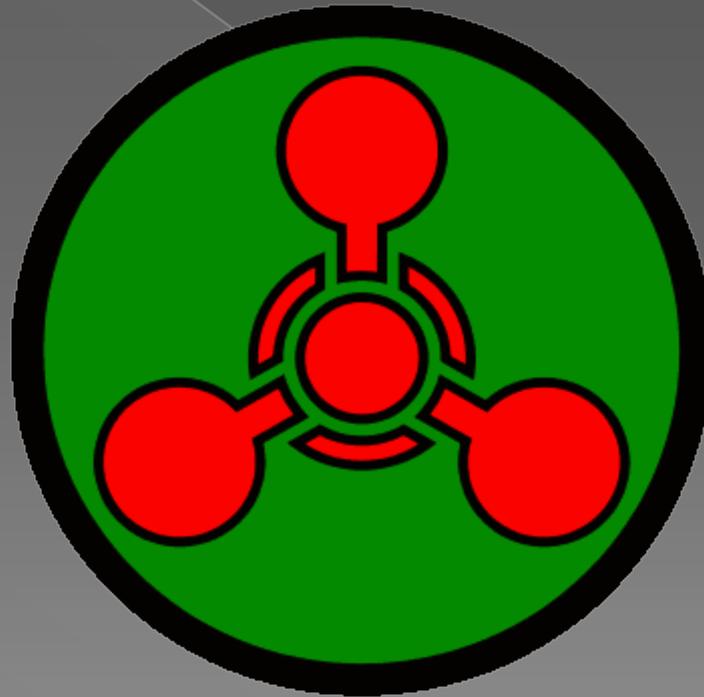


Chemical Weapons



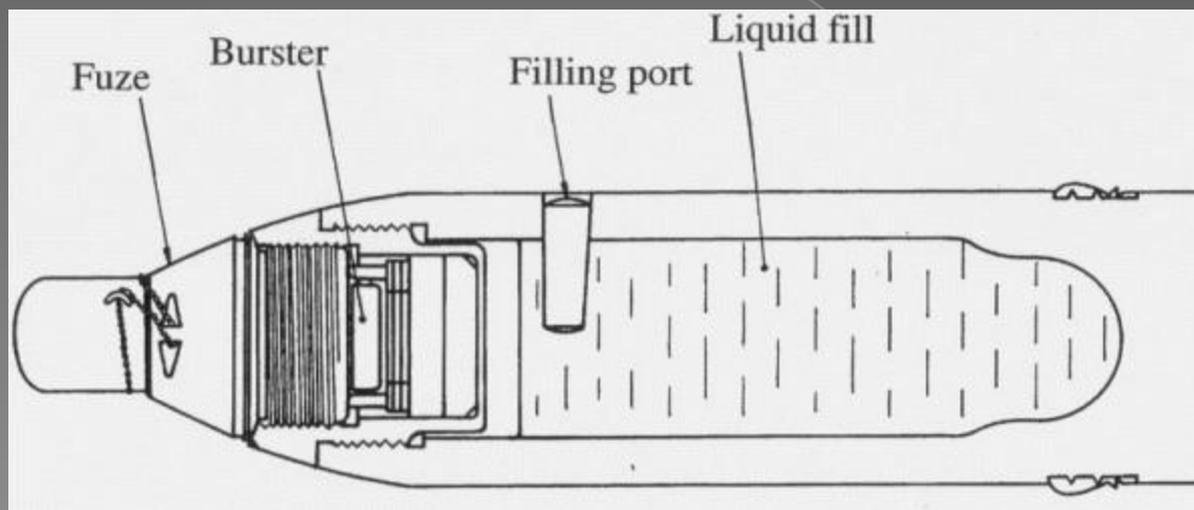
Terrorism

- Terrorism is the unlawful use of force or violence against persons or property to intimidate or coerce a government or civilian population in furtherance of political or social objectives
- Terrorism threats—rogue governments, extremist groups, lone fanatics



Advantages of Chemical Weapons to a Terrorist

- Uniqueness—cheap to develop, lack of effective detectors when stored in binary state, destructive efficiency of small amounts of agent
- Detection—virtually impossible when stored in closed containers and in binary state
- Psychological Aspects—Shock value even when use is only threatened, psychological would be virtually overwhelming if actually used.
- Casualties—potential for large numbers of casualties at low cost in small quantities while virtually undetectable.



Disadvantages

- Delivery of Agent
- Contamination of Terrorists



Remember.....all terrorist incidents are simultaneously

- A crime scene
- A hazardous materials site
- A disaster area



History of Chemical Weapons

- The first large-scale use of chemical weapons, in the modern era, occurred during World War I, on battlefields near Ieper, Belgium. In the course of that war, 100,000 tonnes of toxic chemicals, such as chlorine, mustard gas and phosgene, were deployed against soldiers and civilians, resulting in about 90,000 deaths and over a million casualties.





