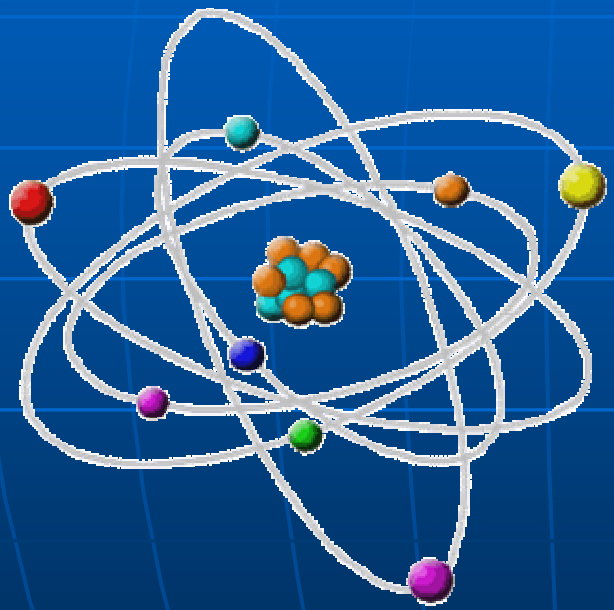
Possible Scenarios

- Nuclear power plant incident
- Hidden source
- “Dirty bomb”
- Improvised nuclear device
- Nuclear weapon

Hypothetical Suitcase Bomb

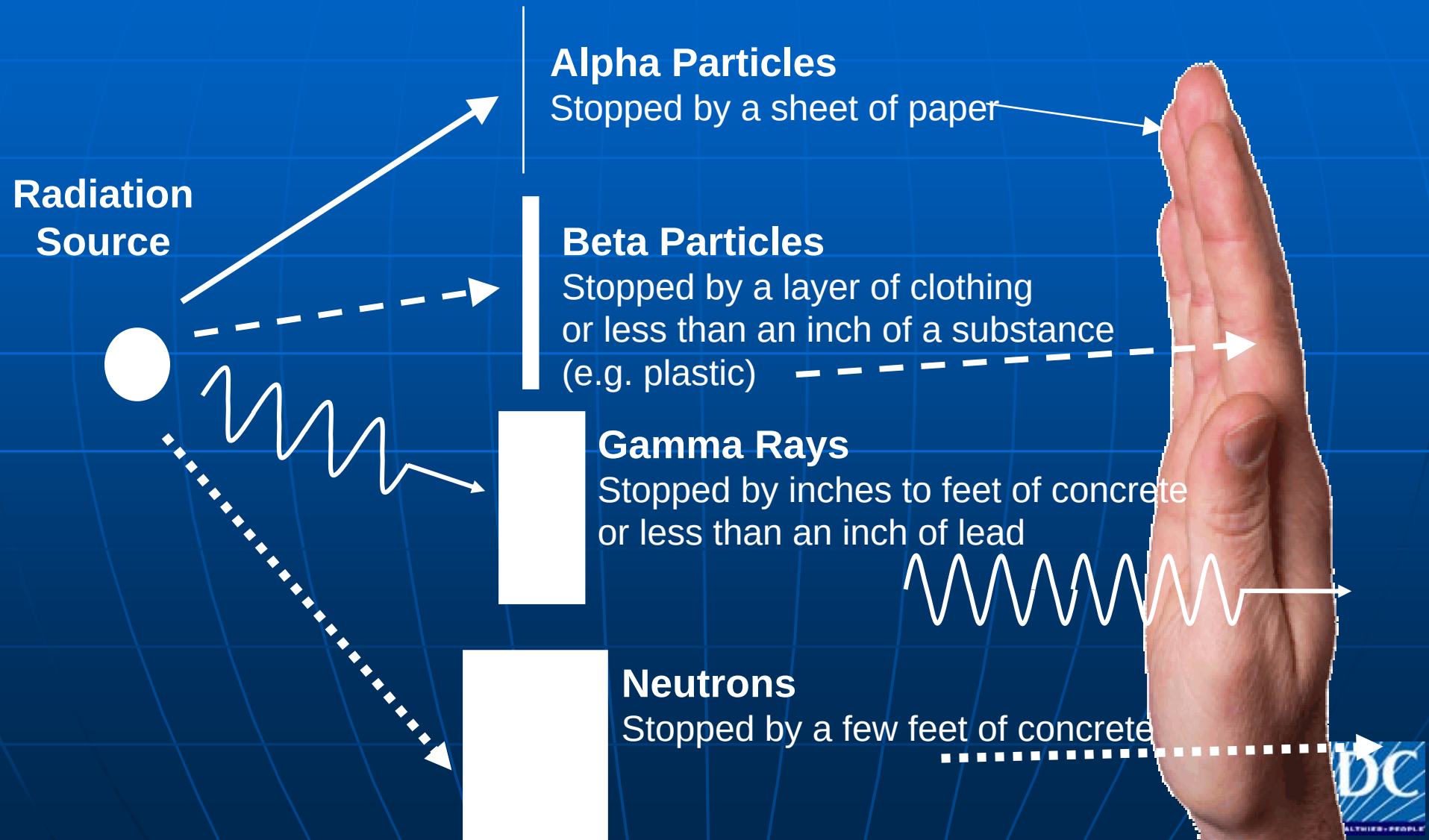
Chairman Dan Burton Committee – Demonstration of example "suitcase nuke" made from US nuclear shell

What is Radiation?



