
Chemical Terrorism Fact Sheet

Vesicants (Blistering Agents) - Mustard Agents

Protective Equipment/Detection

The **mustards** can penetrate cell membranes in tissues and numerous materials: woods, leather, rubber, plants, etc. Since ordinary clothing and surgical gear offer little or no protection, special equipment including a respirator, NBC protective suit, gloves and overboots are required. Due to the slow absorption of mustard by many materials, protective equipment must be changed regularly.

Mustards form, under certain conditions, colored complexes with para-nitrobenzpyridine, making it possible to detect minute amounts. Readily available single and three-color detector papers will detect liquid agent. Monitoring devices for local contamination and water testing kits are also available. Mass spectrometric and immunoassay methods applied to blood samples, as well as urinary thiodiglycol levels, can now be used to confirm exposure.

Decontamination

Skin – Decontaminate skin by physical adsorption or by the combination of physical adsorption and chemical inactivation. Physical adsorption is achieved with adsorbing powders (Fullers earth), while chemical inactivation is achieved by incorporating chlorinating compounds (chloramines, household bleach) into adsorbing powders, ointments, solutions or organic solvents. The skin should not be decontaminated with water as this may spread the agent.

Mucous Membranes and Eyes - The substances used for skin decontamination are too irritating for use on mucous membranes and the eyes. If possible, affected mucous membranes should be flushed immediately with water. The eyes can be flushed with copious amounts of water, isotonic sodium bicarbonate (1.26%), or saline (0.9%).

Additional Information - Decontamination must be efficient and quick since a drop of these agents on the skin can cause serious damage within 2 minutes. Chemical inactivation using chlorination is effective against **mustard (HD)**, but less so against **HN3**. In the case of thickened mustard, first scrape off the agent with a knife or similar hard object, then wet the surface with a cloth drenched in an organic solvent, such as unleaded gasoline. Then proceed with the usual decontaminating procedure.

Decontamination of Wounds - Mustards may be carried into wounds on cloth or other fragments. These wounds should be carefully explored using a no-touch technique, and contaminated materials should be removed and placed in a bleach solution to prevent vapor off-gassing. Wounds should be irrigated using a solution containing 3000-5000 ppm (parts per million) free chlorine (dilute "milton" solution) with a dwell time of about 2 minutes, followed by irrigation with saline. These irrigation methods should not be used in the abdominal or thoracic cavities, or with intracranial head injuries.



Mustard Agent Eye Lesions
Photo Courtesy Department of Defense

Chemical Overview

Mustard agents, **sulphur mustard (HD)** and **nitrogen mustard (HN)**, are known as vesicant, or blistering, agents. **Sulphur mustard**, first synthesized in 1822, is best known as the mustard gas of WWI where it received its name because of its garlicky, mustard odor. **Mustard (HD)** is 2,2'-di(chloro-ethyl)-sulphide. In 1935, it was discovered that the vesicant properties persisted when the sulphur atom was substituted by nitrogen. There are three nitrogen mustard agents – N-ethyl-2,2'-di(chloroethyl) amine, or **HN1**, N methyl-2,2'-di(chloroethyl) amine, or **HN2**, and 2,2', 2''tri(chloroethyl) amine, or **HN3** – of which only **HN3** is likely to be used in war.

HD and **HN3** are the most feared vesicants historically, because of their chemical stability, their persistency in the field, their ability to attack eyes, mucous membranes, lungs, skin and blood-forming organs, and because no effective therapy is yet available. **Mustard (HD)** is easily manufactured and with its weapon potential as a vapor, would be the most likely agent used by terrorists.

Prophylaxis

No drug is available for the prevention of the effects of mustard on the skin and the mucous membranes. It is possible to protect the skin against very low doses of mustard by covering it with a paste containing a chlorinating agent, e.g., chloramine. The only practical prophylactic method is the physical protection of a respirator and special clothing.

Signs and Symptoms

Eyes: Eye damage can occur with an exposure of just 10 mg min/m³. Eye injuries may be divided as follows:

- Mild conjunctivitis (1 to 2 week recovery)
- Severe conjunctivitis (with minimal corneal involvement) includes blepharospasm, edema of the lids and conjunctivae, and orange-peel roughening of the cornea. (2 to 5 week recovery)
- Mild corneal involvement with corneal erosions that stain green with fluorescein. Superficial corneal scarring, revascularization, iritis and temporary relapses are possible. Hospital care required. (2 to 3 month recovery)
- Severe corneal involvement with ischemic necrosis of the conjunctivae. Convalescence may take several months and late relapses are possible. Although temporary blindness may occur, permanent blindness is very rare.

