Lesson Four

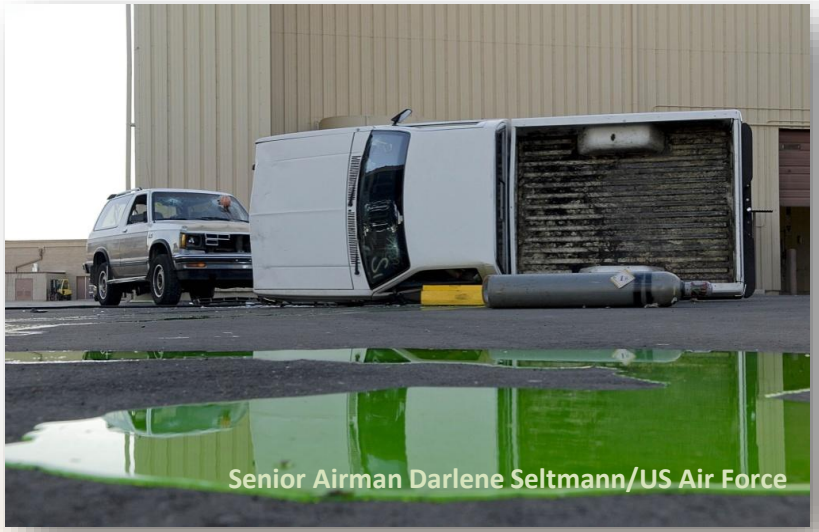
Chemical Disasters

Learning Objectives

- Identify clinical and epidemiologic clues that may suggest occurrence of chemical disaster
- Identify illnesses and injuries seen in chemical disasters
- Describe actions to protect health, safety, and security of responders and affected populations in a chemical disaster
- Discuss diagnostic and treatment considerations for individuals exposed to blister/vesicant agents, choking/ pulmonary agents, asphyxiant agents, and nerve agents

Background

- Chemical agents can be released by a variety of intentional or unintentional means, such as:
  - Industrial accidents
  - Transportation
  - Terrorism



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Detection of Chemical Exposure

- Nature of agent or method of exposure may be unknown
- Each class of agent has a specific set of signs and symptoms, called a *toxidrome*
- *Signs and symptoms* can help determine:
  - Onset – Present within minutes to hours of event
  - Possible Signs/Symptoms – Nausea, vomiting, diarrhea, loss of consciousness, seizures, respiratory difficulty, pupil changes, fasciculation, weakness, etc.

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Detection
Situational Awareness

- Information gathering
  - Multiple 911 calls from same area
  - Known hazards, substance leaking or spilling
  - Time of symptom onset
  - Foul or unusual odors present
  - Dead animals
- Ensure responder safety; prevent secondary contamination

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Detection

- Detection devices may be used by HAZMAT:
  - Multi-gas meters
  - Oxygen sensors
  - Chemical agent monitors
- When detectors are not available, responders must begin treatment based on clinical presentation

Safety and Security

- Responders must utilize PPE to reduce the risk of exposure
- Consider recommendation to shelter in place in contaminated areas vs evacuation
- Notify receiving hospitals early
- For the ill or injured:
  - Remove individual from toxic area
  - Perform decontamination
  - Prevent further exposure