Radiation is energy transported in the form of particles or waves.

Penetration Abilities of Different Types of Radiation



Detecting Radiation

Alpha Survey Meter

Beta and Gamma Survey Meter

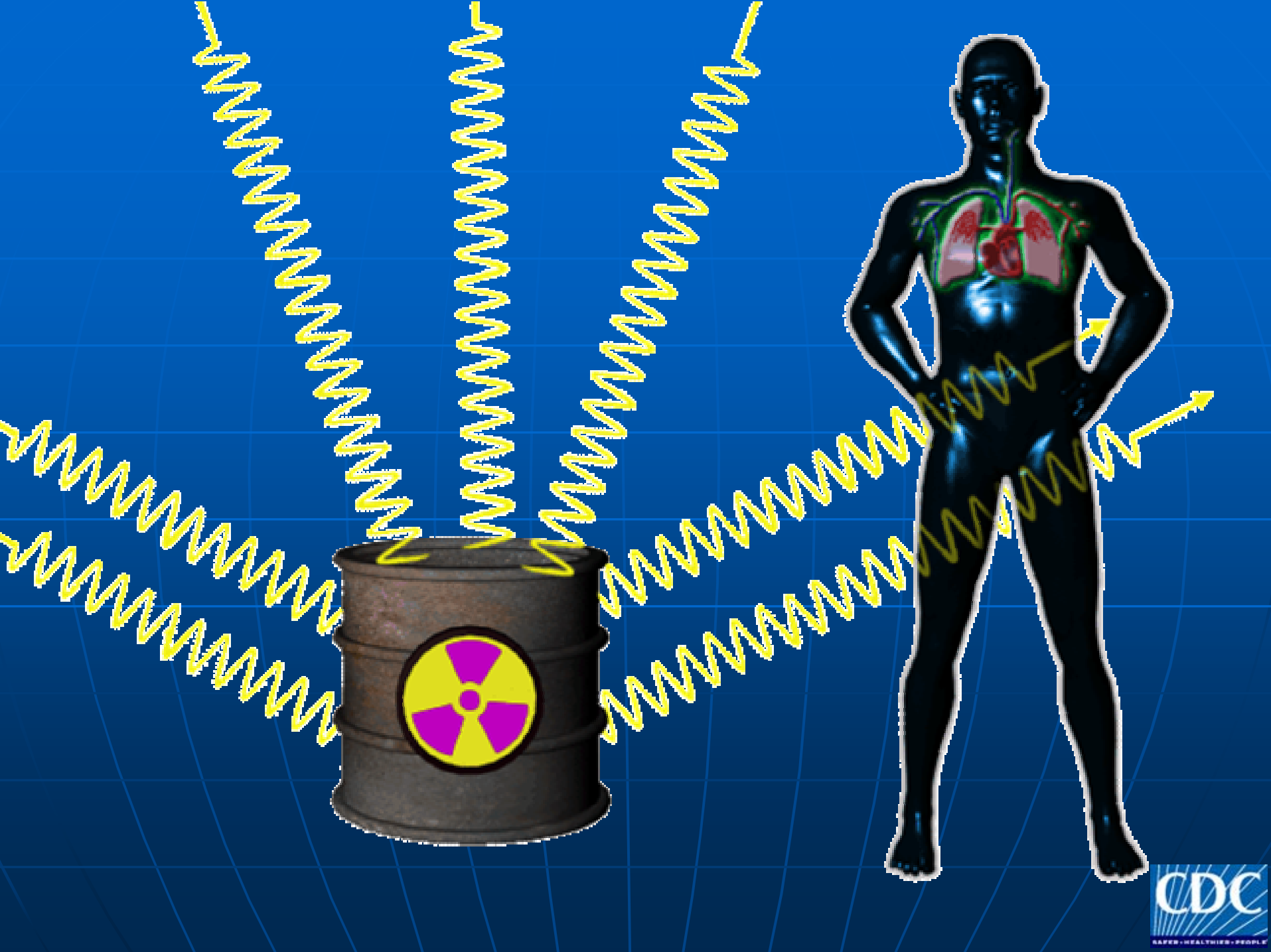
Radiation vs. Radioactive Material

- Radiation: energy transported in the form of particles or waves (alpha, beta, gamma, neutrons)
- Radioactive Material: material that contains atoms that emit radiation spontaneously

Exposure vs. Contamination

Exposure: irradiation of the body → absorbed dose (Gray, rad)

