Lesson Five

Explosive, Nuclear, and Radiologic Disasters

Learning Objectives

- Discuss background and epidemiology of explosions and traumatic disasters, including three primary types of explosions
- Describe the four blast-related mechanisms of injury
- Identify important hazard-specific considerations involved in response to explosion disasters
- Discuss clinical decision making relevant to explosions and traumatic disasters
- Identify individuals who may be at increased health risk in an explosion or other traumatic disaster

Background

- Explosions and traumatic disasters occur throughout the world
- Explosive devices account for about 75% of terror events worldwide
- Over the last 10 years, domestic terrorism-related investigations have grown by 357%

https://www.gao.gov/blog/rising-threat-domestic-terrorism-u.s.-and-federal-efforts-combat-it

Types of Explosions

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Mechanism of Blast Injury

Primary	• Overpressure of blast wave (ear, lung, intestines)
Secondary	• Penetrating injuries from blast wind (flying debris)
Tertiary	• Blunt injuries from blast wind (forceful impact)
Quaternary	• All other blast injuries (burns, psychological trauma)

Situational Awareness

Detection, Safety, Security, and Hazard Assessment

- Beware intentional “targeting” of first responders
- Observe site safety
- Assess hazards
  - Downed power lines?
  - Debris?
  - Fire?
  - Hazardous materials?
  - Smoke or toxic inhalations?
  - Structural?
  - Secondary

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Casualty Management

Begins with performing Life Saving Interventions during the triage process

- Control major hemorrhage
- Open airway
- Needle chest decompression
- Autoinject antidotes

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Casualty Management

- Initial care and decision making should follow established clinical guidelines
- Ongoing care follows specific clinical decision making related to mechanism of injury and injury patterns
  - Consider early intubation for patients with inhalation injury
  - Administer fluid judiciously in combined blast lung and burn

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Clinical Decision Making

Penetrating Ballistic, Stab, or Impaling Injuries

- ”Low velocity” or “high velocity”
- Injuries depend on tissue involved
- Entrance and exit wounds
- Extensively contaminated
- Adequate debridement
- Tetanus prophylaxis and broad-spectrum antibiotics

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Clinical Decision Making

Blunt Ballistic Injuries

- Rubber bullets, beanbag shotgun shells, etc
- Standard bullets impacting a protective vest
- Heart, liver, spleen, lung, and spinal cord are vulnerable
- Injuries may occur beneath benign-appearing skin lesions
- Close observation due to possibility of delayed on-set of symptoms

Casualty Management

Pediatric Blast Trauma Considerations

- When compared with other types of pediatric trauma:
  - Head injuries are more common
  - Injuries are likely more severe and consume more resources compared to adults
- Provide care in pediatric specialty hospitals if possible
  - Comprehensive pediatric specialty care
  - Pediatric intensive care unit

Nuclear and Radiologic Disasters

Learning Objectives

- Discuss difference between nuclear and radiologic disasters with respect to magnitude and health outcomes
- Define basic radiation terms, types, and units of measure important to health personnel
- Describe rationale for time, distance, and shielding in radiation protection
- Identify early clinical signs and symptoms suggestive of radiation exposure
- Discuss general considerations for clinical management of radiation casualties

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Learning Objectives

- Summarize the clinical features and treatment of acute radiation sickness and cutaneous radiation syndrome
- Discuss decorporation techniques and countermeasures for the management of internal contamination with radioactive materials
- Discuss the purpose of emergency public health response actions during a nuclear or radiologic disaster, including risk communication, care of populations with access or functional needs, and population exposure monitoring

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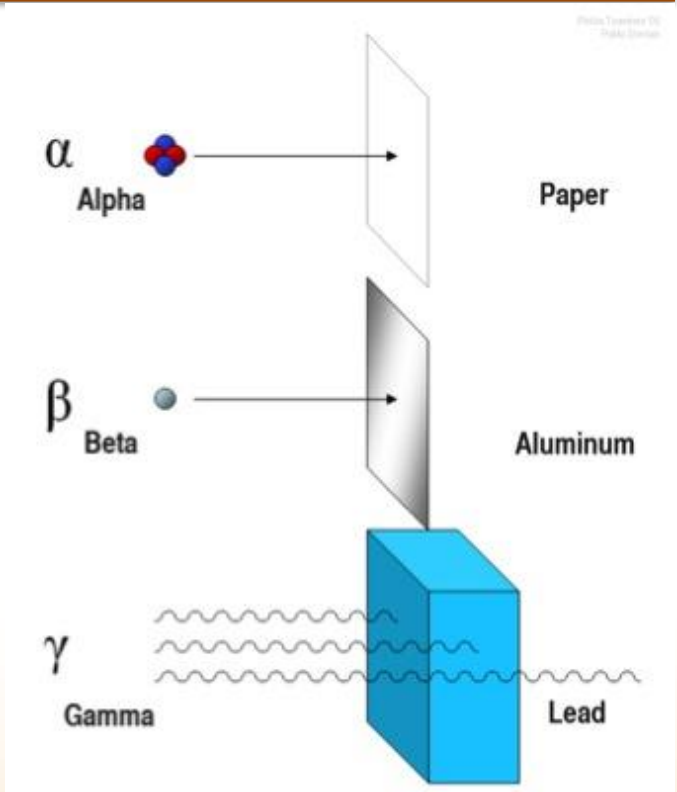
Background

