Radiological Preparedness & Emergency Response

1

Session I

Overview of Different Types of Threats Using Historical Examples

2

Objectives

- Discuss the threat from radiological terrorism and accidents.
- Describe the different types of incidents using historical examples.

3

Why Are You Here?

- Radiation threats are real.
- We may not be well prepared.

4

Are Radiation Sources Available?

- There are around:
  - 150,000 licensed radioactive facilities in the USA
  - 2,000,000 radioactive sources
  - 400 lost sources per year in the world

Source IAEA

5

Emergency Responders Attitudes and Perceptions

- A survey performed in Hawaii hospitals has shown that responders ranked radiation threats highest in terms of the fear generated when compared to chemical or biological terrorist attacks.

6

Emergency Responders and Radiological Preparedness

- Research has shown that US clinicians and Public Health workers felt unprepared to respond to radiological or nuclear incidents.
- Canadian survey-based study: 31% of EMS providers reported receiving training in radiation detection.

7

US Emergency Medicine Physician Survey

- 48% felt uncomfortable caring for radiation victims.
- 56% felt similarly about performing a radiation detection survey on patients.
- 52% and 68% felt uncomfortable diagnosing ARS and internal contamination.
- Majority were unfamiliar with use of DTPA, Prussian blue, and Filgrastim.
- Many respondents were unable to differentiate between contamination and exposure with radiological material.

8

Study in the Medical Reserve Corps Volunteers

- Evaluated perceived threat, perceived efficacy, and personal/organizational preparedness in 4 scenarios:
  - Weather-related disaster
  - Pandemic influenza emergency
  - Radiological ("dirty bomb") emergency
  - Inhalational anthrax emergency
- The radiological emergency consistently received the lowest scores for the attitude/belief statements and response willingness across scenarios.

Errett NA. Assessment of medical reserve corps volunteers' emergency response willingness using a threat- and efficacy-based model.
Biosecur Bioterror. 2013 Mar;11(1):29-40.

9

Possible Scenarios

- Simple radiological device.
- Improvised nuclear device (IND).
- Nuclear weapon detonation.
- Nuclear power plant accident.
- Radioactive dispersal device (RDD).

Photo Credit Sandia National Laboratories and Wikipedia

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Simple Radiological Device

- Exposure to penetrating ionizing radiation.
- Insidious onset.
- Initially silent.

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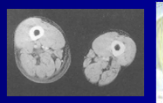
Lja, Republic of Georgia-2002

Source IAEA

12

Yanango, Peru. Feb 20,1999

- Iridium source loss.
- Picked up by worker and put in his back pocket.
- The patient developed severe radiation burn in his pelvic area as well as ARS.
- He survived with significant disability.

Source IAEA

13

Yanango - Peru
May and December,1999

Patient treated in France

May 1999 →

Source IAEA

December 1999 →

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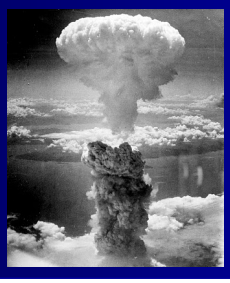
Nuclear Weapon Detonation or Improvised Nuclear Detonation (IND)



Air burst versus ground burst

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Nuclear Detonation

- Fission reaction.
- Damage and mortality secondary to Nuclear weapon detonation:
  - Thermal blast (35%)
  - Radiation (15%): initial and fallout
  - Shock (50%)
- Electromagnetic pulse.

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Nagasaki, 1945

Pre and Post

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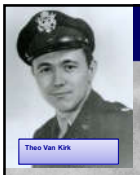
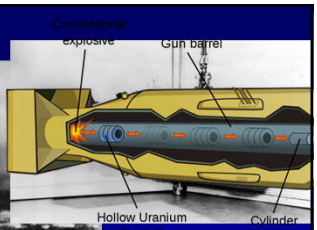


Theo Van Kirk



Little Boy dropped on Hiroshima in August 6 1945

18

Severe damage zone (0.5 mile radius):

- Near complete collapse
- Few, if any, buildings still standing
- 99% immediate fatalities

19

Nevada Atomic Bomb Testing Site - 1955

Film and images at 1 km (0.6 mile) from ~16kT yields

Equivalent to the outskirts of the severe damage zone

20

Moderate damage zone (1 mile radius):

- Some collapsed buildings, blown out building interiors, overturned automobiles, fires
- Significant thermal burns if outdoors
- 38% immediate fatalities, 14% expectant

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Light damage zone:
- 2-3 mile radius
- 25% of windows are shattered
- Huge numbers of glass injuries
- 6% of casualties at risk of death

Temporary blindness 5-10 miles away!

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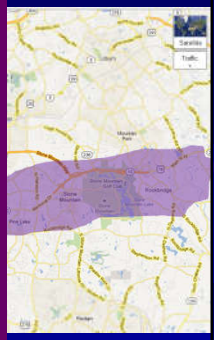
Dangerous Fallout Zone or Dangerous Radiation Zone:
- Extends 25 miles downwind of ground zero
- Reaches maximum extent at 1 hr
- Severely hazardous fallout will descend to the ground within a few hours and may shrink to a few miles in a couple of days (decay)
- Mostly visible to naked eye (grains of sand)
- Exposure rate >10 R/h



NCRP 165 Page 53

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Casualties (10 kT model)

- For large city with 2 million population
  - 230,000 immediate fatalities
  - 323,000 injured survivors
    - 99,000 will succumb without medical treatment
    - 73,000 will still succumb with medical treatment
    - **26,000 can be saved with medical treatment**

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Nuclear Power Plant Accident- Fukushima

- 6 reactors
- Meltdown risk
- I-131
- Other radionuclides

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Nuclear Power Plant Accident-Chernobyl

- Nuclear reactor can occur leading to an explosion.
- Iodine is a fission product and is majorly responsible for human exposure.

26

Firefighters in Chernobyl

- 237 emergency workers had ARS.
- ARS was identified as the cause of death for 28 of these people within the first few months after the disaster.

Source Wikkipedia

27

Long Term Clean Up

Source NY Times

28

Criticality Accident-Tokai Mura Japan in 1999

- Irradiation accident resulting from human error.
- Uranium mixing error.
- 119 workers exposed to 1 msV.
- 3 workers were involved.

Source IAEA and Health Physics

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Worker 1

- Lost consciousness a few minutes after the explosion and then began to vomit.
- He recovered consciousness 70 minutes later and had diarrhea.
- He developed acute radiation syndrome.
- Received BMT from sister.
- Died 3 months later.

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Worker 2

- Vomited after an hour.
- Developed acute radiation syndrome.
- Survived almost one year.