Contamination: radioactive material on patient (external)or within patient (internal)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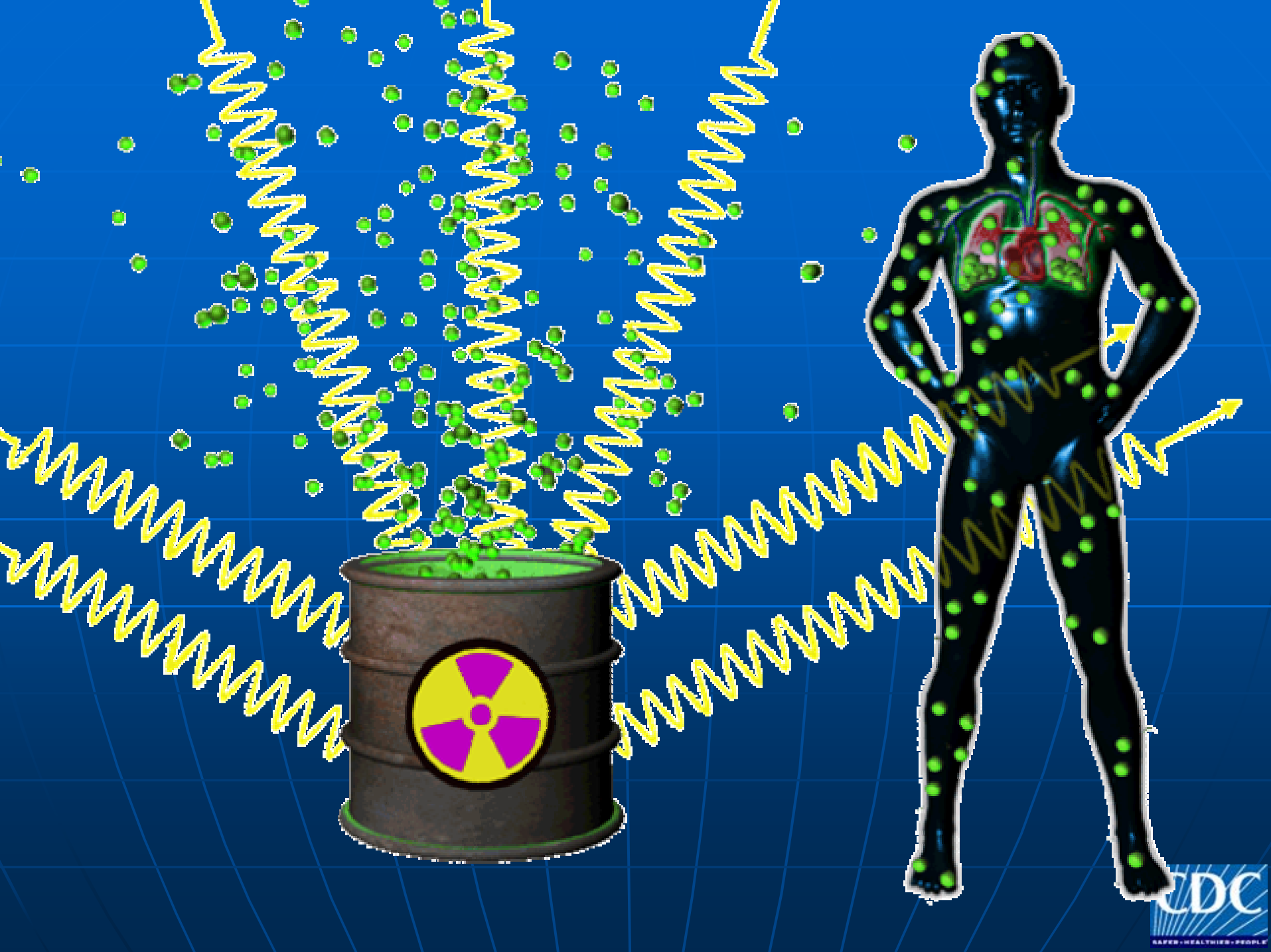
