Health Effects of CBRNE

Chemical, Biological, Radiological, Nuclear, Explosive

FEMA

Objectives

- Identify the classification of chemical hazards.
- Identify biological agents capable of causing a Mass Casualty Incident (MCI).
- Describe the health effects of radiological material.
- Recognize physical indicators of injuries resulting from an explosion.

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Classification of Chemical Agents

Chemical agents may be classified as follows:

- Toxic Industrial Chemicals (TIC),
- Incapacitating agents,
- Riot Control Agents (RCA), or
- Chemical Warfare Agents (CWA).

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Classification of Chemical Agents (continued)

CWA may be further classified as follows:

- Blister,
- Choking,
- Blood, or
- Nerve.

Toxic Industrial Chemicals

Anhydrous Ammonia:

- May be fatal if inhaled, ingested, or absorbed through skin
- Vapors are extremely irritating and corrosive
- Contact with gas or liquefied gas may cause burns, severe injury, or frostbite
- Fire will produce irritating, corrosive, and/or toxic gas

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Toxic Industrial Chemicals (cont.)

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Incapacitating Agents and RCA

Demonstrators Showing Effects of RCA
Courtesy of Seattle, WA
Police Department

"An agent that produces temporary physiological or mental effects, or both, which will render individuals incapable of concerted effort in the performance of their assigned duties." (U.S. Department of Defense, 2005)

FEMA

Characteristics of Incapacitating Agents and Riot Control Agents

Orthochlorobenzylidene malononitrile (CS)(tear gas)—most common RCA. All RCAs

- Have very low toxicity.
- Have a short action duration.
- Have little or no latent period.
- Prevent effective, concerted action.

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Exposure Indicators and Health Effects

Courtesy of Seattle, WA Police Department

RCA exposure causes symptoms affecting the following:

- Eyes,
- Nose,
- Mouth,
- Lungs, and
- Skin.

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Treatment Protocols

The following are general treatments for RCA exposure:

- Patient should be taken into fresh air.
- Remove clothing in the warm zone.
- Eyes, mouth, skin may be washed.
- Oil-based lotions should *not* be used.

FEMA

Treatment Protocols (continued)

The following are general treatments for RCA exposure:

- Do *not* use skin decontaminants containing bleach.
- CS skin decontaminant solution includes
  - 6.7% sodium bicarbonate,
  - 3.3% sodium carbonate, and
  - 0.1% benzalkonium chloride.

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Treatment Protocols (continued)

Pulmonary effects are initially treated in the following manner:

- Assess patient airway.
- Ensure adequate respiration and pulse.
- Stabilize cervical spine if trauma is suspected.
- Administer oxygen or assist ventilation if necessary.
- Place on a cardiac monitor.
- Watch for signs of airway swelling and obstruction.

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Blister Agents

Blister Agent Injury
www.opcw.org

Blister agents include:

- Sulfur Mustard (H, HD, HT),
- Nitrogen Mustard (HN-1, HN-2, HN-3),
- Lewisite (L),
- Mustard-Lewisite (HL), and
- Phosgene Oxime (CX).

FEMA

Blister Agents (continued)

Three types of blister agents are

- Mustard agents—
  - Clear to dark brown, depending on purity;
  - Viscous, oily;
  - Garlic-, onion-, or mustard-like odor.
- L— Lewisite
  - Light amber color;
  - Oily, volatile liquid;
  - Geranium odor.

FEMA

Blister Agents (continued)

Three types of blister agents are (continued)

- CX— Phosgene Oxime
  - Colorless to yellowish-brown;
  - Liquid or solid;
  - Extremely dangerous vapors.

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Exposure Indicators and Health Effects

- Mustard agent may elicit no effects for hours.
- L and CX produce pain immediately.
- Indicators common to mustard agents, L, and CX include
  - Severe itching and blisters;
  - Tearing and spasmodic winking;
  - Bloody diarrhea, nausea, and vomiting; and
  - Extreme weakness.