Source JAEA

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Worker 3

- Was in an office 10-20 m away.
- Asymptomatic. Only mild nausea.
- Survived.

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Radiological Dispersal Device (RDD)

- Radioactive material
  - Dispersed using explosives (dirty bomb)

    or
  - Dispersed without the use of explosives (Goiania incident)

33

Moscow Park and Market-1995

Source PBS

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Jose Padilla

- Arrested in 2002 in Chicago's O'Hare airport.
- Accused of plotting a terrorist attack in the US.
- Thought to have received dirty bomb detonation instructions in Pakistan.

Source Wikimedia Commons

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"Dirty Bomb"

- Conventional explosive + radioactive material= "dirty bomb".
- High "fear factor" in the press/public.
- Economic toll

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"Dirty Bomb simulation"

- Simulation of long-term contamination due to a cobalt-60 bomb in New York City.
- Cancer deaths due to radiation: Inner ring: One per 100 people Middle ring: One per 1,000 Outer ring: One per 10,000.

Courtesy Federation of American Scientists

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Goiania Incident: RDD

- 1985.
- Abandoned teletherapy clinic.
- 2 thieves and a junkyard owner.
- Material glows at night.

Source IAEA

38

Goiania incident

- 112,000 people were surveyed at the Olympic stadium.

Source IAEA

39

Goiania incident

- 249 found to be contaminated.
- 1 amputation
- 4 Deaths.
- Prussian Blue therapy.
- Evacuations.
- Demolition of homes, etc.

Source IAEA

40

Summary Points

- Radiological and nuclear threats are real.
- Emergency responders are not well prepared to respond.
- Different types of threats exist.

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Any Questions?

42

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1

Session II

Basic Radiation Physics

2

Objectives

- Discuss the difference between ionizing and non-ionizing radiation.
- Describe radioactive decay.
- Discuss the different types of ionizing radiation.

3

Radiation in Pop Culture

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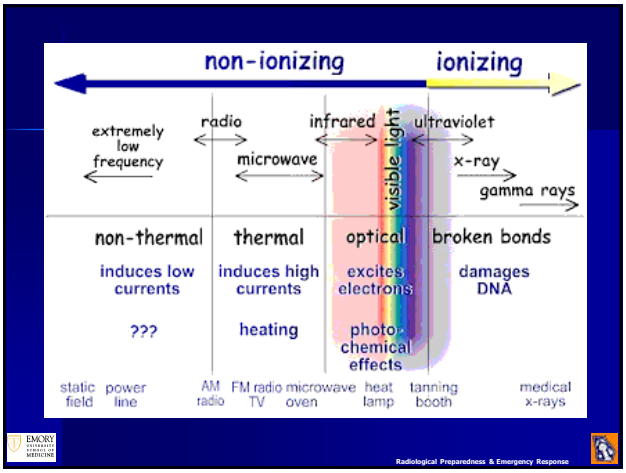

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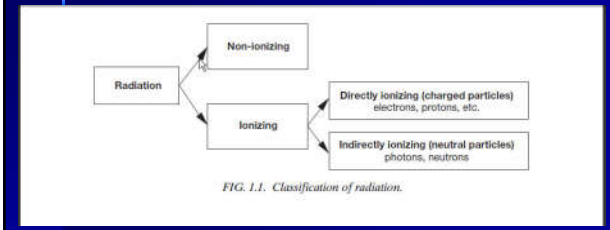
Different Types of Radiation



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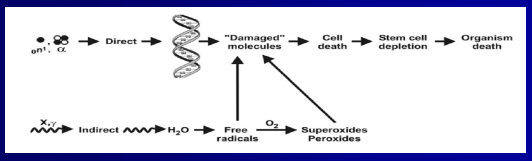
Ionizing Radiation

- Damages DNA.
- Produces free radicals by damaging water molecules.



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Radiation Damage

- Deterministic
  - Threshold dose
  - Local radiation injury
  - Acute radiation syndrome
- Stochastic
  - Random
  - Oncogenesis
  - Teratogenesis

8

Cell Sensitivity

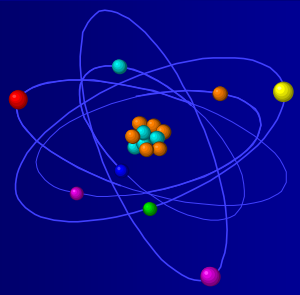
High

Low

- Embryos!!!
- Blood-forming organs (numbers).
- Cancer cells / tumors.
- GI tract.
- Skin (including hair follicles).
- Muscles.
- Central nervous system.

9

What is an Atom Composed Off?



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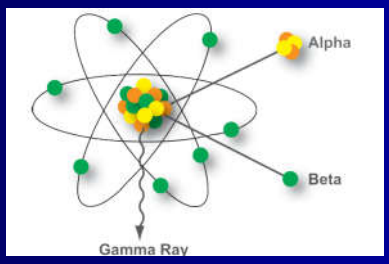
Why do Certain Atoms Emit Radiation and are Radioactive?



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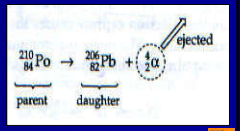
Example of an Alpha Particle Emitter: Polonium-210

- Alpha particles
  - Positively charged, easily stopped by a thin paper, do not present an external hazard.
  - Inhaled/ingested, can result in significant organ damage.

http://www.blackcatsystems.com/science/radprod.html



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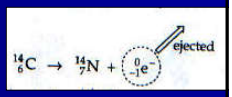
Example of a Beta Particle Emitter: Carbon-14

- Beta particles
  - Negatively charged. electrons, can travel several centimeters through air. Stopped by clothes.
  - If internalized can cause problems.
  - "beta burn".



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Example of a Gamma Ray Emitter: Cesium-137

- Gamma rays
  - Electromagnetic waves.
  - Gamma rays are the same as x-rays -- the difference is their source from within the atom: nuclear for gamma, extranuclear for X-rays.
  - Are a significant hazard (depending on duration of exposure, distance from the source, and type of shielding).

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Example of a Neutron Emitter: Uranium-235

- Neutrons
  - Neutron irradiation can turn previously nonradioactive materials radioactive.
  - Uncharged. Causes whole body irradiation like Gamma rays.
  - Emitted from fission reactions.