- Radiologic and nuclear events represent unique challenge
- Local and state community preparedness to respond may result in saving of tens of thousands of lives
- Nuclear and radiologic events often confused:
  - Nuclear event involves nuclear detonation and accompanying massive explosion
  - Radiologic event involve release of radioactive materials to populated areas (with or without explosion)

Radiation Basics

- Alpha (α) particles
- Beta (β) particles
- Gamma (γ) radiation



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Characteristics of Injuries after Nuclear and Radiologic Disasters

- Blast injuries
- Thermal burns
- Radiation toxicity
- Electromagnetic pulse

Situational Awareness and Detection

Scene assessment

- High index of suspicion
- Visible clues on vehicles or containers
- Use detection equipment to
  - Detect radiation field present
  - Identify radioactive isotopes present

Radiation detection technology

- Field detection devices (meters)
- Airborne particulate detectors
- Isotope identifiers

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Hazard Assessment

Nuclear detonation

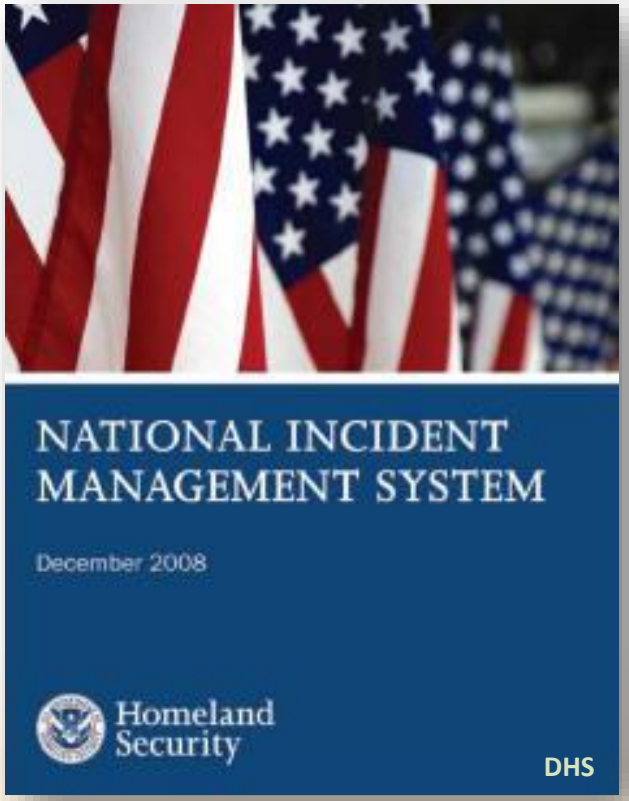
- Prompt radiation
- Activation products
- Fallout (fission) products

Radiation dispersal device

- No activation products
- Lethal radius from blast far exceeds that from radiation
- Radiation from contamination

Incident Management Challenges

- Evacuate vs shelter in place
- Radiation field determination
- Logistical support services
- Personnel shortages
- Information sharing
- Media cooperation



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Workforce Preparedness

Scene safety and security

- Outer and inner perimeter

Personal protective equipment (PPE)

- Typical barrier PPE, Bunker gear
- Respiratory protection

Radiation exposure monitoring

- Radiation exposure limits responders

Casualty decontamination

- Contaminated persons unlikely to present radiation hazard
- Not necessary to decontaminate before LSIs

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Casualty Management

Clinical Management of Radiation Casualties

Basic Concepts and Principles

Sign/Symptom	Mild 1-2 Sv (100-200 rem)	Moderate 2-4 Sv (200-400 rem)	Severe 4-6 Sv (400-600 rem)	Very Severe >6 Sv (>600 rem)
Emesis	<35%	35%-72%	72%-95%	·100%
Emesis (time to onset)	≥2 h	1-2 h	<1 hour	<30 minutes
Survival (Chernobyl data)	41/41	49/50	15/22	1/21
Absolute lymphocyte count 24 hours after exposure (% normal)	78%-100%	60%-78%	50%-60%	<50%

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Public Health Implications of Nuclear and Radiologic Disasters

- Crisis and emergency risk communication
- Mental and behavioral health considerations
- People with functional, access, or other special needs
- Age-related vulnerabilities, both children and elders
- Risk to pregnant women and fetuses

Lesson Summary: Explosive, Traumatic, Nuclear, and Radiologic Disasters

- Understanding the four basic blast-related injury mechanisms guides specific treatment
- Situational awareness of the blast-related hazards is important for all response personnel
- Initial care follows accepted guidelines
- Clinical decision making must identify and address blast-related findings associated with increased risk

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Lesson Summary: Nuclear and Radiologic Disasters

- Radiation provokes special fear
- Clinicians will play role vital in radiation emergency
- Health threat to response personnel is low
- Basic clinically relevant knowledge is key

Questions?

