

**Blister Agents**  
**Lewisite (L) (C<sub>2</sub>H<sub>2</sub>AsCl<sub>3</sub>) CAS 541-25-3, UN 1556; and**  
**Mustard-Lewisite Mixture (HL) CAS Number not available, UN 2810**

Synonyms for Lewisite include L, arsine (2-chlorovinyl) dichloro-, arsenous dichloride (2-chloro-ethenyl)-, chlorovinylarsine dichloride, 2-chlorovinyl dichloroarsine, beta-chlorovinyl dichloroarsine, dichloro-(2-chlorovinyl)arsine, EA1034.

Synonyms for Mustard-Lewisite include HL and Sulfur Mustard/Lewisite.

**Persons whose skin or clothing is contaminated with liquid Lewisite or Mustard-Lewisite Mixture can contaminate rescuers by direct contact or through off-gassing vapor.**

- **Lewisite is an oily, colorless liquid with an odor like geraniums. Mustard-Lewisite Mixture is a liquid with a garlic-like odor. Volatility of both agents is significant at high ambient temperatures.**
- **Lewisite and Mustard-Lewisite Mixture are rapidly absorbed by the skin causing immediate pain and burning followed by erythema and blistering. Ocular exposure to Lewisite or the mixture may cause immediate incapacitating burning and inflammation of the cornea and conjunctiva. Inhalation damages the respiratory tract epithelium and may cause death.**

### Description

Lewisite is an organic arsenical known for its vesicant properties. Pure Lewisite is an oily, colorless liquid, while impure Lewisite is amber to black. It remains a liquid at low temperatures and is persistent in colder climates. It has the odor of geraniums.

Mustard-Lewisite Mixture is a liquid mixture of distilled Mustard (HD) and Lewisite. Due to its low freezing point, the mixture remains a liquid in cold weather and at high altitudes. The mixture with the lowest freezing point consists of 63% Lewisite and 37% Mustard. It has a garlic-like odor.

### Routes of Exposure

#### *Inhalation*

Exposure to Lewisite vapor at a concentration of 8 mg-min/m<sup>3</sup> causes immediate burning pain of the respiratory tract. Its odor is noted at about 20 mg-min/m<sup>3</sup>. The LC<sub>t50</sub> (the product of concentration times time that is lethal to 50% of the exposed population by inhalation) is approximately 1,500 mg-min/m<sup>3</sup>. Exposure to Mustard-Lewisite Mixture vapor induces immediate respiratory tract irritation and severe inflammation after a few

hours latency period. Both agents are readily absorbed from the lungs.

*Skin/Eye Contact*

Absorption may occur after skin or eye contact with liquid or vapor Lewisite. Absorption across the skin begins within minutes. Vesication is caused by about 14 µg of liquid, and the LD<sub>50</sub> of liquid on the skin is about 30-50 mg/kg. Liquid Lewisite causes severe eye damage within minutes of contact. The vapor also acts quickly, with pain on contact, followed by edema of the conjunctiva and eyelids, and iritis and corneal damage with high doses.

Systemic absorption may occur following skin or eye exposure to liquid or vapor Mustard-Lewisite Mixture. The mixture causes immediate stinging pain of the skin, with blistering delayed for hours. Graying of the skin will follow within a very short time if exposure is from liquid (because of Lewisite). Erythema and blisters will appear earlier than from mustard alone. Exposure of the eyes to Mustard-Lewisite Mixture produces lacrimation and inflammation of the conjunctiva and cornea. After exposure to low amounts of Lewisite or to the mixture, temporary loss of eyesight may occur because of blepharospasm or eyelid edema. After exposure to high amounts, permanent loss of sight may occur because of corneal damage; however, this is unusual.

*Ingestion*

Ingestion of either Lewisite or Mustard-Lewisite Mixture is an uncommon route for exposure but can lead to local effects and systemic absorption.

**Sources/Uses**

Lewisite is an arsenical vesicant that was first synthesized in 1918. Large amounts were produced by the United States to be used in Europe; however, World War I ended while the shipment was at sea and the vessel was sunk. There have been allegations that it was used by Japan against Chinese forces in the late 1930s; however, there are no confirmed reports that it has been used in warfare, although it may be stockpiled by some countries. Destruction of U.S. stockpiles of chemical agents, including Lewisite, was mandated by the Chemical Weapons Convention to take place before April 2007.