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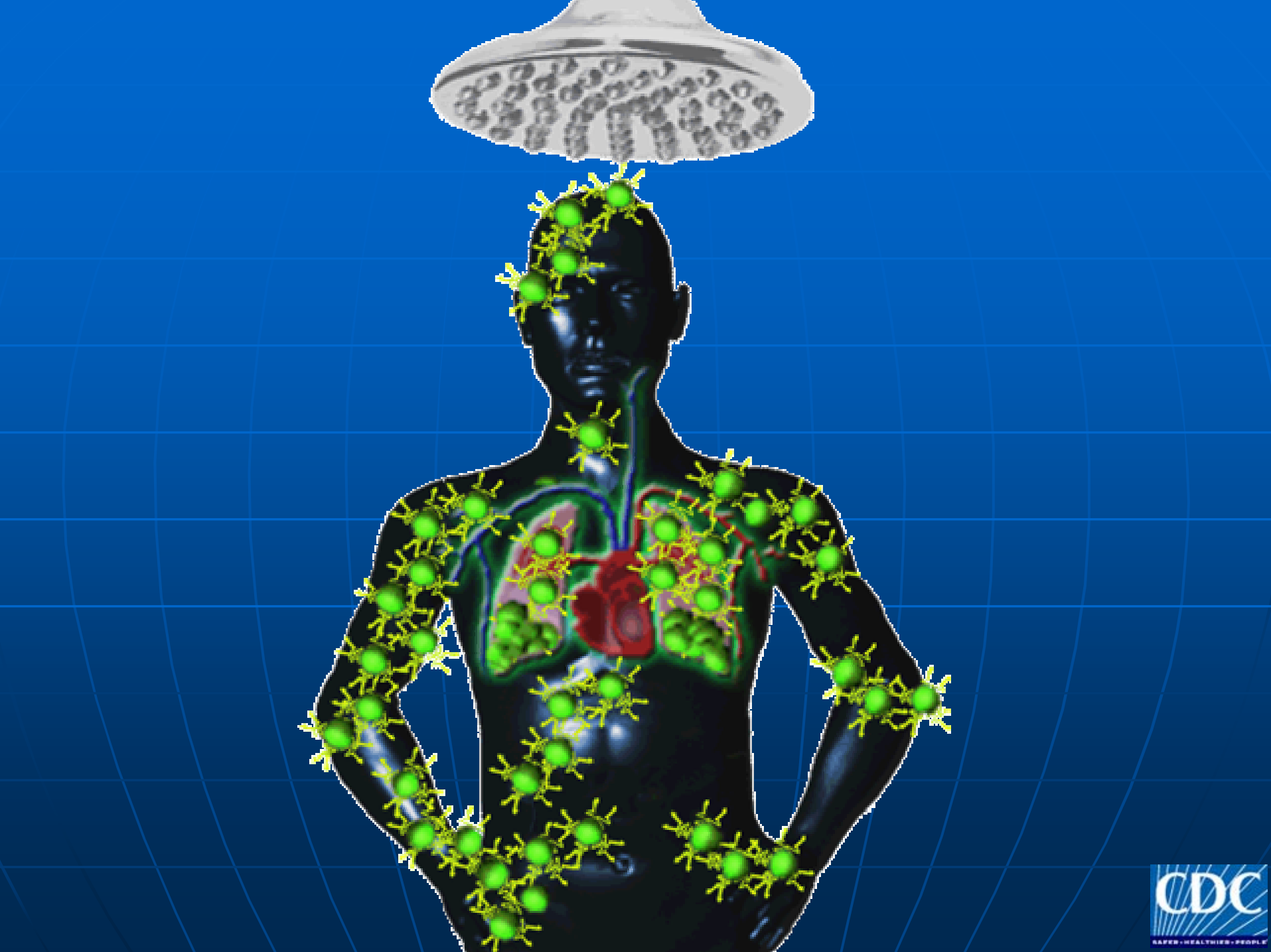
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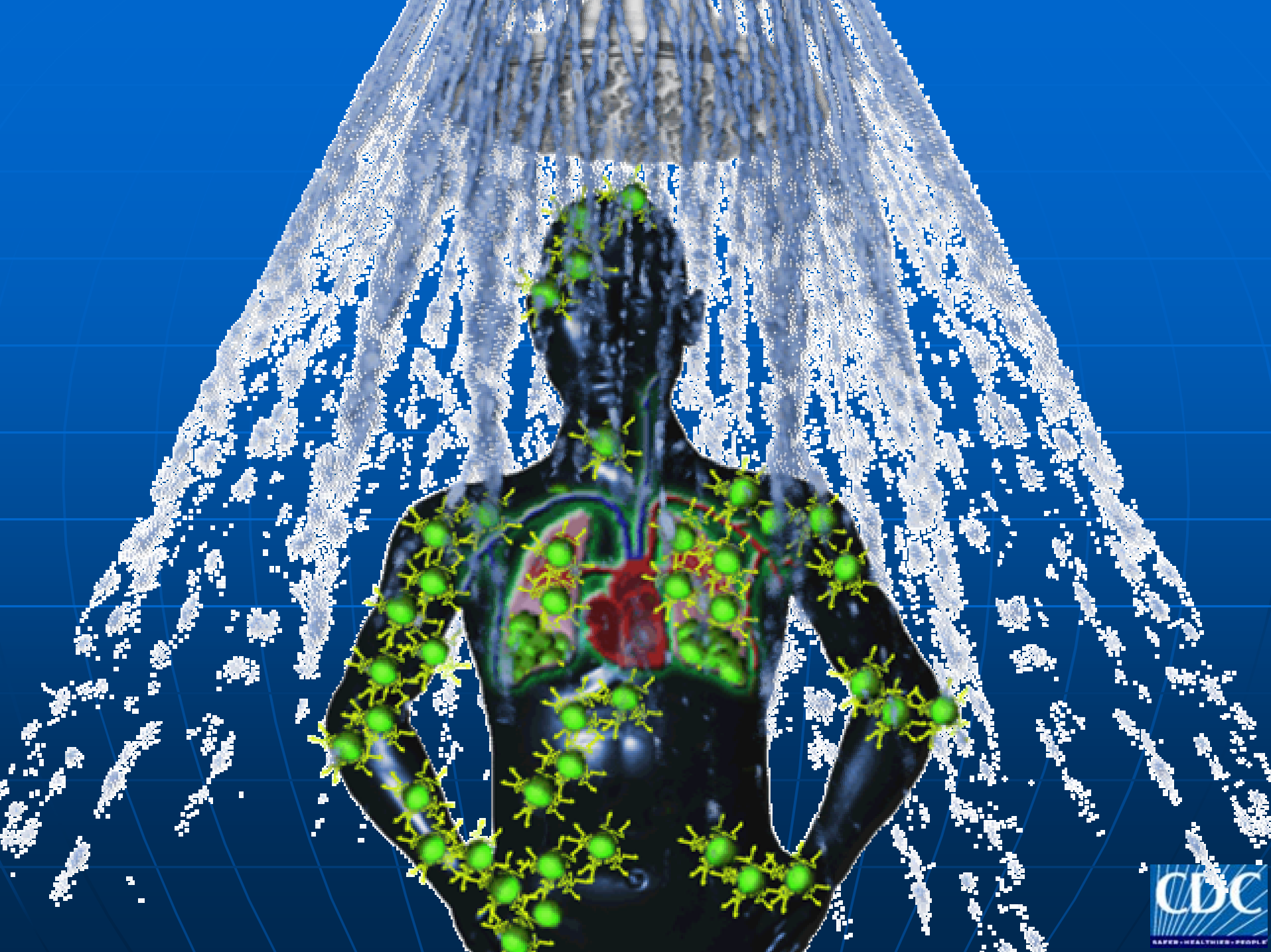

