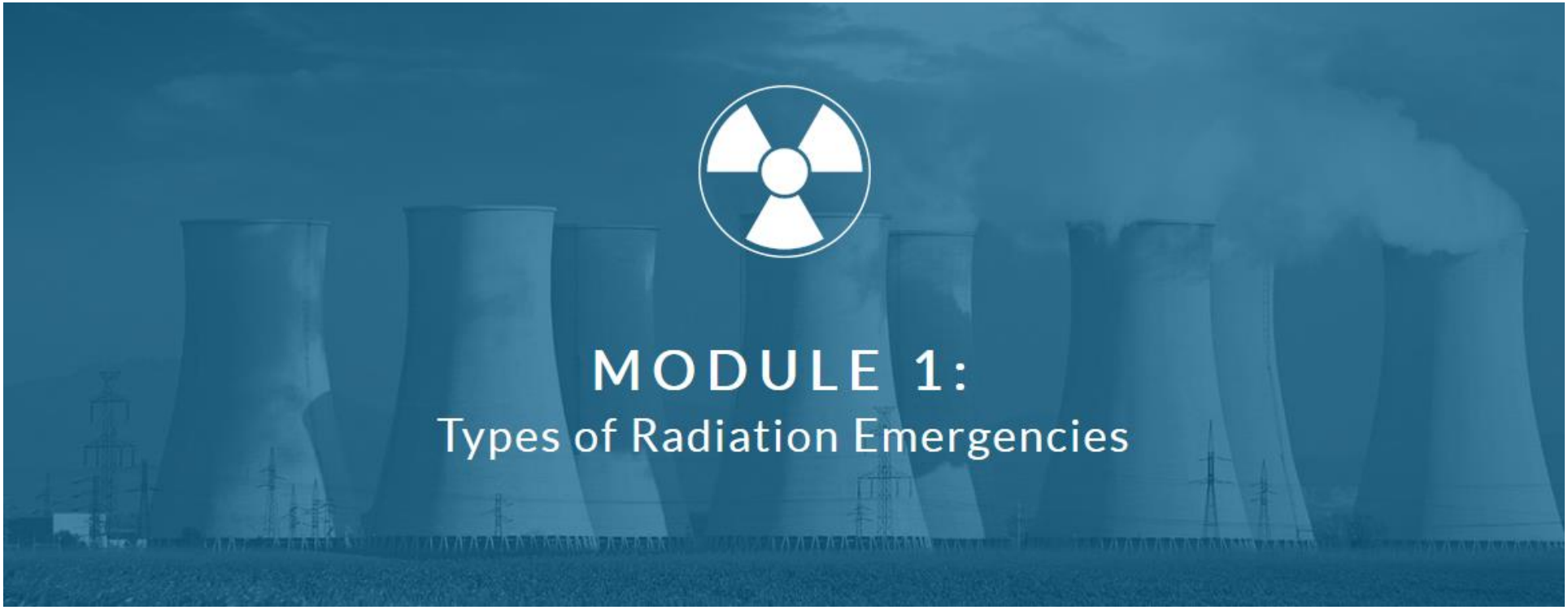
Radiation Emergency Training for Poison Center and Public Health Staff

Module 1: Types of Radiation Emergencies



Audio Transcript: Thank you for joining us for this presentation on radiation emergencies. This five-module course is intended to provide you, poison center staff, with the information you need to act properly in the unlikely event of a radiation emergency. The first module of this course will introduce you to different types of possible radiation emergencies. Additionally, we will cover the two groups of target audiences that will most likely rely on poison centers for information following a radiation emergency.

Overview of Module

- Intentional causes of radiation emergencies
  - Nuclear Weapon Detonation
  - Improvised Nuclear Devices
  - Radiological Dispersal Devices
  - Radiological Exposure Devices
- Unintentional causes of radiation emergencies
  - Nuclear Power Plant Accident
  - Transportation Accident
  - Workplace Radiation Incident
- Poison center information seekers
  - Medical Professionals
  - Concerned Public

Learning Objectives

1. Describe the different types of intentional and unintentional causes of radiation emergencies
2. Identify the audiences most likely to seek information from poison centers following a radiation emergency
3. Describe the primary role of poison center staff in fielding questions from information seekers following a radiation emergency
4. Use communication skills in educating and counseling patients

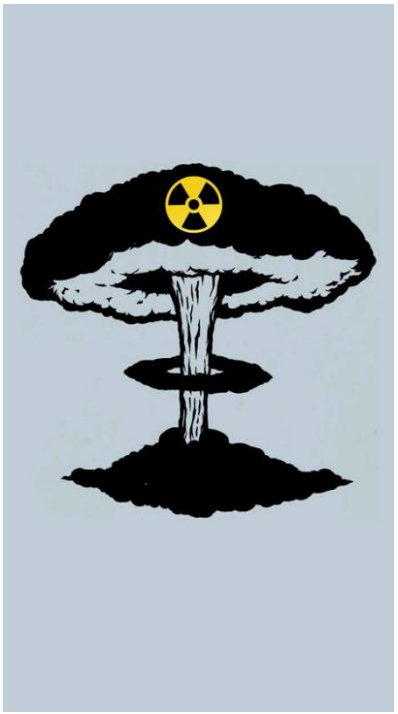
Intentional versus Unintentional Radiation Emergencies

Radiation emergencies might be intentional or unintentional. Intentional radiation emergencies are acts of terrorism, while unintentional radiation emergencies are caused by accidents.

Intentional: Detonation of Nuclear Weapons

Nuclear weapons would be used in acts of terrorism to cause widespread fatalities.

- Nuclear weapons are powerful and have a high explosive yield
  - Explosive yield is the amount of energy discharged when detonated
  - Nuclear weapons cause the release of radiation both during and after the explosion.
- These can be severalfold more powerful than the bomb dropped over Hiroshima
- Countries with advanced nuclear technology develop and maintain nuclear weapons



Intentional: Detonation of an Improvised Nuclear Device (IND)

Improvised Nuclear Devices, or INDs, are small-scale nuclear weapons that can be built from parts of stolen nuclear weapons or from scratch using nuclear material.

- They are believed to be similar in yield to the bomb dropped over Hiroshima during World War II, which had a 15 kiloton yield.
- INDs have the ability to produce catastrophic loss of life, destruction of buildings, and contamination of widespread areas.
- INDs are nuclear because there is a nuclear chain reaction that takes place.

Intentional: IND Explosions

- When an IND explodes, effects of the explosion include a blast wave, intense light, heat, radiation, and the release of radioactive material.
- Upon exploding, a large fireball is created and everything inside vaporizes and is carried upward, creating a mushroom-shaped cloud.
- As the material in the cloud cools it forms dust-like particles, which drop back to the earth as fallout. This fallout is radioactive and can be carried miles from the explosion site by the wind, contaminating anything it lands on including water, crops, people, animals, and homes.

Intentional: Radiological Dispersal Device (RDD)

An RDD is any device used to purposely spread radioactive materials (an act of terrorism). There are two types:

Non-Explosive

- Comes in different forms:
  - Solid
  - Liquid
  - Aerosol
  - Gas
- Contamination can occur in different ways, for example:
  - Dropped from a plane
  - Put in food or water source

Explosive RDD

- Known as a “dirty bomb” and can spread
  - Radioactive shrapnel
  - Non-radioactive shrapnel
  - Radioactive dust

Most casualties come from the explosion itself, not from the radiological material.
The extent of damage for a Radiological Dispersion Device (RDD) is typically far less than an IND.

While it is important to understand the potential health effects of specific causes of radiation emergencies, these will be covered completely in Module 3 and Module 4.

An RDD can be an airplane dispersing radioactive material
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

Audio Transcript: First let's discuss explosive RDDs. These are more commonly known as "dirty bombs." Dirty bombs use conventional explosives, like dynamite, to spread radioactive material in the form of powder or pellets. It is important to note that a dirty bomb is NOT a nuclear bomb. The extent of damage in a dirty bomb explosion is far less than what it would be in a nuclear explosion.

In the event of a dirty bomb, radiation is a concern; however, a majority of casualties and injuries will be caused by the explosion, rather than by the radiological material.

The primary dangers from a dirty bomb are the injuries from the explosion itself, such as burns or trauma, especially for those who were in the immediate area of the blast.

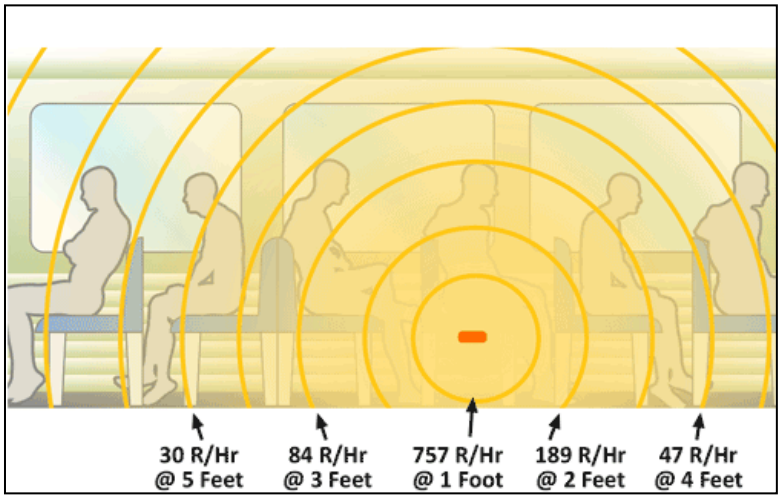
The images on this page depict the two types of RDDs. On the left, you see a depiction of an explosive RDD, or dirty bomb. This shows the makeup of a dirty bomb, with the radioactive material surrounded by dynamite. An explosion of this type will disseminate radioactive and non-radioactive shrapnel and radioactive dust. It is important to note that a dirty bomb cannot create an atomic or nuclear blast.

The image on the right depicts dispersal of radioactive material by plane, which is a non-explosive type of RDD.

Non-explosive RDDs can come in different forms, including solid, liquid, aerosol, or gas. Non-explosive dispersion of unsealed radioactive sources can be done passively or actively. Radioactive material placed in a food or water source is an example of passive dispersion. Active dispersion can occur by someone dropping the radioactive material from a plane, for example.

Intentional: Radiological Exposure Device (RED) or "Hidden Source"

An RED is a hidden, unshielded, sealed radioactive source that someone would place somewhere with the intent of causing harm through exposure (an act of terrorism). For example, an RED might be hidden on a subway car or in a sports stadium where people could be unknowingly exposed. An RED causes radiation exposure and does not cause contamination.

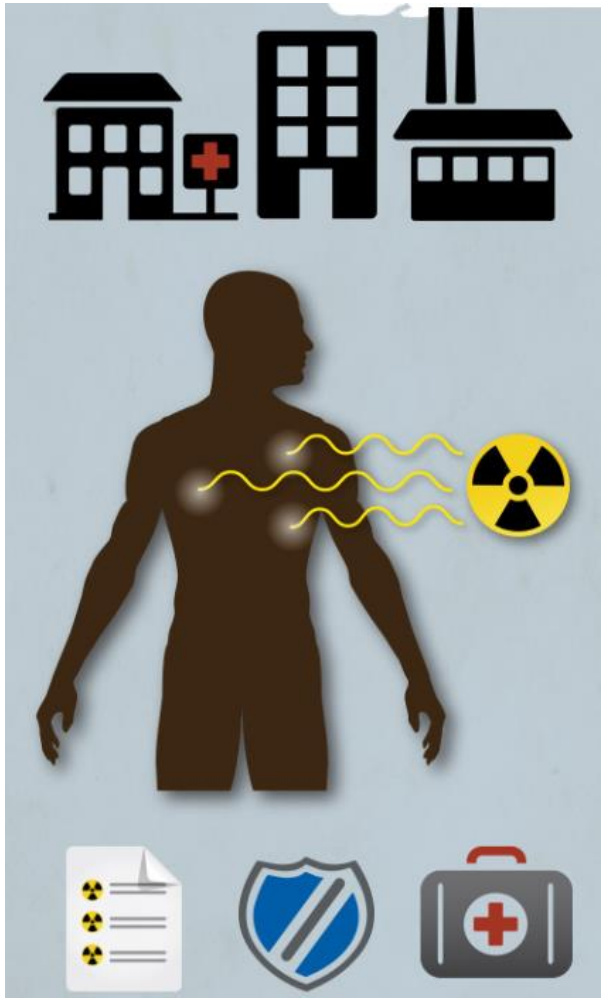


Depiction of an RED in a train or subway car. As you can see, the person seated directly above the RED will receive the most radiation exposure (R/Hr= rem/hour) and those seated further away will receive less radiation.
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

Audio Transcript: The dose from exposure and the specific effect on a person depends on several factors:

- The source properties, including the isotope type, activity, and amount of radioactive material
- The proximity of the person to the source
- The length of exposure or time a person is in proximity to the source
- Whether a person's whole body or only a portion of the body received exposure

People exposed to high levels of radiation from an RED can develop symptoms of Acute Radiation Syndrome (ARS). They can also develop radiation burns. Health effects may take hours, days, or weeks to appear depending on the dose. These effects can range from mild to severe (e.g., cancer or death). Some people may not experience any health effects.



Unintentional: Workplace Radiation Incidents

Workplaces like health care facilities, research institutions, and industrial operations may use radiation sources. A few examples include:

- Medical procedures such as cardiac stress tests which use radioisotopes (e.g., thallium, rubidium, technetium)
- Industrial radiography sources used to obtain an image to look for structural damage in buildings, bridges, etc.

An incident or accident can happen if:

- Radiation sources are stored or used incorrectly
- Safety controls malfunction
- Safety procedures are not followed

The health effects from a workplace incident involving radiation sources could range from no health effects to very serious health effects based on several factors:

- The type and amount of radioactive material
- How long people were near the radioactive material or how long the radioactive material was in or on the body
- How close people were to the radioactive material
- What parts of the body were exposed

For anyone who works in a health care facility, research institution, or industrial operation that uses radiation sources, it is important to use required personal protective and monitoring equipment, be familiar with safety precautions and procedures, and complete required radiation safety trainings.

Unintentional: Nuclear Power Plant Accident

- The core of a nuclear reactor like those found in nuclear power plants contains large amounts of highly radioactive material
- Normally, the radiation is contained inside the reactor building, but if something goes wrong, it may be released and areas at and near the plant may become unsafe. In the event of an incident at a nuclear power plant, workers, the nearby public and the environment can be affected

Potential Impact to Workers and Public	Potential Impact to Environment
• External exposure • External contamination • Internal contamination	• Widespread radioactive contamination • Radiation hazards to plants and wild life • Exclusion and limited human access zones

Unintentional: Nuclear Power Plant Accident

Three Mile Island nuclear plant

If an accident at a nuclear power plant occurs, resulting in the release of radioactivity, several public health protective actions can be taken, including:

- Evacuation
- Sheltering-in-place
- Interdiction/embargo of contaminated or potentially contaminated food
- Use of medical countermeasures

Key Terms to Remember:

- Exposure - occurs when radiation from an external source penetrates the body
- Contamination - occurs when radioactive material is released into the environment and then is ingested, inhaled, injected into the body, or deposited on the body's surface

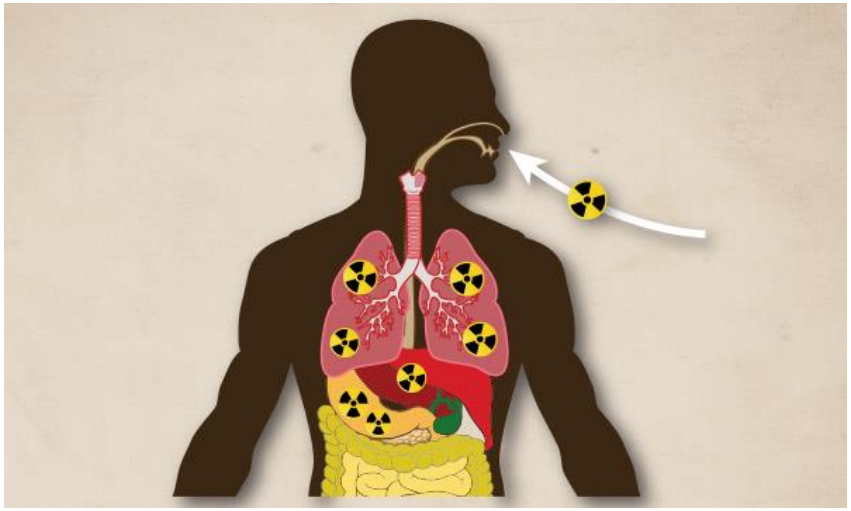


Diagram depicting internal contamination of radioactive material after inhalation or ingestion

Audio Transcript: The Nuclear Regulatory Commission, or the NRC, has defined areas surrounding nuclear power plants as Emergency Planning Zones. These areas are required by the NRC to have plans that will help to ensure that prompt and effective actions are taken to protect the health and safety of the public in the event of an accident.