Mustard-Lewisite Mixture is a mixture of distilled Mustard and Lewisite developed to achieve a lower freezing point for ground dispersal and aerial spraying.

**Standards and**

**Guidelines**

Lewisite and Mustard-Lewisite Mixture: Airborne Exposure Limit (as recommended by the Surgeon General's Working Group, U.S. Department of Health and Human Services) = 0.003 mg/m<sup>3</sup> as a time-weighted average (TWA) for the workplace and a 72-hour TWA for the general population.

**Physical Properties****Table 1. Physical Properties of Lewisite and Mustard-Lewisite Mixture**

Property		
	Lewisite	Mustard-Lewisite Mixture
Description	Oily, colorless liquid	Dark, oily liquid
Warning properties	Odor like geraniums	Garlic-like odor
Molecular weight	207.32	
Boiling point	(760 mm Hg) = 374 °F (190 °C)	(760 mm Hg) = Indefinite, but below 374 °F (190 °C)
Freezing point	0.4 °F (-18 °C)	13 °F (-25.4 °C) (purified mix), -43.6 °F (-42 °C) (typical production batch)
Specific gravity	1.888 at 68 °F (20 °C) (water = 1.0)	1.60 at 68 °F (20 °C) (water = 1.0)
Vapor pressure	0.394 mm Hg at 68 °F (20 °C)	0.248 at 68 °F (20 °C)
Vapor density	7.1 (air = 1.0)	6.5 (air = 1.0)
Liquid density	1.89 g/cm <sup>3</sup> at 77 °F (25 °C)	1.66 g/cm <sup>3</sup> at 68 °F (20 °C)
Flash point	Does not burn easily. When heated, emits toxic fumes of hydrogen chloride and arsenic.	Data not available on flammability. Toxic fumes of hydrogen chloride, sulfur oxides, and arsenic may be produced in a fire.
Solubility in water	Negligible	Practically insoluble
Volatility	4,480 mg/m <sup>3</sup> (20 °C)	No data
NAERG#	153	153

**Incompatibilities**

Heating causes Lewisite to yield arsenic trichloride, tris-(2-chlorovinyl)arsine, and bis-(2-chlorovinyl)chloroarsine.

Mustard-Lewisite Mixture is rapidly corrosive to brass at 65 °C and will corrode steel at a rate of 0.0001 inches of steel per month at 65 °C. It will hydrolyze into hydrochloric acid, thiodiglycol, and non-vesicant arsenic compounds.



## Health Effects

**Lewisite and Mustard-Lewisite Mixture are blister agents that are highly and immediately irritating to the skin, eyes, and airways. Contact with liquid or vapor forms may result in skin erythema and blistering, corneal damage and iritis, damage to the airway mucosa, and pulmonary edema.**

- **Lewisite is a systemic poison binding with thiol groups in many enzymes and may cause pulmonary edema, diarrhea, capillary leakage, and subsequent hypotension.**
- **Systemic absorption of Mustard-Lewisite Mixture may cause bone marrow suppression due to the alkylating properties of the Mustard component.**

### Acute Exposure

Lewisite damages skin, eyes, and airways by direct contact. It inhibits many enzymes, in particular those with thiol groups, such as pyruvic oxidase, alcohol dehydrogenase, succinic oxidase, hexokinase, and succinic dehydrogenase. The exact mechanism by which Lewisite damages cells is not known. Mustard-Lewisite Mixture shares the vesicant properties of Lewisite and the DNA alkylation and cross-linking properties of mustard.

### *Dermal*

Lewisite liquid or vapor produces pain and skin irritation within seconds to minutes after contact. For liquid Lewisite, erythema occurs within 15 to 30 minutes after exposure and blisters start within several hours, developing fully by 12-18 hours. For the vapor, response times are a little longer. The Lewisite blister starts as a small blister in the center of the erythematous area and expands to include the entire inflamed area. Mustard-Lewisite Mixture also produces pain and irritation immediately, and erythema within 30 minutes. Blistering is delayed for hours and tends to cover the entire area of reddened skin.

