time} \)
- Distance
  - \( \text{Exp}_\infty 1/d^2 \)
- Shielding
  - \( \text{Exp}_\infty 1/\text{attenuation} \)
  - Particulate: defined range to stop all radiation
  - Electromagnetic: exponential attenuation