In the event of a serious nuclear power plant accident, there will likely be a window of time before the release of radioactivity begins, which will allow time for the response plan to be implemented.

Workers close to the reactor could be affected by:

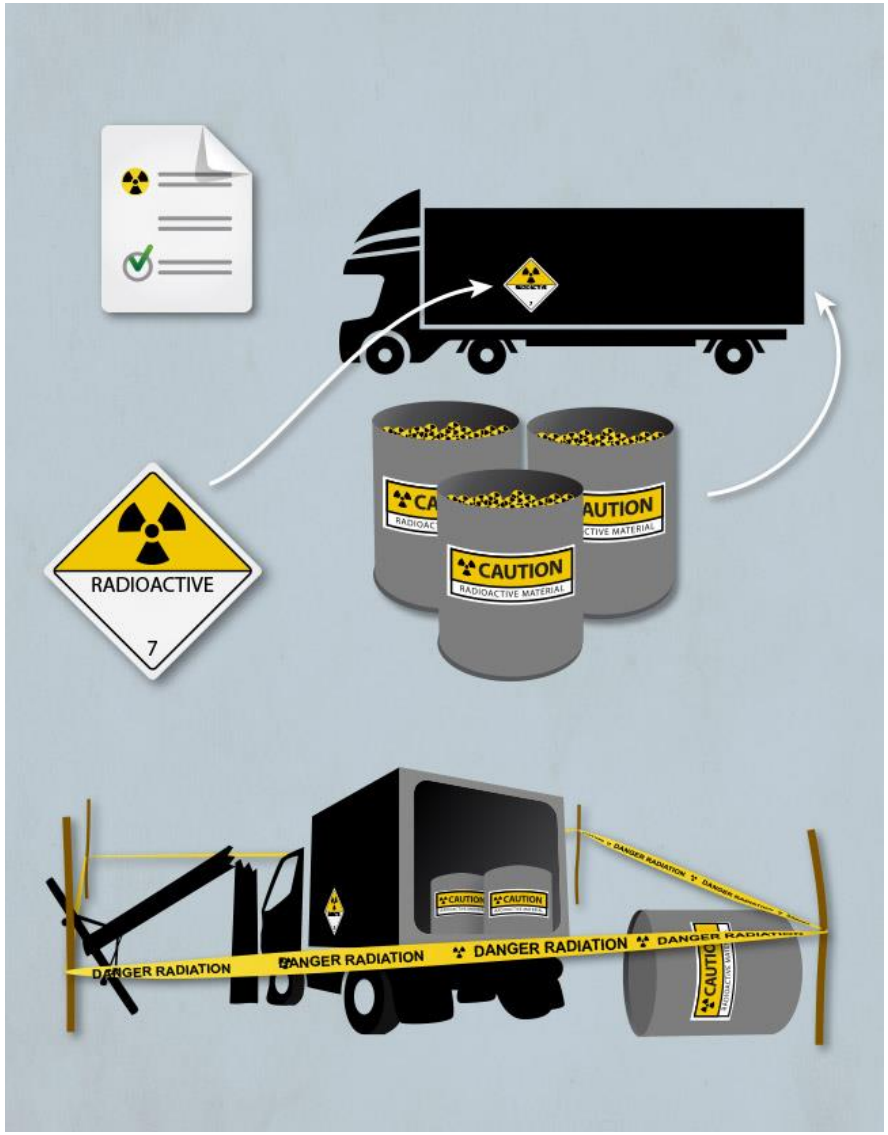
- External exposure to highly radioactive materials within the reactor
- External contamination by radioactivity released and dispersed locally in the plume
- Internal contamination by radioactivity released, dispersed locally, and then eaten, breathed in, and/or incorporated

The general public could be affected by:

- External exposure to radiation emitted from radioactive materials released in the environment
- External contamination by radioactivity released and dispersed widely in the plume
- Internal contamination by radioactivity released, dispersed widely, and then eaten, breathed in, and/or incorporated into the tissues and organs of the body

Exposure, contamination and some of the other concepts alluded to will be more fully explored in later modules.

Unintentional: Transportation Accident

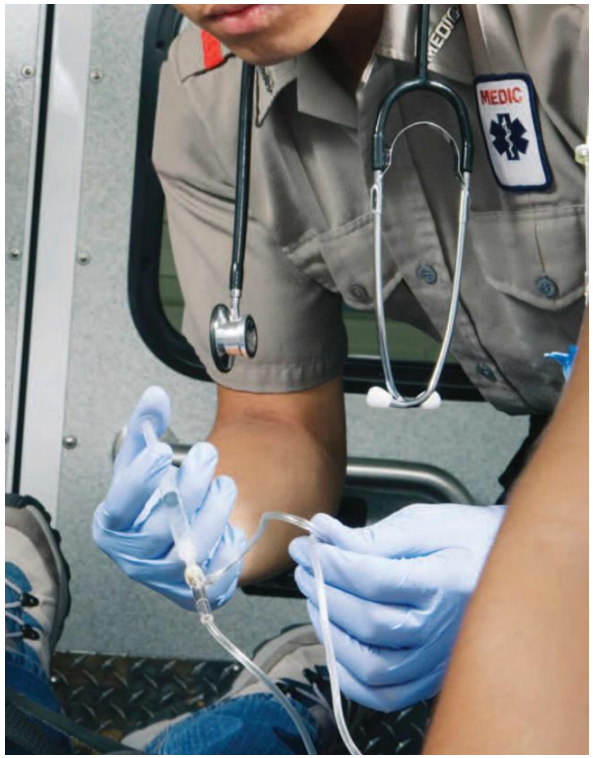


- Radioactive material is transported by trucks, rail, and other shipping methods, packed in special protective containers that are designed and tested to withstand damage.
  - Shipments involving significant amounts of radioactive material are required to have documentation, labels, and placards identifying the cargo as radioactive.
- In the event that the containers are damaged, the main dangers of transportation accidents involving radioactive materials, are contact with the radioactive material and exposure to radiation. It is very unlikely that accidents involving transport of radioactive material will cause any radiation-related injuries or illnesses. Emergency officials have plans in place to respond safely to transportation accidents involving radioactive material.
- Anyone who witnesses a transportation accident involving radiation should report the accident to emergency responders immediately. It is important that individuals stay as far away from the site of the accident as possible and not touch any cargo from the transport container.

A closer look at information-seeking audiences

In the event of a radiation emergency, it is likely that calls to poison centers will increase and require staff to share important information with callers. It is our hope that this training will assist staff in knowing the basics of these types of emergencies and how to respond.

Emergency Medical Services (EMS) Providers



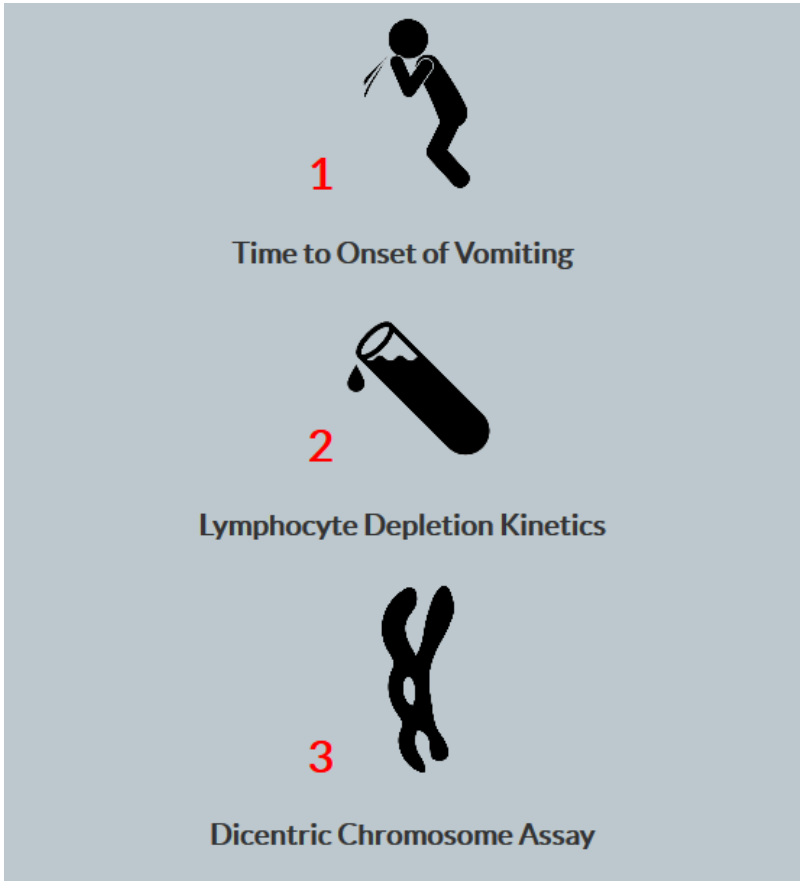
Medical professionals may rely on the poison center staff for information about how to respond in the event of a radiation emergency.

- Emergency Medical Services (EMS) Providers
  - EMS providers should assess the scene for hazards prior to entering the scene.
  - OSHA's Best Practices for Protecting EMS Responders during Treatment and Transport of Victims of Hazardous Substance Releases (2009) should be followed.
  - EMS providers should follow OSHA's regulatory requirements for PPE and training in the OSHA HAZWOPER standard and the OSHA HazCom training, if they are designated to provide those services.
  - For lifesaving operations, the total radiation dose to the responders should be minimized to make the maximum use of scarce worker resources in a prolonged high demand incident. All responder missions in high-risk environments must be optimized and justified.
    - Justification: An action should only be taken if the benefits of the action outweigh the total risk to the responders conducting rescue operations.
    - Optimization: Radiation doses should not exceed the appropriate limits determined from the hazard assessment. Once operations no longer involve lifesaving, limits should follow OSHA regulations for radiation exposure.
  - Every effort must be made to keep exposures As Low As Reasonably Achievable (ALARA) in responding to a radiological emergency.
  - All emergency activities must be carried out taking into consideration both the benefits to be achieved by the emergency response operation, and the potential for additional adverse health impacts to those conducting the operation.
  - EMS providers and vehicles DO NOT require protective equipment to transport victims who had radiation exposure only.
  - EMS providers and vehicles DO require protective equipment to transport victims who are contaminated with radioactive materials or debris.

Audio Transcript: EMS Staff may encounter exposed victims, contaminated victims, or in some cases, victims who are both exposed and contaminated. Exposure and contamination are explored thoroughly in Module 3, but EMS providers should know the differences for transporting victims:
In transporting victims with exposure but no contamination, radiation protection is not required for the vehicle or its personnel.

- In transporting victims with contamination (which could include victims who are both exposed and contaminated), efforts must be made to protect staff, as well as to limit contamination inside the vehicle so it can continue to be used to help additional victims. Necessary safety measures include:
  - Placing two sheets or blankets on the litter before placing the contaminated patient on the litter;
  - Removing the victim's contaminated outer clothing before loading him or her onto the litter;
  - Folding the edges of the two layers of sheets over the patient while maintaining access to the airway and adequate visual surveillance;
  - Placing at least one layer of covering on the gurney before loading the litter onto the gurney;
  - Closing all open compartments within the transport vehicle prior to the transport;
  - Using disposable equipment when possible; and
  - Attempting to reduce contamination inside the vehicle after the transport is completed.

Hospital-Based Emergency Department (ED) Staff



To learn more about estimating dosages, please visit: https://www.remm.nlm.gov/ars_wbd.htm.

Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

The priority for this group is first to perform life-saving care and then to manage radiation issues. It is important for hospital-based emergency departments to be prepared for radiation emergencies in advance. For example:

- Special equipment used for the care of contaminated patients should be kept in a storage area marked "Hazardous Materials Equipment. “
- Adequate supplies should be stored to manage a large disaster with sufficient supplies to protect and assist all personnel expected to participate.
- The storage area should be located within close proximity of the emergency department.
- The key for entering this storage area should be held in a secure location and an inventory list should be placed inside the storage area. The appropriate staff person in the emergency department and the radiation safety team should know where the key is located.
- All monitoring equipment and radiation signs should be inspected and inventoried annually.

It is important that emergency rooms be equipped for decontamination and cross-contamination is avoided.

Audio Transcript: In treating victims, emergency department staff will likely treat both those with exposure and those with contamination. Treatment will differ for these two types of victims.

For victims with exposure, staff will need to look for early clinical signs and symptoms of Acute Radiation Syndrome, or A-R-S, which could include vomiting or diarrhea or a drop in their absolute lymphocyte counts in their complete cell counts, or CBCs. Staff will also need to use Radiation Biodosimetry Tools to estimate whole body radiation dose.

It's important for staff to consider patient signs and symptoms and radiation dose estimate when making clinical decisions about triage, treatment, or transfer. It's also important to re-assess each patient at regular intervals, as the clinical status may change over time.

For victims with contamination, emergency department staff will need to coordinate radiation surveys of patients and decontamination procedures with facility radiation response personnel. This should be coordinated with the hospital's radiation safety officer. Any hospital that uses radiation for imaging will have a radiation safety officer.

Remove the patient's clothing to eliminate a significant proportion of external contamination; bag contaminated clothing and personal items; label with name, date, and time; remove them from the area; decontaminate the victim with soap and water before entering the ED; and consult radiation experts if internal contamination is suspected because the radiation survey remains significantly positive after external decontamination is completed.

Other emergency department staff will need to use appropriate personal protective equipment, such as eye protection, a mask, and a gown for universal precautions.

Calls from Medical Professionals

- Poison centers can share important information regarding radiation countermeasures with this group, including questions about:
  - Administration
  - Side effects
  - Dosing
  - Interactions with other medications
  - Contraindications

MCMs and other treatments are covered in Module 4.

- Poison centers will likely receive calls from medical professionals, including nurse advice lines, emergency departments, hospitals, and other institutions that are not adequately prepared to respond to persons contaminated with radioactive material or exposed to ionizing radiation.
- A majority of calls from medical professionals will likely be related to the use of specific therapies known as medical countermeasures (MCMs).

Calls from the General Public

- After a radiation emergency, most calls to poison centers will be from the general public. These could include:
  - Witnesses or those close to a blast (can be considered as “potentially exposed”)
  - Injured persons
  - Concerned citizens, who are not directly exposed or injured but who are concerned about potential exposure or injury
- In answering calls from the public, one major role for the poison center is to help distinguish those who are exposed and can be managed at home from those who need to go to a medical facility for treatment.
  - The poison center’s role is to help limit the burden on emergency departments by ensuring that concerned citizens, or those who can be treated at home, do not enter hospitals (keeping hospitals free for people with life-threatening injuries or exposures).
- Poison centers can also provide reassurance to callers.

“Concerned citizens” is the preferred phrase for the audience previously referred to as the “worried well.”

Your Role in Communicating with the Public

The role of the poison center in communicating during a radiation emergency is to provide accurate and uniform information to callers. Other roles may include:

- Assisting with caller triage and medical management
- Supporting long-term follow-up activities

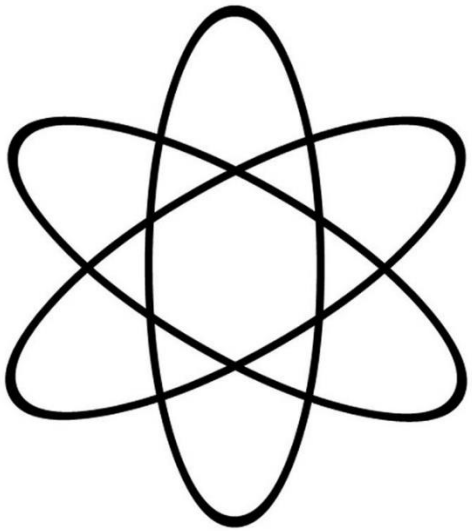
Audio Transcript: Ideally, messages used during a radiation emergency will be coordinated among all public health responders, including state, local, and federal agencies. Poison centers should be included in the development of messages, because you will receive the calls and will be most familiar with the type of questions that will be asked.

First and foremost, poison center staff must communicate accurate, clear, and consistent information to callers.

Poison centers may also manage caller triage, provide medical management, and support long-term public health follow-up activities.

Poison centers routinely follow up with callers to monitor outcomes and provide further recommendations, if needed. This service could be helpful in the creation of a long-term registry of individuals contaminated with radioactive material or exposed to ionizing radiation. For example, after being evaluated at a community reception center, the affected population can participate in follow-up activities via calls with a poison center. Poison centers also can perform follow-up activities over time and work with outpatient medical toxicology clinics.

In Conclusion: Types of Emergencies



Radiation emergencies may be intentional, such as terrorism, or unintentional, such as accidents. The most severe types of radiation emergencies are nuclear emergencies. Types of nuclear emergencies include:

- Improvised Nuclear Devices (IND) and Nuclear Weapons (intentional)
- Nuclear Power Plant Accidents (unintentional)

Additional types of radiation emergencies include:

- Radiological Dispersal Devices or “Dirty Bombs” (intentional)
- Radiological Exposure Devices (RED) or “Hidden Source” (intentional)
- Transportation accidents (unintentional or intentional)

For more information on radiation emergencies and related topics, please visit www.emergency.cdc.cov/radiation.

