Radiation and Environmental Health Response

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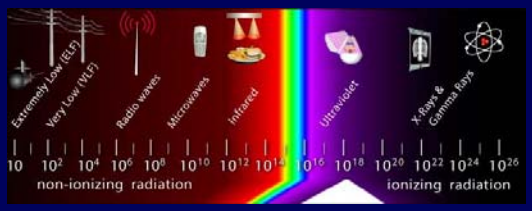
The Basics

- Radiation: “ionizing” vs. non-ionizing
- Different types of radiation
- Radioactive decay/half-life
- Radiation units/dose
- Detection and instrumentation
- Biological effects
- Human health effects

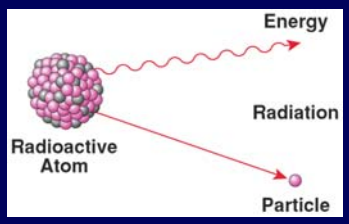


$E = hf \quad f = c/\lambda$

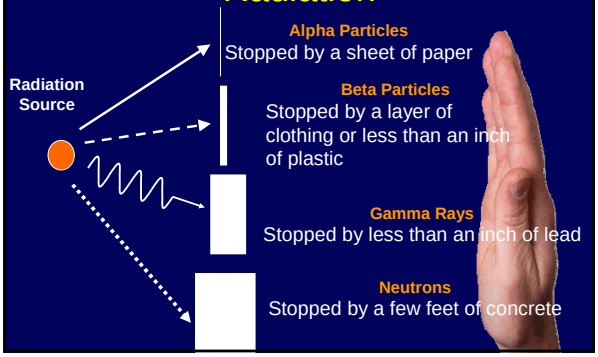
Radioactivity

Spontaneous emission of radiation from the nucleus of an unstable isotope

Disintegration **Decay**



Shielding of Different Types of Radiation



Common Radioactive Nuclides

- Nuclear medicine: *Iodine-131*
- Radiotherapy: *cobalt-60*
- Satellite power*: plutonium-238*
- Nuclear power: *uranium-235*
- Our body: *potassium-40*

Decay Rate/ Half-Life of Radionuclides

Radiation Units

- In U.S.: rem, rad, Roentgen (R), gray
  - – Most common (U.S.) for health effects: rem
- Internationally: Sievert (1 Sievert = 100 rem)

Typical Doses (rem)

NY to London by air	0.005
Chest X-Ray	0.010
Natural bkgd. (annual)	0.300
CT Scan -Abdomen	1
Occupational annual limit	5
50% survival dose	400
Radiotherapy (tumor)	8,000

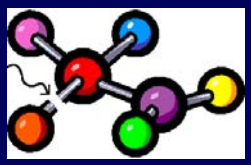
Detecting Radiation

We can not see, hear or smell radiation!
But we can measure it.

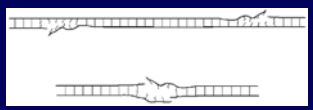
Biological Effects

What Could Ionization do to a Molecule?

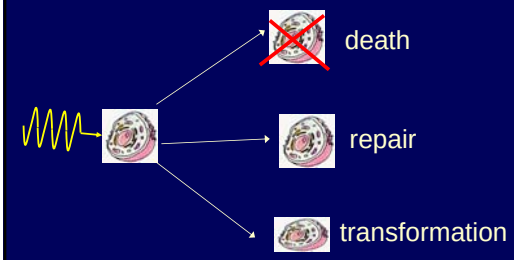
Ionizing radiation can break the bonds between the atoms in a molecule.