Lt Col William Mook, US Army skin specialist, treating mustard gas victim.

Photographs courtesy of Photos of the Great War website
<http://www.gwpda.org>

Saddam Hussein—The Kurds

- City of Halabja, northern Iraq, March 16 and 17, 1988
- 20 chemical and cluster bombs
- Nerve agent—Sarin, Tabun, VX



Japan

- 6/27/94-Aum Shinrikyo (Cult)
- Matsumoto—Sarin—280 casualties, 7 deaths
- Tokyo Subway—Sarin—12 dead, hundreds injured, 5500 sought medical care
- 132 first responders contaminated and injured



Chemical weapon attacks

Location	Weapon Used	Date	Casualties
Hajj Umran	Mustard	August 1983	fewer than 100 Iranian/Kurdish
Panjwin	Mustard	October-November 1983	3,001 Iranian/Kurdish
Majnoon Island	Mustard	February-March 1984	2,500 Iranians
al-Basrah	Tabun	March 1984	50-100 Iranians
Hawizah Marsh	Mustard & Tabun	March 1985	3,000 Iranians
al-Faw	Mustard & Tabun	February 1986	8,000 to 10,000 Iranians
Um ar-Rasas	Mustard	December 1986	1,000s Iranians
al-Basrah	Mustard & Tabun	April 1987	5,000 Iranians
Sumar/Mehran	Mustard & nerve agent	October 1987	3,000 Iranians
Halabjah	Mustard & nerve agent	March 1988	7,000s Kurdish/Iranian
al-Faw	Mustard & nerve agent	April 1988	1,000s Iranians
Fish Lake	Mustard & nerve agent	May 1988	100s or 1,000s Iranians
Majnoon Islands	Mustard & nerve agent	June 1988	100s or 1,000s Iranians
South-central border	Mustard & nerve agent	July 1988	100s or 1,000s Iranians
an-Najaf - Karbala area	Nerve agent & CS	March 1991	Shi'a casualties not known

Iraq War Now? Israeli-Lebanon conflict?

- Accusations of use of chemical agents in battle for Fallujah?
- Accusations of use by Israelis in Southern Lebanon? Ya just never know.....