CDC

Consult with Radiation Experts

- Radiation Safety Officer
- Health Physicist
- Medical Physicist
- Conference of Radiation Control Program Directors (www.crcpd.org)

Consult with Radiation Experts

- Determining/documenting presence of radioactivity, activity levels, and radiation dose
- Collecting samples to document contamination
- Assisting in decontamination procedures
- Disposing of radioactive waste

Injuries Associated with Radiological Incidents

- Acute Radiation Syndrome (ARS)
- Localized radiation injuries/ cutaneous radiation syndrome
- Internal or external contamination
- Combined radiation injuries with
  - Trauma
  - Burns
- Fetal effects

Psychological Casualties

- Terrorist acts perceived as very threatening
- Large numbers of concerned with no apparent injuries
- Mental health professionals should be included

For more information on radiation exposure and pregnancy

www.bt.cdc.gov/radiation/prenatalphysician.asp

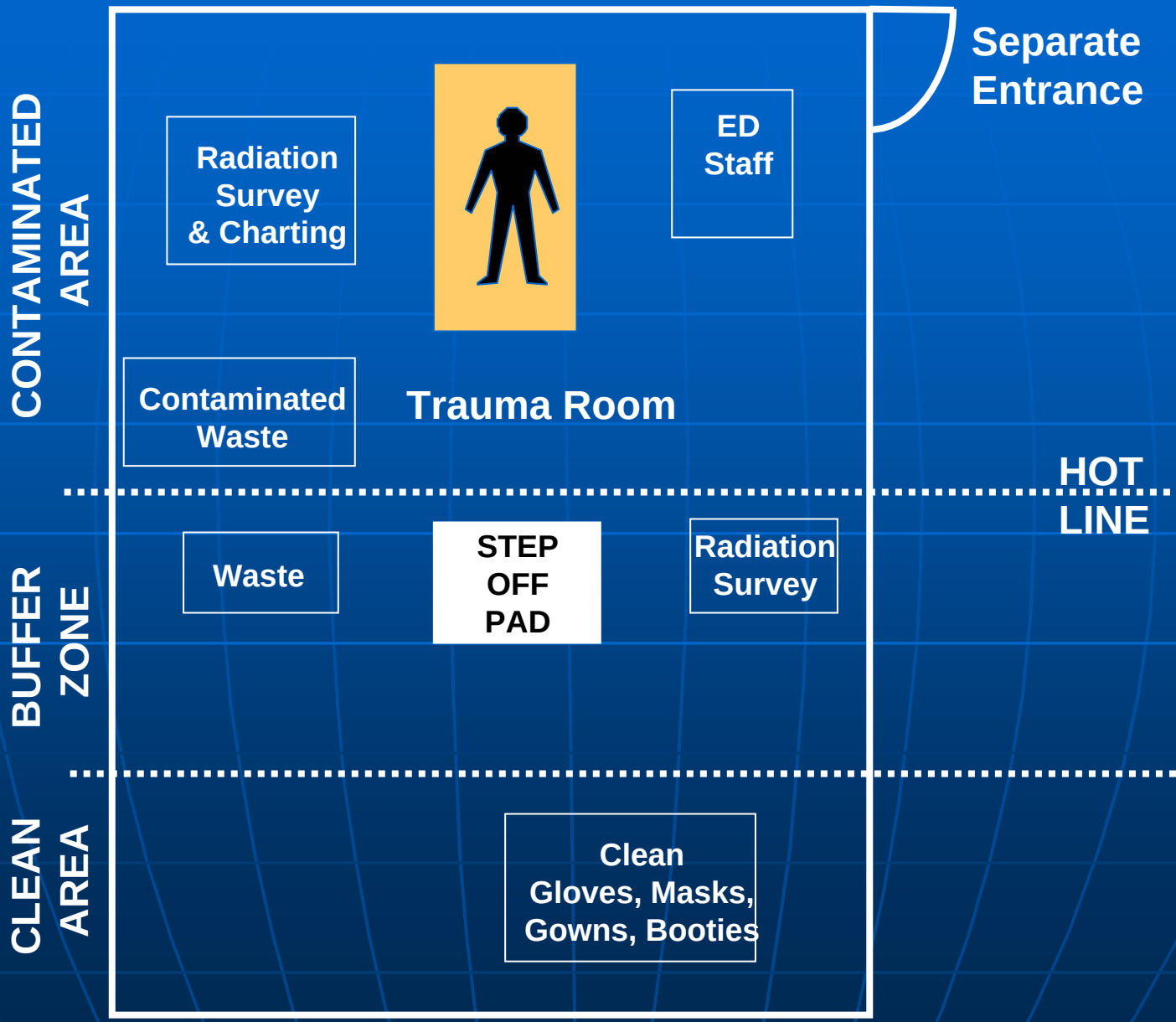
Radiation Protection for Clinical Staff

- Fundamental Principles
  - Time
  - Distance
  - Shielding
- Personnel Protective Equipment
- Contamination Control

Protecting Staff from Contamination

- Use standard precautions (N95 mask if available)
- Survey hands and clothing frequently
- Replace contaminated gloves or clothing
- Keep the work area free of contamination

Contamination Control



Pregnant Staff

- NRC limit for pregnant workers is 5 mGy (0.5 rad)
- Pregnant staff should be reassigned
- CDC prenatal radiation exposure fact sheet:
  www.bt.cdc.gov/radiation/prenatalphysician.asp

Dealing With Staff Stress

Preplanning

- Establish information center
- Train staff on radiation basics

Post Event

- Debrief immediately after event
- Offer Counseling

1986 Chernobyl Accident

"When workers at Chernobyl who were in the reactor area at the time of the nuclear accident were decontaminated, the medical personal at the site received less than 10 mGy of radiation."

