Views expressed are those of the presenters and do not necessarily represent the views of the National Environmental Health Association or official policies or procedures of the Centers for Disease Control and Prevention.

Use of trade names is for identification only and does not imply endorsement by the Centers for Disease Control and Prevention.
Radiation and Environmental Health Response

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The Basics

• Radiation: “ionizing” vs. non-ionizing
• Different types of radiation
• Radioactive decay/half-life
• Radiation units/dose
• Detection and instrumentation
• Biological effects
• Human health effects
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

\[ E = hf \quad f = \frac{c}{\lambda} \]

**Radioactivity**

Spontaneous emission of radiation from the nucleus of an unstable isotope

**Disintegration**

- Energy
- Radiation

**Decay**

- Particle
Shielding of Different Types of Radiation

- Alpha Particles
  Stopped by a sheet of paper

- Beta Particles
  Stopped by a layer of clothing or less than an inch of plastic

- Gamma Rays
  Stopped by a few inches of lead or a few feet of concrete

Common Radioactive Nuclides

- Nuclear medicine: Iodine-131
- Radiotherapy: Cobalt-60
- Satellite power: Plutonium-238
- Nuclear power: Uranium-235
- Our body: Potassium-40
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

Decay Rate/ Half-Life of Radionuclides

Decay rate of radioactivity. After ten half lives, the level of radiation is reduced to one thousandth.

Time: One half life two three four five six seven eight nine

Radiation Units

• International System of units: Sievert (for radiation health effects)

• NOTE: Historically in U.S., most common unit for health effects: rem

(1 Sievert = 100 rem)
Typical Doses (milliSievert/mSv)

- NY to London by air: 0.05 mSv
- Chest X-Ray: 0.1 mSv
- Natural background (annual): 3 mSv
- CT Scan (abdomen): 10 mSv
- Occupational annual limit: 50 mSv
- 50% survival dose: 4,000 mSv

Biological Effects
What Could Ionization do to a Molecule?

Ionizing radiation can break the bonds between the atoms in a molecule.

DNA is the target molecule in a cell.

Cellular Effects

- Death
- Repair
- Transformation

Radiation
Human Health Effects

Depending on radiation dose and dose rate:

- No observable effects
- Acute effects (acute radiation syndrome)
- Late effects (cancer)

Late Effects (cancer)

- Most cancers can be induced by radiation
- Clear evidence for leukemia, breast, thyroid, salivary glands, stomach, colon, lung (& others)
- Young age at exposure increases risk
- Risk persists throughout life
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

Sensitivity to Radiation-Induced Cancer by Age at Exposure

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Sensitivity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td>25</td>
<td>1.3</td>
</tr>
<tr>
<td>45</td>
<td>0.7</td>
</tr>
<tr>
<td>75</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Calc. From BEIR V (1990)

Summary: Key Points

- Radiation types: alpha, beta, gamma
- Dose Units: rem (U.S.)
- Radiation and radioactivity are part of our natural environment
- Radiation can kill in short term or cause cancer in long term.
- It is all about the dose!
DEMO

Types of Radiation

Radiological and Nuclear Incident Scenarios

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Atlanta, Georgia
Potential Radiation Events

- Transportation
- Power Plant
- Weapons
- Laboratory
- Industrial
- Medical
- Space
- Terrorism

Nuclear vs. Radiological Incident

- A nuclear incident involves a nuclear detonation.

- A radiological incident does NOT involve a nuclear detonation.
Hiroshima, Japan  
August 6, 1945

- Design NOT tested in advance
- Employed enriched uranium
- Approximately 100,000 casualties (deaths & injuries)

“Little Boy”

Radiological Dispersal Device (RDD)

- A device that disperses radioactive material by conventional explosive (dirty bomb) or other mechanical means, such as a spray.
Imagine this scene with radioactive dust

Radiological Exposure Device (RED)

- A device whose purpose is to expose people to radiation, rather than to disperse radioactive material. “silent source”

- Radiation

Environmental Health Training in Emergency Response (EHTER) - Awareness Level
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

Summary

• Incidents involving radiation cover a wide range of scenarios.

• A nuclear detonation creates by far the greatest amount damage and loss of life.

• Radiological incidents present many public health challenges, particularly when widespread contamination occurs.