### *Ocular*

Lewisite vapor causes pain and blepharospasm on contact. Edema of the conjunctiva and eyelids follows, and the eyes may be swollen shut within an hour. With high doses, corneal damage and iritis may follow. Liquid Lewisite causes severe eye damage on contact. Mustard-Lewisite Mixture also causes ocular effects extremely rapidly. Lacrimation, photophobia, and inflammation of the conjunctiva and cornea may occur.

### *Respiratory*

Lewisite and Mustard-Lewisite Mixture are extremely irritating to the respiratory tract mucosa. Burning nasal pain, epistaxis, sinus pain, laryngitis, cough and dyspnea may occur. Necrosis can cause pseudomembrane formation and local airway

obstruction. Pulmonary edema may occur following exposure to high concentrations.

*Gastrointestinal* Ingestion or inhalation of Lewisite may cause nausea and vomiting. Ingestion of Mustard-Lewisite Mixture produces severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

*Cardiovascular* High-dose exposure to Lewisite may cause “Lewisite shock,” a condition resulting from increased capillary permeability and subsequent intravascular fluid loss, hypovolemia, and organ congestion.

*Hepatic* Hepatic necrosis may occur due to shock and hypoperfusion following exposure to high levels of Lewisite.

*Renal* Exposure to high levels of Lewisite may cause decreased renal function secondary to hypotension.

*Hematopoietic* Systemic absorption of Mustard-Lewisite Mixture may induce bone marrow suppression and an increased risk for fatal complicating infections.

*Potential Sequelae* Chronic respiratory and eye conditions may persist following exposure to large amounts of Lewisite or Mustard-Lewisite Mixture

**Chronic Exposure** Chronic exposure to Lewisite may lead to arsenical poisoning (see Arsenic MMG). Chronic exposure to Mustard-Lewisite Mixture can cause immune sensitization and chronic lung impairment consisting of cough, shortness of breath, and chest pain.

*Carcinogenicity* There is only anecdotal evidence for the potential carcinogenicity of Lewisite. However, the data are not definitive and do not support classifying Lewisite as a suspected carcinogen. Repeated exposures to Mustard-Lewisite Mixture over a long period of time may produce respiratory and skin cancer due to the mustard content. There are no specific data regarding the carcinogenicity of Mustard-Lewisite Mixture.

*Reproductive and Developmental Effects* Human data regarding reproductive/developmental effects of Lewisite are inconclusive because of limited human exposures. Animal studies show no clear evidence of developmental effects.

## Prehospital Management

**Victims whose skin or clothing is contaminated with liquid Lewisite or Mustard-Lewisite Mixture can contaminate rescuers by direct contact or through off-gassing vapor.**

**Lewisite and Mustard-Lewisite Mixture cause immediate pain and irritation to the eyes, skin, and respiratory tract. Systemic effects include capillary leakage and subsequent shock.**

**Decontamination immediately after exposure decreases tissue damage.**

### Hot Zone

Responders should be trained and appropriately attired before entering the Hot Zone. If the proper personal protective equipment (PPE) is not available, or if the rescuers have not been trained in its use, call for assistance in accordance with local Emergency Operational Guides (EOG). Sources of such assistance include local HAZMAT teams, mutual aid partners, the closest metropolitan strike system (MMRS) and the U.S. Soldier and Biological Chemical Command (SBCCOM)-Edgewood Research Development and Engineering Center SBCCOM may be contacted (from 0700-1630 EST call 410-671-4411 and from 1630-0700 EST call 410-278-5201 ), ask for the Staff Duty Officer.

### Rescuer Protection

Lewisite and Mustard-Lewisite Mixture are readily absorbed by inhalation and by ocular and dermal contact. Both Lewisite and Mustard-Lewisite Mixture are extremely irritating to the respiratory tract, skin, and eyes.

*Respiratory protection:* Pressure-demand, self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to any level of Lewisite and Mustard-Lewisite Mixture vapor.

*Skin/ocular protection:* Personal protective equipment (PPE) and butyl rubber chemical protective gloves are recommended at all times when these chemicals are suspected to be involved.