Mettler and Voelz, New England Journal of Medicine, 2002; 346: 1554-61

Never delay critical care because a patient is contaminated

Immediate Medical Management

- Triage
  - ARS
  - localized/ cutaneous
  - combined injury
- Initial stabilization and treatment
- Psychological effects
- Record keeping/ Dose assessment

Patient Management - Priorities

- Standard medical triage is the highest priority
- Radiation exposure and contamination are secondary considerations

Patient Management - Protocol

Based on:

- Injuries
- Signs and symptoms
- Patient history
- Contamination survey

Prenatal Radiation Exposure

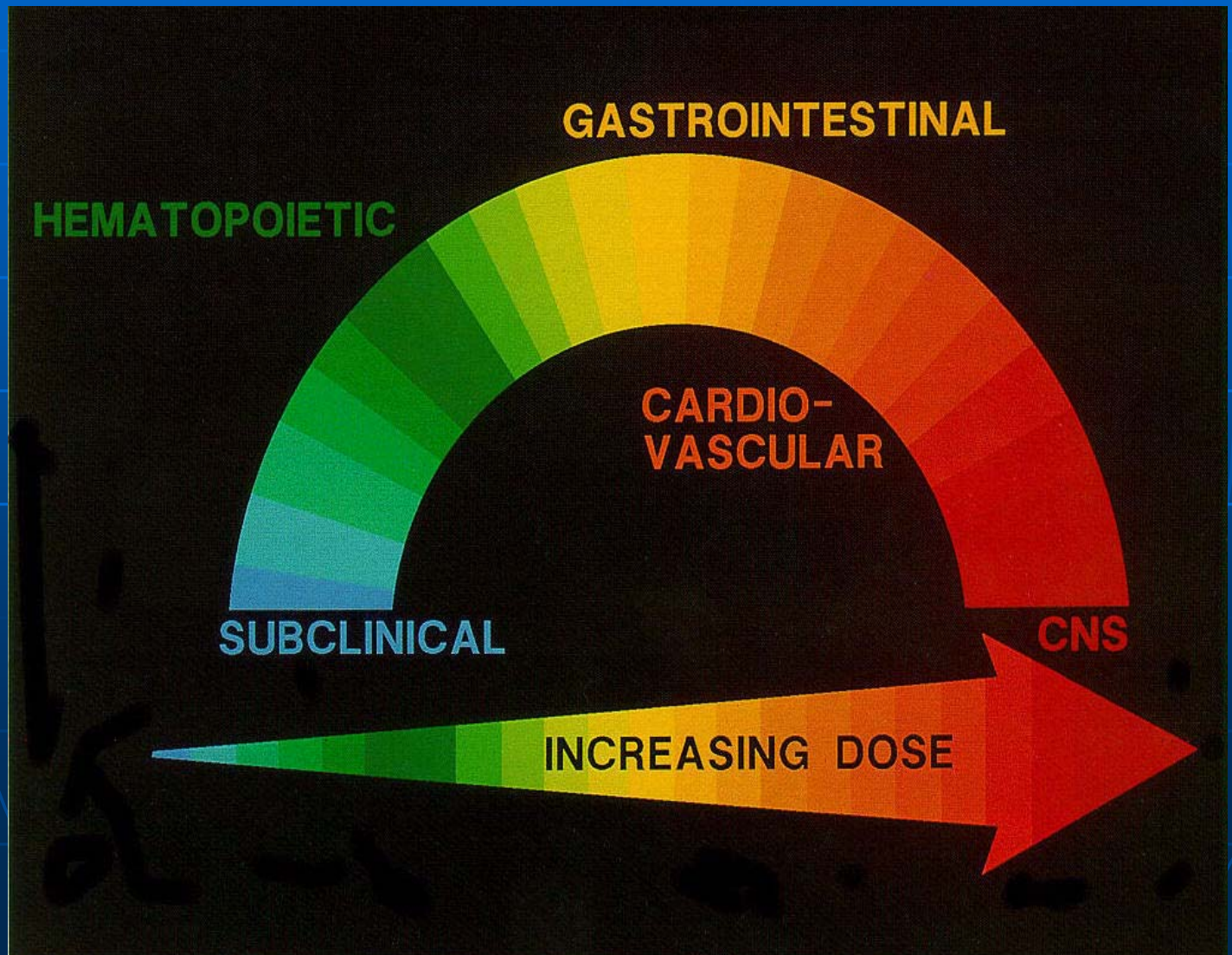
- Human embryo and fetus highly sensitive to ionizing radiation
- At higher doses, effects depend on dose and stage of gestation
- Pregnant patients should receive special dose assessments and counseling
- Information on prenatal radiation exposure

www.bt.cdc.gov/radiation/prenatalphysician.asp

Required Conditions for Acute Radiation Syndrome

- Large dose
- Penetrating
- Most of body exposed
- Acute

Acute Radiation Syndrome (A Spectrum of Disease)