Skin: The hallmark of skin exposure is a latent, symptom and sign-free period for several hours post exposure. The duration of this period and the severity of the lesions are dependent upon the mode of exposure, environmental temperature, and the sensitivity of the individual. High temperature and wet skin produce more severe lesions and shorter latency. Burns may result from either vapor or liquid exposure with significant burns occurring at 200 mg min/m³.

The sequence of skin changes seen with increasing exposure rates is:

- **Erythema** (2-48 hour post exposure) is striking, with slight edema and often intense itching. As the erythema fades, areas of hyperpigmentation remain.
- **Blisters**, while not painful, may be uncomfortable and feel tense. Mustard blisters are fragile and rupture easily, leading to suppurating and necrotic wounds.
- **Deep burning, leading to full thickness skin loss**, is possible anywhere, but is particularly likely to occur in the genital and axillary areas. Damaged tissues are covered with slough, extremely susceptible to infection, and slow to regenerate.

Respiratory Tract: After a 4-6 hour latent period, mustard irritates and congests the mucous membranes of the nasal cavity and throat, as well as the epitheliums of the trachea and large bronchi. Symptoms start with rhinorrhea, burning pain in the throat and hoarseness. A dry, painful cough gives way to copious expectoration. The vocal cords often become damaged, resulting in aphonia. Airway secretions and fragments of necrotic epithelium may cause obstruction, with resultant rales and marked dyspnea. Infection is a major complication after 48 hours. If the inhaled dose is sufficiently high, the victim dies in a few days from pulmonary edema, mechanical asphyxia due to obstruction, or rampant bacterial infection, facilitated by an impaired immune response. Airway damage can occur with a dose of 100 mg min/m³, while the lethal respiratory dose is estimated at 1500 mg min/m³.

Bone Marrow: Mustards can deplete all elements of the bone marrow. Granulocytes and megacaryocytes appear more susceptible to damage than cells of the erythropoietic system. A reactive leukocytosis can occur during the first three days, followed by leukopenia. The development of severe leukopenia or aplastic anemia indicates a poor prognosis.

Gastrointestinal Tract: Ingestion of contaminated food or water may cause destruction of GI mucous membranes. Symptoms include nausea, vomiting, pain, diarrhea and prostration. Vomit and feces may be bloody. Shock may occur.

Systemic Action: Systemically absorbed mustards, by any route, may cause signs similar to those of irradiation, such as headache, nausea, vomiting, leukopenia and anemia. Gastrointestinal pain commonly occurs. Absorption of high doses may result in CNS excitation and convulsions, followed by CNS depression. Cardiac irregularities, AV block and/or cardiac arrest, may occur.

Treatment

There is no specific treatment available for mustard injuries. The aim of therapy is to relieve symptoms, prevent infection, and promote healing. The great majority (97%) of mustard gas casualties survive.

Caveats:

- **Eyes:** Do not use topical anesthetics for pain relief, as they may increase corneal damage. Use systemic, narcotic analgesics when needed. Similarly, do not bandage the eyes; use protective goggles.
- **Skin:** Relieve the intense pruritis with cool compresses or corticosteroids in solution. Do not use creams or ointments, which may increase the risk of infection.
- **Respiratory Tract:** Treat symptomatically and be alert for pneumonia.

Long-term Medical Sequelae

Victims may experience prolonged psychological manifestations including chronic depression, loss of libido and anxiety. Local effects may include visual impairment, scarring of the skin, chronic bronchitis, bronchial stenosis, and increased sensitivity to the agent. Eye damage may rarely result in a delayed keratitis 6-10 years post exposure, with late-onset blindness. **Sulphur mustard** is a known carcinogen causing an increased incidence of lung and laryngeal cancer.

Environmental Sequelae

Due to their physical properties, mustards are very persistent in cold and temperate climates. It is possible to increase the persistency by dissolving them in non-volatile solvents, e.g., chlorinated rubber. These thickened mustards are very difficult to remove by common decontamination methods.

Disclaimer

Information contained in this fact sheet was current as of August 2002, and was designed for educational purposes only. Medication information should always be researched and verified before initiation of patient treatment.

Additional information and references available at <http://www.bioterrorism.slu.edu>



August 2002