



National Marrow Donor Program[®]

Fact Sheet for Health Care Professionals on Mustard Agents (“Mustard Gas”)

Mustard agents were first used in chemical warfare during World War I. In that war, mustard agents were used in their vaporous or gaseous forms, and hence the term “mustard gas” has entered the popular vocabulary. Although the use of mustard agents in warfare has been banned by international treaties, it is possible that these agents may still be used in conventional or terrorist attacks. As part of an ongoing contingency plan to treat casualties resulting from military incidents, the National Marrow Donor Program (NMDP) and the U.S. Navy have developed this fact sheet on mustard agents.

The goal of this fact sheet is to provide medical professionals in the NMDP network with facts about the short- and long-term effects of mustard agents and the basic elements of clinical care for mustard agent victims. Although it is not a common reaction, some victims exposed to mustard agents will have their bone marrow damaged or suppressed. The NMDP may therefore be asked to provide donors for a small percentage of mustard agent victims.

Properties of mustard agents

Mustard agents are organic molecules composed of carbon, hydrogen, chlorine, and either a sulfur atom (sulfur mustards) or a nitrogen atom (nitrogen mustards). There are several varieties of each form: Sulfur mustard varieties are given the military designations H, HD, and HT; nitrogen mustards are designated HN-1, HN-2, and HN-3. Because treatment of mustard agents are very similar for both nitrogen and sulfur mustards, the general term mustard agent will be used throughout this fact sheet.

Mustard agents are alkylating agents and vesicants. In their pure form, mustard agents are colorless, oily liquids that will slowly evaporate at room temperature. In use, mustard agents have a yellow to brown tint due to impurities and will have a slight scent of garlic, or mustard. Mustard agents are only minimally soluble in water, but will readily mix in fats, oils, and organic solvents.

To be effective in chemical warfare, mustard agents must come into contact with a victim’s skin or mucous membranes. Mustard agents belong in a category of “blistering agents,” and the physical damage they cause is due to a burning of the skin or mucous membranes such as the eyes. Thus, inhalation, ingestion, and physical contact are all ways that mustard agents can harm a victim. Mustard agents are not usually fatal, except at high levels of exposure. When used in chemical warfare, mustard agents are intended to incapacitate and demoralize combatants and to overwhelm the enemy’s medical resources. Many of the long-term effects of mustard agents have not been clearly identified, although they are known to be carcinogenic.

Clinical symptoms of mustard agent victims

Clinical presentation of a mustard agent victim varies depending on how the victim contacted the agent and whether the agent has been absorbed systemically. Mustard agents in all forms (vapor, liquid, and solid) can be absorbed through the skin, eyes, and mucous membranes. Vaporous mustard agents can be inhaled, and solid and liquid mustard agents can be ingested if they have been placed in food and water.



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- **Skin exposure:** Redness, swelling and itching of the skin will occur in as little as one hour post-exposure, but reactions may not develop for up to 48 hours after contact. This initial skin reaction will be followed by a yellow blistering of the skin. Contact with high levels of mustard agents will cause second- and third-degree burns.
- **Eye exposure:** Mustard agents contacting the eyes will lead to inflammation, swelling, pain, burns, corneal damage, and, if the contact is severe, blindness may result.
- **Inhalation:** Inhaling mustard agents can damage the cells lining the lungs, pharynx, and the mucous membranes in the nasal and sinus passages. Inhalation of mustard agents can also result in chronic respiratory disease, shortness of breath, and repeated respiratory infections such as pneumonia. Inhalation of high levels of mustard agents can be fatal.
- **Ingestion:** Ingestion of mustard agents may cause local and systemic effects such as diarrhea, nausea, vomiting, and burns to the linings of the mouth, esophagus and stomach.

Mustard agents can also be absorbed systemically via any of the exposure routes outlined above, which can lead to damage of the immune system and bone marrow. However, such systemic damage usually occurs only after severe exposures, so only a minority of victims of a mustard agent attack would typically be at risk for damage to the immune system and bone marrow.

Treatment of mustard agent victims

The information in this section is intended to inform the NMDP network about the basic clinical care of mustard agent victims. It is not meant to provide comprehensive medical information to support the treatment of mustard agent victims, who should be treated by medical specialists. The triage and decontamination of victims at the site of a mustard agent attack are also outside the scope of this fact sheet.

No specific treatment exists for skin and mucous membrane lesions and blisters caused by exposure to mustard agents. Treatment is therefore designed to relieve symptoms, prevent infections, and promote healing.

Most skin burns from mustard agent exposure will be second-degree burns, although liquid exposure may cause third-degree burns. Blister fluid does not contain mustard agents or other toxic substances. Irrigation of the burned areas is indicated followed by the liberal application of a topical antibiotic. Victims with large areas of second- or third-degree burns should be cared for in a burn unit using standard burn treatments.

Eye lesions from exposure can range from mild conjunctivitis to severe damage to the cornea, including perforation. Mild cases can be treated with topical antibiotics and over-the-counter saline solutions. Healing can be expected in about two weeks. More severe lesions should be treated with a topical mydriatic such as atropine and petroleum jelly.

Inhalation of vapor and the subsequent damage (including infections) of the airways is the leading cause of death in mustard agent victims. Systemic antibiotics are typically administered when signs of infection are evident and the infectious organism is identified. Patients with damage below the pharynx require care in a Critical Care Unit by a physician experienced in



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pulmonary injuries and infections. Intubation is indicated in these patients as is oxygen-assisted ventilation. If signs of bronchoconstriction develop, broncodilators are indicated.

Ingested mustard agents will further damage the victim if emesis is initiated, so emetic compounds are not administered. If the victim receives treatment within 30 minutes of ingestion, orogastric lavage may be used to remove the ingested agents, but this treatment is controversial because it carries the risk of bleeding and perforation. Treatment for mustard agent ingestion is usually limited to supportive care.

The role of the NMDP

A small percentage of mustard agent victims may have bone marrow suppression. If the bone marrow has been damaged, white blood cell counts in the peripheral blood will begin to decline 3-5 days after exposure. Often, recovery occurs without any intervention. The efficacy of blood stem cell transplantation is currently unknown, although blood stem cell mobilizing factors such as G-CSF have been successfully used as a treatment for bone marrow suppression caused by nitrogen mustard exposure.

NMDP network organizations should be aware that in the event of a mustard agent attack, there will only be a small percentage of victims who may need any kind of blood stem cell support at all, and an even smaller number who may need a stem cell transplant. However, the NMDP expects that any mustard agent attack resulting in significant casualties will lead to an increase in Registry searches and donor activations. The NMDP and the U.S. Navy have contingency plans in place to accommodate this increased activity and if any victims of a mustard agent attack need a stem cell transplant, the NMDP is prepared to search its Registry to find matched donors to serve them. As of March 2003, the NMDP Registry contained nearly five million potential stem cell donors and more than 25,000 cord blood units, the largest source of blood stem cell donors in the world.

Further information

Web sites:

U.S. Centers for Disease Control and Prevention (CDC) Web site: www.cdc.gov

Agency for Toxic Substances and Disease Registry (ATSDR) Web site: www.atsdr.cdc.gov

Medical literature:

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