Chapter 2

# VESICANTS

## Summary

***NATO Codes:*** H, HD, L, HL

***Signs and Symptoms***: Asymptomatic latent period (hours). Erythema and blisters on the *skin*; irritation, conjunctivitis, corneal opacity, and damage in the *eyes*; range from mild upper respiratory signs to marked airway damage; also gastrointestinal effects and bone marrow stem cell suppression. Fever not typical.

***Detection*:** Joint Chemical Agent Detector (JCAD), M256A1 Kit, M18A2 Chemical Agent Detector Kit, Individual Chemical Agent Alarm (ICAM), M90 Chemical Agent Detector, M8 and M9 Chemical Agent Detector Papers, M21 Remote Sensing Chemical Agent Alarm (RSCAAL), M93 series Fox Reconnaissance System, M272 Chemical Water Testing Kit, M22 Automatic Chemical Agent Detection Alarm (ACADA).

***Decontamination***: Reactive Skin Decontamination Lotion (RSDL), large amounts of soap and water, 0.5% hypochlorate solution.

***Management***: Immediate decontamination (< 2 minutes after exposure) is the only way to prevent damage. Symptomatic management of lesions.

## Overview

Blister agents are second only to nerve agents as a concern to the US military. The primary blister agent threats are sulfur mustard (H, HD), lewisite (L), and a mixture of mustard and lewisite (HL).

Mustard remains a concern because it is both incapacitating and lethal, it is easy to manufacture, and there are large stockpiles. Mustard was the largest cause of chemical casualties in World War I, and it was used extensively by Iraq in the Iran-Iraq War in the 1980s. Although there were many mustard casualties in World War I, only about 3% of them died as a result of the exposure. This low death rate occurred despite the relatively poor protection and level of medical care available at the time (eg, antibiotics had not yet been developed).

Mustard rapidly penetrates the skin, causing both localized cellular damage and systemic damage. What makes mustard deadly is that a casualty exposed to a large amount of liquid or vapor mustard faces total systemic assault. The reasons for this are (1) failure of the body's immune system, with sepsis and infection as the major contributing causes of death, and (2) pulmonary damage, which is also a major contributory factor in death.

## Physical Characteristics

The severity of blister agent effects will be affected, in part, by environmental conditions at the time of exposure. Warm, humid conditions increase the severity of blister agent damage and shorten the time of symptom onset. Cold weather retards the time of symptom onset and, providing the exposed skin remains cold, lessens the severity of blister agent damage.

Mustard has a freezing point of 58°F, while the mixture HL, containing 37% HD to 63% lewisite, has a freezing point of -3°F. HD's lower freezing point makes the mixture more significant in combat operations in a cold environment. Also, blister agents have a relatively high vapor density when compared to air. Mustard has a vapor density 5.4 times greater than air, lewisite has a density 7.1 times greater, and HL is 6.5 times heavier than air. The denser the vapor, the more likely it is to flow to low spots such as valleys, closed spaces, or the floor.

## Mitigation

The care provider should use current intelligence and the physical characteristics of blister agents to determine likely exposure mechanisms (liquid and/or vapor) based on temperature. Utilizing all available data, the care provider can predict the chemical threat and take active steps to prevent or lessen the impact of chemical agent employment on individuals. This information, along with understanding the medical implications of an exposure, will allow the care provider to develop operational scenarios and anticipate the required response needed to optimize casualty care.

If the unit fails to conduct monitoring of personnel and equipment before either enters sleep or work areas, the potential exists for intoxication by multiple routes of exposure. Soldiers could absorb agent through the skin by handling equipment contaminated with a liquid agent. Vapors desorbing from equipment contaminated by liquid agent could affect the eyes and respiratory tract. When operating in cold climates or desert regions, particularly at night, use extreme caution to prevent contamination of warm-up tents, operations areas, or sleeping areas. An agent at its freezing temperature brought in on clothing or skin will liquefy as it warms and slowly produce vapors. Unless contamination is detected early, soldiers will be exposed in these confined spaces. Due to the freezing point of mustard and lewisite, it is critical to monitor personnel and their equipment in a warm-up tent before they occupy work or rest areas. Mustard, for example, has a freezing point of 58°F. Above 58°F the solid will transition to a liquid or gas, creating an exposure risk. All personnel in the monitoring tent must wear protective masks during monitoring.

## Detection

Mustard received its name because of its garlic, horseradish, or mustard odor. It can be detected by smell, visual observation, and all current Defense Department chemical agent detectors. The human nose can detect mustard (H, HD) in concentrations of 0.6 to 1.0 mg/m$^3$ (although this may seem to be an undesirable

way to detect blister agent, alert soldiers will most likely smell the agent vapor before encountering the liquid). Detailed information on detection is provided in Chapter 11, Individual Protective Equipment. After release, H and HD appear as a thick, colorless, or pale yellow liquid, and HL appears as a dark oily liquid.