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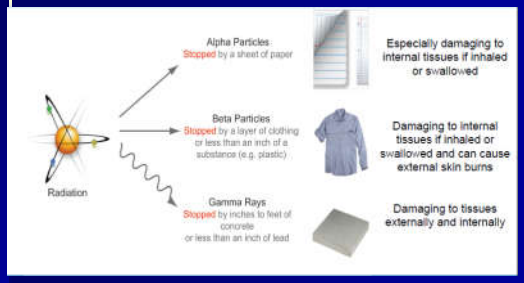
Differences



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CDC Video

17

Radiation Measurement Units

S.I.	Formula	USA
1 Becquerel (Bq)=	$1/3.6x10^{10}$ x	Curie (Ci)
1 Gray (Gy) =	100 x	RAD
1 Sievert (Sv) =	100 x	REM

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Difference Between RAD and REM - Gray and Sievert

- RAD and Gray express the amount of energy deposited per gram of tissue or material.
- REM and Seivert express the health effect from the radiation deposited in a specific organ by a specific type of radiation.
- For gamma rays 1 RAD = 1 REM.

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What is a Radiation Source Activity?

- Activity reflects how radioactive a source is.
- How many disintergrations or decays are occurring every second.
- As time passes, a radioactive source is no longer radioactive.
- The amount of time needed depends on the source radiological half life.

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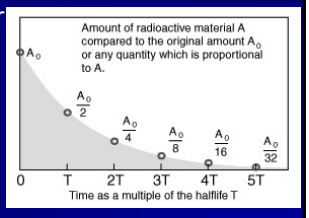
Physical Half Life

- Time required for activity to be reduced by ½
- Specific to each radionuclide
  - I-131 = 8 day
  - Cs-134 = 2 yr
  - Cs-137 = 30 yr



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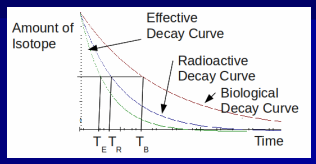
Biological and Effective Half-Life

- Biological: time required for body to eliminate ½ of a particular element
- Effective: combined effect of radioactive decay and physical elimination
- Effective half-life is ALWAYS less than physical or biological half-life



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Where is Radiation Found?

- Natural sources
  - Radon
  - Cosmic rays
- Man-made sources

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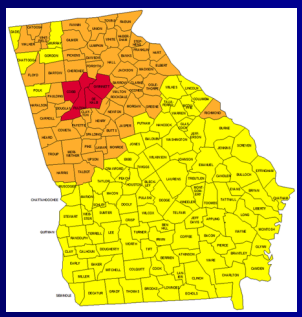
Radon Map Georgia



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Background Radiation

People on Earth Are Exposed to Radiation Every Day of Their Life

In 2006, the average person in the United States received an annual radiation dose of 6.2 milliSieverts

Source of Radiation	Percent Contribution to Total
Radon & thoron (Background)	37
Space (Background)	5
Internal body (Background)	5
Terrestrial (Background)	5
Medical procedures	48
Consumer products	2
Industrial releases	< 1
Occupational	< 1

Source: National Council on Radiation Protection and Measurements Report No. 160 (2009)

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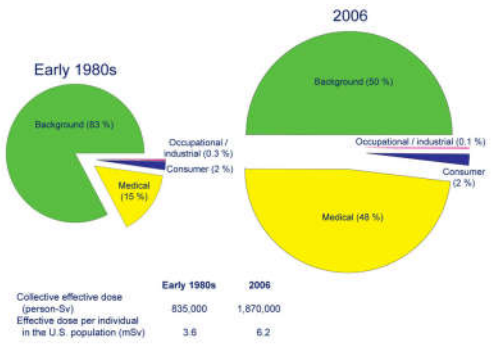
NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States*



	Early 1980s	2006
Collective effective dose (person-Sv)	835,000	1,870,000
Effective dose per individual in the U.S. population (mSv)	3.6	6.2

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ALARA

- "As Low As Reasonably Achievable"
- Work activities in radiation areas must be carefully planned to minimize radiation doses to workers
- Dose to general public kept low
- Control of releases of radioactive materials to the environment

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Summary Points

- Ionizing radiation damages cells and DNA.
- Ionizing radiation includes alpha particles, beta particles, gamma rays and neutrons.
- People are exposed to background radiation at all times.

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Any Questions?

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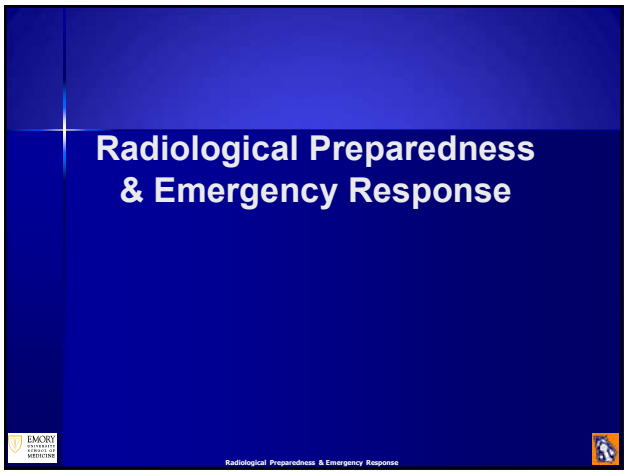
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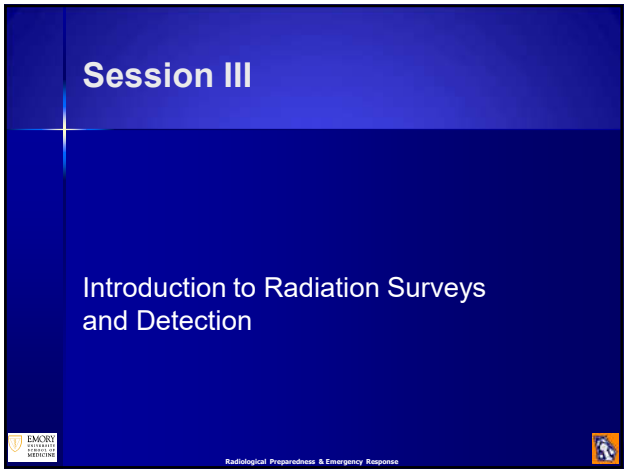
Session III
Introduction to Radiation Surveys and Detection
Radiological Preparedness & Emergency Response

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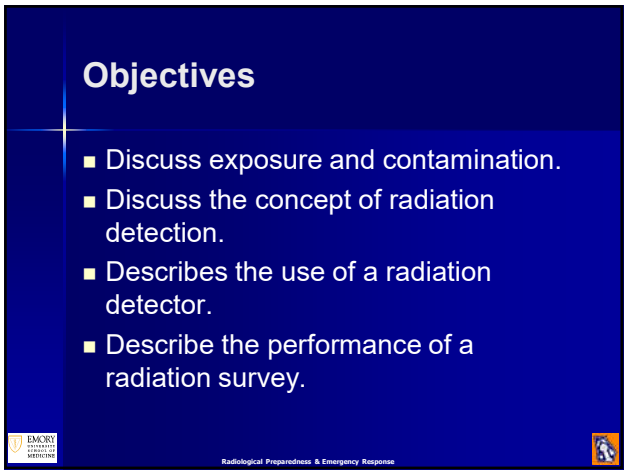
Objectives
Discuss exposure and contamination.
Discuss the concept of radiation detection.
Describes the use of a radiation detector.
Describe the performance of a radiation survey.
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2 Different yet Possible Overlapping Entities

- Exposure
  - Whole body
  - Partial body
- Contamination
  - External
  - Internal

4

Contamination vs. Exposure

- **Exposure**: coming in contact with radioactive waves or particles, e.g., having a chest x-ray
- **Contamination**: deposition of radioactive material in undesired locations

A person can be exposed but not contaminated – think x-ray exams!

