

# MEDICAL MANAGEMENT OF CHEMICAL CASUALTIES

## VESICANTS

U.S. ARMY MEDICAL RESEARCH  
INSTITUTE OF CHEMICAL DEFENSE



*USAMRICD*  
*PROTECT, PROJECT, SUSTAIN*



# OBJECTIVES

- **Know the mechanism of action (pathophysiology)**
- **Identify signs and symptoms for all routes of exposure and the clinical time course**
- **Know specific pre and post exposure treatment regimens**
- **Understand the specific pharmacology of each treatment regimen**
- **Understand the prognosis and triage for mild, moderate, and severe exposure**

# MILITARY VESICANTS

- **Mustards**
  - Sulfur (agent)
  - Nitrogen (chemotherapy)
- **Lewisite**
- **Phosgene oxime**

# MUSTARD HISTORY

- **1822: First synthesized (Despretz)**
- **Mid-1800s: Synthesized again (Niemann, Guthrie)**
- **1880s: Manufacturing process (Meyer)**
- **1917: First battlefield use (Germany)**

# WORLD WAR I CW CASUALTIES

	CW Casualties	%Fatal
<b>Germany</b>	200,000	4.5
<b>France</b>	190,000	4.2
<b>Britain</b>	189,000	4.2
<b>U.S.</b>	73,000	2.0
<b>Russia</b>	475,000	11.8
<b>Kurds</b>	5,000	100?

## WW I USE

- **Caused more than 70% of chemical casualties**
- **Lethality low; under 5%**
- **Long convalescence**

# WORLD WAR II

- **The Bari mustard disaster**
- **02 December 1943**

# POST-WORLD WAR I

- Italy against Ethiopia
- Japan against China
- Iraq against Iran, Kurds
- Alleged: Egypt against Yemen

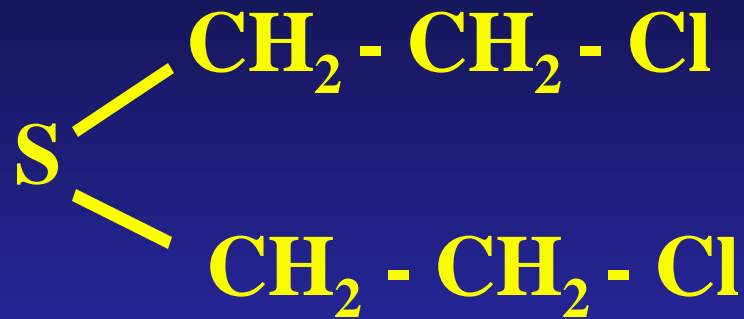


# MUSTARD

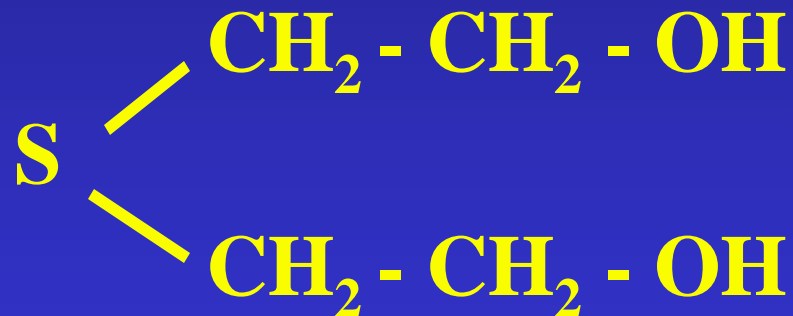
- **HS: Hun Stoff**
- **H: Impure**
- **HD: Distilled, pure**
- **HL: Mustard/Lewisite**
- **HT: Mustard/agent T**