DNA is the target molecule in a cell



Cellular Effects



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

Sensitivity to Radiation-Induced Cancer by Age at Exposure

Age (Years)	Sensitivity Factor
5	1.8
25	1.3
45	0.7
75	0.3

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

Gus Savastano
Mario Iannaccone

Massachusetts Radiation Control Program

Radiological and Nuclear Incident Scenarios

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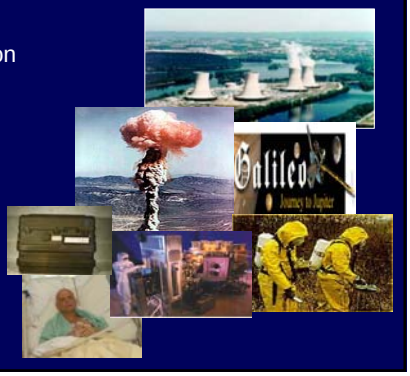
Atlanta, Georgia

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

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

"Little Boy"

National Planning Scenario #1:10-kiloton Improvised Nuclear Device

- *Casualties*
  - Hundreds of thousands
- *Evacuations/Displaced Persons*
  - 100,000 in affected area seek shelter in safe areas (decontamination needed)
  - 250,000 instructed to shelter-in-place as plume moves across region(s)
  - 1 million+ self-evacuate from major urban areas

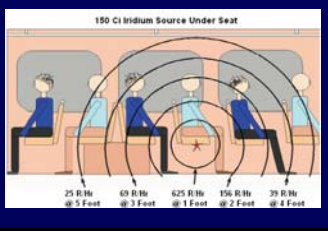
Radiological Dispersal Device (RDD)

- 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"



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 wide-spread contamination occurs.

CASE STUDIES

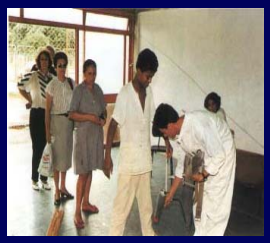
BRAZIL

Goiania, Brazil
September 1987

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

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

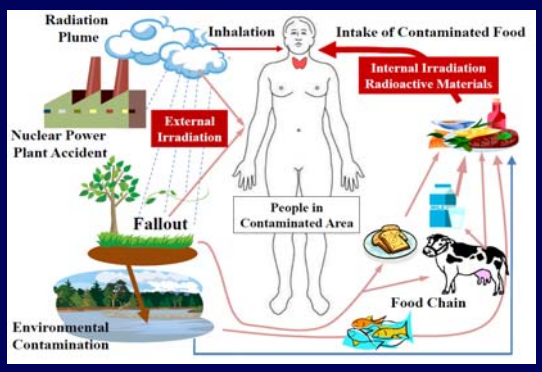
Chernobyl

The world's worst nuclear reactor disaster.

10 km (6 mile) radius uninhabitable - indefinitely

30 died within 3 months (radiation)

April 1986



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

March 11, 2010

- The Japan earthquake resulted in the automatic shutdown of 11 NPPs at 4 sites along the 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 sea water

Principal Radionuclides Released

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

Evacuation

Food Safety

Long Term Clean Up

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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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

Planning

- Determine environmental health roles within local response structure and identify who will fill those roles.
- Are they prepared for assigned tasks in a radiation emergency?
  - Plans and procedures
  - Partnerships
  - Training and exercises

Planning

- Communicate with agencies and stakeholders from inside and outside the public health community.
- Develop a list of resources available within your community that includes radiological expertise.
  - Identify in advance LOCAL radiation experts.

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.

Massachusetts Radiation Control Program

http://www.mass.gov/dph/rcp

Beverly Anderson

Terminology

- Protective Action Recommendation (PAR)
- Protective Action Guide (PAG)
- Derived Intervention Level (DIL)

Protective Action Recommendation (PAR)

- Action intended to avoid or reduce radiation dose to members of the public (and responders).
  - Examples: sheltering in place, evacuation, changing clothes, showering, embargos on agricultural products, etc.

Protective Action Guides (PAGs)

- Projected radiation dose levels at which protective action should be considered
- These are "projected" doses.
  - Examples: PAGs for evacuation, relocation, or administration of potassium iodide (KI)
- Given in units of rem (e.g., 1, 2, 5, 25 rem).
  - 1 rem is approx. same dose as an average CT exam.