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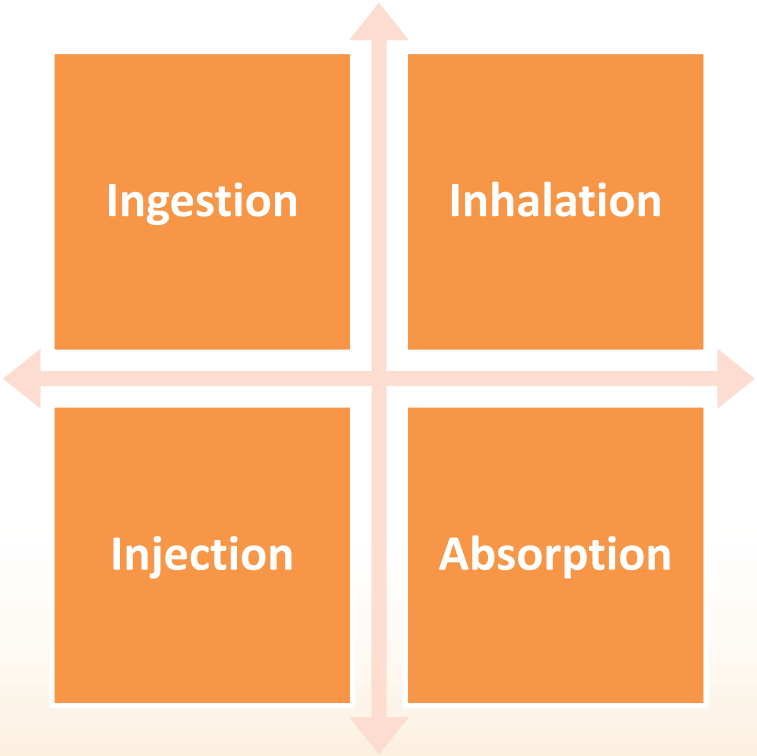
Casualty Management:

General Considerations



- Toxins may enter the body through one of four ways
- Have high suspicion if multiple patients from same location present with same onset symptoms
- Different agents have different probability of secondary exposure

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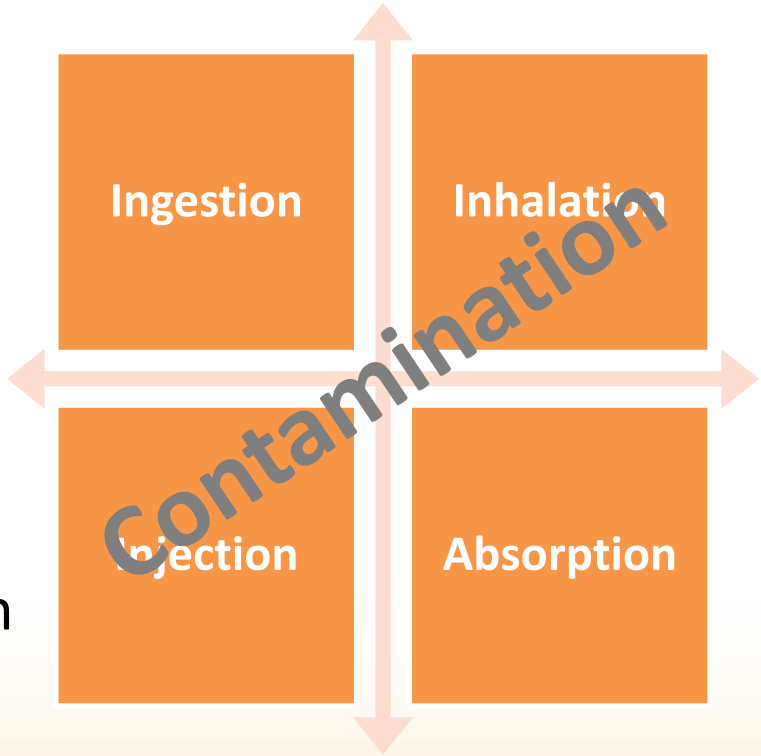
Casualty Management:

Triage Considerations

- Triage - often required when multiple casualties present
- Contamination – Decontaminate prior to medical care but do not delay lifesaving intervention
- Triage pre and post decontamination



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Casualty Management:

Assessment

Cardiovascular	Fast/slow heartbeat, low/high blood pressure, decreased blood flow
Skin	Blistering, redness, pallor, sweating
Gastrointestinal	Nausea, vomiting, diarrhea
Neurologic	Seizures, loss of consciousness
Respiratory	Difficulty breathing, wheezing

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Casualty Management:

Pediatric Considerations

- Children exposed faster and inhale more agent due to faster breathing rate and metabolic rate
- Increased skin absorption due to thin skin
- Agents that are heavier than air more accessible due to child's size
- Limited ability to recognize and flee from danger