Chemical Warfare Agents

- ◉ Chemical Agents

Chemicals used in military operations to kill, injure, or incapacitate

- ◉ Incapacitating vs. Lethal

- ◉ Local vs. Systemic effects



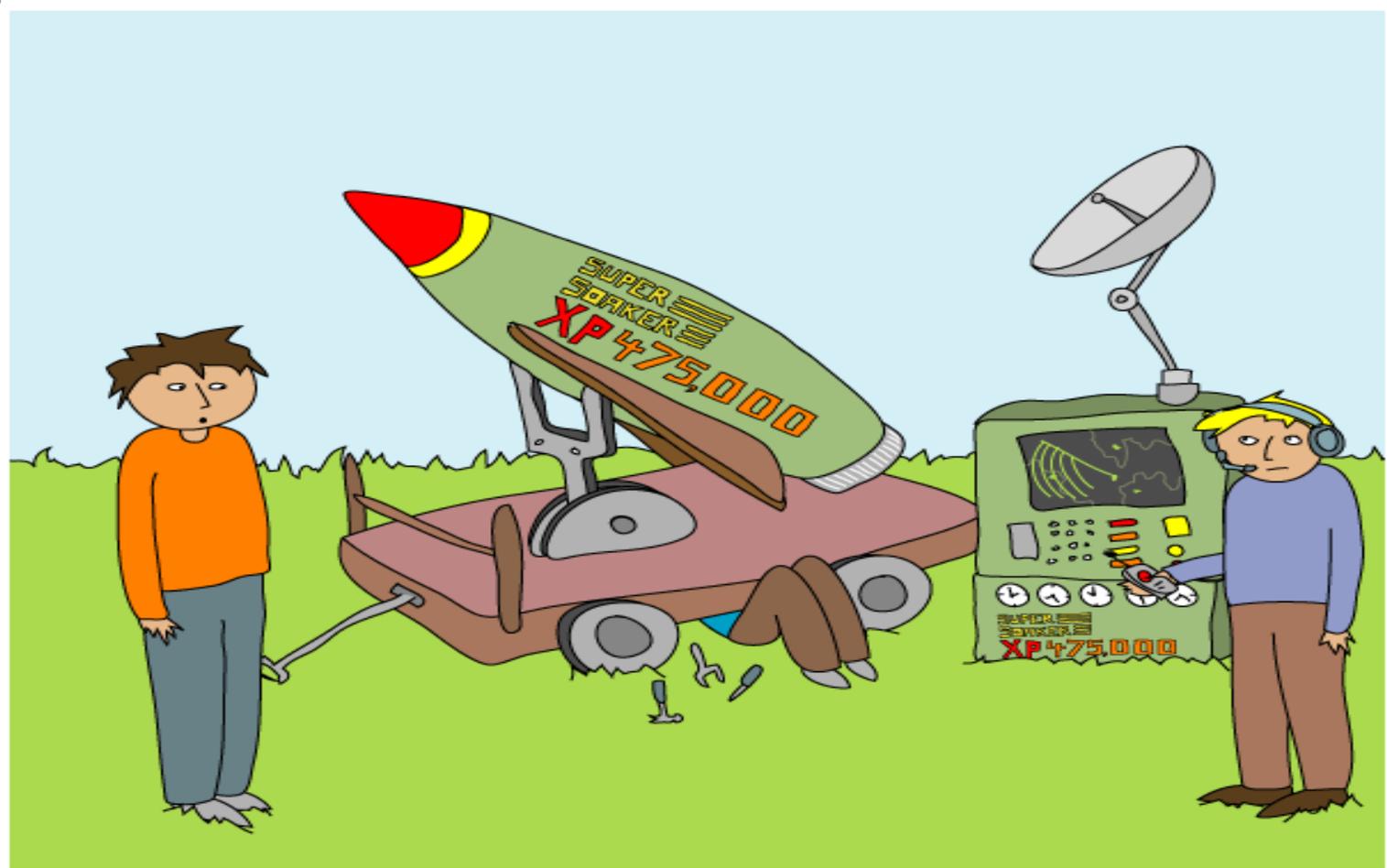
The Chemical Agents

- ◉ Nerve Agents
- ◉ Blister Agents
- ◉ Choking Agents
- ◉ Toxic Industrial Chemicals



Terms

- ◉ Volatility—Readily vaporizable at a relatively low temperature
- ◉ Persistency—The measure of a length of time that an agent remains effective after dissemination



I thought that the Kids down the Street had weapons of mass destruction, but then I realized that they were just Super Soakers

Routes of Entry

- Ingestion
- Eyes
- Respiratory Tract
- Injection
- Skin

Nerve Agents

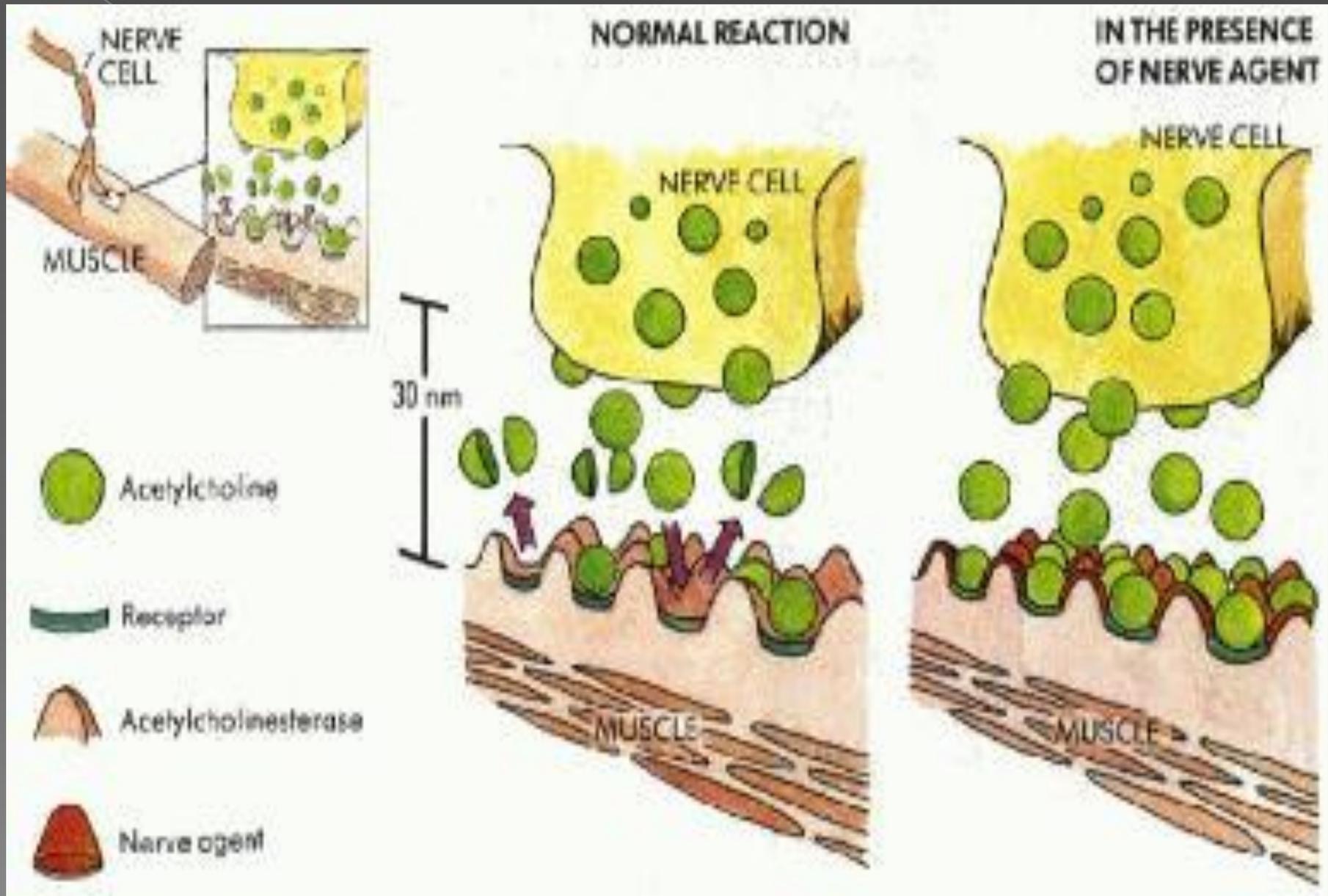
- The most toxic of all weaponized military agents
- They are liquids, not “gas”
- Stored and transported in liquid state