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Exposure Indicators and Health Effects (continued)

- Indicators common to mustard agents, L, and CX also include
  - Nasal secretions,
  - Hoarseness and loss of voice,
  - Progressive coughing and labored breathing, and
  - Mucous membranes destruction.

FEMA

Treatment Protocols

Treatment for mustard agent symptoms is as follows:

- Skin blistering—Flush with water; blot.
- Ocular irritation—Irrigate with tepid water.
- Respiratory—Cough suppressants/bronchodilators; intubate compromised airway.
- Nausea and emesis—Atropine sulfate, 0.4-0.6mg IM or IV.

FEMA

Treatment Protocols (continued)

Treatment for other blister agents is as follows:

- L—Same as mustard, plus 10% dimercaprol.
- CX—Treat like any skin ulcer or lesion.

Choking Agents—Chlorine

- Military Classification—CL.
- Heavier than air, “hugs” terrain, and spreads rapidly.
- Pungent, irritating odor (swimming pool or bleach).
- Gaseous, yellow-green color.

FEMA

Abstract

Beach, F. X. M., Sherwood Jones, E., and Scarrow, G. D. (1969).Brit. J. industr. Med.,26, 231-236. Respiratory effects of chlorine gas. Seven chemical workers who were accidentally exposed to chlorine gas in separate accidents were investigated. The usual symptoms were cough, dyspnoea, and chest pains, the symptoms starting within 10 minutes of exposure and lasting two to eight days. Chest radiographs showed congestion, consolidation, and nodules; lung oedema was also present in a severe case. These changes usually cleared within one week but in the severe case persisted for 10 weeks. Three patients had respiratory failure. Hypoxaemia was found in four patients and was quickly corrected by oxygen therapy in three of them, but in the severe case hypoxaemia persisted for four days despite continuous oxygen therapy. All the patients recovered completely.

Choking Agents—Phosgene

World War II-Era Gas Identification Poster
www.nmhm.washingtondc.museum

- Military Classification—CG.
- TIC used to make plastics and pesticides.
- “Hugs” terrain and spreads rapidly.

FEMA

Choking Agents—Phosgene (continued)

- Colorless or white to pale-yellow cloud.
- Odor differs based on concentration:
  - Low—newly-mown hay;
  - High—unpleasant, foul.

FEMA

Exposure Indicators and Health Effects

Choking agents

- Primarily attack the airway and lungs
- Cause irritation of the entire airway.
- Fill lungs with fluid; pulmonary edema occurs.
- Cause immediate symptom onset.
- Should not be detected by smell.

FEMA

Treatment Protocols

Treatment for choking agents is as follows:

- Keep patient resting until past pulmonary edema risk.
- Evacuate patient in a high Fowler's position.

Blood Agents—Hydrogen Cyanide

Danger
www.sxc.hu

- Military Classification—AC.
- Rapidly acting, colorless gas.
- Lighter than air.

FEMA

Blood Agents—Hydrogen Cyanide (continued)

- Very volatile; produces lethal concentrations at room temperature.
- Flammable, potentially explosive vapor.
- Odor of bitter almonds.
- Bitter, burning taste.

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Blood Agents—Cyanogen Chloride

- Military Classification—CK.
- Rapidly acting, colorless gas.
- Heavier than air.
- Pungent, highly irritating odor.
- Nonvolatile and nonflammable.

FEMA

Exposure Indicators and Health Effects

Blood agents

- Have rapid symptom onset, sometimes within seconds.
  - Cause the following symptoms:
  - Gasping or hyperventilation;
  - Nausea, vomiting, or frothy sputum;
  - Confusion, anxiety, vertigo, or unconsciousness; and
  - Palpitations.

FEMA

Exposure Indicators and Health Effects (continued)

Blood agents also

- Cause agitation, stupor, coma, and death at higher concentrations.
- Cause immediate collapse at high doses.