### Multi-Casualty Triage

Chemical casualty triage is based on walking feasibility, respiratory status, age, and additional conventional injuries. The triage officer must know the natural course of a given injury, the medical resources immediately available, the current and likely casualty flow, and the medical evacuation capabilities. General principles of triage for chemical exposures are presented in the box on the following page. There are four triage categories:

immediate (priority 1), delayed (priority 2), minimal (priority 3), and expectant (priority 4). Clinical signs and effects of lewisite agents associated with each of these categories are presented in Table 2 (below).

**Before transport, all casualties must be decontaminated.** If needed, consult with the base station physician or the regional poison control center for advice concerning management of multiple casualties.

Patients who have sustained injury to the skin, eyes, or airways and patients who have ingested Lewisite or Mustard-Lewisite Mixture should be transported to a medical facility for evaluation and treatment.

Consult with the base station physician, closest Metropolitan Medical Response System, or the regional poison control center for advice regarding triage of multiple victims.

**General principles of triage for chemical exposures are as follows:**

- Check triage tag/card for any previous treatment or triage.
- Survey for evidence of associated traumatic/blast injuries.
- Observe for sweating, labored breathing, coughing/vomiting, secretions.
- Severe casualty triaged as immediate if assisted breathing is required.
- Blast injuries or other trauma, where there is question whether there is chemical exposure, victims must be tagged as immediate in most cases. Blast victims evidence delayed effects such as ARDS, etc.
- Mild/moderate casualty: self/buddy aid, triaged as delayed or minimal and release is based on strict follow up and instructions.
- If there are chemical exposure situations which may cause delayed but serious signs and symptoms, then overtriage is considered appropriate to the proper facilities that can observe and manage any delayed onset symptoms. *For Lewisite and Mustard-Lewisite mixture which do not have delayed effects overtriage would not be appropriate.*
- Expectant categories in multi-casualty events are those victims who have experienced a cardiac arrest, respiratory arrest, or continued seizures immediately. Resources should not be expended on these casualties if there are large numbers of casualties requiring care and transport with minimal or scant resources available.



1. *Immediate*: casualties who require lifesaving care within a short time, when that care is available and of short duration. This care may be a procedure that can be done within minutes at an emergency treatment station (e.g., relief of an airway obstruction, administering antidotes) or may be acute lifesaving surgery.

2. *Delayed*: casualties with severe injuries who are in need of major or prolonged surgery or other care and who will require hospitalization, but delay of this care will not adversely affect the outcome of the injury (e.g., fixation of a stable fracture).

3. *Minimal*: casualties who have minor injuries, can be helped by nonphysician medical personnel, and will not require hospitalization.

4. *Expectant*: casualties with severe life-threatening injuries who would not survive with optimal medical care, or casualties whose injuries are so severe that their chance of survival does not justify expenditure of limited resources. As circumstances permit, casualties in this category may be reexamined and possibly be retriaged to a higher category.

**Table 2. Triage for Lewisite Casualties**

Category (Priority)	Clinical Signs and Symptoms
Immediate (1)	Lower respiratory signs (dyspnea, productive cough)
Delayed (2)	Eye lesions with impaired vision; moderate sized skin lesions for liquid exposure or any body surface burn for vapor exposure; lower respiratory symptoms (cough with sputum production)
Minimal (3)	Minor eye lesion with no vision impairment; small skin lesions in noncritical areas; minor upper respiratory symptoms (cough, sore throat).
Expectant (4)	Lower respiratory signs (dyspnea, necrosis); skin lesion covering more than half of body surface area from liquid exposure

*ABC Reminders*

Quickly ensure that the victim has a patent airway. Maintain adequate circulation. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Apply direct pressure to stop arterial bleeding, if present.

*Victim Removal*

If victims can walk, lead them out of the Hot Zone to the Decontamination Zone. Victims who are unable to walk may be

removed on backboards or gurneys. If these are not available, carefully carry or drag victims to safety.

## Decontamination Zone

All victims require decontamination (see *Basic Decontamination*, below). Rapid decontamination is critical to prevent further absorption by the patient and to prevent exposure to others. Decontaminable gurneys and back boards should be used if available when managing casualties in a contaminated area. Decontaminable gurneys are made of a monofilament polypropylene fabric that allows drainage of liquids, does not absorb chemical agents, and is easily decontaminated. Fiberglass back boards have been developed specifically for use in HAZMAT incidents. These are nonpermeable and readily decontaminated. The **Chemical Resuscitation Device** is a bag-valve mask equipped with a chemical agent cannister that can be used to ventilate casualties in a contaminated environment.