CASE STUDIES

Radiation
Goiania, Brazil  
September 1987

- Abandoned Cancer Clinic
- Discarded canisters from radiotherapy machine
- Junkyard worker opened canisters revealing “glowing” powder
- Many contaminated with or exposed to Cesium-137

Radiation
Goiânia Incident

- 249 exposed; 54 hospitalized
- Eight with radiation sickness
- Four people died
- 112,000 monitored for contamination

Photos courtesy of the International Atomic Energy Agency (IAEA)

Goiânia Incident

- Generated 3,500 cubic meters of radioactive waste disposal.
- Significant public concern and fear (e.g., drink the water?).

Photos courtesy of the International Atomic Energy Agency (IAEA)
RUSSIA

Chernobyl

The world’s worst nuclear reactor disaster.
10 km (6 mile) radius uninhabitable - indefinitely
30 died within 3 months (radiation)

April 1986

Radiation
Chernobyl (cont.)

• Principal radionuclide: Iodine-131
  – About 90% of dose
  – Inhaled and ingested

• Excess thyroid cancers still occurring

• Risk appears to decrease with increasing age at exposure, little effect for adults.
Chernobyl’s Social and Environmental Impact

• Rural populations in contaminated areas could not eat local produce or wild plants; had to give up dairy cattle.

• Countries around the world monitored radioactivity in agricultural products and seafood for years afterward.

JAPAN

Radiation
March 11, 2011

- Earthquake resulted in automatic shutdown of 11 NPPs at 4 sites along northeast coast of Japan including Fukushima Dai-ichi 1, 2, & 3.

Fukushima Dai-ichi NPP

- Units 1-3 shut down.
- Diesel generators started.
- 40 minutes later the tsunami wave caused loss of electrical power.
Fukushima Dai-ichi NPP

- Meltdown risk
- Hydrogen explosions in units 1 & 4
- Venting of steam
- Pumping of seawater

Principal Radionuclides Released

- Iodine-131 (8 d half-life)
- Cesium-137 (30 y)
- Cesium-134 (2 y)
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Evacuation

Food Safety

Radiation
Case Studies Summary

• Lots of experience with radiation incidents worldwide.
  – Many lessons learned.
• Radiation incidents can result in a wide range of health and environmental impacts.
  – Environmental health professionals required!
Environmental Health Planning for a Radiation Disaster

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Atlanta, Georgia

Environmental Health Functions After *Any* Disaster

- Rapid assessment of community health needs
- Potable water, safe food, sanitation and hygiene
- Vector control
- Solid waste, waste water management
- Hazardous material disposal
- Sheltering and housing, mass care safety
- Injury and illness surveillance

- Handling of the deceased
- Registry
- Public service announcements

Radiation
New Orleans 2005

Haiti 2010

Radiation
State Radiation Control Programs

• Every state has one.
  http://www.crcpd.org/Map/map.html

• Coordination with this office is vital in both planning for and responding to a nuclear or radiological incident.

• Know the names and contact information.
References

  www.fda.gov/cdrh/dmgrp/84.html

  www.epa.gov/rpdweb00/rert/pags.html

References (cont.)


• DHS, Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents. 2008.
  http://ogcms.energy.gov/73fr45029.pdf
  http://ogcms.energy.gov/73fr45029.pdf

Radiation
References (cont.)

  

Key Emergency Response Partners

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National Center for Environmental Health  
Centers for Disease Control and Prevention  
Atlanta, Georgia
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National Response Framework

Base Plan → Concept of Operations, Coordinating Structures, Roles and Responsibilities, Definitions, etc.

Emergency Support Function Annexes

ESF 6 – mass care
ESF 8 – public health and med
ESF 10 – hazmat response
ESF 11 – agriculture

Describes common processes and specific administrative requirements

Support Annexes

Incident Annexes → Nuclear/Radiological Incident Annex

Appendices → Glossary, Acronyms, and Compendium of National Interagency Plans

• National Atmospheric Release Advisory Center (NARAC)
• Aerial Measuring System (AMS)
• Federal Radiological Monitoring and Assessment Center (FRMAC)
• Radiological Assistance Program (RAP)
• Radiation Emergency Assistance Center / Training Site (REAC/TS)

Radiation
The Advisory Team for Environment, Food, and Health (A-Team)

The goal of the A-Team is to provide coordinated advice and recommendations to the State, Coordinating Agency, and DHS concerning environmental, food, and health matters.