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Casualty Management:

Injuries and Illnesses ➔ Agent Types

Central Nervous System	• Nerve, incapacitating, asphyxiant, or any agent
Respiratory System	• Nerve, choking, blister, asphyxiant
Circulatory System	• Nerve, incapacitating, asphyxiant, or any agent
GI System	• Nerve, any agent
Skin	• Nerve, incapacitating, blister

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Casualty Management:
Treatment Principles

May include, in accordance with protocols, resources:

- Oxygen therapy
- Placement of intravenous (IV) lines
- Anticholinergic medications/nerve agent antidotes
- Administration of bronchodilators
- Airway control - intubation if needed
- Bleeding control

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Selected Chemical Agents

- Blister (Vesicant) Agents
- Choking (Pulmonary) Agents
- Asphyxiant (Cyanide) Agents
- Nerve (Organophosphate) Agents

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Selected Chemical Agents

Blister (Vesicant)

- Chemicals that cause blisters to form on skin
- Skin primary route of absorption, pulmonary and GI tract secondary route
- Persistent in the environment, heavier than air
- Types are:
  - Lewisite: colorless, oily, smells like geraniums
  - Mustard: oily, smells like horseradish or garlic

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Diagnosis of Blister Agents

Eyes	Itching, burning, blindness
Gastrointestinal	Vomiting, diarrhea
Skin	Blistering and erythema
Respiratory	Edema and sloughing of respiratory tract

Treatment of Blister Agents

- Immediate decontamination of all exposed - symptomatic AND asymptomatic
- Remove clothing, wipe exposed areas with dry material, then wash with soap and water
- British anti-lewisite (BAL) – chelating agent used to reduce lewisite effects
- Overall treatment is supportive

Selected Chemical Agents

Choking or Pulmonary

- Symptoms related to water solubility
  - Highly water-soluble agents cause upper airway damage and have strong warning properties
    - e.g., Anhydrous Ammonia
  - Intermediate water-soluble agents cause upper and lower airway damage and have moderate warning properties
    - e.g., Chlorine
  - Poorly water-soluble agents cause lower airway damage and have poor warning properties
    - e.g., Phosgene

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Chlorine

- No specific diagnostic test
- Chlorine agents:
  - Reacts with water in airways to form hydrochloric acid
  - Bleach-like smell, irritation of nose, throat
  - Lungs: wheezing, pulmonary edema
  - Eyes: burning, corneal abrasions

Phosgene

- No specific diagnostic test
- Phosgene – smells like newly mown hay
- Initial exposure may cause mild tearing and cough or patients may be asymptomatic
  - Early symptoms may not indicate level of exposure
- Asymptomatic patients should be observed for the development of delayed pulmonary edema (up to 24 hours)

Treatment of Choking/Pulmonary Agents

- No specific therapy
  - Supportive care and remove to fresh air
  - Patients should be decontaminated
- Pain
  - Analgesics
- Respiratory complaints
  - Oxygen, Bronchodilators, Intubation PRN
- Eye exposure
  - Irrigate and check pH (goal: pH 7)

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Selected Chemical Agents

Asphyxiant

- Sources
  - Natural occurring (e.g., peach pit)
  - Mass produced for industrial uses
  - Produced by combustion - wool, silk, plastics, synthetics
- Prevents body's cells from utilizing oxygen
- Can be ingested, inhaled, or absorbed through skin

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Selected Chemical Agents
Cyanide

- Bitter almond odor is unreliable (may be no odor)
  - Many people cannot detect the odor (genetic)
- Low level: Nonspecific signs and symptoms: headache, excitement, dizziness, weakness
- High level: Cardiac arrhythmias, hypotension, seizures, death

Treatment
Cyanide Agents

- Remove victim to fresh air quickly, use proper PPE
- Medications
  - Cyanokit – Hydroxocobalamin, 5 g IV
  - Older treatments (Lilly/Pasadena kit) may still be used and consists of three drugs – two given IV
    - Amyl nitrite (inhaled)
    - Sodium nitrite (IV)
    - Sodium thiosulfate (IV)
- Supportive treatment
  - Oxygen