### *Rescuer Protection*

Personnel should wear the same level of protection as required in the Hot Zone (see *Rescuer Protection* under *Hot Zone*, above).

### *ABC Reminders*

Quickly ensure that the victim has a patent airway. Maintain adequate circulation. Stabilize the cervical spine with a decontaminable collar and a backboard if trauma is suspected. Administer supplemental oxygen if cardiopulmonary compromise is suspected. Assist ventilation with a bag-valve-mask device equipped with a cannister or air filter if necessary. Direct pressure should be applied to control bleeding, if present.

### *Basic Decontamination*

To significantly reduce tissue damage, the eyes and skin must be decontaminated **within 1 or 2 minutes** after exposure. Flush the eyes immediately with water for about 5 to 10 minutes by tilting the head to the side, pulling eyelids apart with fingers, and pouring water slowly into eyes. Do not cover eyes with bandages.

If exposure to liquid agent is suspected, cut and remove all clothing and wash skin immediately with soap and water. If shower areas are available, showering with water alone will be adequate. However, in those cases where water is in short supply, and showers are not available, an alternative form of decontamination is to use 0.5% sodium hypochlorite solution or absorbent powders such as flour, talcum powder, or Fuller's earth. If exposure to vapor only is certain, remove outer clothing and wash exposed areas with soap and water or 0.5% solution

of sodium hypochlorite. Place contaminated clothes and personal belongings in a sealed double bag.

In cases of ingestion, **do not induce emesis.**

*Transfer to Support Zone*

As soon as basic decontamination is complete, move the victim to the Support Zone.

**Support Zone**

Be certain that victims have been decontaminated properly (see *Decontamination Zone* above). Victims who have undergone decontamination pose no serious risk of secondary contamination to rescuers. In such cases, Support Zone personnel require no specialized protective gear.

*ABC Reminders*

Quickly ensure that the victim has a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Ensure adequate respiration; administer supplemental oxygen if cardiopulmonary compromise is suspected. Maintain adequate circulation. Establish intravenous access if necessary. Attach a cardiac monitor, as needed. Direct pressure should be applied to stop bleeding, if present.

*Additional Decontamination*

In cases of ingestion, **do not induce emesis.**

*Advanced Treatment*

Intubate the trachea in cases of respiratory compromise. When the patient's condition precludes endotracheal intubation, perform cricothyrotomy if equipped and trained to do so.

Treat patients who have bronchospasm with bronchodilators.

Patients who are comatose, hypotensive, or have seizures or cardiac dysrhythmias should be treated according to advanced life support (ALS) protocols.

*Transport to Medical Facility*

Report to the base station and the receiving medical facility the condition of the patient, treatment given, and estimated time of arrival at the medical facility.



## Emergency Department Management

**Patients whose skin or clothing is contaminated with liquid Lewisite and Mustard-Lewisite Mixture can contaminate rescuers by direct contact or through off-gassing vapor.**

**Lewisite and Mustard-Lewisite Mixture cause immediate pain and irritation to the eyes, skin, and respiratory tract. Systemic effects include capillary leakage and subsequent shock. The Mustard-Lewisite Mixture may cause bone marrow suppression due to the mustard component.**

**British Anti-Lewisite (BAL) can be given by intramuscular injection as an antidote for systemic effects but has no effect on the local lesions of the skin, eyes, or airways. Treatment consists primarily of supportive care.**

### Decontamination Area

Previously decontaminated patients may be treated or held for observation. Others require decontamination as described below.

#### *ABC Reminders*

Evaluate and support the airway, breathing, and circulation. Intubate the trachea in cases of respiratory compromise. If the patient's condition precludes intubation, surgically create an airway.

Treat patients who have bronchospasm with bronchodilators.

Patients who are comatose or hypotensive, or have seizures or ventricular dysrhythmias due to other exposures or trauma should be treated in the conventional manner.