Module 2: Protective Measures

Overview of Module

- Protective measures and training for medical professionals
  - Potential Hazard
  - Protective Gear
  - Training
- Protective measures for the public
  - Potentially Exposed
  - Injured Persons
  - Concerned Citizens
  - Providers

Learning Objectives

1. Describe protective measures and training for medical providers, including personal protective equipment.
2. Communicate important protection messages to the general public for citizens that may have radiation exposure or are actually exposed to or injured by a blast.
3. Use communication skills in educating and counseling patients.

Radiological Emergencies and the Public

- In the event a radiation emergency occurs, the members of the public within the radius of the incident can be placed in one of three categories:
  - Potentially exposed or contaminated: individuals in close proximity to the blast radius who may have received high radiation exposure or contamination.
  - Injured persons: individuals close enough to the blast to experience trauma, such as burns or shrapnel injuries; these individuals may also be at risk for radiation exposure and contamination, which is explored in Module 3.
  - Concerned citizens: individuals not close enough to a blast radius to be at risk for exposure or injury, but who are concerned about safety and the need for precautions.

Medical Professionals Working in Hospitals

- It is still important to take all necessary precautions when responding to emergencies involving contamination with radioactive materials.
- Follow your institutional plans for decontamination of patients.
- Hospital workers should be properly trained according to the OSHA standard and monitored for radiation exposure and use caution when rendering care to patients.

Source: ORISE-REAC/TS https://orise.orau.gov/reacts

Early Phase Precautions

- During the early phase of an emergency, staff must observe an all-hazards approach and assume that biological, chemical, and radiological hazards may be present.
- Only after other hazards are controlled should staff limit their focus to radiological hazards.
- Protection should focus on:
  - Complying with shelter-in-place recommendations
  - Minimizing external exposure
  - Preventing inhalation, inadvertent ingestion of radioactive material, and uptake through an open wound
  - Complying with OSHA standard

Minimizing exposure and contamination is explained in greater detail in Module 3.

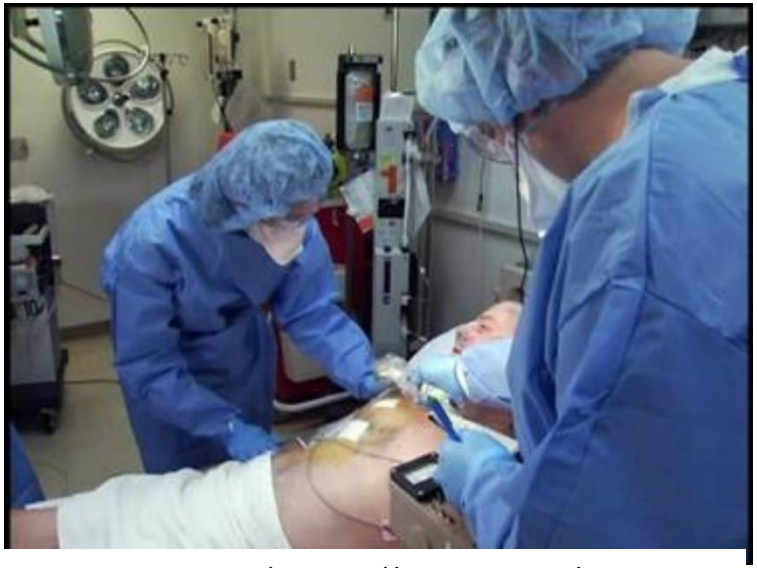
Personal Protective Equipment (PPE)

- What's most important to share with medical professionals and Emergency Medical Services (EMS) providers is that appropriate PPE is effective and can prevent contamination. The purpose of protective clothing when treating the general public during a radiation incident is to prevent contamination of personal clothing and bare skin, as well as to protect the airway and any open wounds.

- All PPE must be used in the context of a comprehensive infection control program that follows CDC recommendations and applicable Occupational Safety and Health Act of 1970 (OSHA) requirements, including the Bloodborne Pathogens (29 CFR 1910.1030), PPE (29 CFR 1910.132), Hazardous Waste Operations and Emergency Response (29 CFR 1910.120), and Respiratory Protection (29 CFR 1910.134) standards, and other requirements under OSHA (e.g., the General Duty Clause, section 5(a)(1).

  - Universal precautions (i.e., standard hospital personal protection procedures) should be followed according to CDC recommendations in the emergency room and any other room where potentially contaminated patients may be treated to protect against contamination.

Hospital Decontamination Zones and Personal Protective Equipment



Source: ORISE-REAC/TS https://orise.orau.gov/reacts

Hospital personnel working with contaminated patients should follow their local operation procedures that are in compliance with OSHA standards.

OSHA defines two functional zones, which guide the application of OSHA's PPE recommendations:

- Hospital Decontamination Zone
- Hospital Post-decontamination Zone

In the **Hospital Decontamination Zone** it is reasonably anticipated that medical personnel and other hospital staff might have exposure to contaminated victims, their belongings, equipment, or waste. This zone includes places where initial triage and/or medical stabilization of possibly contaminated victims occur, pre-decontamination staging areas for victims, the decontamination area, and the post-decontamination victim inspection area. This area will typically end at the ED door. Note that the following recommendations are for a radiation emergency only. If there are additional chemical, physical, or biological hazards, the PPE recommendations below need to be modified to address the additional hazards.

Recommended PPE:

- Powered air-purifying respirator (PAPR) that provides a protection factor of 1,000. The respirator must be NIOSH-approved.
- Combination 99.97% high-efficiency particulate air (HEPA)/organic vapor/acid gas respirator cartridges (also NIOSH-approved).
- Double layer protective gloves.
- Chemical resistant suit.
- Head covering and eye/face protection (if not part of the respirator).
- Chemical-protective boots.
- Suit openings sealed with tape.

The **Hospital Post-decontamination Zone** is an area considered uncontaminated. Equipment and personnel are not expected to become contaminated in this area. At a hospital receiving contaminated victims, the Hospital Post-decontamination Zone includes the ED (unless contaminated).

Recommended PPE:

- Normal work clothes or uniform and PPE, as necessary, for infection control purposes (e.g., gloves, gown, appropriate respirator, if indicated).

Personal Dosimeters

DOSE-GARD® Micro-Electronic Personal Dosimeter. Source: Responder Knowledge Base (RKB), DHS/FEMA
BOTTOM: Optically stimulated luminescence (OSL) dosimeter
Source: Harvard University, Environmental Health and Safety

- Personal radiation dosimeters help providers monitor radiation dose and stay within recommended limits
- Staff actively attending contaminated patients should wear personal monitors and the appropriate PPE.
- Medical professionals who adhere to the OSHA standards for protective gear are at very low risk for contamination.

Audio Transcript: Personal radiation dosimeters can help providers monitor their radiation dose and stay within recommended limits.

The first image here shows an electronic dosimeter that can provide an alarm once a pre-set dose rate and/or total dose limit has been exceeded. The second image shows an optically stimulated luminescence (OSL) dosimeter designed to be worn on the torso.

A Closer Look at the General Public

Potentially Exposed

Get Inside	Stay Inside	Stay Tuned
		
If you are already inside, **stay** inside, closing and locking all windows and doors. This is referred to as "sheltering in place." If possible, individuals sheltering in place should proceed to a basement or the middle of the building and turn off any fans, air conditioners, and forced-air heating units that bring air in from the outside.	Staying inside for at least 24 hours or until it is safe to leave the area can protect members of the public.	It is important to stay tuned once you get inside for updated instructions from emergency response officials. As officials learn more about the emergency, they will communicate the latest information to the public.

Protective Actions for the General Public

- Once inside, potentially or already exposed individuals can take additional precautions to protect themselves from potential exposure:
  - Remove outer layer of clothing
    - Taking off the outer layer of clothing can remove up to 90 percent of radioactive material
  - Wash
    - If you can take a shower, gently wash with lots of soap. Do not use a conditioner when washing hair
    - Do not scald, scrub, or scratch skin

https://www.youtube.com/watch?v=X8988d1zgDk

https://www.youtube.com/watch?v=VXxIQLhL-XA

  - Put on clean clothes
    - Clothes in a closet or drawer away from radioactive material are safe to wear
    - Remain inside until you are told to evacuate. It is very important to remain indoors until radiation levels outside come down to safe levels. You will be provided instructions on where to go (Assembly area or Community Reception Center) once the all clear has been given.

Audio Transcript: Individuals who aren't injured but are sheltering-in-place may call poison centers to find out what they can do to protect themselves. While decontamination and medical countermeasures are explored in Module 4, some at-home protective measures include removing the outer layer of clothing, showering, and re-dressing in clean clothes.

When removing clothing, caution should be taken to prevent any radioactive dust from shaking loose. People need to place the clothing in a plastic bag or other sealable container, seal the bag, and put the bag in an out-of-the-way place, away from people and pets.

- If people *can't* take a shower:
    - They should use a moist wipe, clean wet cloth, or damp paper towel to wipe the parts of the body that were uncovered. Encourage them to pay special attention to the hands and face.
    - They should also gently blow the nose and wipe eyelids, eyelashes, and ears with a moist wipe, clean wet cloth, or damp paper towel.
    - They should then put the used wipes, cloth, or towel in a plastic bag or other sealable container, seal it, and place the bag in an out-of-the-way place, away from people and pets.
- If people *can* take a shower:
    - They should wash their hair with shampoo or soap but *not* use conditioner because it will cause radioactive material to stick to hair.
    - If they were injured, they should keep cuts and abrasions covered when showering to keep from getting radioactive material in open wounds.
    - They should put on clean clothes after showering.

Injured Persons

- Persons injured after a radiation emergency may experience radiation-related injury or blast-related trauma, if the incident was a “dirty bomb” for example.
- Radiation-related injuries, such as acute radiation syndrome (ARS) (described in Module 1) are typically very rare, and depend on a number of factors, such as:
  - The amount of radiation absorbed by the body (the dose)
  - The type of radiation
  - How the radioactive material got in or on the body
  - The length of time a person was exposed
- Blast injuries such as burns, traumatic injuries, or other life-threatening injuries take priority over any radiation-related injury and require immediate medical attention.
- Treat minor, non-radiation related cuts, bruises, or injuries with first aid. Keep cuts and abrasions covered when washing to keep radioactive material out of the wound.

Module 3 and Module 4 explain radiation-related injuries and treatments in more detail.

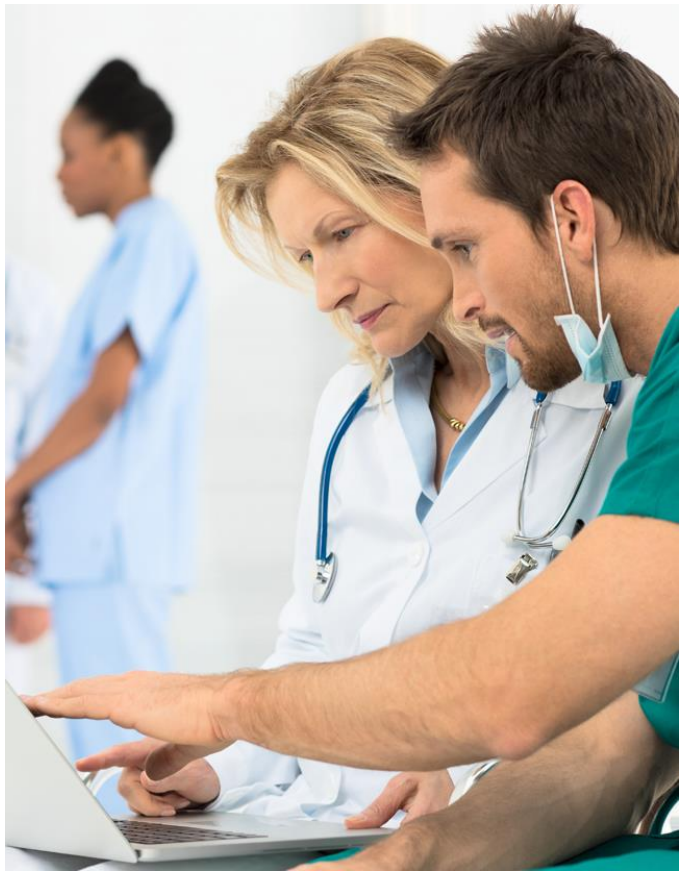
Concerned Citizens

Individuals not necessarily exposed to or injured by radiation may seek information from poison centers out of fear, anxiety, and/or stress. The chief communication objective for this audience is to alleviate anxiety and to discourage people from seeking medical care that they do not need.

Some questions to prepare for include:

- How will I know if food or water is safe?
  - Scientists will test drinking water supplies and food products to make sure they are safe.
  - Until those results are available, bottled water is the only water source that is certain to be free of contamination.
  - The safest food to eat is food in sealed containers (milk, cans, bottles, boxes, etc.); unspoiled food in your refrigerator or freezer is also safe to eat.
- How can I get more information during a radiation emergency?
  - As officials learn more about the emergency, they will communicate the latest information to the public.
  - Television, radio, and social media are some ways that you may receive information.
  - A battery-powered or hand crank emergency radio is one of the best ways to stay tuned, especially if cell and satellite signals have been compromised.
- What should I do if there are problems communicating with others during a radiation emergency?
  - Try using text messages (SMS) to communicate with others, as making phone calls could be difficult.
- How will I know when it is safe to leave my home or place of shelter?
  - Emergency officials will tell you if you need to leave your home (or evacuate). Stay inside where you are until an evacuation order is given.
  - Emergency officials will tell you when to go to an emergency shelter, where the shelter is located, and the safest route for travel. Act quickly and follow instructions.
- How do emergency officials determine when to evacuate an area?
  - Each situation will be different, and emergency officials consider many factors to make sure it is safe to evacuate.
  - Evacuation decisions will be based on wind speed and direction, the size and extent of the disaster, radiation levels, and whether or not roads and structures are damaged.

Conclusion



- For medical professionals:
  - Follow OSHA requirements for training and PPE.
  - Protective measures are very effective when followed.
  - Protective measures focus on minimizing external contamination and preventing inhalation, inadvertent ingestion, or uptake through open wounds of radioactive material.
- For the public:
  - Those potentially or already exposed to radiation should get inside, stay inside, and stay tuned.
  - Injured persons should seek immediate medical attention.
  - Members of the public not injured or exposed during an emergency should be reassured and given resources to seek additional information.

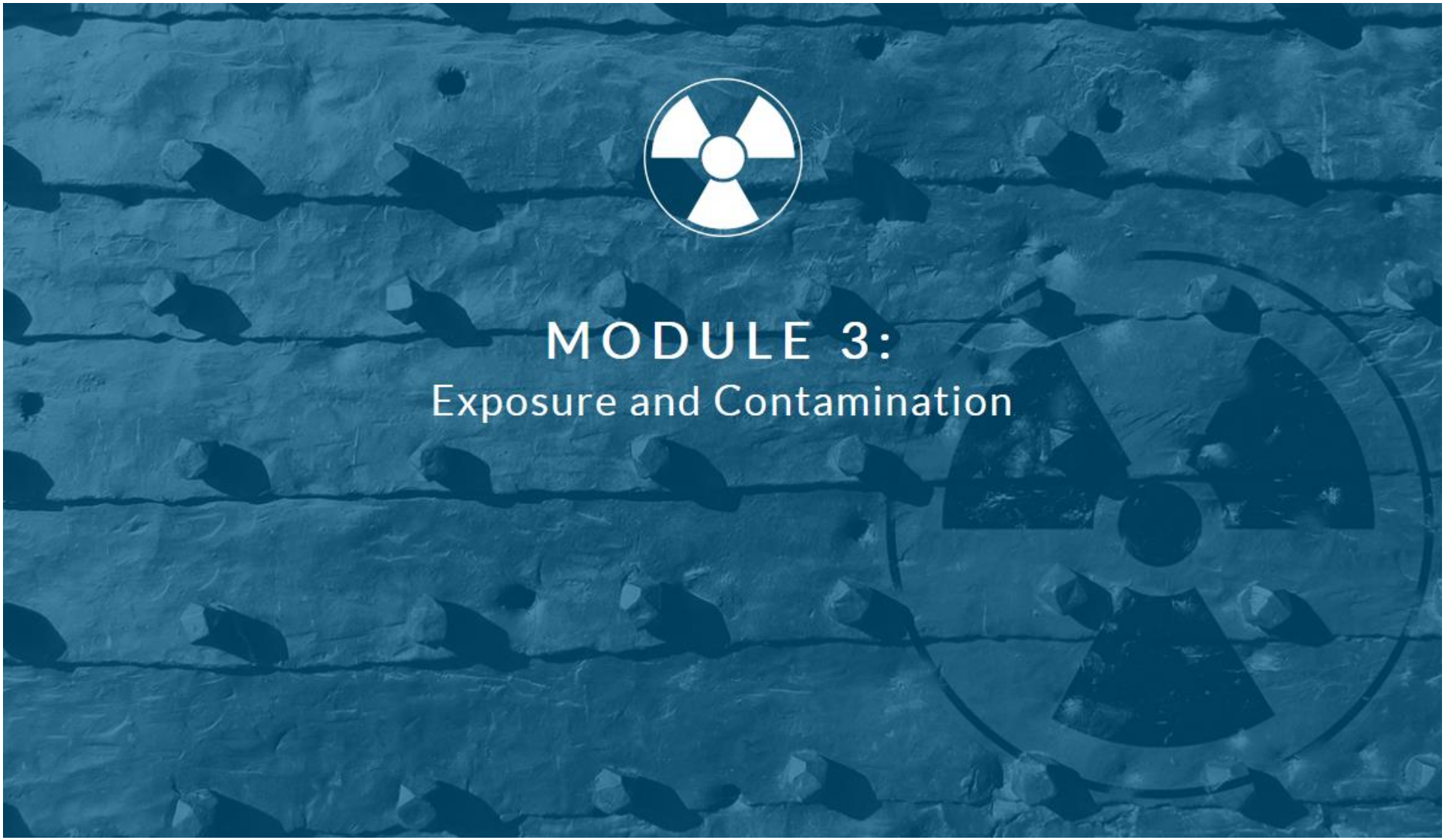
For more information on radiation emergencies and related topics, please visit https://emergency.cdc.gov/radiation/.