Derived Intervention Levels (DILs)

- Refer to concentrations of radioactive material in food items (meat, fruits, and vegetables)
- Food containing DIL amount of radioactivity would deliver a radiation dose equal to the PAG, based on cautionary assumptions.
- Regarding food embargos, science is only one parameter in decision making.

References

- FDA, *Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies.* 1988.
  www.fda.gov/cdrh/dmqrp/84.html
- EPA, *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*; EPA 400-R-92-001. 1992 [Recently updated.]
  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
- Homeland Security Council, *Planning Guidance for Response to a Nuclear Detonation*. 2009
  www.afrri.usuhs.mil/outreach/pdf/planning-guidance.pdf

Key Emergency Response Partners

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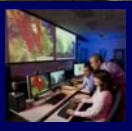
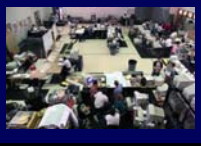
National Center for Environmental Health
Centers for Disease Control and Prevention
Atlanta, Georgia

National Response Framework

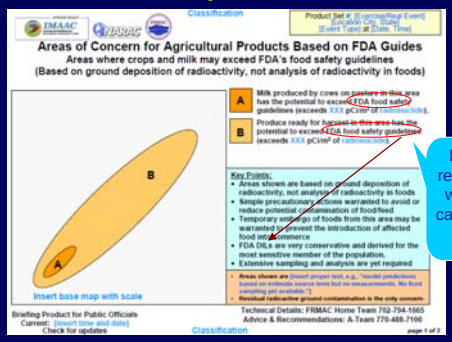
U.S. Department of Energy
National Nuclear Security Administration
NNSA

- 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)



Example : Technical data you may use!

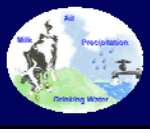


Do you remember what we call these?

EPA Response Assets

- Radiological Emergency Response Team
  - Rad monitoring expertise, sample prep vehicles, and mobile laboratories
- National Decontamination Team
- Environmental Response Team
- Environmental Radiation Ambient Monitoring System (RadNet)





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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.

Membership is comprised principally of :

and other Federal agencies as needed

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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 impacts
- Surveillance and epi studies of exposed population


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CDC RESPONSE

Advise on:

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

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Population Monitoring and Community Reception Centers for Radiation Emergency Response

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Population Monitoring

The process of identifying, screening, and monitoring people for exposure to radiation or contamination with radioactive materials.

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.

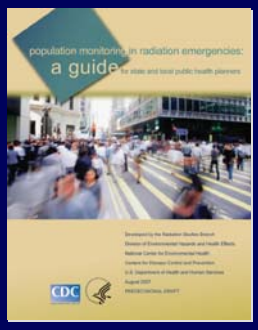
Guiding Principles

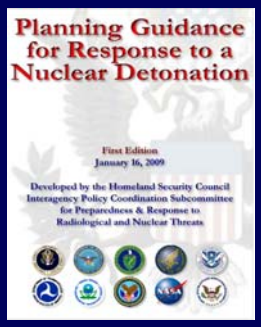
- The first priority is to save lives: respond to and treat the injured first.
- Contamination with radioactive materials is not immediately life-threatening.

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.

Resources





Community Reception Center (CRC)

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 Additional Services

- Monitoring for internal contamination
- Collection of Bioassays
- Medical intervention for decorporation
- Counseling
- Relocation services
- Pet monitoring

Add modules as resources become available.

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.

DEMO

Radioactive Contamination Screening

Gus Savastano
Mario Iannaccone

Massachusetts Radiation Control Program

Safety and Health Concerns in a Radiation Disaster

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Protective Measures

- Protection from external and internal radioactive sources can be achieved through effective use of:
  - Time, distance, and shielding
    (Examples: evacuation and sheltering)
  - Dosimetry and monitoring
- Radiological countermeasures for internal contamination, e.g., Potassium Iodide (KI)

Radioprotective Measures:

Time, Distance and Shielding

Guiding principle for controlling exposures:

ALARA
As Low As Reasonably Achievable

Time

Decreasing the amount of time spent near the source of radiation will decrease the dose of radiation received.