Scenario 4: Explosives & Radiation

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Explosives/Blast Injuries

Blast injury mechanisms

- Primary – overpressure from blast wave: ears, lungs, intestines
- Secondary – penetrating trauma from flying debris
- Tertiary – blunt trauma from forceful impact
- Quaternary – everything else: burns, psychological trauma

Immediate casualty management

- Per SALT triage
  - Sort and assess
  - Life saving interventions

Subsequent casualty management

- Per PHTLS®/ATLS®/ABLS guidelines
  - ABCDEs
  - Beware secondary devices!

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Radiological/Nuclear Events

Radiologic and nuclear injuries are fortunately rare

- Life sustaining treatment should precede decontamination

Concurrent blast/burn injuries usually more lethal

- Management should follow PHTLS®/ATLS®/ABLS guidelines

Blast/burn effects exceed radiation/nuclear effects

- Acute radiation syndrome requires high doses

No significant hazard to properly garbed rescuers

- No reports of rescuers being harmed by radiation

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Scenario 4: Explosives & Radiation

Group 1

There has been an explosion at a sporting event in the metro area.

- Your facility is the closest hospital
- Stability of sports stadium is unknown
- Rescue teams have been dispatched to explosion site
- EMS units on scene, triage ongoing
- Self-referred patients already inundating the entrance and ED with traumatic injuries, some patients unresponsive to verbal commands

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Scenario 4: Explosives & Radiation

Group 1

***Scene Update* 30 minutes into event**

- Hospital security locks down entrances
- Approximately 300 victims arrive at the ED by self transport
- City police cordon off evacuation route from scene
- Ambulances arrive with dozens of “immediate” patients

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Scenario 4: Explosives & Radiation

Group 2

There has been an explosion at a grain elevator near hospital.

- Your facility is the closest hospital
- Stability of grain elevator building unknown
- USAR Teams dispatched to explosion site
- EMS units reach scene, triage ongoing
- Self-referred patients already inundating the hospital entrance and ED, with many thermal burns to the skin in addition to traumatic injuries
- Estimated that 200 employees were in the facility

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Scenario 4: Explosives & Radiation

Group 2

***Scene Update* 30 minutes into event**

- 50 patients arrive who self transported to the ED
- Hospital security locks down entrances
- City police cordon off evacuation route from scene
- Ambulances arrive with initial “immediate” patients having severe burns and associated trauma, they estimate 20-30 more incoming

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Scenario 4: Explosives & Radiation

Group 3

There has been an explosion at a movie theater near hospital.

- Stability of movie theater building is unknown
- Rescue teams have been dispatched
- EMS units reach scene, triage ongoing
- Self-referred patients already inundating the hospital entrance and ED

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Scenario 4: Explosives & Radiation

Group 3

***SCENE UPDATE* 30 MINUTES INTO EVENT**

- Radiation was detected on scene by HAZMAT
- News of the radiation was broadcast as breaking news on multiple media outlets
- Approximately 200 victims arrive at ED to “get checked”
- Initial monitoring from fire department indicates relatively low levels of radioactive contamination on those who are inundating the hospital
- The battery on the hospital’s only radiation survey meter is nearly depleted and is essentially nonfunctional
- Uninjured but potentially contaminated people are demanding immediate medical assistance and have overwhelmed hospital security personnel

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Scenario 4: Explosives & Radiation

Group 4

A suburban hospital about one hour drive from the center of a very large urban metropolis receives reports of a large explosion collapsing buildings downtown.

- Multiple casualties are said to be coming to the hospital due to a lack of access downtown
- Conflicting reports indicate that potentially hundreds of casualties are to be expected
- Unprecedented traffic gridlock is causing extreme delays in patient transport to the hospital
- The initial arrivals are reported to be mainly severe lacerations from broken glass.

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Scenario 4: Explosives & Radiation

Group 4

***Scene Update* 30 minutes into event**

- News media report that a nuclear device was detonated at city center; high levels of radiation exposure are verified at the site
- The power grid is reportedly down at city center, extending to the suburbs; the hospital generator comes on due to power outage
- The hospital activates its disaster plan and mobilizes all available staff, but few are able to reach the hospital, while others refuse
- Large numbers of injured patients begin to arrive by private transport, some complaining of nausea, while a few are vomiting

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Scenario 4: Explosives & Radiation

Group 4

***Scene Update* 1 hour into event**

- EMS transports begin to arrive, with extensive, severe partial and full thickness burns; many such victims appear to be in shock
- Victims report that hundreds of others are left at the scene, many of whom appear dead, while the scene remains in near total chaos
- Authorities now estimate that thousands of surviving victims of trauma, burns, and radiation exposure are still trapped at the scene
- Radiation decontamination is faltering at the ED entrance, owing to insufficient personnel and resources to provide emergency care

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