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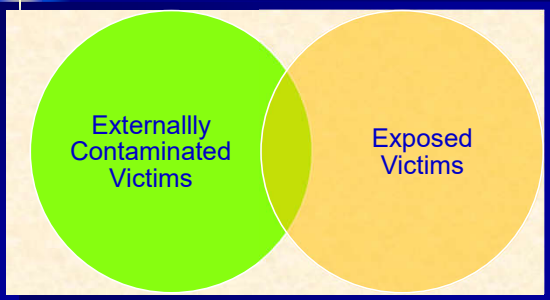
Most Externally Contaminated Patients are Exposed



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All Internally Contaminated Patients are Potentially Exposed

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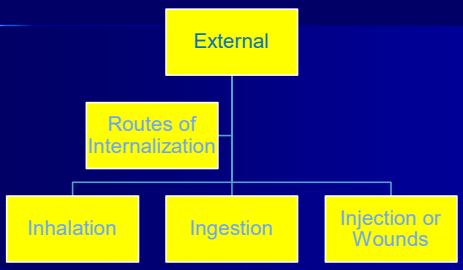
Contamination



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To Explain this Important Concept Better: CDC Video

9

What is a Radiation Detector

- Identifies the presence of radioactive material.
  - Gas-filled
  - Liquid-filled
  - Solid-filled

10

Before Performing a Radiation Survey

- Select your equipment.
- Check your equipment battery.
- Obtain a background reading.

11

Commonly available radiation detectors used for contamination surveys

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Radiation Detection in the ED

- Victims should be surveyed with Geiger-Muller counters.
- Standard G-M cannot detect radiation exposure; they detect external gamma, some beta, and no alpha unless using a specialized alpha probe.
- They can detect internal gamma, less beta, and no alpha regardless of the probe.

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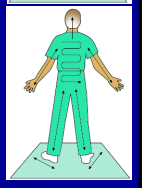
Radiation Survey



- **Survey patient for radiological contamination and mark areas on body diagram.**
- **Remove contaminated clothes and label them.**
- **Except for an instance of highly-radioactive shrapnel, contamination should NOT deter medical staff from treating life-threatening injuries.**

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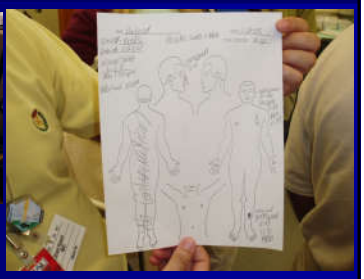
Radiation Survey in the ED and Decontamination



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RadEye B-20ER

16

RadEye G's

17

Radiation Detection

- Pocket dosimeters.
- Film badges.
- Thermoluminescent dosimeters (TLD)

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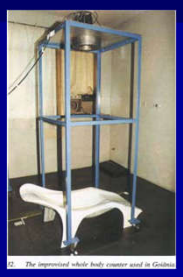
In Vivo Measurements

- Whole body counters.
- Chest counters for Plutonium and Uranium.
- Wound monitoring instruments.



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Portal Monitors

- Gamma detectors.
- Patients walk through the monitor.
- The State of Georgia has 36 of these monitors in health districts – 10 more in counties near nuclear plants.

20

Summary Points

- Radiation is relatively easily detectable.
- There are different types of detectors with a similar operation principle.
- Performing a detection survey is an easy but meticulous step.

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Any Questions?
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Session IV

PPE and Decontamination Principles

2

Scenario

3

Objectives

- Discuss the different types of PPE.
- Describe radiological decontamination.
- Describe chemical decontamination.
- Discuss the differences between different types of decontamination.

4

Ypres, Belgium, during the afternoon of 15 April 1915

- Germans released150 tons of chlorine gas from some 6000 cylinders.
- 800 deaths. But Germans were not ready to take advantage of the British troops retreat.

5

Protective Masks Developed

- Small box respirator developed by the British.
- Placed on mules as well.

6

Various Types

7

Protective Suits

- Scottish soldiers particularly vulnerable to mustard burns.

8

Choosing the Type of PPE

- Can choose PPE necessary for respiratory protection separately from PPE needed for skin protection
- Should use at least the minimum level for each, as appropriate

9

Level A

10

Disadvantages of Level A Suits

- Oxygen source is limited.
- Needs a physically fit person.
- Heat stress.
- Heat stroke.
- Cumbersome.
- Lose manual dexterity.

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Level B

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Firefighters: Flame Retardant Suit

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Level C

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Standard or Universal Precautions

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Decontamination

- Decontamination is the reduction or removal of hazardous materials such as chemical or radiological compounds.
- It can be done by physical removal or chemical neutralization.

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General Principles

- Removal of all clothing can reduce contamination on the patient up to 90%.

17

Radiological Decontamination

- Decontamination should not delay or impede stabilization of any patient contaminated with radiological material.

18

Whole or Partial Body Exposure to Radiation

- A person who was exposed to radiation is like having had an x-ray.
- Decontamination is unnecessary.

19

Secondary Radiological Contamination

- Can occur from:
  - Externally contaminated patients.
  - Internally contaminated patients
    - Can contaminate or expose others from the material inside their bodies.
- The body fluids (blood, sweat, urine) of an internally contaminated person can contain radioactive materials.

20

Historical Incidents

- Goiania, Brazil (1985):
  - Health care workers caring for patients internally contaminated with cesium, were not secondarily exposed or contaminated.

21

Historical Incidents

- London, England
  - 26 health care workers who cared for Mr. Litvinvenko did not get secondarily contaminated with polonium.

22

Potential Hazard

- May occur with a highly radioactive shrapnel.
- In that case, apply Time-Distance-Shielding-Forceps

23

Fundamental Principles of Radiation Protection in whole body exposure

24

The Power of Distance

Distance from Source (Feet)	Radiation Dose (Gy)
2 feet	16
4 feet	4
8 feet	1

Radiological Preparedness & Emergency Response

25

Recommended PPE- Radiological Victims

Radiological Preparedness & Emergency Response

26

Radiological Preparedness & Emergency Response

27

OSHA Recommendation for Hospital-Based Decon

- Level C
- Is it realistic in an a mass casualty incident?
- Is it necessary?