# SULFUR MUSTARD

Mustard

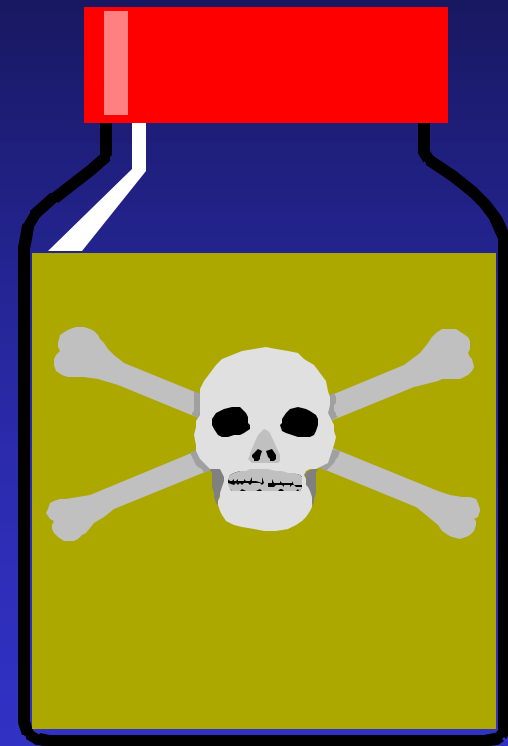


Thiodiglycol



# MUSTARD

- **Oily liquid**
- **Light yellow to brown**
- **Vapor heavier than air**
- **Liquid heavier than water**
- **Low volatility; persistent**
- **Freezes/melts at 58°F**



# MUSTARD DETECTION

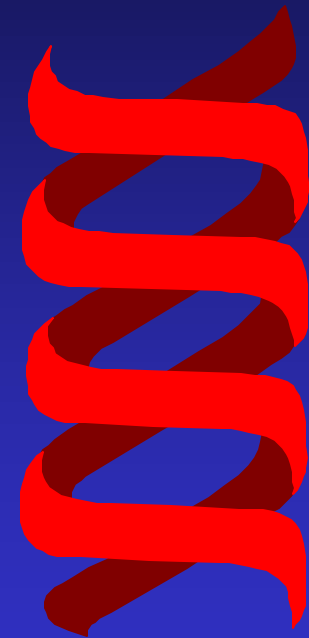
- **Liquid: M8, M9 papers**
- **Vapor: M256A1; CAM**

# MUSTARD PENETRATION

- **Through skin surfaces in 2 minutes**
- **80% on skin evaporates**
- **Part is “fixed” in skin, rest circulates**

# MUSTARD

- **Quickly cyclizes in tissue**
- **Alkylates cell components  
(DNA, proteins)**
- **DNA damage leads to:**
  - cell death
  - mutation



# MUSTARD TOXICITY

**Vapor unprotected (mg•min/m<sup>3</sup>)**

<b>Eye</b>	<b>10 to 50</b>
<b>Airways</b>	<b>100 to 500</b>
<b>Skin</b>	<b>200 to 1,000</b>
<b>Death</b>	<b>1,500</b>

# MUSTARD TOXICITY

## Liquid

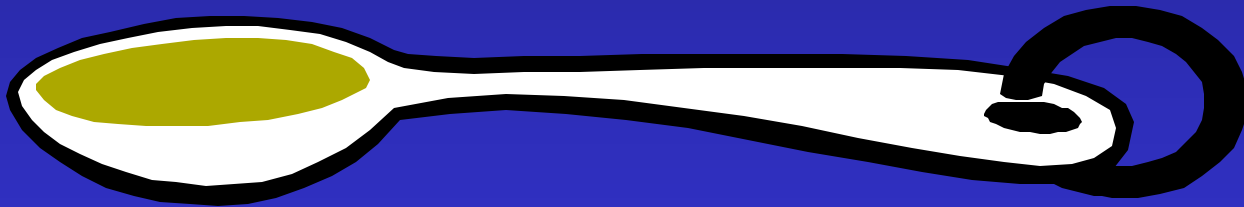
Blister

10ug

Death

100 mg/kg

7 gm/70 kg





# MUSTARD: DAMAGES

- **Skin**
- **Eyes**
- **Airways**
- **Systemic:**
  - **Bone marrow**
  - **GI tract**
  - **CNS**
  - **Lymphoid tissue**