Selected Chemical Agents

Nerve

- Interfere with body's ability to break down acetylcholine
- Major cause of death is hypoxia
- Found in pesticides: diazinon and parathion
- Warfare agents: sarin (GB), tabun (GA), soman (GD), VX

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Diagnosis of Nerve Agents

- Detection based on toxidrome
  - **D** iarrhea
  - **U** rination
  - **M** iosis – pinpoint pupils
  - **B** ronchorrhea/bronchospasm
  - **E** mesis
  - **L** acrimation – tearing
  - **S** alivation/sweating
- Large inhalational dose lethal immediately
- Small dermal doses may have delayed effects

Treatment of Nerve Agents

- Rapid control of airway – intubation as needed
- Medications:
  - Atropine
  - Pralidoxime chloride
  - Benzodiazepines

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Lesson Summary

- Chemical agents
  - Released intentionally or unintentionally
  - Varied time of onset
  - Effect on children different than adults
- Have a high suspicion for chemical incidents

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Lesson Summary

- Use proper PPE
- Decontaminate any contaminated patient prior to medical treatment (except LSI)
- Treatment plans may be guided by clinical presentations rather than identification of agent

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Questions?

Scenario 3: Chemical Exposures

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Chemical Exposures

Patient symptoms provide clues to nature of the agent

- Blister agents – severe skin, eye, mucosal pain, irritation
- Choking agents – respiratory compromise due to fluid buildup
- Asphyxiant agents – toxic gases displace oxygen, cause suffocation
- Nerve agents – cholinergic crisis (SLUDGEM, DUMBELS)

Decontamination and supportive care are essential

- Blister agents – soap and water (± British anti-Lewisite)
- Choking agents – remove from source, high concentration O_2
- Asphyxiant agents – CO: high concentration O_2; HCN: hydroxocobalamin
- Nerve agents – atropine + pralidoxime (± benzodiazepine for seizures)

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Scenario 3: Chemical Exposures

A large sporting event is being held in a stadium filled with a capacity crowd of 52,000. It is early October, 13:00 hours. The sky is cloudy with a 1-3 mph wind blowing from the west. Temperature is 73 degrees Fahrenheit.

A train passing the stadium on nearby tracks suddenly derails. Smoke and a plume approach the stadium.

There is pandemonium in the stadium, with spectators scrambling towards the exit tunnels and onto the field to exit via the large player's tunnel. The exit tunnel quickly becomes blocked as some people have begun to collapse.

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Scenario 3: Chemical Exposures

Group 1

Underneath the seating area, the paramedic crew medic 7 reports the following over both the medical and disaster radio frequencies:

- Hundreds have collapsed, some are seizing
- Many others are having trouble breathing and/or are vomiting repeatedly
- Others have runny nose, tremors or twitching, and watery or runny eyes
- A fair percentage of those on the ground also have traumatic injuries from being trampled

Scenario 3: Chemical Exposures

Group 2

Underneath the seating area, the paramedic crew medic 7 reports the following over both the medical and disaster radio frequencies:

- An unusual smell and mild eye irritation
- A few victims are coughing and having shortness of breath
- A fair percentage of those on the ground also have traumatic injuries from being trampled

Scenario 3: Chemical Exposures

Group 3

Underneath the seating area, the paramedic crew medic 7 reports the following over both the medical and disaster radio frequencies:

- A large number of victims near the west side of the stadium are on the ground, not moving
- A fair percentage of those on the ground also have traumatic injuries from being trampled
- Victims who escaped from the stadium are reporting dizziness and shortness of breath

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Scenario 3: Chemical Exposures

GROUP 4

Underneath the seating area, the paramedic crew medic 7 reports the following over both the medical and disaster radio frequencies:

- There is a pungent ammonia-like odor
- Victims have skin burning, shortness of breath and eye irritation
- A fair percentage of those on the ground also have traumatic injuries from being trampled

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