Nerve Agent Physiology

- Inhibits the enzyme that breaks down Acetylcholine (neurotransmitter)
- Causes Hyper stimulation of organs of cholinergic nervous system
- Muscarinic—smooth muscles and glands
- Nicotinic—Skeletal muscles, ganglions

S	Salivation
L	Lacrimation
U	Urination
D	Defecation
G	Gastrointestinal Pain/Gas
E	Emesis
M	Miosis



Effects of Nerve Agents on Muscarinic Sites

Smooth Muscle Contractions

- Eyes: Small Pupils---Dim Vision
- Airways: Narrowing—Shortness of Breath
- Intestine: Hyperactivity—nausea, vomiting, diarrhea

Increased Secretions

- Increased secretions
- Saliva
- Tears
- Runny Nose
- Secretions in Airways
- Secretions in GI Tract
- Sweating



Effects of Nerve Agents on Nicotinic Sites

Ganglion

- Tachycardia
- Hypertension

Skeletal Muscles

- Fasciculations
- Twitching
- Weakness
- Flaccid Paralysis

Nerve Agent Exposure

Liquid Skin Exposure

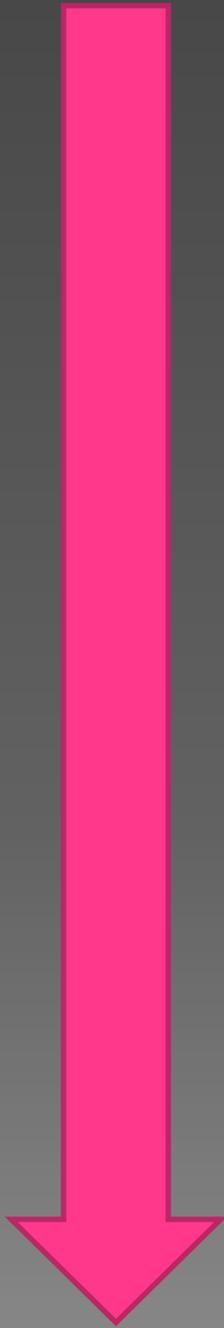
Vapor

- Effects occur within seconds, peak within minutes
 - Low exposure—miosis (dim vision, eye pain), runny nose, SOB
 - High Exposure—Immediate loss of consciousness, seizures, apnea, flaccid paralysis
-
- Small Amount—Localized Sweating, fasciculations
 - Moderate amount (<LD 50)—GI Effects
 - Large amount (LD 50) Sudden loss of consciousness, seizures, apnea

SEVERE

MODERATE

MILD



- Pinpoint Pupils/Blurred Vision
- Excessive Sweating
- Unexplained Runny Nose
- Drooling
- Tightness in the chest
- Headache
- Drowsiness
- Bronchospasm
- Difficulty Breathing
- Nausea/Vomiting
- Abdominal Cramps
- Involuntary urination or defecation
- Jerking, twitching and staggering
- Coma
- Convulsions
- Apnea