and other Federal agencies as needed

CDC RESPONSE

• Deploy Strategic National Stockpile and Technical Advisory Response Unit

• Evaluate health impact on public and emergency personnel

• Establish exposure registry to monitor long-term effects

• Surveillance and epidemiologic studies of exposed population

Radiation
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

CDC RESPONSE

Advise on:

• Triage
• Patient treatment and decontamination
• Medical intervention
• Disease control and prevention measures
• Safety and protection of health care providers (NIOSH)

Population Monitoring and Community Reception Centers for Radiation Emergency Response

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Centers for Disease Control and Prevention  
Atlanta, Georgia
Radioactive Contamination Screening

Population Monitoring (Japan 2011)
Public Shelters & Reception Centers (Japan 2011)

National Response Framework
Nuclear/Radiological Incident Annex

Decontamination/Population Monitoring are:
“the responsibility of State, local, and tribal governments.”
Objectives of Population Monitoring

1. Identify people in immediate danger.
2. Identify people who need medical treatment for contamination or exposure.
3. Recommend and facilitate practical steps to minimize risk.
4. Register people for long-term health monitoring.

Guiding Principles

• The first priority is to save lives: respond to and treat the injured first.
• Contamination with radioactive materials is not immediately life-threatening.
Guiding Principles (Cont.)

• Initial population monitoring activities should focus on preventing or mitigating acute radiation health effects.
  – Cross contamination issues are a secondary concern

• Scalability and flexibility are an important part of the planning process.
Community Reception Center (CRC)

- The place to conduct “population monitoring”
- Public health lead
- Opened 24-48 hours post event
- Located outside of hot zone
- Staffed by local government and organized volunteers (e.g., Medical Reserve Corps)

Environmental health professionals likely to be called upon to assist
Community Reception Center (CRC)

- Basic services include:
  - external contamination screening
  - external decontamination
  - registration
  - prioritizing people for further care

- Benefits include:
  - reducing burden on hospitals
  - managing scarce medical resources
  - supporting shelters, co-located within shelters
Summary

- Population monitoring is a critical public health need in a radiation emergency.
- Environmental health professionals are likely to be called upon to assist in staffing community reception centers.
- Training and planning tools are available from CDC.

Safety and Health Concerns in a Radiation Disaster

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Centers for Disease Control and Prevention
Atlanta, Georgia
Environmental Health Training in Emergency Response (EHTER) - Awareness Level

Protective Measures

• Protection from external and internal radioactive sources:
  – Time, distance, and shielding
    (Examples: evacuation and sheltering)
  – Dosimetry and monitoring

• Radiological countermeasures for internal contamination, e.g., Potassium Iodide (KI)

• Safety officer on scene!

Evacuation vs. Sheltering

• Not a simple decision process!
• Estimated radiation dose levels (protective action guidance from feds)
• Timing of evacuation
• Quality of available shelters
• Recommendations from public health and emergency management authorities
REMEmBER, In a radiation emergency:

• Many environmental issues will be just like any other emergency!

• However, radiation levels may be elevated or radioactive materials may be present.
REMEMBER…

• The first priority is to save lives: respond to and treat the injured first.

• Contamination with radioactive materials is NOT immediately life-threatening.

• If reporting on scene, always consult with safety officer first.

Important Contacts

• Expertise available from your state program, CDC, ATSDR, and other federal agencies.

• Know name and contact information for your state radiation control program director:

  www.crcpd.org/Map/map.html
CDC Products for Training, Education, and Planning

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http://emergency.cdc.gov/radiation
Radiological Terrorism: A Tool Kit for Emergency Services Clinicians

- Webcasts
- Fact Sheets
- Pocket Guide
- Self-Study Training
- Just in Time Training for Hospital Clinicians

Radiological Terrorism: A Tool Kit for Public Health Officials

- How to Use Handheld Radiation Survey Equipment Video
- Webcasts
- Fact Sheets
- Guides (e.g., Population Monitoring)
- Self-Study Training
The Virtual Community Reception Center (vCRC)

- Web-based training
- Animated exploration area
- Interactive flow diagram
- Embedded video segments
- Supporting resources
  - Job Action Sheets
  - Forms
  - Customizable for jurisdiction

www.emergency.cdc.gov/radiation/crc/vcrc

Radiation Event Medical Management (REMM)

www.remm.nlm.gov

MEDICAL MANAGEMENT (Diagnosis & Treatment)
Thank You

The findings and conclusions in this presentation are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry.

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