FEMA

Treatment Protocols

Treatment for blood agents is as follows:

- Remove patient from the contaminated area.
- If feeble or no respirations, administer ventilation with oxygen.
- Continue assisted ventilation until
  - Spontaneous breathing returns, or
  - Ten minutes after last sign of heart activity.

FEMA

Treatment Protocols (continued)

Treatment for blood agents is as follows (continued):

- Intubate if unconscious or airway cannot be protected.
- Establish an IV line.
- Provide cardiac monitoring.
- Administer sodium bicarbonate if unconscious or hemodynamically unstable.

FEMA

Treatment Protocols (continued)

Treatment for blood agents is as follows (continued):

- Administer cyanide antidotes for relatively certain diagnosis.
- Administer vasopressors for hypotension unresponsive to fluid intake.
- Supportive care/oxygen administration has proven effective.

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Nerve Agents

Nerve agents include

- Tabun (GA),
- Sarin (GB),
- Soman (GD), and
- VX.

FEMA

Nerve Agents (continued)

- Highly toxic vapors, causing illness and death.
- G-series—nonpersistent; liquid or vapor easily dispersed.
- VX—oily and persistent.
- Nerve agents are liquids.
- More volatile types present liquid and vapor hazards.

FEMA

Exposure Indicators and Health Effects

SLUDGEM

- **S**alivation
- **L**acrimation
- **U**rination
- **D**efecation/diarrhea
- **G**astric distress
- **E**mesis
- Miosis

DUMBELS

- **D**efecation/diarrhea
- **U**rination
- **M**iosis
- **B**ronchoconstriction/ bronchorrhea
- **E**mesis
- **L**acrimation
- **S**alivation

FEMA

Treatment Protocols

Treatment for nerve agents is as follows:

- Immediately decontaminate the patient.
- If symptomatic, inject (IM) Nerve Agent Antidote Kit (NAAK).
- If symptomatic post-NAAK
  - Inject two more NAAK sets.
  - Inject one Convulsant Antidote for Nerve Agents (CANA).
  - 10 mg valium is injected by CANA.

FEMA

Nerve Agent Antidote Kit

- NAAK consists of four separate components—
  - Atropine autoinjector (2 mg [0.7 ml] atropine in solution);
  - 2-PAM chloride autoinjector (600 mg pralidoxime chloride in solution);
  - Plastic clip; and
  - Foam carrying case.

FEMA

Nerve Agent Antidote Kit (continued)

Each autoinjector includes

- Antidote solution (atropine or 2-PAM chloride);
- Pressure-activated, coiled-spring mechanism; and
- Needle for injection of the antidote solution.

FEMA

Antidote Treatment–Nerve Agent Autoinjector

Autoinjector
www.carson.army.mil

Antidote Treatment-Nerve Agent Autoinjector (ATNAA)

- Approved by the Food and Drug Administration (FDA).
- Single, prefilled, dual-chambered autoinjector.
- Contains 2.1 mg atropine and 600 mg pralidoxime.
- Will replace the NAAK.

FEMA

Biological Agents

Biological agents are

- Organisms or toxins to kill or incapacitate humans.
- Grouped by most likely biological weapon types:
  - Bacteria,
  - Rickettsia,
  - Viruses, and
  - Toxins.

FEMA

Categories of Biological Agents

Smallpox patient
Courtesy of CDC

Category A biological agents

- Disseminate or transmit easily.
- Have high mortality rates, high public health impact.
- Cause social panic and disruption.
- Require special public health preparedness.

FEMA

Categories of Biological Agents (continued)

Category B biological agents

- Moderately easy to disseminate.
- Have moderate morbidity rates, low mortality rates.