Nerve Agents

Name	Code	Persistence	Action	State @ 20 C	Odor
Tabun	GA	24-48	Very Rapid	Colorless/Brown Liquid	Fruity to None
Sarin	GB	.5-24	Very rapid	Colorless Liquid	Near Odorless
Soman	GD	24-48	Very Rapid	Colorless Liquid	Camphor to Fruity
VX	VX	240-720	Very Rapid	Colorless Liquid	Odorless

Nerve Agents: Treatment

- Airway/Ventilation
- Antidotes—Atropine, 2-Pam Cl, Valium
- Decontaminate



Atropine

- Dries secretions, relaxes smooth muscle
- May cause cardiac arrhythmias when given IV in hypoxic patients
- Starting dose = 2 mg, max dose 20 mg
- How much? Until secretions are drying or dry. Until ventilation is easy (if conscious and casualty is comfortable)
- Don't rely on heart rate/pupil size

Pralidoxime Chloride

- Removes nerve agent from AChE in absence of “aging”. 2Pam is “crowbar”
- “Aging”= the bond between enzyme and nerve agent.
- Usually enough time to prevent aging before bond is permanent except with Soman (GD) (2 minutes)

Mark I Kits

- ◉ Nerve agent antidote medications are only given if patient is showing signs and symptoms of nerve agent poisoning. **THEY ARE NOT TO BE GIVEN PROPHYLACTICALLY**
- ◉ Bronchospasm and respiratory secretions are the best indicators of need for atropine and 2-PAM therapy



Hot Zone Administration Guide

Signs and Symptoms	Onset	# Autoinjectors to Use
Vapor: Small exposure—Pinpoint Pupils, Runny Nose, Mild SOB	Seconds	1 Initially, may repeat x1 in 10 minutes
Liquid: Small exposure Sweating, twitching, vomiting, feeling weak	Minutes To Hours	1 initially, may repeat x1 in 10 minutes
Both: Large Exposure Convulsions, apnea, copious secretions	Seconds To Hours	3 initially followed by a 10 mg Valium autoinjector

Cold Zone Administration Guide

Signs and Symptoms	Onset	# Autoinjectors to Use
Vapor: Small exposure—Pinpoint Pupils, Runny Nose, Mild SOB	Seconds	Observe
Liquid: Small exposure Sweating, twitching, vomiting, feeling weak	Minutes To Hours	1 initially, may repeat x1 in 10 minutes
Both: Large Exposure Convulsions, apnea, copious secretions	Seconds To Hours	3 Mark I's or 6 mg atropine 10 mg Valium IM (or 5-10 mg IV) Repeat valium 2 mg IV q 10-30 min PRN seizures

Vesicants (Blister Agents)

- Chemicals that cause redness and blistering of the skin

- Military Vesicants

Sulfur Mustard

Lewisite

- Other Vesicants

Poison Ivy, Industrial Chemicals,
chemotherapy drugs



[Nerve gas antidote made by goats](#)

Scientists have genetically modified goats to make a drug in their milk that protects against deadly nerve agents such as sarin and VX. | These poisons are known collectively as organophosphates - a g...
(photo: Public Domain file)

Mustard

- ◉ Vapor and Liquid Threat
- ◉ Topical eye, skin, and airway damage; causes extensive blistering
- ◉ Latent period between exposure and effects—EMS may not be involved, victim may present at ED
- ◉ Treatment is symptomatic
- ◉ Systemically toxic; damages bone marrow



American worker
from chemical
weapons
factory—
accidental direct
contact with
liquid mustard



Saddam Hussein's
handiwork from
Halabja



Onset of Mustard Symptoms

- Chemical cell damage—1-2 minutes
- Clinical effects: 2-48 hours, usually 4 to 8 hours
- Responders will not see these casualties at the scene but may be called to transport them hours later.

How Mustard Works

- ◉ Quickly cyclizes in tissue
- ◉ Alkylates cell components—DNA
- ◉ DNA damage, cell death
- ◉ May affect eyes, skin, and respiratory tract
- ◉ Very similar to radiation poisoning.