# MUSTARD CASUALTIES FROM WWI

- Eyes.....85%
- Respiratory Tract....75%
- Scrotum .....42%
- Face .....27%
- Anus .....24%
- Legs.....11%
- Buttocks .....10%
- Hands .....4%
- Feet.....1.5%

## **MUSTARD: ONSET**

- **Cellular interaction: 1 to 2 minutes**
- **Clinical effects: 2 to 48 hours**  
**Usually 4 to 8 hours**

# MUSTARD: SKIN

- **Erythema**
- **Small vesicles; later coalesce**
- **Blisters/bulla**
- **Possible coagulation necrosis with liquid exposure**

## **MUSTARD: ONSET**

- **Chemical cell damage: 1 to 2 minutes**
- **Clinical effects: 2 to 48 hours**
- **Usually 4 to 8 hours**

## **MUSTARD: EYE**

- **Mild: conjunctivitis, blepharospasm**
- **Moderate: lid inflammation and edema, blepharospasm, corneal roughening**
- **Severe: Corneal opacification, ulceration, and/or perforation**

## MUSTARD: EYE

- **75% only mild conjunctivitis**
  - Return to duty in 2 weeks
- **15% moderate conjunctivitis**
  - Return to duty 4-6 weeks
- **10% severe; under 1% with residual damage**
- **0.1% “legal” blindness**

# MUSTARD: ACUTE EFFECTS

- **Upper airway**
  - **Hemorrhage**
  - **Pain**
- **Larynx**
  - **Hoarseness**
  - **Stridor**



# MUSTARD: ACUTE EFFECTS

- **Trachea/bronchi**
  - bronchospasm
  - pseudomembranes
- **Small airway and alveoli (massive exposure)**
  - hemorrhagic edema

# MUSTARD: DEATH

- Usually pulmonary:
  - Damaged airways
  - Infection
  - Depressed immune system
  - Sepsis

## **MUSTARD: MARROW**

- **Damaged stem cells**
- **Decreased WBC, RBC, platelets  
(Day 7 to day 14)**
- **Survival rare if WBC <200  
(Iran / Iraq)**

## MUSTARD: GI

- **Early (< 24 hours):**
  - transient symptoms
  - cholinergic effect
- **Late (>3 days):**
  - severe damage
  - cytotoxic effect

# SEVERE MUSTARD EXPOSURE

- CNS
  - Apathy, lethargy
  - Euphoria
  - Convulsions, **only with massive exposure!**
  - Coma
  - Death

# MUSTARD

- **Radiomimetic (DNA)**
  - **epithelial cells**  
(eye, pulmonary, skin, GI)
  - **hematopoietic**
  - **damages many tissues**

# MUSTARD: SYMPTOMS

- **Symptoms within 4 hours = severe injury**
- **Airway symptoms within 6 hours is often fatal**

# DIFFERENTIAL DIAGNOSIS

- **Isolated cases: plant, animal, other chemicals**
- **Many cases:**
  - **Latent effects: Mustard**
  - **Immediate effects: Lewisite, Phosgene Oxime**



# MUSTARD: DIAGNOSTICS

- **Non-specific**
- **CBC**
- **Early chemical pneumonitis:  
fever, WBC, chest x-ray**
- **Pneumonia: sputum exam / culture**
- **Urinary thiodiglycol: DA TB Med 296**

# MUSTARD: MANAGEMENT

**Protect Self!!!**

# DECONTAMINATION

- **Early decon protects casualty**
  - **within minutes**
- **Late decon protects medical personnel and facility**

## MANAGEMENT: SKIN

- Soothing cream/lotion
- Unroof large blisters
- Debridement of burns
- Frequent irrigation
- Antibiotics: Topical / Systemic (cellulitis)
- Systemic analgesics
- Appropriate IV fluids and electrolytes

# MANAGEMENT: EYES

- Soothing eye drops
- Topical mydriatics
- Topical antibiotics
- Vaseline on lid edges
- Avoid topical analgesics
- Topical steroids - ??
- Sunglasses