Audio Transcript:

- This module covered two separate audiences who may seek information on protective measures during a radiation emergency: medical professionals and the general public.
- Each of these audiences will have different roles and concerns following an emergency, and poison center staff may be called to address any of these concerns.
- Medical professionals, including first responders, may have concerns about personal danger or risk posed by treating patients, so it is important to reiterate the effectiveness of personal protective equipment and universal precautions.

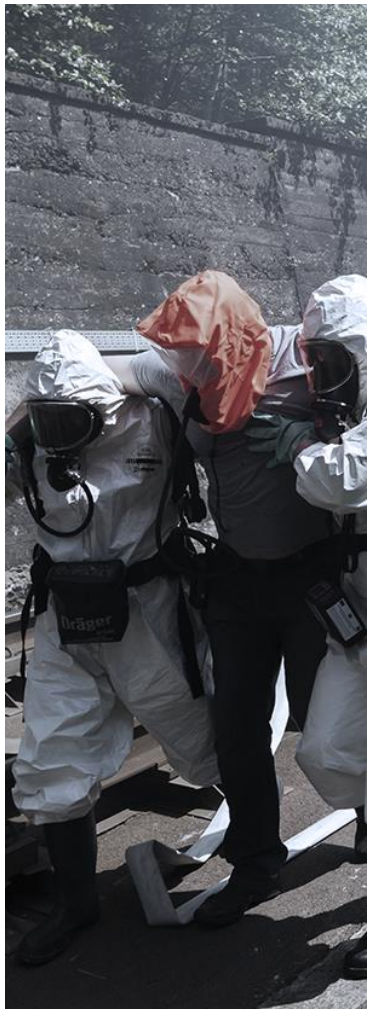
The general public can be divided into three groups: those near the blast or incident and potentially exposed, those injured by a blast, and those geographically removed from the incident but concerned. Each of these groups will need different communication messages

Module 3: Exposure and Contamination



Overview of Module

- Exposure versus contamination
- Signs and symptoms
- Threats to high-risk groups
- Assessment and management



Learning Objectives

1. Differentiate between exposure and contamination
2. Identify high-risk populations
3. Define short- and long-term health effects related to exposure and contamination
4. Provide initial triage and management actions for individuals exposed or contaminated
5. Use communication skills in educating and counseling patients

Exposure vs. Contamination

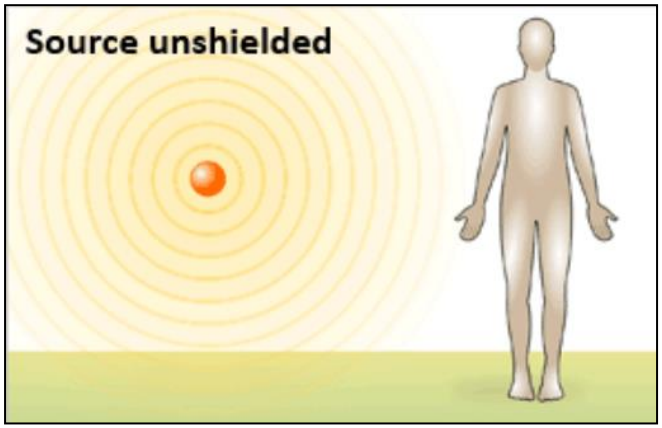
Key principles to understand and communicate during any radiation emergency include:

- **Exposure:** occurs when radiation energy from an external source penetrates the body
- **Contamination:** occurs when radioactive material is released into the environment and then is ingested, inhaled, injected or deposited on the body's surface

The incidents described in Module 1 may lead to exposure or contamination.

Throughout this module, we'll take a closer look at radiation exposure and contamination, the different types of each, and how they affect people differently, including short-term and long-term health effects, as well as higher risk populations.

A Closer Look at Exposure



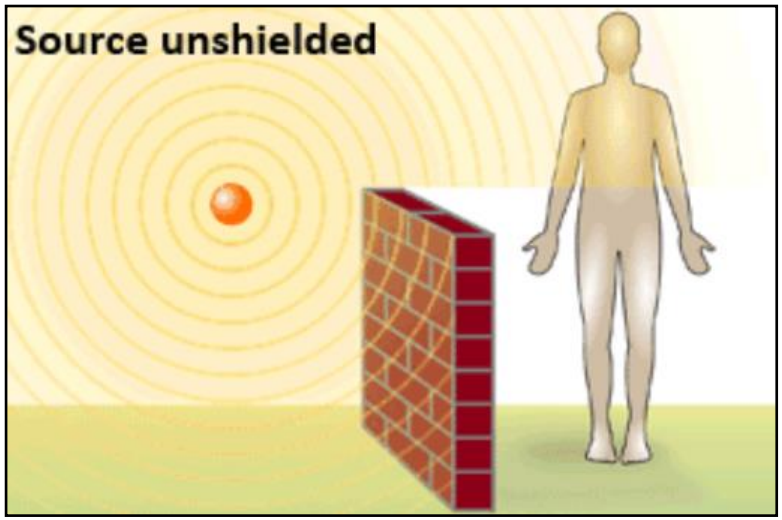
Person is in close proximity to a source of gamma radiation. When the source is unshielded, the person is at risk for exposure. When the source is shielded, the person is not at risk for exposure.
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

Types of Exposure

- **Whole body exposure** occurs when a person receives penetrating radiation without any portion of the body being shielded.
- **Partial body exposure** occurs when shielding of sufficient thickness blocks a portion of the body from receiving penetrating radiation.

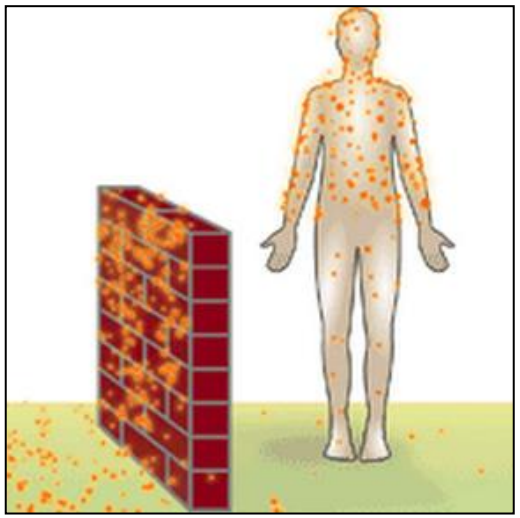
Radiation Exposure

- Risk of exposure will be mitigated only after the following steps are taken:
  - The source of radiation is shielded completely
  - The process causing exposure stops
  - A person moves to a safe distance away from the source



Person is <u>partially</u> shielded from gamma radiation source, leading to a risk of partial body exposure.
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

A Closer Look at Contamination



Person is partially shielded from the radiation source and contamination. The lower body is shielded from radioactive material and contamination is concentrated to the torso, arms, and head. Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

Radiation Contamination

This module focuses on contamination of people.

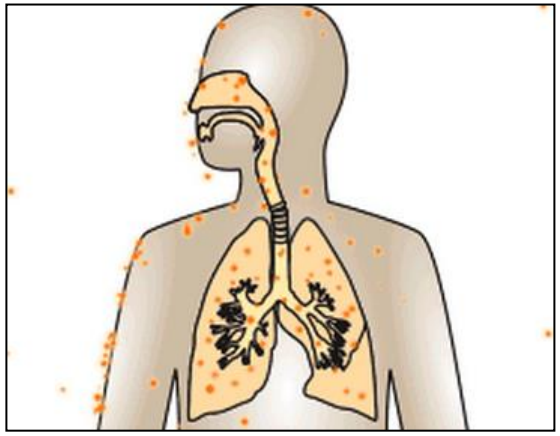
- Contamination occurs when radioactive material is deposited on or in a person.
- Radioactive materials released into the environment can cause air, water, surfaces, soil, plants, buildings, or animals to become contaminated.
- While contamination of people is the primary focus of this module, it is important to note that radiation emergencies may lead to contaminated air or water supplies, as well as contamination of other environmental objects and living things.

External Contamination

- External contamination occurs when radioactive material, such as dust, powder, or liquid, comes into contact with a person's skin, hair, or clothing.
- External contamination stops when the radioactive material is removed:
  - Shedding contaminated clothes
  - Completely washing off the contamination
- External contamination may lead to internal contamination if material enters the body.
  - For example, shrapnel wounds from an exploded dirty bomb may contain radioactive material that enters the blood stream.

Module 4 fully explores decontamination, but it’s important to note that when a person is externally contaminated, radiation exposure stops only when the radioactive material is carefully removed.

Internal Contamination



Internal contamination depicted through inhalation of radioactive material
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

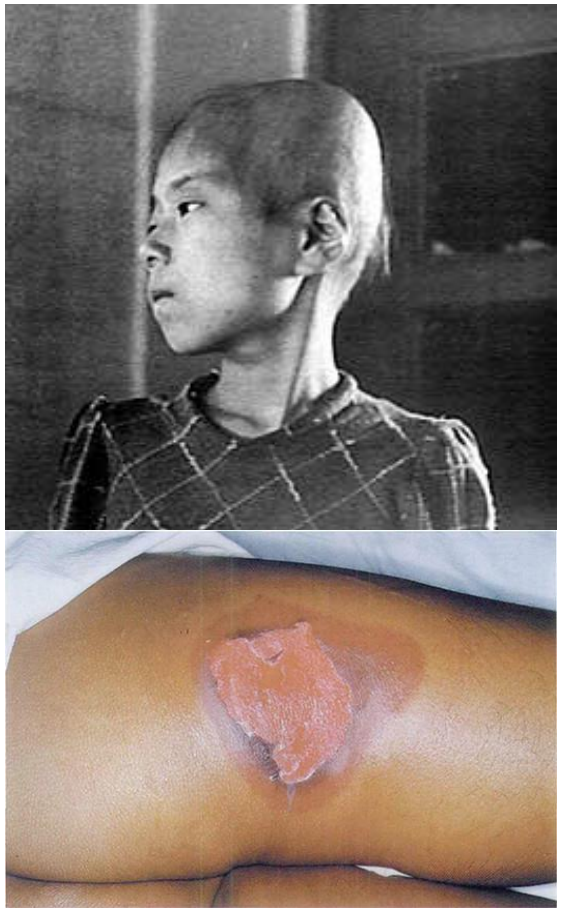
Internal contamination occurs when radioactive material is taken into the body.

- **Inhalation**: radioactive material can be breathed in and particles tiny enough may reach the alveoli while larger particles may sit in airways.
- **Ingestion**: radioactive materials may be swallowed inadvertently, such as when a food or a water source is contaminated.
- **Injection**: if an open wound is contaminated with radioactive materials, tiny particles may be absorbed into the body's bloodstream or lymphatic system.
  - An exception to this is tritium, which may permeate intact skin
- When radioactive material is deposited into an organ, exposure at that location results.
- Internal contamination continues until the radioactive material decays, is flushed from the body by natural processes, or is removed by medical countermeasures for certain specific radionuclides.
- Medical countermeasures and decontamination are explored more fully in Module 4.

Signs and Symptoms of Exposure and Contamination

- Understanding the key differences between exposure and contamination will help poison center staff field inquiries from first responders, medical professionals, and the general public, particularly in the aftermath of a radiation emergency.
- Following a radiation emergency, many people will understandably be frightened and confused about their own risk, even if they are not near the site of an incident, so it is important to help reassure them.
- For those near a blast or for those responding to injuries, the primary communication objective is to treat life- and limb-threatening injuries first while properly protected according to OSHA standards.

Acute Health Effects



Top: Young girl with acute radiation syndrome (ARS) as a result of the blast at Hiroshima.
Source: Wikimedia Commons.

Bottom: Cutaneous radiation injury from exposure to industrial radiography source (Ir-192)
Source: Ricks RC and reprinted with permission

- Acute radiation syndrome (ARS) occurs when the dose of radiation is very high (around 10,000 times or more than the amount received in a typical chest x-ray). Overall, small amounts of internal or external contamination will not cause these types of symptoms.

  - Initial signs of ARS include nausea, vomiting, headaches, or diarrhea within minutes to days after exposure.
  - These symptoms should be addressed immediately by a medical professional.
  - ARS occurs only if the radiation dose was high, penetrating, received in a short time, and the whole body was exposed.

Treatment of ARS is explored in Module 4.

- Cutaneous radiation injury (CRI) occurs when a large dose of radiation causes injury to skin. CRI is usually delayed, and may occur several days to weeks after the exposure.
  - The dose required to cause CRI is high.
  - Signs and symptoms include itching or tingling skin, swelling, or redness around the affected area, but may progress to blistering or necrosis.

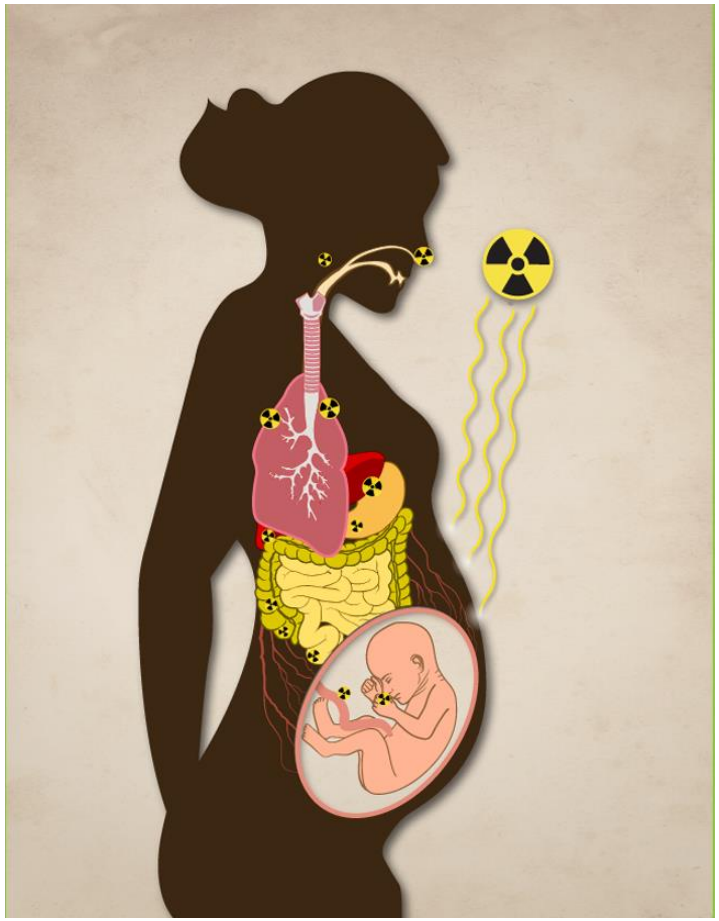
Individuals who suspect CRI should seek medical attention immediately.

Long-Term Health Effects

- People who receive high doses of radiation could have a greater risk of developing cancer later in life, depending on the radiation dose.
- For people who receive low doses of radiation (such as from an x-ray), the risk of cancer from radiation exposure is so small that it cannot be separated from other cancer-causing processes (e.g., exposure to chemicals, genetics, smoking, or diet).
- Some populations are more vulnerable to radiation exposure, including children and fetuses.
  - These groups also may develop long-term health effects related to radiation exposure.
- Questions about long-term health effects during a radiation emergency may take a backseat to inquiries about protection, decontamination, or treatments, but questions following a blast or other emergency may emerge.
- Following a radiation emergency, health officials will monitor people affected by radiation emergencies for long-term health effects, including different cancers.