#### *Personal Protection*

If contaminated patients arrive at the Emergency Department, they must be decontaminated before being allowed to enter the facility. Decontamination can only take place inside the hospital if there is a decontamination facility with negative air pressure and floor drains to contain contamination. Personnel should wear the same level of protection required in the Hot Zone (see *Rescuer Protection* under Hot Zone, above).

#### *Basic Decontamination*

Flush the eyes with water for about 5-10 minutes by tilting the head to the side, pulling eyelids apart with fingers, and pouring water slowly into eyes. Do not cover eyes with bandages; if necessary, use dark or opaque goggles to relieve discomfort from photophobia.

If a liquid splash is suspected, clothing must be removed and the patient showered using soap and water. Showering should be accomplished using cool water and enough water pressure to quickly reduce the potential for agent penetration of the skin. If the patient was exposed to vapor only, remove outer clothing and wash exposed skin with soap and water. Place contaminated clothes and personal belongings in a sealed double bag.

In cases of ingestion, **do not induce emesis**. If the victim is alert and able to swallow, give 4 to 8 ounces of milk or water to drink if not already administered. There are no data regarding the efficacy of activated charcoal after exposure to Lewisite or Mustard-Lewisite Mixture.

### Critical Care Area

Be certain that appropriate decontamination has been carried out (see *Decontamination Area*, above).

#### *ABC Reminders*

Evaluate and support the airway, breathing, and circulation (as in *ABC Reminders*, above). Establish intravenous access and continuously monitor cardiac rhythm in seriously ill patients.

Patients who are comatose or hypotensive, or have seizures or ventricular dysrhythmias due to other exposures or trauma should be treated in the conventional manner.

#### *Triage*

Patients arriving at the emergency department directly from the scene of potential exposure (within 30-60 minutes) will have pain or irritation if they were exposed. If they have no pain or irritation, they may be sent home and told to return with the onset of symptoms. Following decontamination, patients with signs of airway involvement should be admitted directly to the Critical Care Unit. Whether in the hospital or not, patients with no symptoms should be observed for 18 to 24 hours. Patients arriving later should be evaluated as described below. The sooner after exposure that symptoms occur, the more likely they are to progress and become severe.

#### *Eye Exposure*

Mild conjunctivitis beginning more than 12 hours after exposure is unlikely to progress to a severe lesion. The patient should have a thorough eye examination (including a test for visual acuity), treatment with a soothing eye solution such as Visine or Murine, and be advised to return if there is worsening. Conjunctivitis beginning earlier and other effects such as lid swelling and signs/symptoms of inflammation indicate a need for inpatient care and observation.

Lesions more severe than conjunctivitis should be treated with a topical mydriatic (e.g., atropine), topical antibiotics, and vaseline or similar substance applied to the lid edges several times a day. Consult an ophthalmologist for patients with severe corneal injuries. Topical analgesics should be used only for an initial examination (including slit lamp and a test of visual acuity), but not after. Pain should be controlled with systemic analgesics. Once the lid edema and blepharospasm subside and the eyes are open, dark glasses may reduce the discomfort of photophobia. Some authorities feel that topical steroids (used within the first 24 hours only) may reduce inflammation.

#### *Skin Exposure*

A small area of erythema beginning later than 12 hours after exposure is unlikely to progress to a significant lesion. The patient should be examined, treated with a soothing lotion and a systemic analgesic, sent home, and instructed to return if progression occurs. A patient with a significant area of erythema or one seen earlier with a significant area of erythema with or without blistering should be admitted for further evaluation.

Most burns are second degree although third degree burns may occur after liquid exposure. In general, small blisters (i.e., <1 cm) should remain roofed and larger ones (i.e., >1 cm) should be unroofed. This is a controversial issue, but many feel that the roof will eventually come off anyway. The denuded area should be irrigated two or three times a day using a whirlpool if the lesion is large (the patient should be given ample amounts of a systemic analgesic beforehand). This should be followed by liberal application of a topical antibiotic. Skin lesions may take many months to heal. Fluids are not lost as they are in thermal burns, and fluid replacement should be according to the general needs of the patient and not according to "burn therapy" formulas. Systemic antibiotics should be used when there are signs of infection and a culture indicates the responsible organism. Patients with a large area of second or third degree burns should be transferred to a Burn Unit for further care and reverse isolation.