Some indicators of an attack in progress or contact with agent from a previously unknown attack are as follows:

- out-of-place smell of mustard, garlic, or onion;
- color change in M9 detector tape;
- color change in M8 detector card;
- overt indications such as enemy helicopters spraying liquid or indirect artillery fire that detonates with dull or muffled explosions;
- a feeling of oily "rain" as agent contacts exposed skin; and
- liquids that appear thick or oily and out of place on equipment, plants, or terrain.

## Effects

**H, HD**. The major effects, onset, and severity of H and HD are shown in Table 2-1. Clinical signs and symptoms from mustard exposure are not apparent until hours later; however, tissue damage occurs within 2 minutes. Decontamination after the 2

**Table 2-1. Effects of Mustard Vapor**

| Organ | Severity | Effects | Onset |
|---|---|---|---|
| Eye | Mild | Tearing, itchy, burning, gritty feeling | 4–12 hours |
| | Moderate | Above, plus reddening, swelling of lids, moderate pain | 3–6 hours |
| | Severe | Marked swelling of lids, possible cornea damage, severe pain | 1–2 hours |
| Airways | Mild | Runny nose, sneezing, nosebleed, hoarseness, hacking cough | 12–24 hours |
| | Severe | Above, plus severe productive cough, shortness of breath | 2–4 hours |
| Skin | Mild to severe | Erythema (redness), blisters | 2–24 hours |

minutes of exposure will not prevent a mustard injury. Clinical effects occur on the skin and in the eyes and airways. Effects of severe exposure can occur days later in the bone marrow and gastrointestinal tract.

The effects on the skin are redness (erythema) that resembles sunburn and, later, blisters. The eyes initially are irritated and later may swell shut. The first airway effects occur in the upper airways (central airway compartment) with a hacking cough, hoarseness, and throat and nasal irritation. Severe agent exposure will later damage the lower airways. Inhaled HD will cause tissue to slough off in large sheets, known as pseudomembranes, which block the airway. The various degrees of central airway compartment obstruction may cause sneezing and coughing, hoarseness when talking, wheezing noises when breathing, or inability to breathe.

**HL.** The effect of HL liquid on the eyes and skin, or HL vapor in the eyes or respiratory tract, is immediate, causing intense pain and eyelid twitching. Casualties feel stinging pain within seconds after contact with liquid HL and will attempt to decontaminate themselves. Rapid decontamination is the only way to avoid severe burns. After 5 minutes of contact with HL, the upper layer of skin (epithelium) will die and appear gray. Painful erythema will begin shortly afterwards, and painful blisters may appear within 12 hours. Within an hour, edema of the conjunctivae and eyelids begins, which rapidly results in eye closure.

The immediate irritation from HL vapor is so intense that an individual will immediately mask or exit the area. Respiratory casualties will be unable to do either. Pulmonary effects are similar to those caused by mustard alone, except that pulmonary edema (fluid in the lungs) is more likely after lewisite exposure.

## Self-Aid and Buddy Aid

The actions needed for self-aid or buddy aid are essentially nonmedical. Reacting as quickly as possible to warnings of an attack by donning a protective mask and going to mission-oriented protective posture (MOPP) level 4, detecting the agent as early as possible, and removing any suspicious liquid using

RSDL are the easiest ways to prevent a blister agent casualty. Reacting quickly to attack indicators will prevent most, if not all, casualty-causing exposures.

When exposure is suspected, time is critical. Unless the individual was wearing a protective mask at the time of the suspected exposure, the assumption must be that the eyes were exposed. Copiously flush the eyes with water to prevent or lessen the physical damage from blister agent exposure. Following the task in the *Soldier's Manual of Common Tasks* (STP 21-1-SMCT), individuals must decontaminate their own eyes, and although this is not a buddy-aid task, having assistance will increase the effectiveness of the procedure. Remember that time is critical for effective mustard decontamination because blister agents become "fixed" to tissue components within 2 minutes after deposition. Also use RSDL as soon as possible to remove agent from hands and around the eyes.

## Immediate Casualty Decontamination

As described above, self-aid decontamination must be done at the time of exposure. The casualty should have performed skin decontamination with RSDL and equipment decontamination with the M295 Individual Equipment Decontamination Kit before being seen by the care provider. Because of the persistent nature of blister agents, patient decontamination must be as thorough as possible. As with nerve agent exposure, care providers must protect themselves by masking and donning MOPP gear. When beginning treatment, attempt to determine what type of decontamination has been done and when. Understanding the potential contamination threat posed by the casualty will allow the care provider to avoid cross contamination. Decontamination performed within 2 minutes reduces the toxic effects by more than 50%. Decontamination is explained in detail in Chapter 10, Patient Decontamination Station.