Effects on the Eyes

- Mild conjunctivitis
- Moderate/severe conjunctivitis, lid inflammation and edema, corneal reoughening
- Corneal opacification, ulceration and/or rupture
- WWI—95% had only mild to moderate conjunctivitis
- Under 1% had permanent damage to cornea

Mustard Effects on Skin

- Erythema
- Small Vesicles
- Blisters
- Possible Coagulation Necrosis with Liquid



Mustard Effect on Airway

- Upper airway: Nosebleed, sore throat, hacking cough
- Mid: Hoarseness
- Lower: dyspnea, productive cough
- Pulmonary edema is rare

Mustard Effect on Bone Marrow

- ◉ Must have significant amount of mustard absorbed
- ◉ Damages stem cells
- ◉ Decreased WBC, RBC, platelets
- ◉ Survival is rare if WBC <200
- ◉ Treatment is supportive since there is no antidote for mustard

GI effects of Mustard

- ◉ Within 24 hours: Nausea/vomiting; cholinergic effects
- ◉ After 3 to 5 days: Tissue destruction

Skin Decontamination of Vesicants

- Part of supportive treatment
- Physical removal by whatever means: Remove clothing (the victim's clothing, not yours), flush skin
- Must be done within minutes to prevent damage
- Delays in decontamination will not prevent illness but will prevent cross contamination

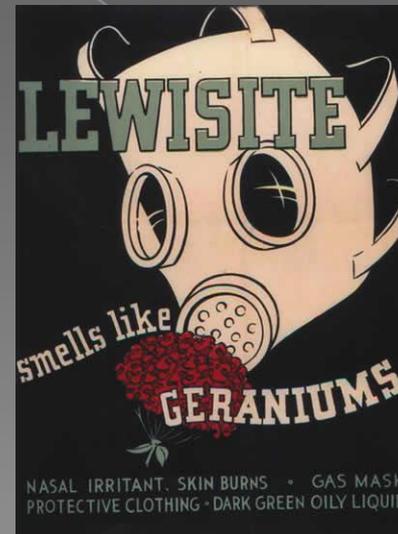


Vesicants--Treatment

- ◉ Cover eyes for photophobia (do not use pressure dressing)
- ◉ Reassurance
- ◉ Oxygen/intubation (intubate early before laryngeal spasm or edema manifests)
- ◉ Bronchodilators (wheezing, bronchospasm, severe distress)

Vesicants-Lewisite

- Just like mustard but a heck of a lot worse
- Immediate effects
- Decon with bleach, soap/water
- ANTIDOTE—British Anti-Lewisite (BAL) given IM. Is administered in the hospital, not in the field.



Name	Code	Persistence @21-32 C	Action	State @ 20 C	Odor	Remarks
Sulfur Mustard	HD	24-48 hrs	Delayed	Colorless to Pale yellow Liquid	Garlic	
Nitrogen Mustard	HN-1, 2, 3	24-72 hours	Delayed	Dark Liquid	Fishy, soapy, near odorless	
Phosgene Oximine	CX	2-4 hours	Immediate	Colorless Solid or Liquid	Sharp/Penetrating	
Lewisite	L	24-36 hours	Rapid	Dark Brown or Yellow Oil/Liquid	May resemble geraniums	
Mustard Lewisite	HL	24-36	Delayed	Dark Brown or Yellow Oil/Liquid	Garlic	
Ethyl dichloroarsine	ED	1-2 hours	Immediate	Colorless Liquid	Fruity and Biting	

Triage of Blister/Vesicant

Green
Priority

- Liquid mustard burns on less than 2% BSA

Yellow
Priority

- Liquid mustard burns covering 2-50% of BSA
- Victims with Eye Involvement

Red
Priority

- Severe Pulmonary Signs/Symptoms

- Liquid Mustard Burns > 50% BSA, no detectable respiration or pulse

Blood Agents

- Cyanide: Salts (solids), Liquids (hydrocyanic acid, cyanogen chloride)
- Bitter Almond odor—undetected by 40% of the population
- Must be delivered in large quantities (bombs and shells) to produce death

How Blood Agents Work

- ◉ Binds to iron in the cellular mitochondria preventing cell from using oxygen
- ◉ Without oxygen the cells die, heart and brain affected initially.

Blood Agents Inhalational Poisoning

High Concentrations
(inhalation)

Low Concentrations (non-
lethal)

- Victims become anxious
 - Hyperventilate
 - Develop headache, dizziness, vomiting
 - Skin may be flushed
 - Symptoms improve when victim is removed from source
-
- 0-15 Seconds—anxious, hyperventilate
 - 0-30 Seconds—seizures
 - 3-5 minutes-breathing ceases
 - 6-10 minutes—asystole, death
 - Normal or dilated pupils
 - Initial absence of cyanosis

Blood Agent Treatment Regimen

- Remove from area; take off clothing (the victim's clothing, not yours)
- If conscious and breathing O₂ and observe, no antidotes
- If unconscious-O₂, airway management, BVM ventilations—NO MOUTH TO MOUTH



