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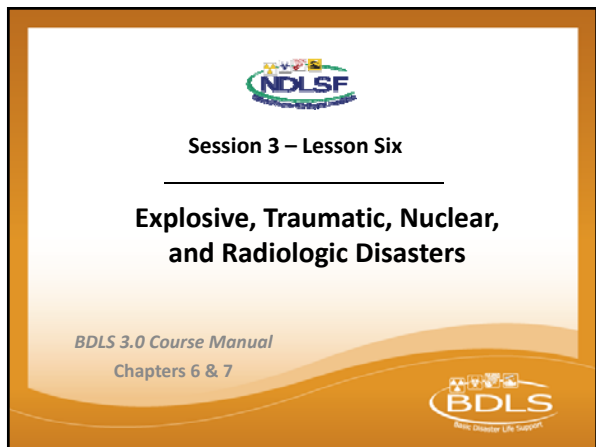
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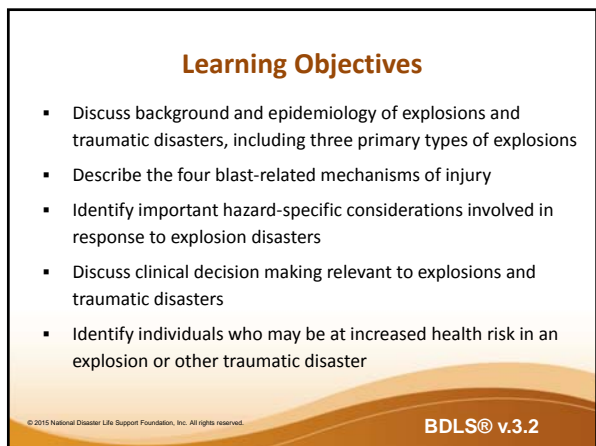
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- Discuss background and epidemiology of explosions and traumatic disasters, including three primary types of explosions
- Describe the four blast-related mechanisms of injury
- Identify important hazard-specific considerations involved in response 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

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### Background

- Explosions and traumatic disasters occur throughout the world
- Explosive devices account for about 75% of terror events worldwide
- Number of criminal bombings in United States doubled in last decade



Jocelyn Augustino/FEMA

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### 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)

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**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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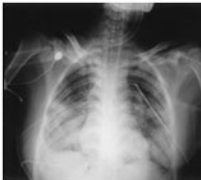
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### Clinical Decision Making Pulmonary Blast Injury ("Blast Lung")

- Explosions tear alveolar walls
- Hemorrhage, barotrauma, AV fistulae
- Signs and symptoms
  - Respiratory distress
  - X-ray findings
- Treatment
  - Airway and oxygen
  - Mechanical ventilation challenges
  - Avoid excessive positive ventilation



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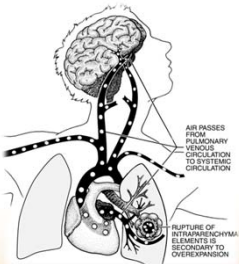
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### Clinical Decision Making Arterial Gas Embolism



AIR PASSES FROM PULMONARY CIRCULATION TO SYSTEMIC CIRCULATION

RUPTURE OF INTRAMUSCULAR ELEMENTS IS SECONDARY TO OVEREXPANSION

- Air embolizes directly between bronchial tree and disrupted pulmonary vasculature
- Manifestation
  - Rapid decompensation
  - "Sudden death"
- Management
  - Positioning
  - 100% Oxygen

Physiology, 2002

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### Clinical Decision Making Traumatic Asphyxiation

- Mechanism of Injury
  - Compression of chest that impedes venous return to heart
- Signs and symptoms
  - HEENT: Facial edema or cyanosis, subconjunctival hemorrhages
  - Chest: Respiratory distress, chest wall ecchymosis
  - Skin: Petechiae of head, neck, and chest
- Treatment
  - Rapid extrication - ***The most important survival factor!***
  - Evaluate for other life-threatening injuries
  - Supportive care

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### Clinical Decision Making Traumatic Amputation

- Control hemorrhage
- Tourniquet should be first line treatment for life threatening extremity hemorrhage



Richard Schwartz  
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### Clinical Decision Making Crush Injury and Crush Syndrome

- **Crush injury** - Compression of large mass of skeletal muscle
- Ongoing compression - Tissue ischemia and rhabdomyolysis, with toxins released from cellular breakdown
- **Crush syndrome** - Systemic complication of rhabdomyolysis and ischemic reperfusion injury
- Life threatening - Hyperkalemia, hypovolemia, etc, leading to cardiac dysrhythmias and profound shock

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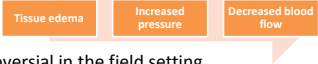
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### Clinical Decision Making Compartment Syndrome

- Compartment syndrome is complication of crush injury
- Signs include *severe* pain, erythema, blistering, swelling, and diminished pulses
- Treatment
  - Fasciotomies, controversial in the field setting
  - Transport to a facility that is capable of providing this care