# MANAGEMENT: AIRWAYS

- **Steam, cough suppressants**
- **Oxygen**
- **Bronchodilators, steroids**
- **Early intubation**
- **Assisted ventilation**
- **Antibiotics AFTER organism identified**

# MANAGEMENT: GI

- **Atropine**
- **Antiemetics**
- **Fluid therapy**
- **Electrolyte replacement**

# MANAGEMENT: MARROW

- **Blood component replacement**
  - RBC, WBC, Platelets
- **Marrow transplants**
- **Hormonal therapy**
- **Reverse isolation**



# MUSTARD: LONG TERM

- **Carcinogen / mutagen**
- **No evidence of human reproductive toxicity**
- **Chronic exposure**
  - **Respiratory cancer**
  - **Unclear: chronic bronchitis, emphysema**

# MUSTARD: LONG TERM

- **No evidence of cancer after one or two exposures**
- **Chronic eye problems / damage may follow severe eye exposure**

# LEWISITE

- **World War I origin; not used**
- **Possible use by Japan vs China**
- **No other known use**
- **Sparse data**

# LEWISITE

- **Oily, amber to brown liquid**
- **Freezing point ~ 0°F**
- **Heavier than air, water**
- **Persistent**
- **Geranium odor**

# LEWISITE: TOXICITY

## Vapor

- Eyes Effects 2 mg-min/m<sup>3</sup>
- Vesication 1,500 mg-min/m<sup>3</sup>
- Death 1,500 mg-min/m<sup>3</sup>

## Liquid

- Blister 14 mg
- Death 2.8 g

# LEWISITE: MECHANISM

- **Contains arsenic**
  - carcinogen ??
- **Reacts with many constituents: cellular necrosis**
- **Mechanism unknown**

# LEWISITE: DAMAGES

- Eyes
- Skin
- Airways
- Capillaries

# LEWISITE: TIME OF ONSET

- Pain, irritation within 1 min
- Tissue necrosis within 5 min



# LEWISITE: SKIN

- **Progresses to blister**
- **More necrosis than from mustard**

## **LEWISITE: EYES**

- **Pain, blepharospasm on contact**
- **Rapid edema of conjunctiva, lids**
  - **Eyes swollen shut in an hour**
- **Damage to iris and cornea**

# LEWISITE: AIRWAYS

- **Severe irritation**
- **Bronchial epithelial necrosis, similar to mustard**
- **More prone to pseudomembranes, pulmonary edema than mustard**

# LEWISITE SHOCK

- **Increased capillary permeability**
  - **Plasma volume decreased**
  - **Hemoconcentration**
  - **Hypotension**
  - **Pulmonary edema**
  - **Circulatory failure**
  - **Death**

# LEWISITE: MANAGEMENT

- **Immediate decontamination**
- **Treat as mustard lesion**
- **British Anti-lewisite (BAL)**  
**Dimercaprol**
  - **Systemic**
  - **Topical**
  - **Ophthalmic**

# LEWISITE: TREATMENT

- **Hospital care - severe exposure**
  - **IM injection of BAL (10% in oil)**
  - **Initial dose: 0.5cc per 25 lbs**  
**(up to 4cc total)**
  - **May be given at 4, 8, 12 hours after initial dose**

# BAL SIDE EFFECTS

- **Lacrimation**
- **Constriction of throat**
- **GI cramps, vomiting, nausea**
- **Anxiety, myalgias**
- **Hypertension**
- **May last up to 30 minutes**

# PHOSGENE OXIME (CX)

- **Rapid onset**
- **Toxic, irritating, corrosive**
- **Urticant, not vesicant**
- **Sparse data**
- **Never used in combat**
- **Stockpiled by USSR**



## PHOSGENE OXIME (CX)

- Phosgene oxime corrosive to all tissues (skin, lungs, eyes)
  - Pulmonary edema
- Phosgene oxime manufactured from Phosgene
- Phosgene (CG) - lung agent only

# PHOSGENE OXIME: MANAGEMENT

- **Management:**
  - **Symptomatic**
  - **Supportive**
  - **Same as mustard**

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## SUMMARY

### ANY QUESTIONS?

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