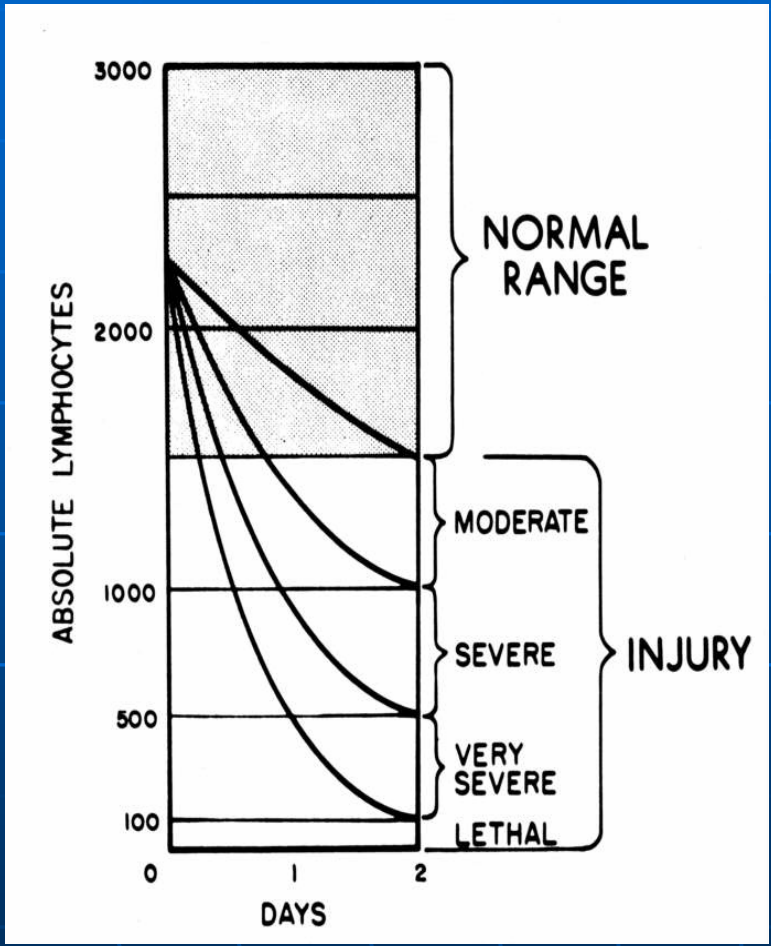


Biodosimetry Assessment Tool

Armed Forces Radiobiology Research Institute

www.afrri.usuhs.mil/

Andrews Lymphocyte Nomogram



- Confirms suspected radiation exposure
- Determines significant hematological involvement
- Serial CBCs every 3 - 4 hours

From Andrews GA, Auxier JA, Lushbaugh CC: The Importance of Dosimetry to the Medical Management of Persons Exposed to High Levels of Radiation. *In* Personal Dosimetry for Radiation Accidents. Vienna, International Atomic Energy Agency, 1965, pp 3- 16

Phases of Acute Radiation Syndrome

www.bt.cdc.gov/radiation/arsphysicianfactsheet.asp

Special Considerations

- High radiation dose and trauma interact synergistically to increase mortality
- Close wounds on patients with doses > 1 Gy (100 rad)
- Perform wound/burn care and surgery in first 48 hours or delayed for 2 to 3 months when dose is > 1 Gy (100 rad)

Emergency Surgery	Hematopoietic Recovery No Surgery	Surgery Permitted
24 - 48 Hours	~3 Months	After adequate hematopoietic recovery

Skin Effects

- Epilation
- Erythema
- Pigmentation
- Dry desquamation
- Moist desquamation that heals

NUREG / CR-4214, p II-68

Treatment of Large External Exposures

- Treat patients symptomatically
- Prevent and manage infections
  - Hematopoietic growth factors, e.g., GM-CSF, G-CSF (24-48 hr) (Neupogen®)
  - Irradiated blood products
  - Antibiotics/reverse isolation
  - Electrolytes
- More information on ARS:

www.bt.cdc.gov/radiation/arsphysicianfactsheet.asp

Treatment of Cutaneous Radiation Syndrome

- Lesions do not appear for days to weeks
- Perform surgical treatments within 48 hrs
- Consult Radiation Emergency Assistance Center/ Training Site (REAC/TS) for advice for further treatment, 865-576-1005 or www.orau.gov/reacts/

Decontamination of Patients

- External
  - Skin
  - Wound
- Internal
  - Decorporation agents

Patient Decontamination

- Remove and bag the patient's clothing and personal belongings (this typically removes 80 - 90% of contamination)
- Handle foreign objects with care until proven non-radioactive with survey meter
- Survey patient and collect samples
  - Survey face, hands and feet
  - Survey rest of body

External Contamination

- Radioactive material (usually in the form of dust particles) on the body surface and/or clothing
- Radiation dose rate from contamination is usually low, but while it remains on the patient it will continue to expose the patient and staff

Decontamination Priorities

- Wounds
- Intact skin (areas of highest contamination first)

Change outer gloves frequently to minimize spread of contamination

Decontamination of Wounds

- Contaminated wounds:
  - Irrigate and gently scrub with surgical sponge
  - Debride surgically only as needed

- Contaminated thermal burns:
  - Gently rinse
  - Changing dressings will remove additional contamination