#### *Airway Exposure*

A patient with a mild, non-productive cough, irritation of the nose and sinuses, and/or a sore throat that began later than 12 hours after exposure should be advised to use a cool steam vaporizer and lozenges or cough drops, and sent home with instructions to return if the symptoms worsen. Intubation should be done at the first sign of more severe effects. A patient with more severe effects (laryngitis, shortness of breath, a productive cough, pulmonary edema, pseudomembrane formation) should be provided with oxygen-assisted ventilation as necessary and

admitted directly to the Critical Care Unit once decontamination has been assured. Signs of damage to the larynx or lower airway indicate oxygen-assisted ventilation with PEEP. Patients with less severe effects should be admitted to a routine care ward.

Lewisite causes systemic capillary leakage, and hypovolemic shock may occur in severely exposed patients. Closely monitor blood pressure, blood volume, and hepatic and renal function.

*Ingestion Exposure*

**Do not induce emesis.** Treat nausea and vomiting with antiemetics.

*Antidotes*

British Anti-Lewisite (BAL), also called Dimercaprol, is a chelating agent shown to reduce systemic effects from Lewisite exposure. Due to toxic side effects, **BAL should be administered only to patients who have signs of shock or significant pulmonary injury.**

Chelation therapy should be performed only by trained personnel. Consultation with the regional poison control center is recommended. The standard dosage regimen is 3 to 5 mg/kg IM every 4 hours for four doses. This regimen can be adjusted depending on the severity of the exposure and the symptoms. Contraindications to BAL include pre-existing renal disease, pregnancy (except in life threatening circumstances) and concurrent use of medicinal iron.

Alkalinization of the urine stabilizes the Dimercaprol-metal complex and has been proposed to protect the kidneys during chelation therapy. If acute renal insufficiency develops, hemodialysis should be considered to remove the Dimercaprol-arsenic complex. Side effects of BAL administered at 3 mg/kg are mostly pain at the injection site. At 5 mg/kg, the effects may include nausea; vomiting; headache; burning sensation of the lips, mouth, throat, and eyes; lacrimation; rhinorrhea; salivation; muscle aches; burning and tingling in the extremities; tooth pain; diaphoresis; chest pain; anxiety; and agitation.

*Laboratory Tests*

Routine laboratory studies should be done for all patients requiring admission. These include CBC, glucose, serum electrolytes, and liver and kidney function tests. Consider monitoring hourly fluid intake and output. Chest X-ray and pulse oximetry (or ABG measurements) are recommended for all patients with inhalation exposures. Since Lewisite contains arsenic, urinary arsenic excretion may be helpful if the diagnosis is in doubt. A test for urine thiodiglycol, a metabolite of mustard,



<b>Disposition and Follow-up</b>	<p>can be performed at specialized laboratories, but is not a routine laboratory measure.</p> <p>Patients who have skin, eye, or airway signs and symptoms will require hospitalization, as discussed above.</p>
<i>Delayed Effects</i>	<p>Skin burns take up to 18 hours to fully develop. Chemical pneumonitis may begin within 24 hours or up to 3 days after inhalation exposure. Significant systemic absorption of Mustard-Lewisite Mixture may produce a fall in the leukocyte count beginning on days 3 through 5. Erythrocytes and thrombocytes may subsequently fall if bone marrow damage is severe and in this case the risk of life-threatening infection rises.</p>
<i>Patient Release</i>	<p>A patient who initially had mild symptoms should be observed for at least 18 to 24 hours after exposure. If no further symptoms develop and there is no significant progression, the patient may be discharged. Discharged patients should be advised to rest and to seek medical care promptly if symptoms develop (see below, <i>Follow-up Instructions</i>, included with the <i>Lewisite and Mustard-Lewisite Mixture Patient Information Sheet</i>).</p>
<i>Follow-up</i>	<p>Follow-up laboratory evaluation of bone marrow, hepatic, and renal function should be arranged for severely exposed patients until they are completely recovered. Patients who have mild skin burns or corneal lesions should be reexamined within 24 hours.</p>
<b>Reporting</b>	<p>Other persons may still be at risk in the setting where this incident occurred. If a public health risk exists, notify your state or local health department or other responsible public agency.</p>



## **Lewisite and Mustard-Lewisite Mixture Patient Information Sheet**

This handout provides information and follow-up instructions for persons who have been exposed to Lewisite or Mustard-Lewisite Mixture.

