JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH | Center for Health Security

Sulfur Mustard (Blister Agent)

Fact Sheet

Background

Blister agents, also known as vesicants, are a class of chemical weapon first used in combat during World War I.[1] The prototypical and most common blister agent is sulfur mustard (SM) (bis-(2-chloroethyl) sulfide), commonly referred to as mustard gas. Other examples of blister agents include Lewisite[2] and nitrogen mustard,[3] which has also been used as a chemotherapeutic agent.

Use as a Chemical Warfare Agent

Before blister agents were introduced in 1917, most of the chemical weapons in use were choking agents—chlorine and phosgene gas—which necessitated the use of gas masks for respiratory protection. SM was a technological innovation that produced increased morbidity, eventually earning it the moniker "King of the Battle Gases."[1] While not exceptionally lethal (mortality due to SM exposure was ~ 2-3%), SM caused large numbers of causalities that required medical care and support. SM was most recently deployed during the Iran-Iraq War of the 1980s.[4]

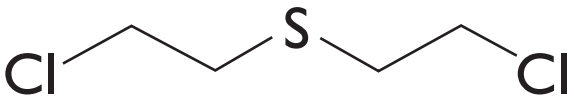
Use of SM and other chemical warfare agents during armed conflict is proscribed by the 1925 Geneva Protocol and the Chemical Weapons Convention (CWC).[5,6] Under the aegis of the Cooperative Threat Reduction program, the United States and Russia are in the process of destroying the stockpiles of chemical weapons they accumulated during the Cold War.[7,8] However, the presence of stockpiled chemical agents and associated munitions in unstable regions of the world raises the potential for terrorist acquisition of these weapons.[9] In addition to intentional exposures, accidental or occupational exposures can occur when an individual comes into contact with an improperly discarded munition or container.[10,11]

Mechanism of Action and Physical Properties

SM is an alkylating agent which, upon absorption, binds readily to a range of biologically important molecules, including proteins and nucleic acids. The intermediate has 2 chemically active regions (see Figure 1) that, when bound to DNA, cause cross-linking and eventual cell death. This is thought to be a major contributor to SM pathogenesis.[12]

In liquid phase, SM is commonly described as dark yellow and oily with an "industrial" or garlic-like odor. When deployed as a chemical weapon, or in higher ambient temperatures, SM may also be encountered as a vapor. As its density is greater than air, residual SM vapor will collect and may persist in low laying areas for prolonged periods. A dry or dusty preparation has also been described.[4]

Figure 1 – Chemical Structure of Sulfur Mustard



Source: Medical management guidelines for blister agents: sulfur mustard agent H/HD, sulfur mustard agent HT. US Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry Web site. March 2011. http://www.atsdr.cdc.gov/MMG/MMG.asp?id=924&tid=191. Accessed March 5, 2013.

Signs and Symptoms of Exposure to SM

The onset of signs and symptoms can range from 1-24 hours postexposure, depending on the concentration and phase of SM present in the environment.[11,13] Dermal exposure to SM vapor will typically cause first and second degree chemical burns, whereas exposure to liquid SM will cause second and third degree burns.[13]

The severity of acute signs and symptoms will likewise be dependent on dose, route of exposure, and presence of protective clothing. As patients may not immediately exhibit signs and symptoms, they should be medically monitored for at least 6 hours prior to discharge.[13] The most commonly affected organ systems are the skin, eyes, and respiratory tract.[14]

SM is rapidly absorbed through the skin, though the onset of clinically significant signs and symptoms may be delayed. Regions of the body predisposed to moisture, including the axilla and groin, are particularly susceptible.[10,14] Following the latent period, acute dermal exposure will typically result in pain, itching, and redness, followed several hours later by development of a fluid-filled blister (see Figure 2).

Ocular exposure will produce the most rapid symptoms and can result in pain, redness, tearing, conjunctivitis of varying severity, photophobia, and blindness.[13,14]

Inhalation of SM vapor will lead to respiratory distress in a dose dependent manner. Patients with a mild exposure may present with dyspnea, epistaxis, pain, coughing, or tachypnea.[10,13]

More serious exposures may result in bone marrow suppression and leukopenia, reaching its nadir at day 9 postexposure.[11,12]

A cohort of Iranian soldiers who were exposed to SM and other CW agents during the Iran-Iraq War is being followed to better describe the long-term health effects of exposure. As SM is highly reactive with DNA, long-term sequela may include cancer.[15]

Diagnosis

History of a chemical exposure and exam findings will be diagnostic for SM exposure. Other blister agents that should be considered in the differential diagnosis include Lewisite (an arsenical), or nitrogen mustard.[11] SM exposure can be confirmed by laboratory urinalysis for the SM metabolite SBMTE.[11]

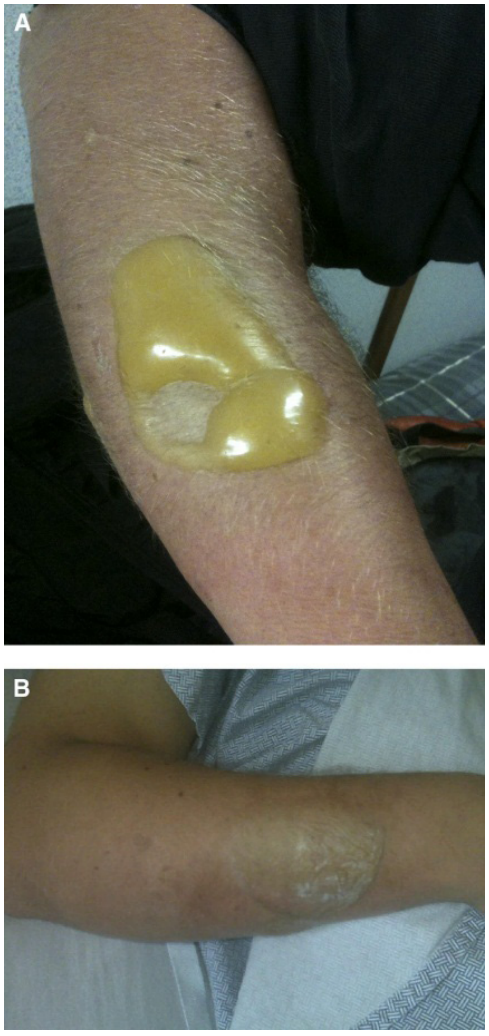
Treatment

As patients who have been exposed to SM can easily contaminate their surroundings, first responders and healthcare providers should utilize personal protective equipment at all times and take steps to minimize patient contact. Prehospital considerations include: rapid removal of patients from the area, rapid decontamination, and rapid transport to a hospital setting.[13]

There is no broadly recognized treatment algorithm for SM-exposed patients.[10] Medical management should prioritize rapid decontamination with copious amounts of soap and water, followed by supportive care that may include fluids, respiratory support, analgesia, infection prevention, and basic burn dressings. Larger blisters (> 2cm) may heal faster if lanced and debrided. Fluid from the blister does not pose a threat to healthcare workers.[11] Administration of sodium thiosulfate or GM-CSF has also been suggested.[11,14]

Upon confirmation of an SM exposure, clinicians should alert state and local health departments.

Figure 2 – Dermal Injury due to Sulfur Mustard. Panel A) 24 hours postexposure. Panel B) 6 days postexposure.



Source: Weibrecht K, Rhyee S, Manuell ME, et al. Sulfur mustard exposure presenting to a community emergency department. Ann Emerg Med. *2012;59(1):70-74. Used with permission.*

References

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