- Analogy - *Spend a day at the beach, you will likely get sunburned. But, if you limit time in the sun, you won't.*

Distance

The farther away you are from a radiation source, the less exposure you will receive.

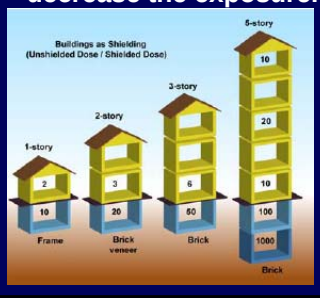
- Analogy - *Compare this to sitting in front of a fireplace. You can sit directly in front or across the room…*

Evacuation vs. Sheltering

- Not a simple decision process!
- Estimated radiation dose levels (Protective Action Guides)
- Timing of evacuation
- Quality of available shelters
- Recommendations from public health and emergency management authorities

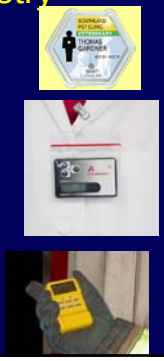
Shielding

Increasing the shielding between a person and the radiation source, will decrease the exposure.



Personal Dosimetry

- Personal dosimetry for responding staff
  - Most common provide:
    - Permanent dose record
    - No direct reading
  - Some provide:
    - Direct reading
    - Audible alarm for dose or dose rate



Detection and Instrumentation Requires Training!

OSHA/NIOSH Interim Guidance - August 30, 2004
Chemical - Biological - Radiological - Nuclear (CBRN)
Personal Protective Equipment Selection Matrix for Emergency Responders
Radiological Dispersal Device (RDD)

First Responders

- Protective clothing effective against external skin contamination with alpha/beta emitting material – *not effective against external gamma radiation.*
- For protection against inhaling particulates:
  - at least a full-face air-purifying respirator with a P-100 or HEPA.
  - CBRN-approved respirators preferred.
  - Otherwise, use alternate NIOSH-approved respirators.

www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/radiological.html

FIRST RECEIVERS

- Recommendations for respiratory PPE is identical regardless of the agent involved.
- Adopting an "all hazards" approach, use PAPRs.
- Downgrade as appropriate based on environmental data.
- **Always consult with your safety officer.**


OSHA BEST PRACTICES
for
HOSPITAL-BASED FIRST RECEIVERS OF VICTIMS from Mass Casualty Incidents Involving the Release of Hazardous Substances
OSHA

www.osha.gov/dts/osta/bestpractices/firstreceivers_hospital.pdf

REMEMBER, In a radiation emergency:

- Many environmental issues will be just like any other emergency!
- Radiation contamination is NOT immediately life-threatening.
- Radiation detectors are simple to use with a little training.
- Always consult with your safety officer.

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

Radiation Event Medical Management (REMM)

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

Key Messages

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Rad Emergencies Are Not So Different!

- Environmental health functions: same in rad emergency as in natural disasters.
- *However*, radiation levels may be elevated or radioactive materials may be present.
- Environmental health functions (ensuring safe food and water or healthy shelters) remains the same!

REMEMBER, In a radiation emergency:

- Expertise available from CDC, ATSDR, and your State program.
- Many environmental issues will be just like any other emergency!
- Radiation contamination is NOT immediately life-threatening.
- Radiation detectors are simple to use with a little training.

In a radiation emergency:

- Environmental health professionals need to work closely with radiation protection professionals (health physicists).

Important Contact!

- Know name and contact information for your state radiation control program director.

Any state: www.crcpd.org/Map/map.html

Massachusetts: www.mass.gov/dph/rcp