FEMA

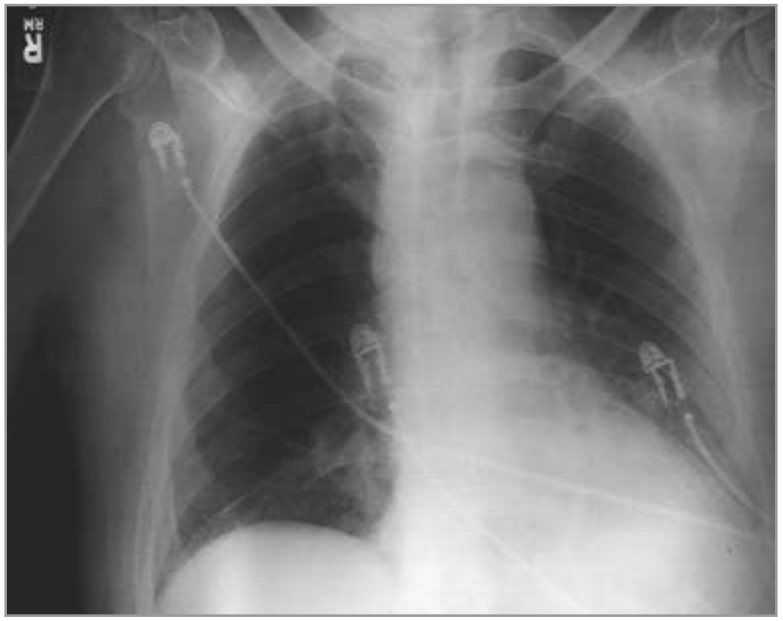
Anthrax

Anthrax lesion on the skin of the forearm caused by the bacterium *Bacillus anthracis*
Courtesy of CDC

- Caused by *Bacillus anthracis.*
- Forms spores for resiliency.
- Routes of entry include
  - Respiratory tract,
  - Cuts and/or abrasions, and
  - Digestive tract.

FEMA

Anthrax (continued)



Initial X-Ray of inhalation anthrax patient, showing widened mediastinum
Courtesy of CDC

Signs and symptoms include

- Nonspecific symptoms of fever, malaise, and fatigue.
- Nonproductive cough and vague chest discomfort.
- Severe respiratory distress; dyspnea, stridor, diaphoreis, cyanosis (acute phase).

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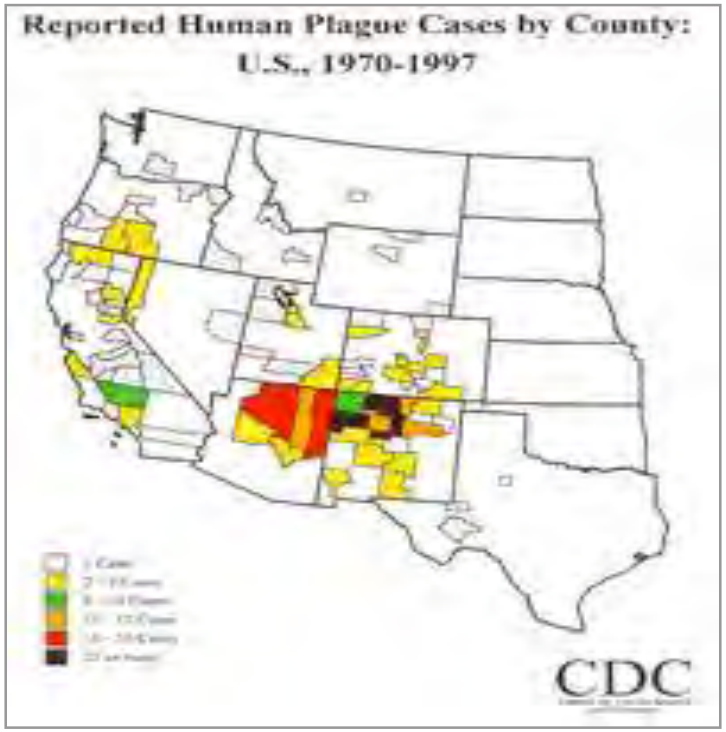
Plague



Plague Cases by County within Southwestern U.S.
Courtesy of CDC

- Caused by bacterium *Yersinia pestis.*
- Last urban epidemic in United States, Los Angeles, 1924–1925.
- Currently scattered, rural cases (average 10–20 people/year).