Avoid overly aggressive decontamination

Change dressings frequently

Decontamination of Skin

- Use multiple gentle efforts
- Use soap & water
- Cut hair if necessary (do not shave)
- Promote sweating
- Use survey meter

Cease Patient Decontamination

- When decontamination efforts produce no significant reduction in contamination
- When the level of radiation of the contaminated area is less than twice background
- Before intact skin becomes abraded

Consider internal contamination

Internal Contamination

- Radioactive material may enter the body through
  - Inhalation
  - Ingestion
  - Wounds
- Internal contamination generally does not cause early signs or symptoms
- Internal contamination will continue to irradiate the patient

Treatment of Internal Contamination

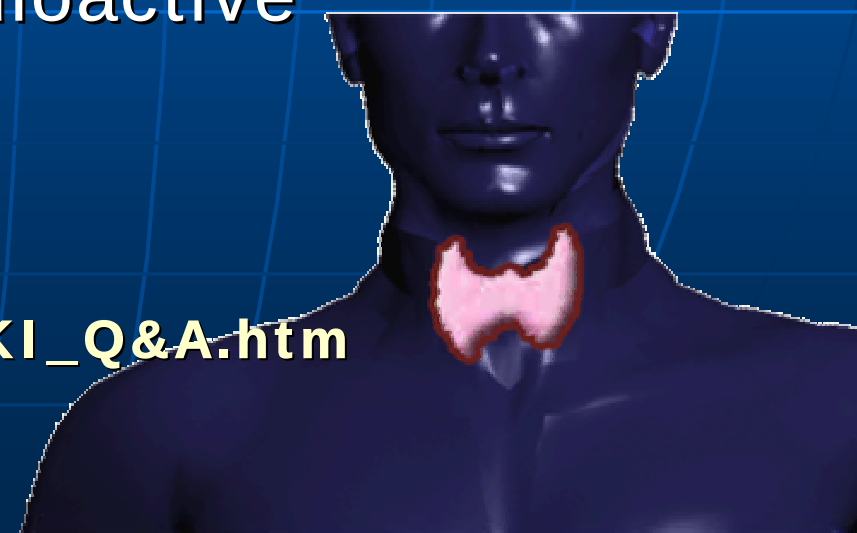
- Rare earths *
  - Plutonium
  - Transplutonics
  - Yttrium
- Uranium
- Cesium, rubidium, thallium *
- Tritium

* Treatment for these involves investigational new drugs available from REAC/TS

Potassium Iodide (KI)

- Only helpful in special cases
- KI saturates the thyroid gland with stable iodine
- KI must used prior to or within hours of exposure to radioactive iodine
- See the FDA web site:

www.fda.gov/cder/drugprepare/KI_Q&A.htm



Longer Term Considerations Following Radiation Injury

- Neutropenia
- Pain management
- Necrosis
- Plastic/reconstructive surgery
- Psychological effects (PTSD)
- Counseling
- Dose assessments
- Possible increased risk of cancer

Consult Radiation Emergency Assistance Center/ Training Site (REAC/TS) for advice for further treatment: www.orau.gov/reacts/, 865-576-1005.

Key Points

- Stabilization is the highest priority
- Radiation experts should be consulted
- Training and drills should be offered
- Adequate supplies and survey instruments should be stocked
- Standard precautions (N95 mask if available) reduce contamination
- Early symptoms and their intensity indicate the severity of the radiation injury
- First 24 hours are the most critical

More Incident Assistance

- The Radiation Emergency Assistance Center/ Training Site (REAC/TS)
  - www.orau.gov/reacts/
  - Phone: (865) 576-1005
- The Armed Forces Radiobiology Research Institute, Medical Radiobiology Advisory Team (MRAT)
  - www.afrri.usuhs.mil/
  - Phone: (301) 295-0530
- The American Association of Poison Control Centers
  - www.aapcc.org/
  - Phone: (800) 222-1222

Other Resources

- Books:
  - *Disaster Medicine*; Hogan and Burnstein, 2002.
  - *Medical Management of Radiation Accidents*; Gusev, Guskova, Mettler, 2001.
  - *The Medical Basis for Radiation-Accident Preparedness*; REAC/TS Conference, 2002.
  - *National Council on Radiation Protection and Measurement Report No. 65: Management of Persons Accidentally Contaminated With Radionuclides*, 1980.
  - *National Council on Radiation Protection and Measurement Report No. 138: Management of Terrorist Events Involving Radioactive Material*, 2001.

- AFRRI Publications: *Medical Management of Radiological Casualties Handbook*; Jarrett, 2003, and Terrorism with Ionizing Radiation Pocket Guide

Other Resources

- Article: "Major Radiation Exposure - What to Expect and How to Respond," Mettler and Voelz, New England Journal of Medicine, 2002; 346: 1554-61.
- Web Sites:
  - www.va.gov/emshg/ - Department of Homeland Security Working Group on Radiological Dispersal Device Preparedness, Medical Treatment of Radiological Casualties
  - www.crcpd.org – Conference of Radiation Control Program Directors
  - www.bt.cdc.gov/radiation/index.asp - Centers for Disease Control and Prevention Radiation Emergencies Page
  - www.acr.org/flash.html - Disaster Preparedness for Radiology Professionals
  - www.hps.org/ - The Health Physics Society
  - www.fda.gov/ - The Food and Drug Administration