In the next section, we'll explore some considerations for high-risk populations, including fetuses, which may also be at risk for long-term health effects following exposure.

Radiation Exposure and Contamination among High-Risk Groups



High-Risk Groups

- A developing fetus is most vulnerable to the effects of radiation exposure.
- Other high-risk groups who are more vulnerable to health effects include:
  - Infants and children
  - The elderly
  - People with compromised immune systems
  - Breastfed children: Mothers can pass radioactive material to their babies through breast milk.

Medical professionals must be able to identify these groups and to respond to their needs appropriately, particularly as they relate to treatments. It is important for everyone, especially these groups, to follow the protective action instructions outlined in Module 2 and to seek medical attention after a radiation emergency as soon as it is safe to do so.

Triaging Exposure and Contamination

The overarching objective for first responders is to stabilize and manage medical injuries while wearing the appropriate PPE according to OSHA standards.

Some radiation emergencies, such as an IND or RDD, may cause traumatic injuries as well as radiation exposure or contamination, called combined injuries. Patients with external contamination should receive decontamination according to your institution's plan.

First responders and medical professionals may also have concerns about potential exposure resulting from treating injured patients. Reiterate to any personnel that if the proper PPE according to OSHA standards are worn and followed, their risk is minimal.

Conclusion

- **Exposure**: when radiation energy from an external source penetrates the body.
- **Contamination**: when radioactive material is released into the environment and then ingested, inhaled, injected, or deposited on the body's surface.
- An individual may be both exposed and contaminated.
- Health effects can be acute or chronic (long-term).
- Medical triage is paramount.

For proper decontamination and treatment of radiation-related injuries, please see Module 4.

For more information on radiation emergencies and related topics, please visit www.emergency.cdc.cov/radiation.

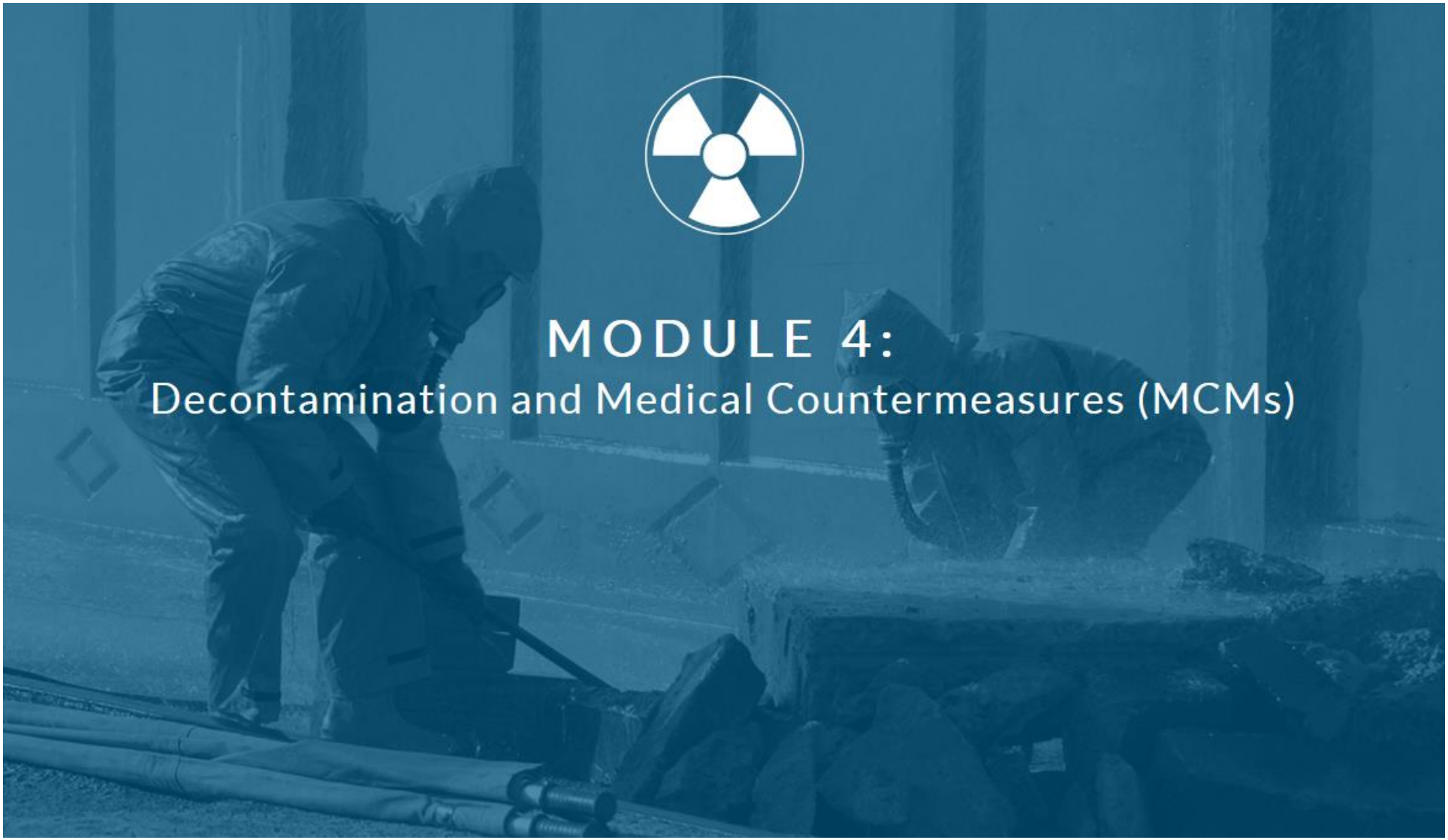
Audio Transcript: Understanding the difference between exposure and contamination, including internal and external, is fundamental to a radiation emergency response and communication.

Many inquiries may be made by people who aren't exposed or contaminated, but who are nervous or frightened about their risk.

Explaining these concepts can help alleviate concern and prevent local emergency services from being overwhelmed.

For first responders and medical professionals, the primary concern is to triage and treat medical injuries using the proper PPE according to OSHA standard CFR 1910.120.

Module 4: Decontamination and Medical Countermeasures (MCMs)



Overview of Module

- External decontamination
- Internal decontamination
- Acute Radiation Syndrome (ARS)
- Cutaneous Radiation Injury (CRI)
- Psychosocial support

Learning Objectives

1. Define internal and external contamination
2. Identify the signs of internal and external contamination
3. Define Acute Radiation Syndrome
4. Identify the associated symptoms and treatment options of Acute Radiation Syndrome
5. List two or more medical countermeasures that can be used in a radiation emergency
6. Use communication skills in educating and counseling patients

A closer look at decontamination

- External contamination is defined as radioactive material located in places it should not be. Therefore, the goal is to remove all contamination located on the outside of the body, or as much contamination as possible without damaging the skin or creating other adverse effects.
- Once you have performed a site assessment and have donned proper PPE according to OSHA standards, perform life-saving medical care.
- Once lifesaving care is provided, decontaminate the victim.
- The goal is to minimize the radiation dose to the patient from internal contamination and provide medical countermeasures, if any are indicated and available.

Screening for External Contamination

Top: Radiation portal monitor

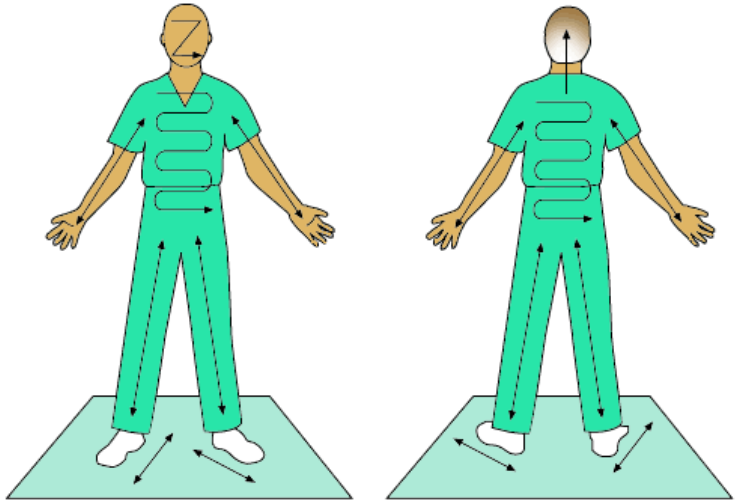
Bottom: Geiger-Muller detector used for radiation surveys
Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

- Individuals from a variety of professional backgrounds may be asked to help with a radiological survey or screening for external contamination.
- When monitoring for radioactive contamination, very sensitive detection instruments are necessary, such as Geiger counters and portal monitors.
- After a large-scale radiation incident, such as a “Dirty Bomb” explosion, a nuclear power plant accident, or other incident described in Module 1, many individuals may need to be screened for contamination.
- Survey meters are hand-held instruments most commonly used to measure radiation and are frequently referred to as "radiation detectors," "survey meters," “Geiger counters” or "friskers".

Audio Transcript: There are simple instructions for screening for external contamination. Callers may have questions about the process, including how to:

1. Inspect the equipment
2. Perform a battery check
3. Conduct a source/operational check
4. Conduct a background reading
5. Screen for external contamination

How to Screen for External Contamination



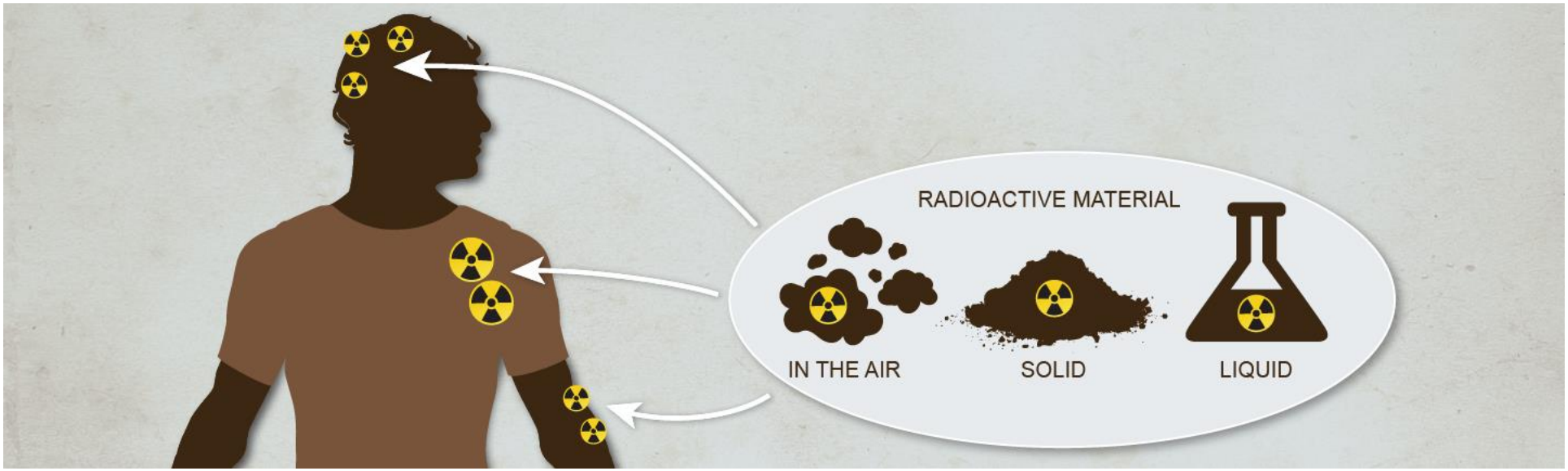
Begin on one side of the body at the head and continue in a back and forth motion over the whole body, moving up and down the extremities. Pay attention to the face, hands, and feet, which are the most likely areas for contamination. Image courtesy of Radiation Emergency Medical Management: REMM (US Department of Health and Human Services)

Using a hand-held radiation detector, start at the head and slowly continue systematically over the whole body, including the feet and soles. Repeat on the other side of the body. A full survey can take many minutes.

You can view a video of how to use a hand-held radiation detector at this link: https://emergency.cdc.gov/radiation/screeningvideos/index.asp.

Audio Transcript: To screen for external contamination using a handheld radiation detector, begin on one side of the body at the head and continue in a back and forth motion over the whole body, moving up and down the extremities slowly. Pay attention to the face, hands, and feet, which are the most likely areas for contamination. This will help the practitioner gauge the severity of contamination levels and could help with patient triage. It is important to screen the feet, including the soles, and repeat the process on the other side of the body.

External Decontamination



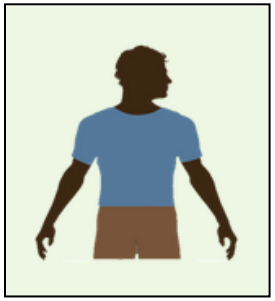
Radioactive material deposited on the outside of the body.

- Removing radioactive material from a person, object, or place is called decontamination.
- External decontamination is the process by which that radioactive material is cleared.
- External contamination occurs when radioactive material, such as dust, powder, or liquid, comes into contact with a person's skin, hair, or clothing.
- It is important to remove radioactive material as soon as possible; removing contamination lowers exposure and minimizes risk of harm.

Instructions for External Decontamination

External decontamination involves three steps:

Step 1	Step 2	Step 3

Take off outer layer of clothing.
• Be very careful in removing your clothing to prevent radioactive dust from shaking loose.
• Put the clothing in a plastic bag or other sealable container. Seal it.
• Put the bag in an out-of-the-way place, away from other people and pets. Follow instructions for proper disposal by public health officials.
 
	Wash yourself off.
	• If you can take a shower:
	  ○ Use soap and shampoo. Do not use conditioner because it will cause radioactive material to stick to your hair.
	  ○ Do not scald, scrub, or scratch your skin.
	  ○ Keep cuts and scrapes covered when washing to keep from getting radioactive material in open wounds.
	• If you cannot take a shower:
	  ○ Wash your hands, face, and parts of your body that were uncovered at a sink or faucet. Use soap and plenty of water.
	• If you cannot use a sink or faucet:
	  ○ Use a moist wipe, clean wet cloth, or damp paper towel to wipe the parts of your body that were uncovered. Pay special attention to your hands and face.
	  ○ Blow your nose and wipe your eyelids, eyelashes, and ears with a moist wipe, clean wet cloth, or damp paper towel.
	  ○ Put used wipes or towels in a bag and keep away from other people and pets.
	  
		Put on clean clothes.
		If you do not have clean clothes (clothes stored in a closet or drawer away from radioactive material), you can:
		• Take off your outer layer of clothing, shake or brush off your clothes, and put your clothes back on.
		• Rewash your hands, face, and exposed skin at a sink or faucet.
		 

Audio Transcript: For the public, the first step of the external decontamination process is to remove clothing and safely store it in a location away from people and pets. Clothes should be placed in a sealable bag or container placed in the corner of a room. Removing the outer layer of clothing during a radiation emergency can remove a large amount of radioactive material. Step two involves washing off the radioactive material. A shower is the most effective option for this step.

If individuals can shower, they should use soap on the body and shampoo to wash their hair, but NOT use conditioner as this will cause radioactive material to stick. They should be careful not to scrub or scratch the skin and not use very hot water. They should keep cuts or abrasions covered when washing to prevent radioactive material from entering an open wound. Tap water is safe to use for decontamination.

When showering is not an option, individuals should wash exposed skin with a damp towel or wet wipe, paying special attention to the face and hands. Individuals should also be encouraged to gently blow their nose, and wipe eyelids, eyelashes, and ears with a damp towel or wet wipe.

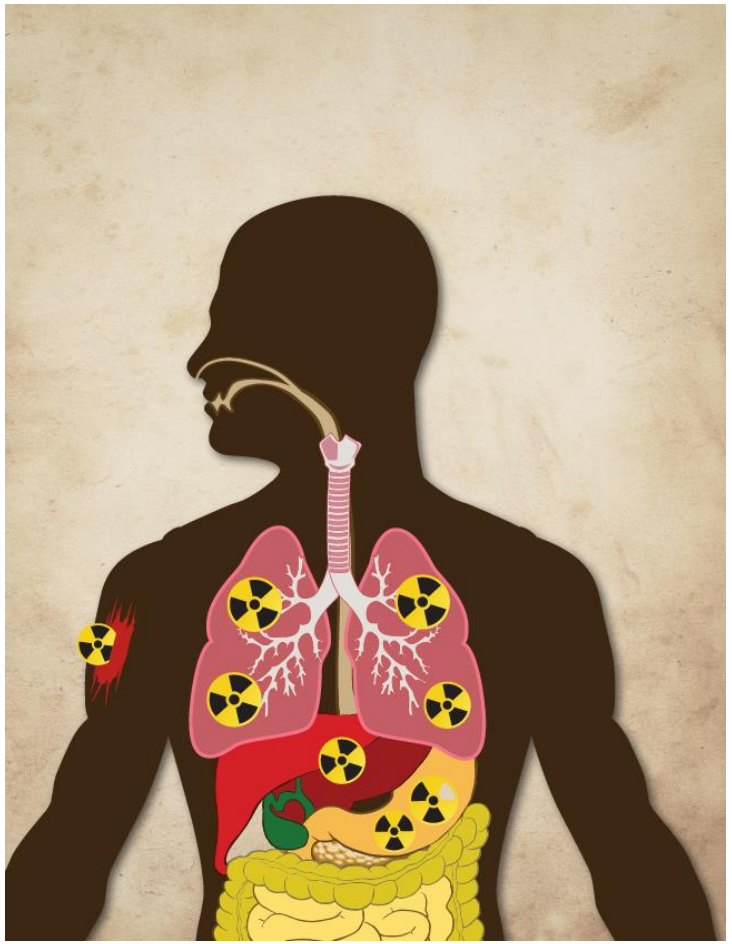
The final step of external decontamination involves re-dressing in clean clothes. Clothes that have been stored in a drawer or closet, away from radioactive material, are safe to wear. If clean clothes are not available, individuals should put the outer layer of clothing back on after brushing and shaking it off. If this step is taken, it is important to rewash hands, face, and any exposed skin.