### **What are Lewisite and Mustard-Lewisite Mixture?**

Lewisite is a chemical warfare agent that was first produced in 1918. It has not been used in warfare, although it may be stockpiled by some countries. Mustard-Lewisite Mixture is a mixture of Lewisite and Mustard. It was developed to achieve a lower freezing point for ground dispersal and aerial spraying.

### **What immediate health effects can be caused by exposure to Lewisite and Mustard-Lewisite Mixture?**

Lewisite and Mustard-Lewisite Mixture produce pain and skin irritation immediately after exposure. Both compounds cause skin blisters and damage to the airways and eyes. They are also extremely irritating to the eyes, skin, nose, and throat. Exposure to very high levels may result in kidney and liver damage. Mustard-Lewisite Mixture can also damage the immune system.

### **Can Lewisite and Mustard-Lewisite poisoning be treated?**

Immediate decontamination reduces symptoms. Intramuscular injection of British Anti-Lewisite (BAL) may be used to treat severe conditions but will not prevent lesions on the skin, eye, or airways. Persons who have been exposed to large amounts of Lewisite and Mustard-Lewisite Mixture will need to be hospitalized.

### **Are any future health effects likely to occur?**

Adverse health effects, such as chronic respiratory diseases, may occur from exposure to high levels of these agents. Severe damage to the eye may be present for a long time after the exposure.

### **What tests can be done if a person has been exposed to Lewisite or Mustard-Lewisite?**

There is no specific test to confirm exposure to Lewisite or Mustard-Lewisite Mixture; however, measurement of arsenic in the urine may help to identify exposure.

### **Where can more information about Lewisite or Mustard-Lewisite be found?**

More information about Lewisite and Mustard-Lewisite Mixture can be obtained from your regional poison control center; the Agency for Toxic Substances and Disease Registry (ATSDR); your doctor; or a clinic in your area that specializes in toxicology or occupational and environmental health. Ask the person who gave you this form for help locating these telephone numbers.

## Lewisite and Mustard-Lewisite Mixture Follow-up Instructions

Keep this page and take it with you to your next appointment. Follow *only* the instructions checked below.

Call your doctor or the Emergency Department if you develop any unusual signs or symptoms within the next 24 hours, especially:

- coughing, wheezing, shortness of breath, or discolored sputum
- increased pain or discharge from injured eyes
- increased redness, pain, or a pus-like discharge from injured skin; fever; or chills

No follow-up appointment is necessary unless you develop any of the symptoms listed above.

Call for an appointment with Dr. \_\_\_\_\_ in the practice of \_\_\_\_\_.

When you call for your appointment, please say that you were treated in the Emergency Department at \_\_\_\_\_ Hospital by \_\_\_\_\_ and were advised to be seen again in \_\_\_\_\_ days.

Return to the Emergency Department/ \_\_\_\_\_ Clinic on (date) \_\_\_\_\_ at \_\_\_\_\_ AM/PM for a follow-up examination.

Do not perform vigorous physical activities for 1 to 2 days.

You may resume everyday activities including driving and operating machinery.

Do not return to work for \_\_\_\_\_ days.

You may return to work on a limited basis. See instructions below.

Avoid exposure to cigarette smoke for 72 hours; smoke may worsen the condition of your lungs.

Avoid drinking alcoholic beverages for at least 24 hours; alcohol may worsen injury to your stomach or have other effects.

Avoid taking the following medications: \_\_\_\_\_

You may continue taking the following medication(s) that your doctor(s) prescribed for you: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Other instructions: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

• Provide the Emergency Department with the name and the number of your primary care physician so that the ED can send him or her a record of your emergency department visit.

• You or your physician can get more information on the chemical by contacting: \_\_\_\_\_ or \_\_\_\_\_, or by checking out the following Internet Web sites: \_\_\_\_\_; \_\_\_\_\_.

Signature of patient \_\_\_\_\_ Date \_\_\_\_\_

Signature of physician \_\_\_\_\_ Date \_\_\_\_\_