Name	Code	Persistence	Action	State @ 20 C	Odor
Hydrogen Cyanide	AC	.25-.5 hours	Very Rapid	Colorless gas or liquid	Bitter Almonds
Cyanogen Chloride	CK	.25-.5 Hours	Rapid	Colorless Gas	Mild Garlic
Arsine	SA	.08-.25	Delayed	Colorless Gas	Mild Garlic

Triage of Blood Agents

Green
Priority

- No symptoms

Yellow
Priority

- Mild headache, nausea, vomiting, hyperventilation, dizziness

Red
Priority

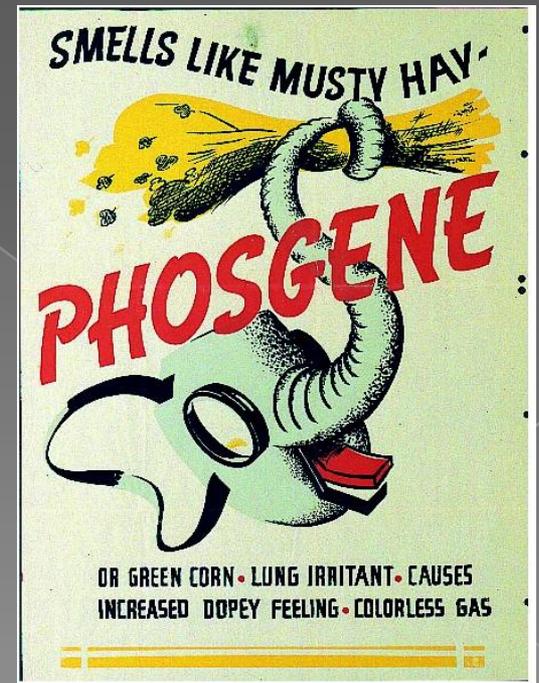
- Convulsions, apnea, sudden loss of consciousness

- Dead

Choking Agents

- Cause severe life-threatening injury after inhalation
- Adverse effects often delayed
- Treatment is supportive

World War II Phosgene Poster



Phosgene

Characteristics

- ◉ Colorless Gas (white if water vapor)
- ◉ Smell of fresh mown hay or green corn (if you can smell it, you're too close)
- ◉ Four times heavier than air
- ◉ Gas above 47 F

Toxicity

- ◉ Inhalation Hazard
- ◉ Phosgene + Water = CO₂ and HCL
- ◉ Initially, irritation to eyes, nose, throat and upper airways
- ◉ Mild cough, transient

Phosgene—Toxicity

- Penetrates slowly down airways
- Symptom Free period—(2-24 hours)
- Leakage of fluid into lung cells (up to 1 liter per hour)
- Patients become severely short of breath (non-cardiogenic pulmonary edema) and hypotensive

Phosgene--Treatment

- At the scene----
- ABC's
- Remove from source of exposure
- Keep victims quiet, **do not allow to ambulate**
- Transport by stretcher
- Decon by removal of clothing (the victim's clothing, not yours)
- **NO EXERTION!!!**

Phosgene--Treatment

- Phosgene causes volume depletion. Even though the patient looks like traditional heart failure, DO NOT GIVE DIURETICS!!!!
- Do not allow pt's to ambulate. Life threatening lung damage can be accelerated by physical exertion of any kind
- Consider early intubation

Ammonia

- ◉ Colorless, water soluble, alkaline gas
- ◉ Pungent Odor
- ◉ Wide industrial use
- ◉ Used to make fertilizer, explosives, dyes, plastics



Ammonia--Characteristics

- Rapidly absorbed by mucosal surfaces
- Corrosive produced when combined with water---liquefaction necrosis.
- Household ammonia pH <12—limited damage
- Anhydrous ammonia pH >12 extensive damage

Ammonia Clinical Signs

Eyes

- Burning
- Tearing
- Severe Pain—Injury to the Cornea and Lens



Lungs

- Cough
- Shortness of Breath
- Chest Pain
- Hypoxia
- Chemical Pneumonia
- Hemorrhage with moderate to severe exposures

Ammonia Clinical Signs

skin

- Pain
- Blister formation
- Deep Burns

Gastrointestinal

- Severe mouth pain, cough, abdominal pain
- Nausea/Vomiting
- Edema to lips and mouth (leading to airway obstruction)
- Esophageal structures and perforation

Ammonia--Treatment

- Remove from the exposure
- Decontaminate in the field prior to transport
- Irrigate eyes (Morgan Lens) with 3 + liters of NS—must be started early to save the eyes, topical analgesics to eyes (tetracaine)
- Early Intubation if inhaled

Chlorine

- ◉ Greenish-Yellow Gas
- ◉ Less alkaline than ammonia
- ◉ Chlorine + water = HCL
- ◉ 30x more irritating to lungs than HCL
- ◉ Eye irritation, cough, SOB, wheezing
- ◉ 12-24 hours, non-cardiogenic pulmonary edema
- ◉ Sudden death due to hypoxia