28

Level C in Tokai Mura Japan

29

Double Glove!

30

External Screening Survey

- To determine if a patient is contaminated with radiological material
- May be performed if not done yet.

31

Cut Away from the Head

32

33

Roll Clothes Inwards

34

Remove Clothes by Rolling them into a Sheet

35

36

Survey the Back

37

Store Clothes in Bag and Store it Away from Patient

38

Remember

- Label bag with date, patient name, time, and name of staff.
- Store away from patient in a designated area.
- Work with your RSO.

39

Radiological Decontamination

- Paired with radiological survey.
- Draping.
- Soap and Water.
- Out to In.
- Targeted.
- Meticulous.

Radiological Preparedness & Emergency Response

40

Draping




adiological Preparedness & Emergency Response

41

Targeted

- Soap and water
- Decontamination should proceed in a centrifugal manner

42

Meticulous

43

Check the Radiation Counts

- Try to maintain the same location for the probe when reading the counts

44

Radiation detection

- Excreta or swabs from the victims should be collected and labeled.

45

When to Stop

- The activity is less than twice the average background activity.
- Decontamination efforts do not substantially reduce the activity.
- Skin is being abraded.

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46

Survey Staff

- Perform staff survey and decontamination if necessary.
- Use step off pad.

47

Chemical Decontamination

- Hazards to staff dictate decontamination prior to caring for victims with life threatening conditions.

Radiological Preparedness & Emergency Response

48

Water Disposal

- In a small event, collection into a separate drainage and storage system is feasible.
- In large mass casualty events, collection of waste effluent may not be easy.
- Control it to the best extent possible.

49

Remember Commonly Ignored Areas During decontamination

- Scalp
- Genitalia
- Skin creases & folds
- Hands
- Feet
- Nails

50

Wound Decontamination

- Wounds need to be assessed for foreign bodies as well as underlying injuries.
- Wound care needs to be balanced against contamination.
  - What is in there? How much is in there?

51

Summary Points

- Radioactive contamination is easy to detect.
- Chemical contamination may be difficult to detect.
- Provision of life-saving treatment should take priority over radiological decontamination.

52

Summary Points

- Provision of life-saving treatment does not take priority over chemical decontamination.
- Radiological decontamination is paired with a radiation survey.
- Soap and water are sufficient for decontamination.

53

Any Questions?

54

Radiological Preparedness & Emergency Response

1

Session V

Clinical Evaluation and Management of Internal Contamination

2

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.

3

Clinical Consequences of Internal Contamination

- Acute and subacute
  - End organ damage
  - Acute Radiation Syndrome
  - Multiorgan failure
- Chronic
  - Solid tumors
  - Leukemias

4

Radionuclides of Concern

- Transuranics
- Cesium-137
- Strontium
- Cobalt-60
- Polonium-210

5

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.

6

In Vivo Measurements

- Whole body counters.
- Chest counters for Plutonium and Uranium.
- Wound monitoring instruments.

7

Diagnosis By Excretion (Bioassay) Sampling

- Collect urine or feces to measure excretion rates.
- Challenging interpretation
  - Time when contaminationoccured
  - Charcteristics of inhaled or internalized radionuclides

8

Management Strategies

- Supportive care.
- Decreasing absorption.
- Decorporation and enhanced elimination.
- Long term monitoring.

REAC/TS Should be Contacted for Assistance

9

Internal Contamination

Radionuclide	Medication
Iodine	KI (potassium iodide)
Transuranics such as Plutonium & Americium	Zn-DTPA Ca-DTPA
Uranium	Bicarbonate
Cesium Rubidium Thallium	Prussian Blue* [Ferrihexacyano- Ferrate (II)]
Tritium	Water

10

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.

11

DTPA Treatment of ^{239}Pu

Retention (% of Uptake)	Control	Treated with DTPA
Liver	14.0	0.47
Skeleton	57.0	5.9

12

DTPA decorporation of ^{239}Pu (in rats): Decline in efficacy with delay to treatment

	Radioactivity as Percent of Control	
Time to treatment	Liver	Skeleton
1, 24, 48 hours	7	10
7 - 11 days	22	46

from Catsch, 1964

13

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 interruts enterohepatic circulation.

14

Cesium-137

Table 2: Cesium-137 Effective Half-life During and After Treatment with Insoluble Prussian blue
(In Days, by Age, and Dose of Insoluble Prussian blue)

Group	Age (Years)	Insoluble Prussian blue dose (grams/day)	No. of Pts.	During Insoluble Prussian blue Treatment - ^{137}Cs $T_{1/2}$	Off Insoluble Prussian blue Treatment - ^{137}Cs $T_{1/2}$
Adults	> 18	10	5	26 ± 6 days	80 ± 15 days (all 21 adult patients)
Adults	> 18	6	10	25 ± 15 days	
Adults	> 18	3	6	25 ± 9 days	
Adolescents	12 -14	< 10	5	30 ± 12 days	62 ± 14 days
Children	4 - 9	< 3	7	24 ± 3 days	42 ± 4 days

Half life decreased between 43 & 60%
PB treatment inverts the feces/urine 137Cs ratio for 1:4 to 4:1

15

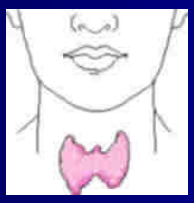
Radiogardase®

- 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.

16

Radioactive Iodine Exposure

- Iodine Prophylaxis and Treatment
  - Potassium iodide (KI) is an effective, inexpensive thyroid-blocking agent.