Everyone, including medical professionals or responders who assists with the external decontamination of others needs to take the following precautions:

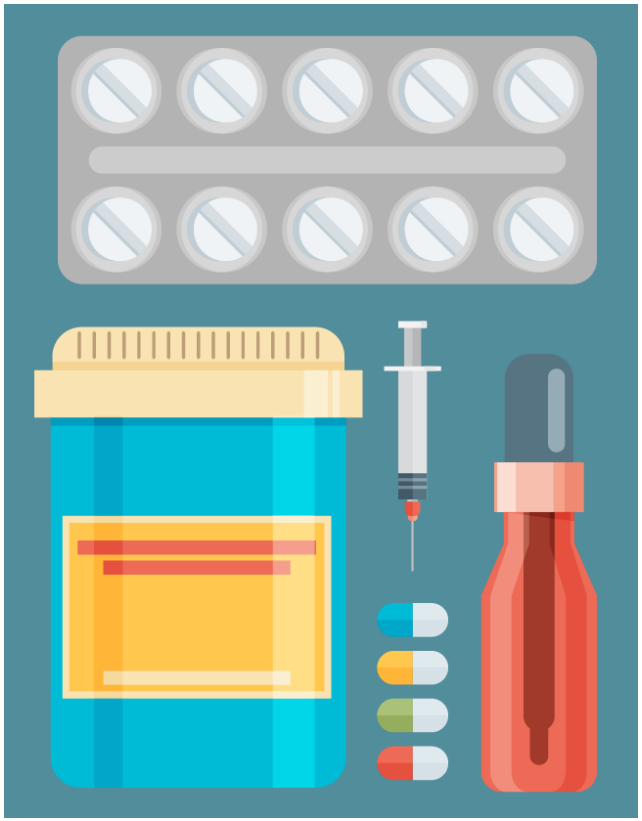
- Wear waterproof gloves and gown
- If you are in the emergency department, you need to wear a surgical mask and apply universal precautions.
- Keep cuts and scrapes covered when washing to keep radioactive material out of the wound
- At a sink or faucet, rewash the hands, face, and parts of the body that were uncovered

Internal Contamination

- During a radiological or nuclear emergency, radioactive materials may be released into the air and then breathed into the lungs, or may get into the body through open wounds causing internal contamination.
- Radioactive materials can also contaminate the local food supply and get into the body through eating or drinking.
- The sooner internal contamination is removed from the body, the fewer and less severe the health effects will be.
- Small amounts of internal contamination may not need treatment.



A Closer Look at Medical Countermeasures (MCMs)

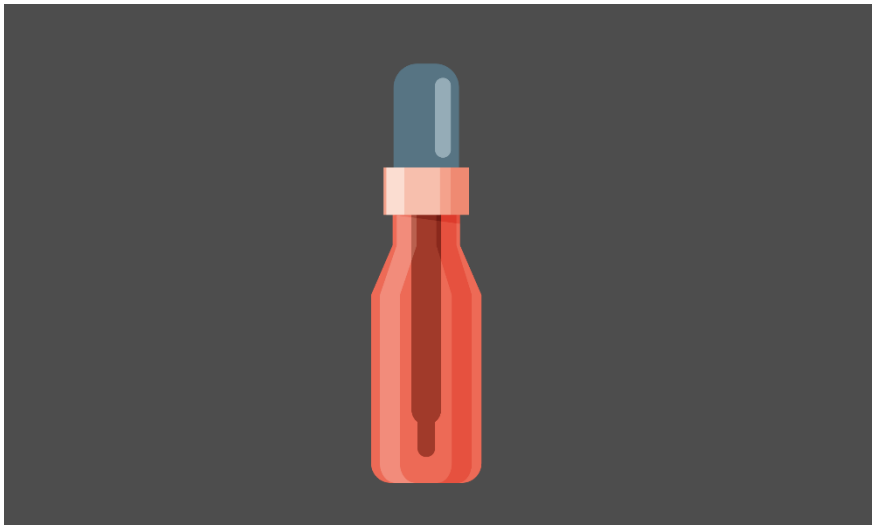


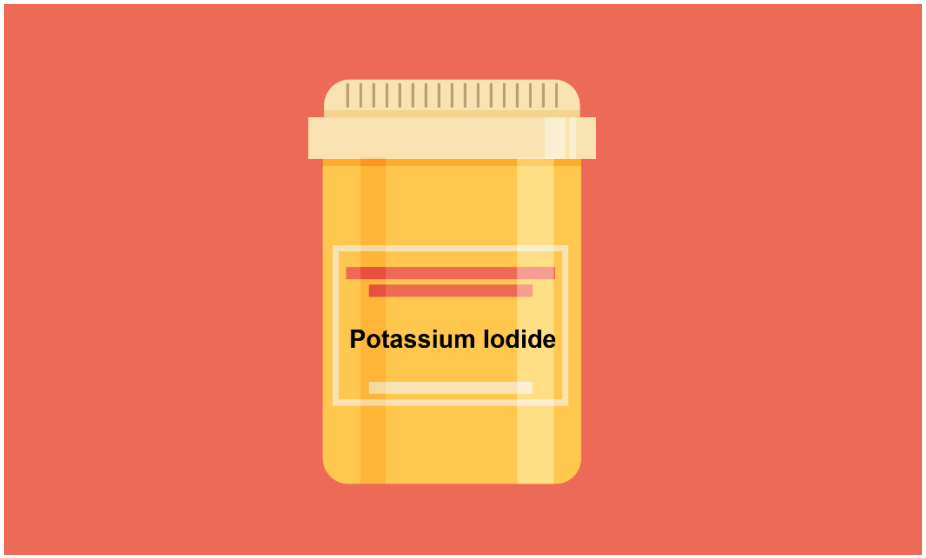
- Medical countermeasures (MCMs) for radiological-associated illness typically fall into two categories: those that treat the effects of radiological-associated illness such as ARS, and those that limit or help eliminate radioactive material absorbed into the body (internal contamination).
- Please note that each MCM has a particular medical indication (more in the following pages). A single MCM does not work for all radioactive materials.
- During ARS, the high dose of radiation damages the hematopoietic system by preventing the proliferation of blood cells leading to anemia, bleeding and infection. Treatment includes antineutropenics like the following 2 FDA-approved drugs:
    - Filgrastim (Neupogen®)
    - Pegylated filgrastim (Neulasta ®)

- Some medical treatments are available for limiting or removing internal contamination depending on the type of radioactive material involved. Treatments include:
    - Potassium iodide (KI)
    - Prussian Blue
    - DTPA (diethylenetriamine pentaacetate)
- These MCMs are in the Strategic National Stockpile (SNS) which is available for state, local, tribal and territorial responders requesting federal assistance when their local supplies run out in a public health emergency. For more information, please go to: https://www.cdc.gov/phpr/stockpile/index.htm.

Potassium Iodide (KI)

- Potassium iodide is a salt of stable (not radioactive) iodine and is indicated for blocking uptake of radioactive iodine (i.e., I-131 from a nuclear reactor accident) or other incidents in which radioactive iodine is released.
- When administered promptly (within hours), it can help block radioactive iodine from being absorbed by the thyroid gland, thus protecting this gland from radiation injury.
- Potassium iodide does not keep radioactive iodine from entering the body and cannot reverse the health effects caused by radioactive iodine once the thyroid is damaged.
- **Potassium iodide protects only the thyroid from radioactive iodine uptake.** Potassium iodide does not provide protection from other radionuclides.





- Potassium iodide is available over-the-counter in liquid or tablet forms; however, there are health risks associated with it, and people should wait on the advice of public health or emergency management officials before taking it following a radiation emergency.
- Individuals should not take potassium iodide until told to do so by the authorities. If an individual takes it when there is no anticipated release of radioactive iodines, he or she may develop adverse effects that could have been prevented.

Potassium Iodine (KI) Summary Table

Recommended Dosage, Frequency, and Length of Time	**Newborns (birth to 1 month of age)** • Single dose of 16 mg (¼ of a 65 mg tablet or ¼ mL of solution) by mouth • FDA does not recommend repeat dosing unless other protective measures are not available. • This dose is for both nursing and non-nursing newborn infants. **Infants and Children (between 1 month and 3 years of age**) • 32 mg (½ of a 65 mg tablet OR ½ mL of solution) daily by mouth • This dose is for both nursing and non-nursing infants and children. **Children between 3 and 18 years of age** • 65 mg (one 65 mg tablet OR 1 mL of solution) daily • Children who are adult size (greater than or equal to 150 pounds) should take the full adult dose, regardless of age. **Adults (>18 years of age)** • 130 mg (one 130 mg tablet OR two 65 mg tablets OR two mL of solution) daily **Women who are breastfeeding or pregnant** • One dose of 130 mg • FDA does not recommend repeat dosing unless other protective measures are not available.
Indication	Blocking internal uptake of radioactive iodine (i.e., I-131 from a nuclear reactor accident)
When administer	As soon as possible after exposure with predicted thyroid dose: Children and pregnant women (> or = 0.05 Gy), adults 18 through 40 years (> or = to 0.1 Gy) and adults over 40 years (> or = to 0.5 Gy)
Prophylactic?	Yes, most efficacious when given prior to exposure
Requires Prescription?	No, is available over-the-counter (OTC) as liquid or tablet
How administered	Orally
Contraindications/Warnings	• Persons with known iodine sensitivity should avoid KI, as should individuals with dermatitis herpetiformis and hypocomplementemic vasculitis, extremely rare conditions associated with an increased risk of iodine hypersensitivity. • People with nodular thyroid with heart disease should not take KI. Individuals with multinodular goiter, Graves' disease, and autoimmune thyroiditis should be treated with caution -- especially if dosing extends beyond a few days.
Notes	• Only protects thyroid from internal contamination with radioactive iodine. • Since KI protects for approximately 24 hours, it should be dosed daily in situations involving continuing or ongoing contamination.

	• If primary public health protection measures (evacuation, sheltering, and control of the food supply) cannot be readily put into place, multi-dosing of KI may be required, sometimes up to 7-14 days. • Unless other protective measures are not available, FDA does not recommend repeat dosing in pregnant women and neonates because of the potential to suppress thyroid function in the fetus and neonate.

Audio Transcript: If public health or emergency management officials advise that potassium iodide may be taken, it is important to understand appropriate dosing. Infants, young children, and pregnant women are at higher risk for adverse health effects following exposure or contamination. Women who are pregnant or who are breastfeeding and newborns should only take a single dose of potassium iodide. Please refer to this table for dosages.

Tablets come in two strengths, 65 milligrams and 130 milligrams. The tablets have lines on them so they can be cut into smaller pieces for lower doses. Each milliliter of the oral liquid solution contains 65 milligrams of potassium iodide. Taking a stronger dose of potassium iodide, or taking it more often than recommended, does not offer more protection and can potentially cause adverse effects.

Adults older than 40 have the lowest chance of developing thyroid cancer or thyroid injury unless they are internally contaminated with a very large dose of radioactive iodine. Therefore, they should not take potassium iodide unless specifically instructed to by public health or emergency management officials.

Prussian blue

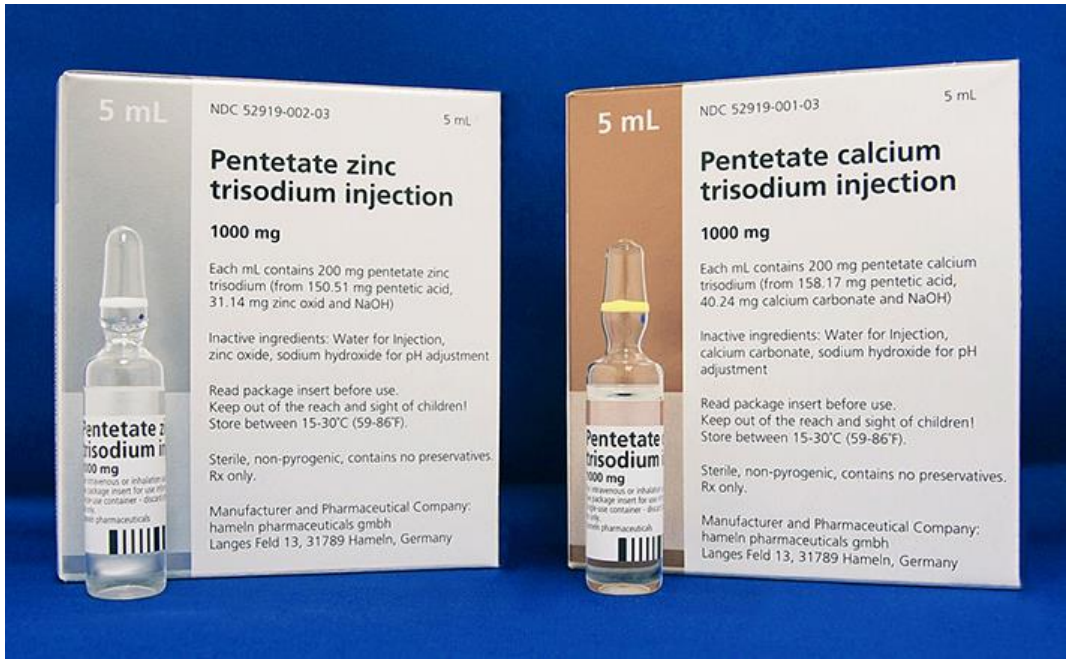
- Prussian blue is a pill indicated to prevent the absorption of radioactive cesium (i.e., Cs-137) and thallium by trapping it in the gut lumen. The radioactive material is then moved through the bowels and excreted without being absorbed.
- People who have had constipation, blockages in the intestines, or certain stomach problems should be sure to tell their doctors before taking Prussian blue.
- Before taking Prussian blue, people also should be sure to tell their doctors about any other medicine they are taking.
- People **SHOULD NOT** take Prussian blue artist's dye in an attempt to treat themselves. This type of Prussian blue is not designed to treat radioactive contamination and can be harmful if ingested.
- Prussian blue is only available by prescription and is given in 500-milligram capsules that can be swallowed whole. The drug is safe for most adults, including pregnant women, and children (2 to12 years) but safe dosing has not been established for infants.
- Pediatric patients and those who cannot tolerate swallowing large numbers of capsules should open the capsules and mix with bland food or liquids.
- Studies of Prussian blue in breastfeeding women have not been conducted.
    - If internal contamination with radioactive cesium and/or thallium is suspected, breastfeeding should be avoided to prevent transmission via breastmilk.

Prussian Blue (summary table)

Recommended Dosage, Frequency, and Length of Time	**Infants (newborn to 2 years of age)** • Not FDA approved in this age group, however an investigational new drug (IND) or emergency use authorization (EUA) may be obtained. • Duration of therapy depends on total body burden and response to treatment **Pediatric (2-18 years of age)** • 1 gram, 3 times daily • Capsules may be opened and contents mixed with food. • Duration of therapy depends on total body burden and response to treatment. **Adults (>18 years of age), including pregnant women** • 3 grams, 3 times daily • Duration of therapy depends on total body burden and response to treatment.
Indication	Internal contamination of radioactive cesium (i.e. Cs-137) and thallium
When administer	After diagnosis of internal contamination has been made using laboratory tests (urine bioassay or whole body counting)
Prophylactic?	No
Requires Prescription?	Yes
How administered	Orally
Contraindications/Warnings	• No absolute contraindications • People who have had severe constipation, blockages in the intestines, or certain stomach problems should be sure to tell their doctors before taking Prussian blue.
Notes	• People should not use Prussian Blue artist's dye. This is not made for treating radioactive contamination. • FDA recommends a minimum of a 30-day course, but decision to stop treatment should be made on a case-by-case basis. • Monitor urine bioassay and whole body counting to assess treatment efficacy.