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**Clinical Decision Making**  
**Gastrointestinal Blast Injury (“Blast Belly”)**

- Intestinal (usually colon) injury from stretching and ischemia resulting in bowel wall weakening, leading over time to bowel rupture
- Intra-abdominal trauma to liver, spleen, etc, from blunt or penetrating associated trauma following explosion
- Signs and symptoms
  - Nausea and vomiting, Abdominal pain, Diarrhea

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**Clinical Decision Making**  
**Auditory Blast Injury (“Blast Ear”)**

- Blast-related damage to inner ear
- Acute hearing loss
  - May be unable to hear verbal instructions (complicates triage)
- Ear pain, vertigo, tinnitus
- Avoid irrigation and consider antibiotics
- May be associated with other blast injuries



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**Clinical Decision Making**  
**Ocular Blast Injury (“Blast Eye”)**

- Vulnerable to secondary and tertiary blast injuries
- Symptoms – foreign body sensation, pain and visual loss
- Injuries – may be serious, globe rupture, penetrating FB
- Referral to ophthalmologist



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**Clinical Decision Making**  
**Flash Burns**

- Short-lived intense heat of blast
- Wounds tend to be superficial
- Confined to exposed areas of body
  - Face and hands most common
- Managed as other burns are



Lance Cpl Joseph M. Peterson



Uniformed Services University

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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 onset of symptoms

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**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

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**Session 3 – Lesson Six**

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**Nuclear and  
Radiologic Disasters**

*BDLS 3.0 Course Manual*  
Chapter 7



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**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)

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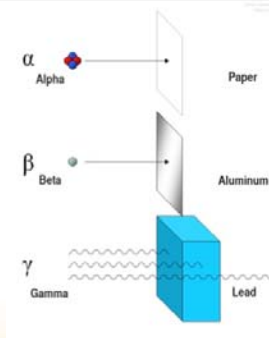
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### Radiation Basics

- Alpha ( $\alpha$ ) particles
- Beta ( $\beta$ ) particles
- Gamma ( $\gamma$ ) radiation



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**Characteristics of Injuries after Nuclear and Radiologic Disasters**

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

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**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



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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



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Radiation dispersal device

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

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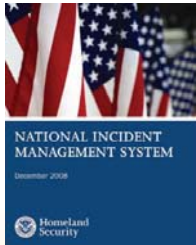
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### Incident Management Challenges

- 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 treatment

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### Casualty Management



```
graph LR; A[Mass casualty triage] --> B[Providing emergency care]; B --> C[Decontamination]; B --> D[Evacuation];
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### 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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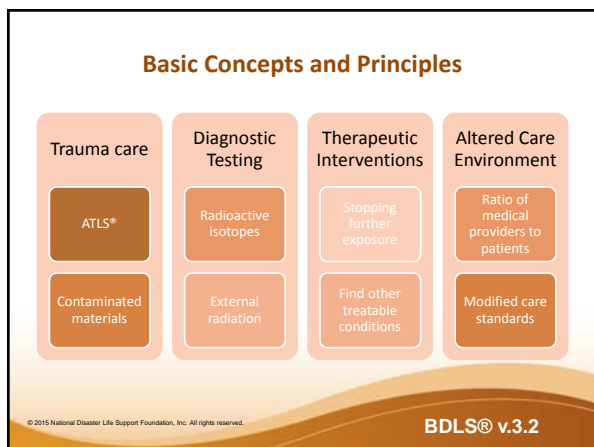
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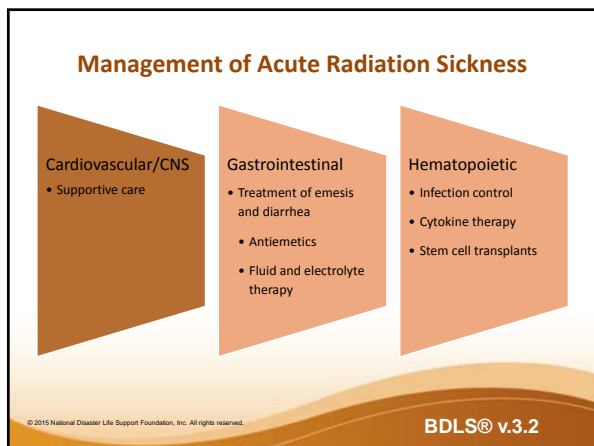
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**Cutaneous Radiation Syndrome (CRS)**

- Seen in highly irradiated casualties
- Patients often present with acute radiation sickness
- CRS worsens prognosis
- Conservative vs surgical treatment
  - Anti-inflammatories and antimicrobials
  - Surgical debridement and grafting

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**Management of Internal Radioisotope Contamination**

Isotope determination

- Organ scanning
- Nose sampling
- Bioassays

Decorporation techniques and countermeasures

- Lavage
- Blocking deposition
- Elimination

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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

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**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

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**Questions?**



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