Chlorine--Treatment

- Remove from source of exposure
- ABC's
- Flush skin and eyes with copious amounts of wter
- O2, cool mist, bronchodilators
- Airway management—early intubation, PEEP
- Hydration

Triage of Choking Agents

Green
Priority

- Respiratory symptoms more than six hours after exposure

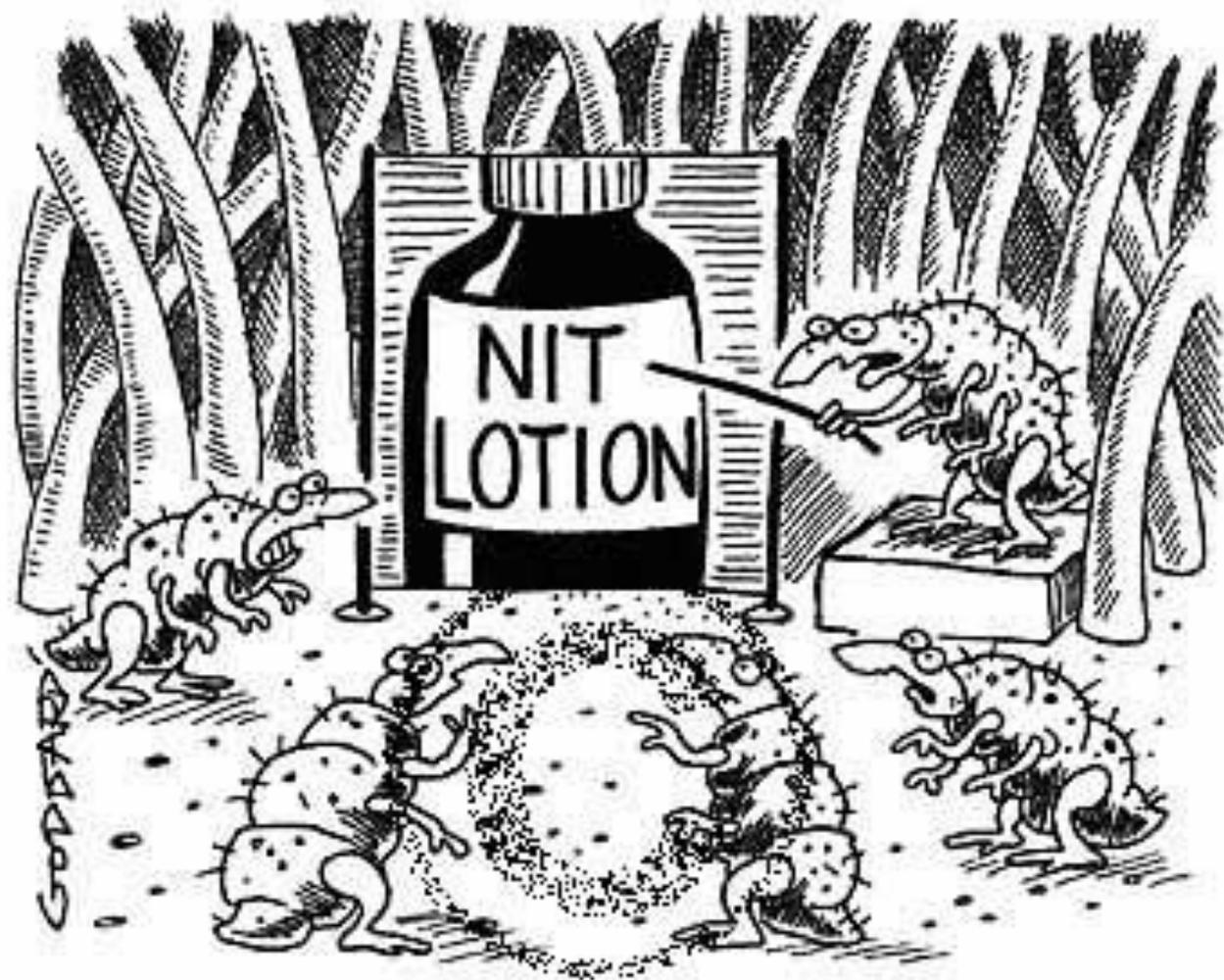
Yellow
Priority

- Same as above, look at degree of respiratory symptoms

Red
Priority

- Severe respiratory distress during triage or unstable vital signs (support available)

- Severe respiratory distress within six hours of exposure (no support available)



"Reconnaissance pictures clearly show
the enemy's chemical stockpile. "