DTPA (Diethylenetriamine pentaacetate)

- DTPA (Diethylenetriamine pentaacetate) is a prescription medication that can bind to radioactive material to decrease the amount of time it takes to expel that material from the body through the urine.
- DTPA is available in two forms: Calcium DTPA and Zinc DTPA.
- DTPA can successfully bind to radioactive plutonium, americium, and curium.
- DTPA does not work on all radioisotopes (for example cesium-137) that may enter the body following an emergency.
- DTPA works best when given shortly after radioactive plutonium, americium, and curium have entered the body.



Source: Hameln Pharmaceuticals

- Ca-DTPA has been shown to cause birth defects in laboratory animals (FDA pregnancy category C). Therefore, only Zn-DTPA should be used as first and subsequent doses in pregnant women.
- Studies of Ca-DTPA or Zn-DTPA in breastfeeding women have not been conducted.
    - If internal contamination with plutonium, americium, or curium is suspected, breastfeeding should be avoided to prevent transmission via breastmilk.

DTPA (summary table)

Recommended Dosage, Frequency, and Length of Time	**Pediatric (less than12 years of age)** • Calcium/Zinc DTPA 14 milligrams per kg body weight (not to exceed 1 gram per day) IV • Note: Safety and efficacy of nebulized route has not been studied in pediatric patients. • Duration of therapy depends on total body burden and response to treatment. **Adults and Adolescents (12 years of age or older)** • Calcium/Zinc DTPA 1 gram IV or via nebulizer per day • 1 gram mixed with 10 cc 2% lidocaine in 100 cc D5W or NS for wound irrigation of contaminated wounds by indicated radionuclides • Duration of therapy depends on total body burden and response to treatment. **Pregnant Women** • Zinc DTPA at above dosages should be used exclusively, if available. • If only Calcium DTPA is available (FDA Pregnancy Category C), a single dose can be given with zinc supplementation.
Indication	• Internal contamination with radioactive plutonium, americium, curium and other transuranic metals Does <u>not</u> work on all radioisotopes (for example cesium-137) and should not be used for uranium or neptunium
When administer	• DTPA works best when given as soon as possible after internal contamination. • Begin treatment with Calcium DTPA, then change to Zinc DTPA for maintenance, as indicated.
Prophylactic?	No
Requires Prescription?	Yes
How administered	Intravenous, inhaled via nebulizer or solution used for wound irrigation
Contraindications/Warnings	• No absolute contraindications • Use carefully in patients with diminished renal function and also a history of hemochromatosis. • DTPA may chelate essential metals such as zinc, magnesium, and manganese. Supplementation may be required.
Notes	• DTPA is available in two forms: Calcium DTPA and Zinc DTPA. • When given within the first 24 hours after internal contamination has occurred, Calcium DTPA (Ca-DTPA) is 10 times more effective than Zinc DTPA (Zn-DTPA). After 24 hours have passed, Ca-DTPA and Zn-DTPA are equally effective. • Even when treatment cannot be started right away, individuals should be given DTPA as soon as the products are available. • Studies of Ca-DTPA or Zn-DTPA in breastfeeding women have not been conducted; however if internal contamination is suspected, breastfeeding should be avoided to prevent transmission via breastmilk.

Colony Stimulating Factors (CSF)

Image Source: Wikimedia Commons

- A person who has received a very high dose of radiation may experience bone marrow suppression, possibly resulting in infection and uncontrolled bleeding.
- Filgrastim (Neupogen®) and Pegylated-Filgrastim (Neulasta®) are FDA-approved medications to treat people who have received high doses of radiation resulting in bone marrow suppression.
- Sargramostim (Leukine®), TBO-filgrastim (Granix®) and filgrastim-sndz (Zarxio®) are not FDA-approved for this indication, but have been used successfully for cancer patients to stimulate the growth of white blood cells after chemotherapy or radiation therapy.
- They may be authorized for use via FDA issuance of an Emergency Use Authorization (EUA) in an emergency.
- In certain cases, severe radiation exposure may lead to bone marrow destruction, and these drugs could be used during such an emergency. It is important to follow the recommendations by public health officials because these medications may cause serious side effects (i.e., bone pain and spleen rupture). Generally, only people who have received large radiation doses that cause ARS would benefit from these medications.

Colony Stimulating Factors (CSF) (continued)

Image Source: Wikimedia Commons

Recommended Dosage, Frequency, and Length of Time	**Adults and Pediatrics (Filgastrim)**
	• 10 mcg/kg subcutaneous injection of Filgrastim (Neupogen®) daily
	• Continue daily administration until absolute neutrophil count remains greater than 1,000/mm^3 (= 1.0 x 10^9 cells/L) for 3 consecutive (daily) CBCs or exceeds 10,000/mm^3 (= 10 x 10^9 cells/L) after a radiation-induced nadir.
	Adults (Pegfilgastrim)
	• Two doses of pegfilgastrim (Neulasta®), 6 mg each, administered subcutaneously one week apart
	• A CBC should be obtained prior to administration of the second dose of Neulasta®. Subject matter experts recommend not administering the second dose if absolute neutrophil count is greater than 5,000/mm^3 (= 5.0 x 10^9 cells/L).
	Pediatrics (Pegfilgastrim)
	• For pediatric patients weighing more than 45 kg, use adult dosing
	• Otherwise, two doses subcutaneously one week apart based on weight:
	  ○ Less than 10 kg: 0.1 mg/kg
	  ○ 10-12 kg: 1.5 mg
	  ○ 21-30 kg: 2.5 mg
	  ○ 31-44 kg: 4 mg
	• A CBC should be obtained prior to administration of the second dose of Neulasta®. Subject matter experts recommend not administering the second dose if absolute neutrophil count is greater than 5,000/mm^3 (= 5.0 x 10^9 cells/L).

Indication	Bone marrow myelosuppression seen in acute radiation syndrome (ARS)
When administer	As soon as possible after suspected or confirmed exposure to radiation doses greater than 2 gray (Gy)
Prophylactic?	No
Requires Prescription?	Yes

How administered	Subcutaneous injection
Contraindications/Warnings	• Previous allergic reaction to filgastrim or peg-filgastrim • Monitor patients for fatal splenic rupture, acute respiratory distress syndrome (ARDS), fatal sickle cell crisis and glomerulonephritis.
Notes	• Generally only people who have received large radiation doses that cause ARS would benefit from these medications. • If possible, obtain a baseline complete blood count (CBC) prior to administration of first dose and then serial CBCs about every third day until the absolute neutrophil count (ANC) remains greater than 1,000/mm^3 (= 1 x 10^9 cells/L) for 3 consecutive CBCs. • Sargramostim (Leukine®) is another granulocyte and macrophage colony stimulating factor that is available by emergency use authorization (EUA). Please see package insert for specific information. http://products.sanofi.us/Leukine/Leukine.pdf.

A Closer Look at Radiation Illnesses and Treatments - Acute Radiation Syndrome (ARS)

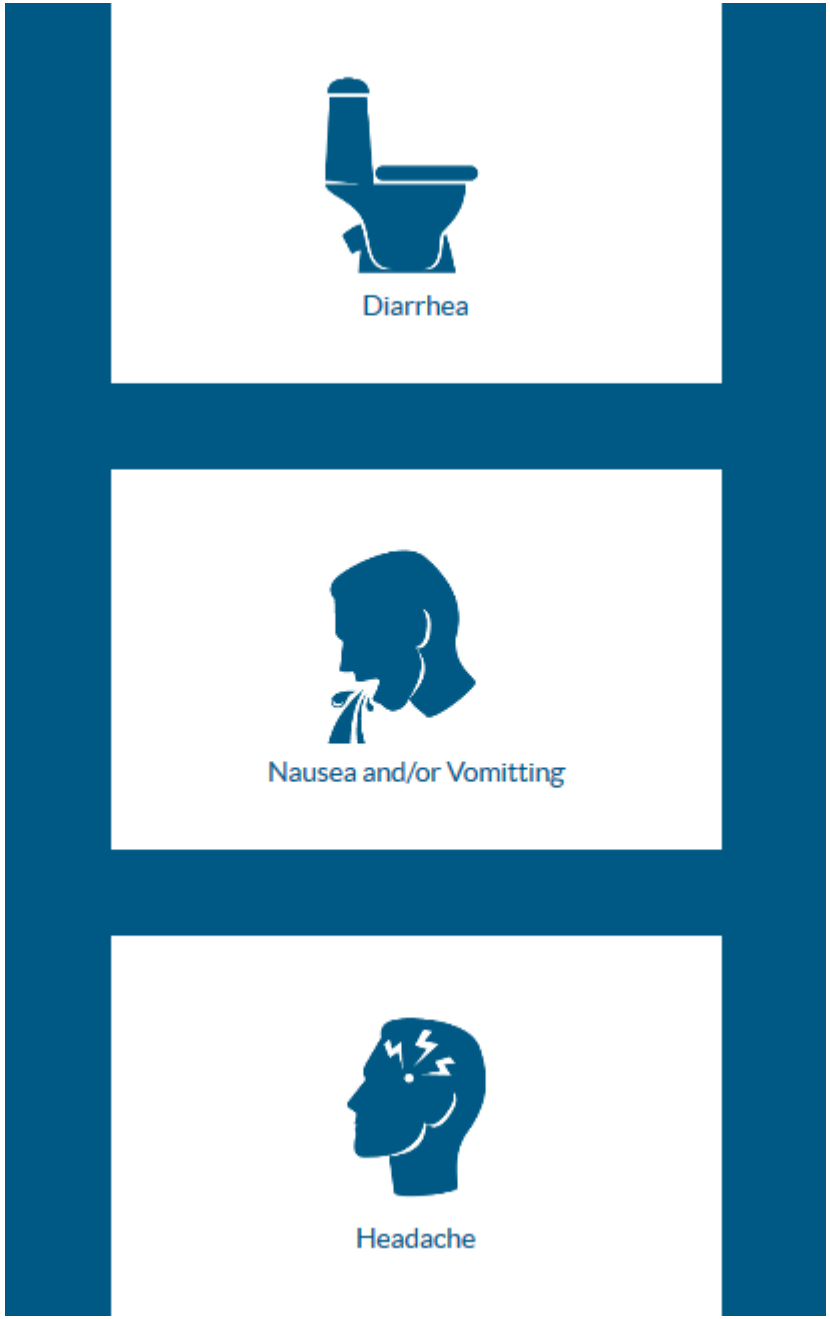
- ARS is a serious illness that can happen when a person is exposed to very high levels of radiation, usually over a short period of time.
- The amount of radiation that a person's body absorbs is called the radiation dose.
- People exposed to radiation will get ARS only if:
    - The radiation dose was very high.
    - The radiation was able to reach internal organs.
    - The person's entire body, or most of it, received the dose.
    - The radiation was received in a short time, usually within minutes.

Symptoms of ARS

- Initial or prodromal symptoms of ARS may include nausea, vomiting, headache, and diarrhea.
- After the initial symptoms, a person usually looks and feels healthy for a period of time, after which he or she will become sick again with variable symptoms. Severity varies depending on the radiation dose that he or she received.
- People who receive a high radiation dose also can have concomitant radiation injury to the skin (covered in the following page).
- If a person experiences these symptoms after a radiation emergency, he or she should seek medical attention as soon as emergency officials determine it is safe to do so.

Treatment of ARS

- Treatment of ARS is supportive and focuses on reducing and treating infections, maintaining hydration, and treating injuries and burns. Some patients may benefit from treatments that help the bone marrow recover its function.
- The lower the radiation dose, the more likely it is that the person will recover from ARS.
- The cause of death in most cases is the destruction of the person's bone marrow, which results in infections and internal bleeding.
- Filgrastim (Neupogen®) and Pegfilgrastim (Neulasta®) have been approved by FDA to treat people who have received high doses of radiation.
- For survivors of ARS, the recovery process may last from several weeks up to two years.



Cutaneous radiation injury from a prolonged medical x-ray fluoroscopy procedure.
Source: Biomedical Imaging and Intervention Journal, LK Wagner, 2007.

A Closer Look at Radiation Illnesses and Treatments - Cutaneous Radiation Injury (CRI)

- CRI happens when exposure to a large dose of radiation causes injury to the skin.
- The presence of a CRI is suspected when a skin burn develops on a person who was not exposed to a source of heat, electrical current, or chemicals.
- People may experience a Cutaneous Radiation Injury (CRI) when:
- They are exposed to certain types of radioactive materials that give off beta particles or penetrating gamma radiation or low-energy x-rays.
- They may experience ARS; however, not everyone who develops CRI will have ARS, especially if the radiation exposure was localized.

Cutaneous Radiation Injury (CRI) (continued)

Symptoms of CRI

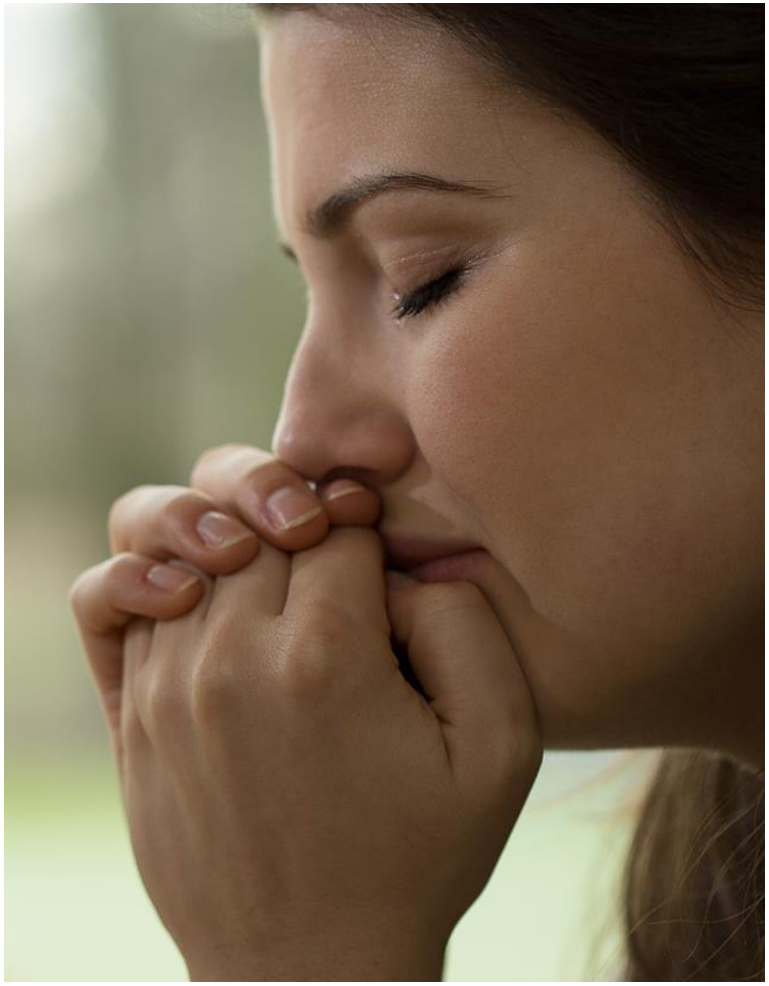
- Symptoms of CRI can appear within a few hours to several days after exposure. The early signs and symptoms of CRI include:
  - Itchiness
  - Tingling
  - Skin redness (erythema)
  - Swelling caused by a buildup of fluid (edema)
- Later signs and symptoms can include erythema, desquamation, and necrosis depending on the dose of radiation received.

Treatment of CRI

- After a radiation emergency, if the person experiences these symptoms, he or she should seek medical attention as soon as emergency officials say it is safe to do so.
- If the person cannot get medical attention quickly, gently rinse the area with water.
- Keep the area clean, dry, and covered until a doctor can provide additional treatment.
- Generally, medical treatment will be supportive (anti-histamines, anti-inflammatories and possibly antibiotics) and will depend on the severity and time course of the radiation exposure.
- Treatment also includes surgical debridement and grafting.

Radiation burn from exposure to industrial radiography source (Ir-192) showing symptoms of Cutaneous Radiation Injury (CRI), including blistering and the hyperpigmented reaction of a lesion with necrotic edges. (Photos courtesy of Ricks RC and reprinted with permission)

A Closer Look at Non-Physical Injuries



An emergency involving radiation will create uncertainty, fear, and terror. Following a radiation emergency, many people with and without physical injury may require social and mental health support to address anxiety caused by the incident.

