Also known as bis(2-chloroethyl) sulfide (CAS Registry Number 505-60-2), yperite or Lost, mustard gas is a colourless to amber oily liquid of neutral reaction, freezing at 14 °C when pure and boiling at 228 °C with slow decomposition. At high concentrations, it has a pungent odor resembling that of horseradish, onions or garlic, much of which may be due to contamination with ethyl sulfide or similar by-products of its synthesis. It is only slightly soluble in water, but may dissolve in organic solvents and fats. Chemically and physically, it is a relatively stable substance. When dissolved in water, it first hydrolyses and then oxidizes to the less toxic sulfoxide and sulfone.

Mustard gas is heavier than air and will settle in low-lying areas.

Exposure

Exposure to both liquid and vapor occurs, mainly via inhalation and skin contact. Mustard gas produces significant adverse health effects over a wide range of dosages. Incapacitating eye injury may be sustained at concentrations of about 100 mg.min/m^3. Significant skin burns may begin at 200 mg.min/m^3. The estimated respiratory lethal dose is 1500 mg.min/m^3. On bare skin, 4 g–5 g of liquid mustard gas may constitute a lethal percutaneous dosage, while droplets of a few milligrams may cause incapacitation and significant skin damage and burns. Mustard liquid and vapour can penetrate clothing.

Latency period from exposure to symptoms

Without protection, signs and symptoms develop gradually after an interval of several hours. The duration of this interval depends on the mode and level of exposure, environmental factors (humidity and temperature) and probably also on the individual.

Soon after exposure, however, nausea, retching, vomiting and eye irritation may be reported. Acute systemic effects, such as central nervous excitation convulsions and death only after very severe exposure.

Main clinical symptoms

Few hours after the exposure

- Eyes: gritty feeling, progressive soreness and bloodshot appearance, lachrymation, blepharospasm and photophobia
- Increased nasal secretion, sneezing

- Sore throat, coughing, hoarseness and dyspnoea
- Lung oedema occurs when severe exposure or within next 12–24 hours

Within 4–16 hours after exposure

- The above mentioned symptoms become much more marked and distressing
- Eyes begin discharging and are very painful
- Nasal discharge is more purulent, voice is husky or suppressed
- Nausea, retching and vomiting, associated with epigastric pains
- Itchy skin and dusky erythema of the exposed parts of the body
- Formation of blisters filled with yellowish fluid (the fluid does not contain mustard)

At the end of 24 hours

- All the above mentioned symptoms may increase in severity, but death almost never occurs during the first da
- Severe inflammation of the upper and lower respiratory tract
- Chemical pneumonitis, adult respiratory distress syndrome
- Secondary bacterial infection
- Bone marrow depression with leucopaenia at 3–5 days post exposure

Principles of medical management

Adequate decontamination is very important to protect others from secondary exposure. Rescue workers should wear protective clothing and purifying respirators when dealing with contaminated causalities. Victims should be removed from the contaminated area. Contaminated clothing should carefully be removed so that chemical is not spread onto the skin. Clothing should not be pulled off over the head – it should be cut off if necessary. Skin can be decontaminated by washing with soap (preferably liquid soap) and water using a rinse-wipe-rinse procedure. If water is not available, then an absorbent powder such as fullers earth, talcum or flour can be used – this should be applied then wiped off. NB the powder and washing water should be regarded as contaminated waste. Contaminated clothing and personal effects should be sealed in labeled plastic bags.

The eyes should be immediately rinsed out, using copious amounts of normal saline or clean water. If necessary a topical analgesic can be used to aid decontamination.

Prophylaxis/treatment

- No prophylactic treatment against mustard gas is available, prophylaxis depending entirely on the protection of skin and airways by adequate protective garments.
- Treatment is symptomatic as there is no antidote for mustard poisoning.
- For skin lesions, soothing lotions such as calamine lotion, topical steroids and/oral antihistamines may relive itching. Small blisters can be left intact, however, larger blisters

should be unroofed and irrigated several times daily with saline or soapy water then covered an antibiotic such as silver sulphadiazine and petroleum gauze dressings.

- Once irrigated, eye lesions should be treated by applying petroleum jelly on follicular margins to prevent sticking, and the use of cyclopegic eye drops, such as atropine or homatropine to prevent adhesion of the iris to the cornea. The eye should not be patched. The use of local anesthetic drops to relieve pain should be avoided since this may damage the cornea. Systemic narcotic analgesics should be used instead.
- Inhalation of moist air may relieve irritation. Acetylcysteine may be used as a mucolytic. Bronchodilators should be given if there is bronchoconstriction. An antibiotic should be given if there is evidence of infection e.g. cultures from sputum.
- If there are signs of airway damage below the pharynx, intubate and give oxygen, using positive end expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) ventilation.
- Bone marrow depression leading to severe leukopenia and aplastic anaemia should be treated with granulocyte, platelet and red cell transfusions.
- In severely ill patients, appropriate intensive care measures are necessary.

Stability/neutralization

Sulfur mustard can be quite persistent in the environment, depending on the temperature. It represents a serious persistent hazard, particularly at temperature below 0 °C. Substances such as metal, glass and glazed tiles are generally impervious to mustard, although painted surfaces may take it up for a time and then release it later. Decontamination procedures for skin, equipment and material have been widely developed, using neutralizing, active chemicals such as chloramine solutions, or neutral adsorbing powders, e.g. fuller’s earth.

Protection

Military-type active-carbon containing protective clothing, butyl rubber chemical-protective gloves and a full-face gas mask with an appropriate filter should be used.

References:

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