FEMA

Plague (continued)

Swollen lymph glands from bubonic plague
Courtesy of CDC

Routes of entry include

- Flea-bitten rats (bubonic plague), and
- Aerosol via respiratory tract (pneumonic plague).

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Plague (continued)

Signs and symptoms include

- High fever and chills,
- Headache,
- Shortness of breath, and
- Spitting up blood.

FEMA

Tularemia

Skin ulcer caused by tularemia
Courtesy of CDC

- Caused by bacterium *Francisella tularensis.*
- Routes of entry include
  - Broken skin/mucous membranes;
  - Infected deerfly, tick, mosquito bites;
  - Dust inhalation; and
  - Contaminated food.

FEMA

Smallpox

- Caused by Category A agent *Variola major.*
- World Health Organization (WHO) declared eradication in 1980.
- Route of entry is
  - Respiratory, and
  - Person to person as an aerosol.

FEMA

Smallpox (continued)

Signs and symptoms include

- Malaise and high fever;
- Rigors and vomiting;
- Headache and backache;
- Rash spreading in pattern as follows:
  - Face, hands, and forearms; then
  - Trunk and lower extremities.

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Smallpox (continued)

Chickenpox

Chickenpox lesions
Courtesy of CDC

Smallpox

Lesions caused from
smallpox
Courtesy of CDC

FEMA

Viral Hemorrhagic Fevers

Caused by various Category A viral agents, including

- Arenaviruses, Lassa virus
- Phlebovirus, Rift Valley Fever, Lone Star & Heartland
- Nairovirus, Tillamok, Nairobi Sheep Disease
- Hantavirus, Sin Nombre – Four corners N.M. 1993
- Flavivirus, Yellow Fever
- Filoviruses. Ebola Virus

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Viral Hemorrhagic Fevers (continued)

Routes of entry include

- Person to person contact.
- Sick patients' body fluids.

FEMA

Viral Hemorrhagic Fevers (continued)

Signs and symptoms include

- Bleeding—
  - Under the skin,
  - In internal organs, or
  - From mouth, ears, eyes.
- Shock, delirium, and seizures.
- Nervous system malfunction.
- Coma.

FEMA

Botulinum Toxin

- Produced by Category A bacterial agent *Clostridium botulinum.*
- Routes of entry include
  - Ingestion,
  - Inhalation, and
  - Injection.

FEMA

Botulinum Toxin (continued)

Signs and symptoms include

- Descending paralysis,
- Weakness,
- Dizziness,
- Dry mouth and throat, and
- Blurred vision.

FEMA

Q Fever

- Caused by Category B agent *Coxiella burnetii.*
- Spore-forming rickettsia pathogen.
- Routes of entry include
  - Inhalation,
  - Infected cow milk, and
  - Rarely, tick bites and human to human.

FEMA

Q Fever (continued)

Signs and symptoms include

- High fever, sore throat;
- Severe headache, confusion;
- General malaise, chills, and sweats;
- Nonproductive cough;
- Nausea, vomiting, and diarrhea; and
- Joint pain and chest pain.

FEMA

Ricin

Castor beans
Courtesy of USDA

- Toxin from category B agent *Ricinus communis.*
- Small amount causes great harm.
- Routes of entry include
  - Respiratory system,
  - Ingestion, and
  - Injection.

FEMA

Exposure vs. Contamination

External Exposure

External Contamination

Internal Contamination

FEMA

Acute Radiation Syndrome

Signs and symptoms occur in four phases:

- Prodromal phase,
- Latent phase,
- Manifest illness phase, and
- Recovery phase or death.