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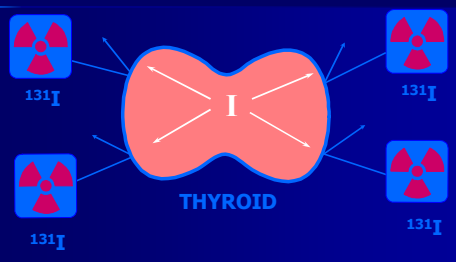
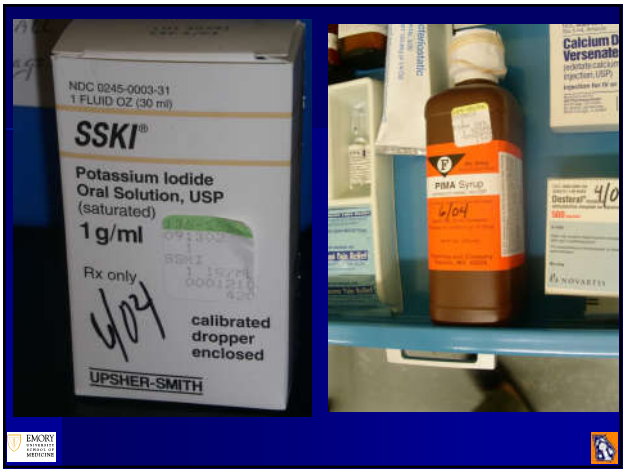
Radioactive Iodine Exposure



Saturate the Critical Organ with the Stable Isotope

18



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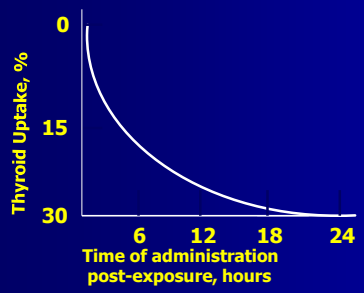
Efficacy of KI is time dependent



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Dose depends on age, special considerations (pregnant, lactating), and dose to thyroid gland.

TABLE 12.14—*Threshold thyroid radiation doses and recommended doses of KI for different risk groups (adapted from FDA, 2001).*[a]

Age Category	Predicted Absorbed Dose to the Thyroid (Gy (rad))[b]	KI Dose (mg)[c]	Number of 130 mg Tablets	Number of 65 mg Tablets	KI Solution 65 mg mL^{-1} (mL)
Adults >40 y	≥5 (500)	130	1	2	
Adults 18 – 40 y	≥0.1 (10)	130	1	2	
Pregnant or lactating women	≥0.05 (5)	130	1	2	
Adolescents 12 – 18 y[c]	≥0.05 (5)	65	0.5	1	1
Children 3 – 12 y	≥0.05 (5)	65	0.5	1	1
1 month – 3 y	≥0.05 (5)	32	0.25	0.5	0.5
Birth – 1 month	≥0.05 (5)	16	0.125	0.25	0.25

[a]The protective effect of KI lasts ~24 h. For optimal prophylaxis, KI should therefore be administered daily, until a risk of significant exposure to radioiodines by either inhalation or ingestion no longer exists.
[b]Without KI treatment.
[c]Adolescents approaching adult size (>70 kg) should receive the full adult dose (130 mg).

21

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.

22

Psychological Impacts

23

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.

24

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25

Main Issues

- Food and water contamination concerns.
- Patients may become volatile and agitated.

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26

Shelter-in-Place or Evacuation

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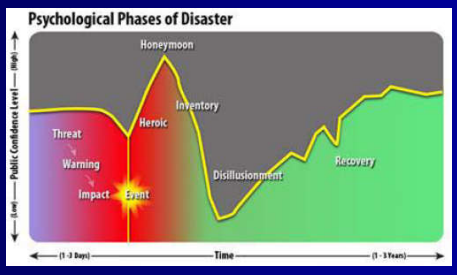
27

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.

28

Different Phases



29

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.

30


Any Questions?
Radiological Preparedness & Emergency Response

31

Radiological Preparedness & Emergency Response

1

Session VI

Clinical Evaluation of Acute and Subacute Radiation Injuries 2

2

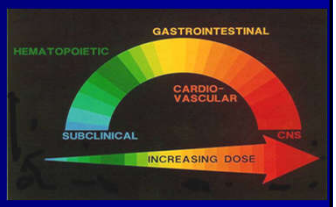
Objectives

- Discuss the diagnosis of acute radiation syndrome (ARS).
- Describe the management of ARS.
- Discuss the Cutaneous Radiation Syndrome (CRS) and Local Radiation Injury.
- Describe the management of CRS.

3

Acute Radiation Syndrome (ARS)

- Deterministic effect.
- Prodrome phase.
- Hematopoetic syndrome.
- Gastrointestinal syndrome.
- CV/CNS syndrome.



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Prodrome

- Vague Sx: nausea, vomiting, headache.
- Help predict the dose: the higher the absorbed dose the earlier and the more frequent the Sx occur.

Dose Estimate	Victims with Vomiting	Time to Onset of Vomiting
Gy	%	*h*
0	–	–
1	19	
2	35	4.63
3	54	2.62
4	72	1.74
5	86	1.27
6	94	0.99
7	98	0.79
8	99	0.66
9	100	0.56

2004 Annals of Internal Medicine Volume 140 • Number 12

5

Time to Vomiting:

- Patients experiencing a time to vomiting less than 4 hours after their exposure should receive immediate medical care, and those that vomit in less than 1 hour often die.
- Patients who vomit after 4 hours will require less urgent care.

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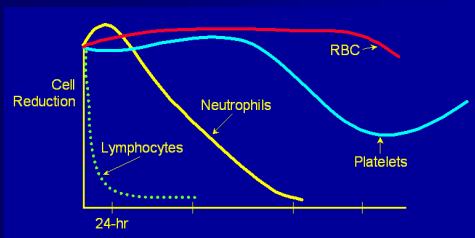
6

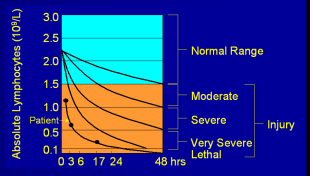
Hematopoetic Syndrome (2-6 Gy)



7

Lymphocyte Depletion Kinetics

- Andrew's nomogram helps estimate the dose of radiation.
- WBC with differential every 6 hrs for first 24-48 hours.



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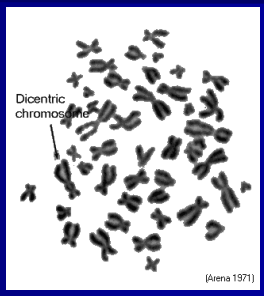
Cytogenetics

- Rate of dicentric chromosomes in peripheral lymphocytes.
- Available at REAC/TS and AFRRI
- Takes up to a week.



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Management of the Hematopoetic Syndrome

- Complications: infection and bleeding.
- Treatment is primarily supportive:
  - Reverse isolation
  - IVF
  - Blood products (irradiated)
  - Antibiotics before the onset of fever
  - Colony stimulating factors such as filgrastim or G-CSF (300 mcg s/c per day)
    - GM-CSF and peg-G-CSF
  - Stem cell transplant for severe cases (save early blood sample)

10

ARS: Gastrointestinal Syndrome

- Dose > 800 rads (8 Gy).
- Vomiting, diarrhea, hemorrhage and CV collapse.
- Treatment is supportive.
- Analgesia, antiemetics, IVF.
- Prognosis is bad.

11

ARS: CV/CNS Syndrome

- Dose > 2,000 rads (20 Gy).
- Cerebral edema, coma and death.
- Treatment is palliative.
- Prognosis is very poor.