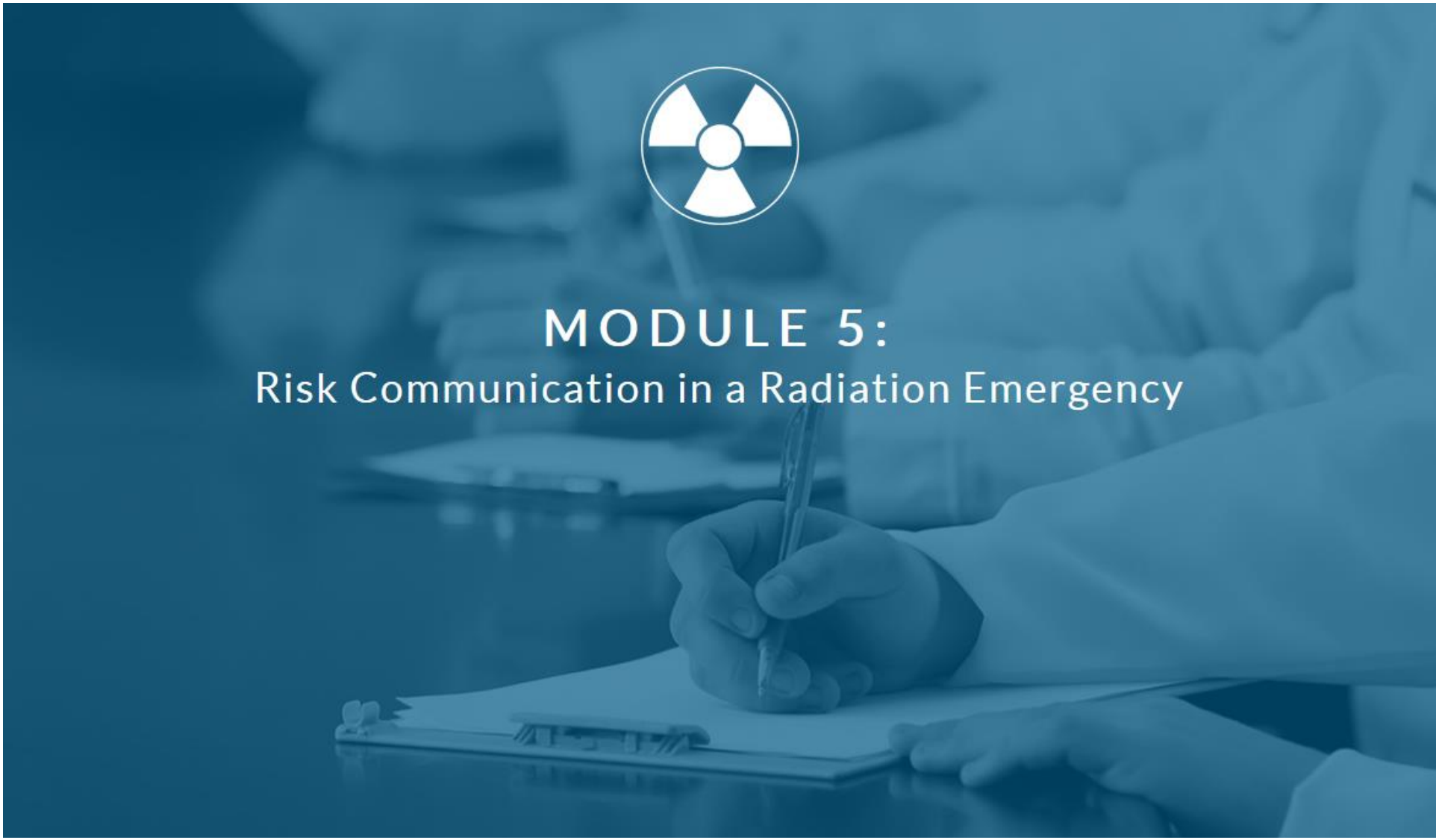
- Those at high risk of developing psychological effects include:
    - Those directly exposed (e.g., people near the blast and those participating in rescue and recovery operations of people and remains)
    - Those who were more vulnerable before the event because of existing mental illness
    - Those who suffered resource losses and disruption of their social supports after the event
- The management of acute psychological and behavioral responses will be as important as the treatment of radiation-related physical injuries and illnesses.

In Conclusion: Decontamination and Medical Countermeasures (MCMs)

- Do not delay or impede stabilization of urgent medical conditions by decontaminating first. Perform a hazard assessment, then don the proper PPE according to OSHA's standard CFR 1910.120, and then perform life -saving medical care.
- If an individual is exposed to radiation and has radioactive contamination, implement external and/or internal decontamination as soon as feasible after life-threatening conditions have been stabilized.
- Decontamination should be conducted according to local policies and procedures.
- Treatment of internal contamination should be conducted under the guidance of a medical professional.
- If symptoms of Acute Radiation Syndrome or Cutaneous Radiation Injury occur, the patient should seek medical attention immediately.

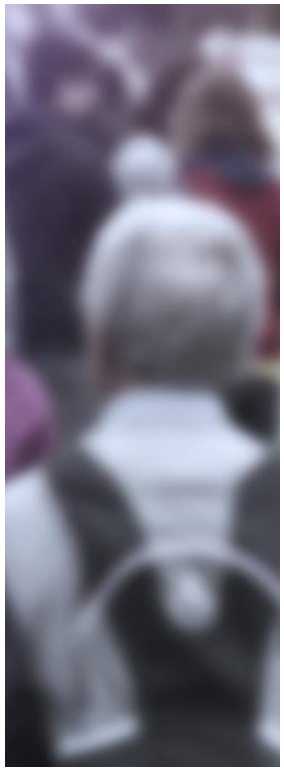
For more information on radiation emergencies and related topics, please visit https://emergency.cdc.gov/radiation/.

Module 5: Risk Communication in a Radiation Emergency



Overview of Module

- Importance of radiation emergency risk communication
- Target audiences and information needs
- Radiation emergency risk communication recommendations
- Radiation emergency risk communication preparation



Learning Objectives

1. Explain the importance of effective communication during a radiation emergency
2. Outline key audiences and their information needs during a radiation emergency
3. Explain radiation risk communication recommendations
4. Use communication skills in educating and counseling patients

Importance of Radiation Emergency Risk Communication

In the event of a radiation emergency, effective communication with the public is one of the most critical elements of emergency response.

Our job as public health and emergency communicators is to:

- Offer the information the public needs
- Counter emotionally-driven behaviors common during an emergency
- Support the public, our colleagues, and the organizations that are offering help

Effective communication will be critical in saving lives and minimizing injury.

Communication Goals

Radiation emergencies are different than many other emergencies you may address at a poison center. Effective communication in radiation emergencies can:

- Decrease illness, injury, and death
- Facilitate response and recovery efforts
- Assist the public in taking desired action and direct individuals to appropriate informational resources
- Reduce rumors and misinformation
- Minimize medically unnecessary self-referrals to hospitals and other critical facilities

Target Audience and Information Needs

Two groups of people are likely to contact a poison center in the event of a radiation emergency: the general public and medical professionals.

- General Public
    - People potentially exposed because of close proximity to a radiological device or hazard
    - Citizens who are not at risk but who are concerned and vocal
- Medical Professionals
    - Emergency Medical Services (EMS) Staff
    - Hospital-Based Emergency Department (ED) Staff
    - Community Clinic and Health Center Staff

Key Information Needs

In the event of an emergency, poison center staff may receive a variety of questions related to radiation exposure, poisoning, sickness, decontamination, and protection.

- Radiation
  - What is radiation?
  - Does radiation cause cancer?
  - How much radiation is considered safe?
  - Who is at risk for health effects after radiation exposure?
  - Is there a treatment for radiation-related health effects?
  - Are there special protective measures for vulnerable populations (pregnant women, elderly, children, and the disabled)?
  - Can radiation be spread from person to person?
- Decontamination procedures:
  - What is decontamination?
  - What should people do if they think they have been contaminated?
  - How should people decontaminate their homes and possessions?
  - How should people decontaminate their pets?

- Food and water safety: Is the food or water safe to ingest?
- Air safety: Is the air safe to breathe?
- Evacuation and shelter:
  - Who should evacuate and who should seek shelter?
  - What should people do if they're told to evacuate?
  - What should people do if they're told to seek shelter?
  - Why are some people being evacuated and not others?

Radiation Emergency Risk Communications Recommendations

Recommendations Based on Research

- CDC's Radiation Emergency Communications team conducted in-depth research (http://emergency.cdc.gov/radiation/pdf/health-message-testing-detonation-of-an-improvised-nuclear-device.pdf) to gain a greater understanding of communicating during a radiation emergency.
- Messages and materials were tested for comprehension, believability, and ability to motivate desired actions.
- Research findings provided insight into effective language and delivery methods to use during a radiation emergency.
- You can click here (https://radiationtraining.rti.org/radiationtraining/RAD-ToolKit/resources.html) for a range of resources available.

Message Development Recommendations

- Create messages that address public concerns.
    - In the first 72 hours of an emergency, provide information that relates to safety and survival as opposed to definitions of technical radiation terms.
- Ensure messages answer the questions they were meant to address.
- Ensure messages directly respond to questions or the public may feel that authorities are hiding information, leading to mistrust of other messages.
- Tailor messages to various audiences.
    - Adapt messages to audiences based on their distance from the incident and regional characteristics.
- Remember the principles of effective crisis and risk communication: Be first, be right, and be credible!

Audio Transcript: Communication research has shown that participants were less interested in hearing definitions of technical radiation terms, and more interested in messages that provided information that had a direct impact on their safety and survival.

Some said they would be more interested in these messages in the weeks and months following the incident, or prior to the event, but that in the first 72 hours, these were not important to them. If a message did not directly answer a question, research participants perceived that authorities were hiding information. This led them to mistrust other messages.

Research participants suggested that the messages should be more specific, based on the distance from the incident and the characteristics of the region, so they would only receive information that is pertinent to them and their vicinity.

Segmenting messages by both time post-event and distance from an incident blast, using damage zones, will help participants take appropriate protective actions. Though precise radiation exposure characteristics will not be known in the first hours following an event, conservative estimates will help communicators target specific messages to the correct audiences.

When reviewing messages about taking shelter, research participants noted that they would want to go get their loved ones and take them home in an emergency. As such, communicators will need to develop strong messaging to convince the public that it is better to stay inside.

Language Recommendations

- Make messages concise.
    - Communicate the main idea of the message in the first one to two sentences. Use plain language when possible.
- Tone should be urgent and serious, but provide a sense of hope.
    - Develop messages that accurately reflect the severity of the situation but also let people know what they can do to survive.
- Use authoritative and declarative language.
    - Modify words like “may”, “might”, and “should” to “will.”
- Use plain, non-technical language.
    - Avoid using unknown terms and phrases.
- Use active voice and plural/personal pronouns in future messaging.
    - Active voice puts more emphasis on the information presented and improves comprehension.
- Provide messages in multiple languages for non-English speakers.

Commonly Misunderstood Radiation Terms	
Background radiation	Protective actions
Contamination/contaminant	Protective measures
Detrimental health effects	Radiation particles
Dose	Radioactive materials
In the path/downwind	Rem/sievert
Internal/external contamination	Responders
Low/high radiation levels	Risk of exposure
Potassium iodide	Sheltering/shelter-in-place

Audio Transcript: Participants requested simple, concise messages. In messages that had no action items, participants often got lost in the content and struggled to identify the main idea. Messages should be less verbose and more to the point. People recalled messages that contained succinct instructions, even if the message was longer than informational messages.

Messages should create a sense of urgency, but also let people know what they can do to help themselves and their families survive an emergency.

The tone of the message must be more directive than suggestive.

Many participants were unfamiliar with radiation terminology, so messages should be written using as little technical jargon as possible. If technical language is unavoidable, unfamiliar terms and phrases should be defined or explained clearly.

Message Structure Recommendations

- Give prioritized action items in each message.
    - Provide simple action items to help build a sense of self-efficacy among message receivers and to empower them to help themselves and others.
- Provide details on how to stay informed.
    - Outline timeframes on next available updates and alternative methods for additional information.
- Create messages for different environments.
    - Provide specific safety information for those who are at home, at work, at public venues, or in transit (on a bus, train, etc.).
- Schedule the timing and order of messages.
    - Organize messages by order of importance.
    - In the first few hours, provide short, simple, action-oriented messages that relate to survival.
    - Group messages with similar content together (e.g., food and water messages).

Audio Transcript: Providing instructions led to a sense of self-efficacy among participants and empowered them to help themselves and others.

Participants wanted more details and instructional information, and wanted instructions tailored to different environments.

Even messages that only instructed participants to stay tuned for additional information were better received than messages that didn't contain any instructions.

Messages with instructions provided reassurance and comfort to participants.

Some participants felt that if a message didn't provide instructions, it would create panic in the community.

Message Delivery Recommendations

A collection of CDC infographics detailing radiation emergency preparation and response information.

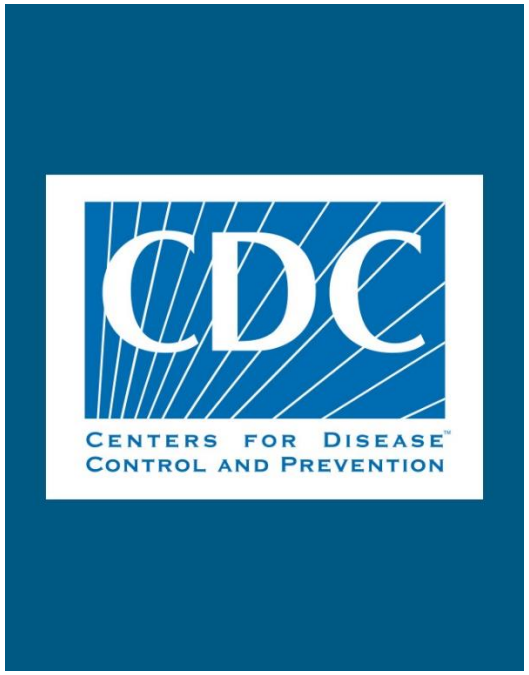
- Maintain message consistency across agencies and communications channels.
- Tailor message by delivery method.
- When possible, use a live voice, not a recording, to deliver the messages.
- Use visuals and pictures.
    - Images and text can work well together to convey messages.
    - Infographics are a well-received method to relay radiation emergency preparation and response information.
    - Infographics are available: http://emergency.cdc.gov/radiation/resourcelibrary/infographics.asp

Radiation Emergency Risk Communications Preparation

As you begin to think through how you will effectively communicate with audiences during a radiation emergency, consider the following questions:

- How will we meet audience needs for information?
- How can we bridge the gap between technical information and risk perception?
- How can we describe radiation in ways that promote responsible public action?

Next Steps



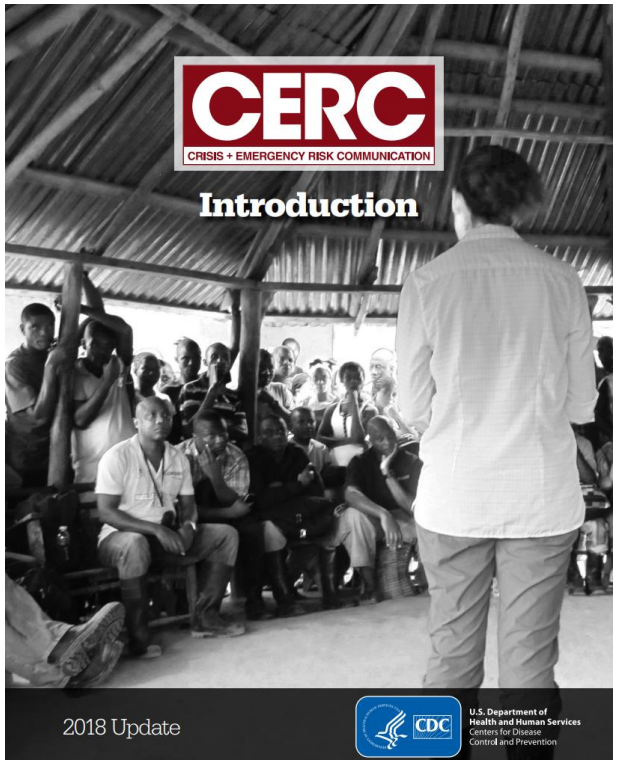
- Consider reviewing your state's radiation emergency plans.
    - Ask your manager for the latest version for review and become familiar with the provided recommended key messages.

An interagency group of communications and radiation technical experts developed the messages in the following documents. These documents include key messages for the impacted community and the nation, and anticipated questions and answers for distribution to the public in the immediate aftermath of a radiation emergency. Review the following FEMA message libraries:

- Improvised Nuclear Device response and recovery: Communicating in the Immediate Aftermath: http://www.fema.gov/media-library/assets/documents/33036
- Communicating During and After a Nuclear Power Plant Incident: http://www.fema.gov/media-library/assets/documents/33011

Consult these materials BEFORE an emergency happens so you are prepared to respond as advised.

Resources



- CDC Radiation Emergency Communications Research: http://emergency.cdc.gov/radiation/audience.asp
- CDC Radiation Emergency Preparedness and Response: http://emergency.cdc.gov/radiation/resourcelibrary/communications.asp
- CDC Radiation Emergency Preparedness and Response, Information for Media and Communication Professionals: http://emergency.cdc.gov/radiation/media.asp
- CDC Risk Communication Handbook: https://emergency.cdc.gov/cerc/manual/index.asp
- Radiation Thermometer, to help put common radiation doses into perspective: https://emergency.cdc.gov/radiation/radiationthermometer.asp

For more information on radiation emergencies and related topics, please visit https://emergency.cdc.gov/radiation/.