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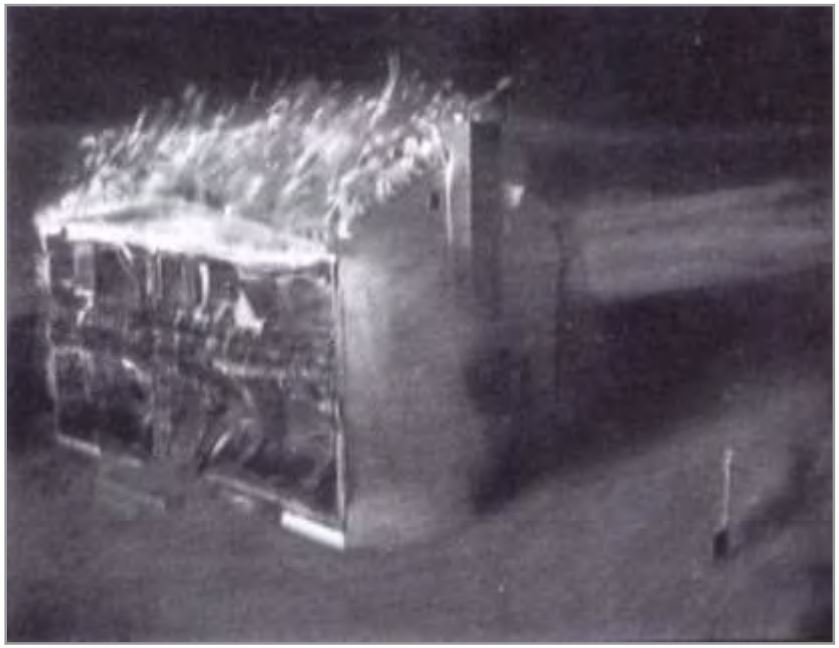
Explosion Effects



Explosion effects
Courtesy of DOE

Explosion causes several types of effects, including

- Incendiary/thermal;
- Fragmentation;
- Ground/water shock; and
- Blast effect
  - Positive pressure, or
  - Negative pressure.

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Primary Injuries

Primary injuries from explosions include the following:

- Lung injury,
- Ear injury,
- Abdominal injury, and
- Brain injury.

FEMA

Secondary Injuries

Secondary injuries from explosions

- Are caused by flying objects.
- Can occur far from the blast site.
- Include the following injury types:
  - Blunt-force trauma,
  - Glass-fragment injuries, and
  - Penetrating injuries.

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Tertiary Injuries

Tertiary injuries are

- Caused by being thrown by blast wind.
- Injuries to any part of the body.
- Commonly fractures, traumatic amputations, and brain injuries.

FEMA

Quaternary Injuries

- Quaternary injuries are those not otherwise classified.
- Blast effects can exacerbate existing conditions.

Quaternary Injuries (continued)

- Typically includes
  - Crush injuries,
  - Brain injuries,
  - Asthma, Chronic Obstructive Pulmonary Disease (COPD), other breathing difficulties.
- May also include
  - Angina,
  - Hyperglycemia, or
  - Hypertension.

FEMA

Medical Management Options for Blast Injuries

- Blast injuries considered for exposure to explosive force.
- Abdominal injury signs possible to overlook initially.
- Penetrating and blunt trauma—most common injury.
- Blast lung presents soon after exposure.
- Auditory system injuries and concussions easily overlooked.
- Isolated TM rupture not a morbidity marker.

FEMA

Medical Management Options for Blast Injuries (continued)

- Traumatic limb amputation—marker for multisystem injuries.
- Air embolism is common.
- Compartment syndrome associated with structural collapse.
- Look for inhaled toxin exposure and poisonings.
- Wounds can be grossly contaminated.
- Ear effects may necessitate written communication.

FEMA

Conclusion

- Identify the classification of chemical hazards.
- Identify biological agents capable of causing a Mass Casualty Incident (MCI).
- Describe the health effects of radiological material.
- Recognize physical indicators of injuries resulting from an explosion.

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Hospital Emergency Response Training—Home Training

Health Effects of CBRNE—End of Module

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