12

Scenario from Grady Hospital

- Male patient presents with
- He denies any thermal or electrical injury.
- Works as a Janitor at GA Tech.
- Time of onset is uncertain.

Schwartz M, Morgan B. Response to a Suspected Victim of a Weapon of Mass Destruction, Clin Tox September 2000;38,No. 5:577

13

Local Radiation Injury/Cutaneous Radiation Syndrome

- Deterministic effect.
- Burn that occurs with or without systemic manifestations including immune dysfuction.
- Complications may be delayed and secondary to vascular insufficiency, multiorgan malfunction and sepsis.
- Management includes analgesia, early surgical grafting, topical steroids and prophylactic antibiotics.
- Hyperbaric oxygen therapy has had mixed reviews.

14

Local Radiation Injury/CRS

- May be divided into several types:
  - Erythema
  - Epilation
  - Dry desquamation
  - Wet desquamation
  - Necrosis

15

Worker in Gilan, Iran-1996

- Worker at a fossil fuel plant found a loose iridium radiography source on the ground and placed it in his right breast pocket for 1.5 hrs.
- He removed it due to dizziness, lethargy, burning feeling in the chest, and nausea.

16

Erythema

- Manifests at different stages.
- If dose is 3 Gy, then onset at 3 weeks.
- If dose is 6 Gy, then onset at 24-48 hours. It then disappears to reappear days later.

17

PHOTO 2. Dark erythema with dry desquamation starting at the nipple on Day 12.

Start of reddening of the right side of the chest and upper abdomen on Day 6.

Source IAEA

18

Epilation

- Body hair loss.
- Dose > 3 Gy.
- Takes 2-3 weeks to develop.

19

Dry Desquamation

- Dryness or peeling of the skin.
- Dose > 10 Gy.
- Time to expression 2 to 4 weeks.

PHOTO 2. Dark erythema with dry desquamation starting at the nipple on Day 12.

20

Moist Desquamation

- Blisters.
- Dose 15-25 Gy.
- Occurs between 2-8 weeks.

28. Large bulla on palmar surface of the hand. Note wet desquamation.

Pt from Goiania Incident (IAEA)

21

Moist Desquamation

22

PHOTO 7. Moist desquamation on the medial side of the right antecubital fossa on Day 25.

PHOTO 4. Erythema and tense bulla in the left palm on Day 19.

23

PHOTO 15. Moist desquamation on the left palm on Day 35.

24

Necrosis

- Dose > 50 Gy.
- Occurs from days to weeks.

TO 5. Necrosis of the epidermis on Day 15 (the white spots refer to silver ointment).

25

PHOTO 6. Loss of epidermis on the right side of the chest on Day 25.

PHOTO 13. Re-epithelialization from the edges of the chest lesion on Day 35.

26

PHOTO 17. Chest graft (made on Day 63) well taken on Day 85.

27

PHOTO 19. Self-healed hand lesion without functional impairment on Day 85.

28

21. Fully vitalized graft on the chest and a small fissure below it in September 1997.

Right retraction of the body to the right side due to the fibrotic chest graft in 97.

29

Helpful Resources

30

REMM Website

- Radiation Emergency Medical Management.
- *www.**remm**.nlm.gov*

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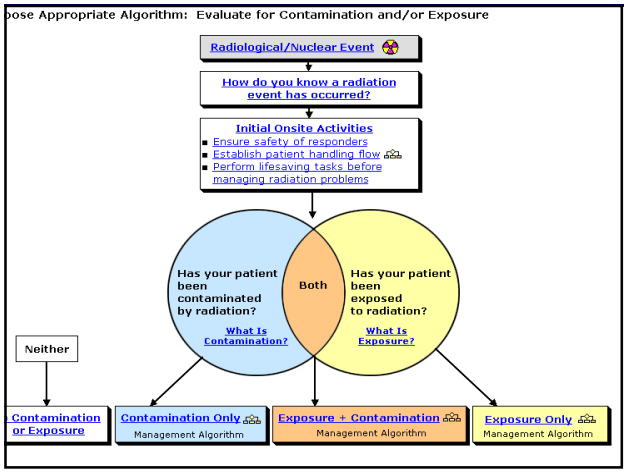

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CDC Radiation Studies Branch

- www.emergency.cdc.gov/radiation
- Fact Sheets
- Tool Kits
- Virtual CRC

Radiological Preparedness & Emergency Response

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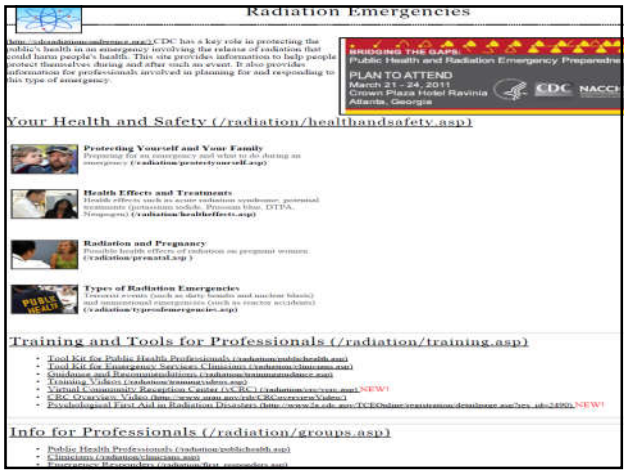

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REAC/TS

- Radiation Emergency Assistance Center/Training Site
- *orise.orau.gov/**reacts***

35

Summary Points

- ARS consists of a prodrome and 3 sub-syndromes.
- The hematopoetic syndrome is survivable.
- The onset of vomiting and serial absolute lymphocyte counts can assist in triage of victims.
- The cutaneous radiation syndrome is delayed in onset.
- Supportive care is key.

36


Any Questions?
Radiological Preparedness & Emergency Response

37

Radiological Preparedness & Emergency Response

1

Special Session

Table Top Exercise

2

EXERCISE PROCEDURES

Situation Update

1. Scenario advances
2. Questions

Group Reaction

3. Participants brainstorm independently or discuss questions openly (5 min.)

Group Discussion

4. Participants respond individually or collectively through appropriate agent (15 min.)
   Each group will identify a spokesperson

3

Divide the audience into 2 groups:

- Prehospital:
  - Fire , EMS, Hazmat and Police
- Hospital
  - Nurses, Physicians, Administrators, Social Services, Mental Health and Security

4

EXERCISE PROCEDURES

Ground Rules

Assume that the information you are given is accurate and that scenario events directly impact your position

You are playing yourself but you'll need to think outside normal role

Keep criticism constructive

Promote maximum group interaction

PARTICIPATE !!
(no wrong answers … only better ones … that's why we're here)

5

QUESTIONS BEFORE EXERCISE BEGINS…

6

Stadium Video

7

What PPE will Responders Don?