## Field Treatment

Initial medical treatment by the care provider at the time of exposure is limited. The actions required at the unit level medical treatment for blister agent casualties are two-fold: (1) triage for

evacuation or return to duty, and (2) the actual treatment of the casualty. Triaging the soldier is based on several factors: the severity of observable effects, the opinion of the triaging care provider as to whether or not the effects will progress further, and the impairment of normal duty requirements caused by the symptoms.

Casualties with signs or symptoms that appear at the earliest onset time possible (see Table 2-1) generally require evacuation to a medical treatment facility (MTF), with little chance for quick return to duty, because the initial effects will progress. Fast onset of symptoms can indicate exposure to high concentrations of agent, causing severe lesions, for which the care available at an MTF is required.

**Eyes**. Individuals with mustard conjunctivitis require application of a steroid antibiotic eye ointment. FM 4-02.285, *Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, recommends dexamethasone sodium phosphate-neomycin ophthalmic ointment for this use. This drug decreases inflammation and has antibacterial effects. Systemic narcotic analgesics are recommended for eye pain. Under no circumstances should the eyes be bandaged because it may cause the eyelids to stick together, the secretions will not have a means to drain, and the resulting accumulation in the conjunctival sac can lead to infection and corneal ulcerations. Individuals presenting with blister agent conjunctivitis require evacuation to an MTF for treatment by an ophthalmologist as soon as possible. Petroleum jelly or antibiotic ointments should be placed on the eyelashes to prevent abscess formation.

**Skin**. Evacuate individuals presenting with erythema that limits motion in a limb. Also, patients with erythema covering more than 5% of the body in noncritical areas, using the "rule of nines" to determine the coverage (Figure 2-1), require evacuation. Individuals with erythema involving less than 5% of the body may need evacuation, depending on the location of the erythema and the resulting duty impairment. Treat erythema as needed for itching and burning sensations. Application of a topical steroidal cream or calamine lotion will provide temporary relief.

1. Head and neck: 9%
2. Anterior trunk: 18%
3. Posterior trunk: 18%
4. Upper extremities: 18% (9% each)
5. Lower extremities: 36% (18% each)
6. Perineum: 1%

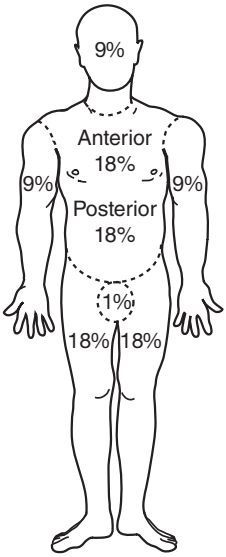


**Figure 2-1.** Rule of nines.
Figure reproduced from: *Emergency War Surgery*. 4th US Revision. Fort Sam Houston, TX: Borden Institute; 2013: Fig. 28-2.

Normally erythema progresses to vesication (blister formation). The size and number of blisters depends on the severity of exposure, skin condition (sweaty and moist or dry) at the time of exposure, and location of the exposure on the body. If possible, blisters the size of a quarter or smaller should be left intact because they act as a protective cover over the wound, providing good protection from infection. The blister fluid is sterile and does not contain live agent. Small unbroken blisters should be covered with a petrolatum gauze bandage. The dressing should be changed every 3 to 4 days.

Large blisters should be unroofed, and blisters that have broken should have the ragged blister roof removed. The area of the open blister should be cleaned with tap water or saline and a petrolatum gauze bandage should be applied. The primary concern when treating blisters of any size is preventing infection.

The decision to evacuate casualties or return them to duty must not be made on the basis of blister formation only. Initial blister formation may be slight, but over time the condition could progress to large blisters that are unmanageable in the field. If a casualty is not evacuated, the care provider must instruct the individual on self-aid care for the blister. The individual should be given a topical antibacterial cream, such as 10% mafenide acetate or silver sulfadiazine burn cream, and instructed to apply a 1/8-inch layer to the blister four times a day. A petrolatum gauze bandage should then cover the area.

**Lungs**. Soldiers who present with any sign or symptom of respiratory exposure should be evacuated promptly. The care provider cannot determine damage to the larynx or trachea. Any unnecessary delay in diagnosis and required treatment at the MTF must be avoided. If the airway is obstructed by blisters, the blisters may be unroofed when surgical and supportive care is available.