- Standard Precautions
- Respirators? Level C?

8

What Triage System will you Use?

- START
- SALT

9

Any Special Triage Considerations with Radiation?

- Time of onset of vomiting.
- Other manifestations:
  - Diarrhea
  - LOC

10

Will you Transport Victims in the Ambulance?

- Victims will be transported in ambulances.
- Scene decontamination may be performed.
- If decontamination is not performed, clothes removal and or wrapping the patient in a sheet is sufficient.

11

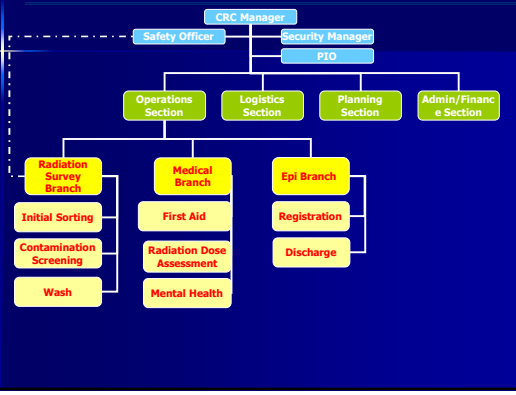
Situation Update

- You are now at the local Community Reception Center (CRC).
- Several people have arrived requesting to be evaluated.

Please Refer to the CRC Chart in Manual

12

CRC ICS Chart



13

What PPE Should the CRC Staff Use?

- Level D or Standard Precautions

14

What are Initial Sorting Issues and Components that Need to be Addressed?

15

Initial Sorting Staff Identify People Who:

1- Have an urgent medical need.
2- Are highly contaminated.
3- Require special assistance.
4- Have showered or been decontaminated before coming to the reception center.

16

Victim 1: Peter Fines

- 55 yo male who was outside the stadium in the outdoor parking lot explosion.
- He has no complaints but wants to know if he was injured by radiation.
- He has not showered and has not been decontaminated.
- Vital Signs: Stable
- Exam: No obvious injuries.

17

What Should be Done to this Person?

- Contamination Screening
- Screening shows that he is not contaminated. What is the next step?
- Registration and Discharge. Consider mental health screening.

18

Victim 2: Mary Hurt

- 45 yo female who was inside the stadium when the explosion occurred. She walked out on her own.
- She has shortness of breath and right arm pain.
- She has not showered and has not been decontaminated.

19

Victim 2: Mary Hurt

- Vital Signs: HR 125 bpm, SBP 100mm of Hg, RR 25/min
- Exam: Deformed RUE with gaping wound. Chest wall pain and crepitus.

20

What should be your Next Step?

- Transport to First Aid Station.
- Transport to ED immediately.
- May remove clothes if time permits
- If stable, may perform contamination screening and decontamination prior to transport.

21

Victim 3: Anguish Williams

- 25 yo female who was outside the stadium when the explosion occurred.
- She has throat tightness and feels the world is closing in on her.
- She has showered after the incident and has not been decontaminated.
- Vital Signs: Stable.
- Exam: No obvious injuries.

22

What Should be Done to this Person?

- Contamination Screening
- Screening shows that he is not contaminated. What is the next step?
- Registration and Discharge.
- Mental health counseling.

23

Victim 4: Paul Rubbles

- 25 yo male who was inside the stadium when the explosion occurred.
- He complains of a minor headache and nausea. He vomited twice, 3 hours after the explosion.
- He has not showered after the incident and has not been decontaminated.
- Vital Signs: Stable.
- Exam: No obvious injuries.

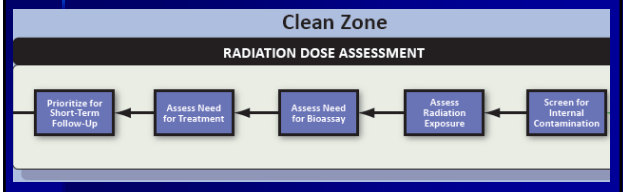
24

What is your Next Step?

- Contamination Screening.
- She is found to be contaminated. What is next?
- Decontamination step (clothes removal and shower).
- The patient is no longer contaminated. What is the next step?

25

What is your Next Step?



26

Scenario Update: You are now in the ED.

27

You are Expecting to Receive Several Victims by EMS:

- What steps do you need to take in preparation?

28

Preparatory Steps

- Decontamination set up.
- PPE.
- Radiation Safety Officer.
- Radiation detector.
- Radiation Emergency Area.
- Diagnostics and Therapeutics.

29

How do you Care for the Following Victims?

30

Victim 1: Janet Blue

- 25 yo female patient with an open right leg fracture and cough.
- VS: Stable.
- What do you do in the radiation emergency area?

31

Radiation Emergency Area (REA)

- Remove clothes.
- Radiation survey.
- Survey shows radiation over open fracture wound and face.

32

Decontamination

- Soap and water.
- Face and wound.
- Repeat survey, stop when indicated.
- What do you do next?

33

Assess for Internal Contamination

- Nasal swab?
- Bioassays (urine, feces).
- In vivo testing.

- What else do you need to do?
- Assess for exposure.

34

The patient Vomited 3 hours after the Explosion.

- The patient may develop the hematopoetic syndrome.

- What blood tests do you perform?
- CBC with differential every 4-6 hours.

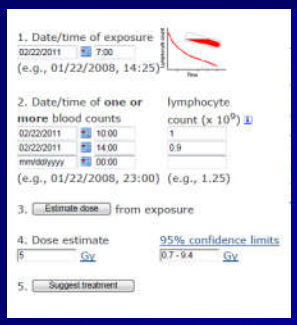
35

Cell Counts

	T1=3 hours after explosion	T2=7 hours after explosion
WBCC x10^9	4	3.6
Lymphocytes (%)	25	25
Absolute Lymphocyte Count	1	0.9

36

Using REMM Tool



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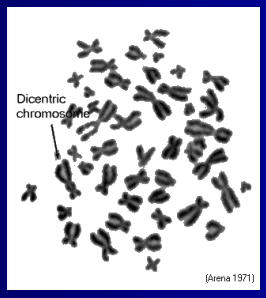
What Additional Test Can you Obtain a Few Days Later?



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What Therapies Are Recommended?

- G-CSF
- Antibiotics
- Antivirals
- Antigfungals
- Neutropenic precautions
- Stem cell transplant
- Early surgery

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You Are Informed the Patient is Internally Contaminated with Cesium-137

- What therapy do you need?

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What if it was Plutonium?

- Calcium or Zinc DTPA

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Thank you for your time!

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