MMSL
Military Medical Science Letters

Mil. Med. Sci. Lett. (Voj. Zdrav. Listy) 2011, vol. 80, p. 38-41
ISSN 0372-7025
DOI: 10.31482/mmsl.2011.005

REVIEW ARTICLE

PHOSGENE OXIME – FORGOTEN CHEMICAL WEAPON

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Received 22th January 2011.
Revised 7th March 2011.
Published 6th April 2011.

Summary
Phosgene oxime is an organic compound with the formula Cl_2CNOH. It is a potent chemical weapon from the group of vesicants, specifically a nettle agent. Phosgene oxime is also known by its military designation, "CX". Phosgene oxime in both liquid and vapor forms causes severe pain and local tissue destruction on contact with eyes, skin, and mucous membranes.
Depending on the exposure, injury may be local or systemic. The effects of the poisoning occur almost immediately. No antidote for phosgene oxime poisoning is known. Generally, any treatment is supportive. Phosgene oxime is nonpersistent in the environment and not presents great bigger risk for animal nature.

Key words: phosogene oxime; vesicants; poisoning; treatment; decontamination; prophylaxis

INTRODUCTION

Phosgene oxime is an organic compound with the formula Cl_2CNOH. It is a potent chemical weapon from the group of vesicants or blister agents, specifically called as an urticant or nettle agent. The compound itself is a colorless solid, but impure samples are often yellowish-brown when it is a liquid. It has a strong, disagreeble odor and a violently irritating vapor. Phosgene oxime is halogenated oxime that possesses somewhat different properties and toxicity from the other vesicant agents (11).

In the simplest terms, vesicants are chemicals that cause tissue blistering (19). Their toxic effect is not limited to the skin only and their mode of action is very complex (12,13). These cytotoxic alkylating agents were developed as chemical weapons used to induce ocular, dermal, and respiratory damage resulting in casualties, reduction in fighting efficiency, and demoralization. Phosgene oxime is also referred as a corrosive agent because of the type skin and tissue damage it causes (1).

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HISTORY

The halogenated oximes, diiodoformoxime, dibromoformoxime, monochloroformoxime and dichloroformoxime, were first synthesized in the late 1920's. Dichloroformoxime is the most irritating and is commonly known as phosgene oxime. Phosgene oxime was first produced in 1929, but probably never been used on the battlefield. It is one of the least studied chemical warfare agents, so specific information is limited (10). Phosgene oxime is also known by its military designation, "CX".

CHEMISTRY

Phosgene oxime (Cl_2C=N-OH, CAS RN 1794-86-1) is a white crystalline powder that can be liquefied at room temperature. Its prismatic crystals are hygroscopic and have a m.p. 39-40°C, b.p. 129 °C. Compound is soluble in water and organic solvents, but hydrolyses fairly rapidly, especially in the presence of alkali (10). It has a high vapor pressure and can vaporize at ambient temperature ($c^{20}max$ = 21 $g.m^{-3}$). Phosgene oxime vapor is heavier than air (3.9), so it will settle in low-lying areas. Compound is generally prepared by reduction of chlorpicrin by tin in the presence of hydrochloric acid (15):

$$Cl_3CNO_2 + 2\,Sn + 5\,HCl + H_2O \rightarrow Cl_2C{=}N\text{-}OH + 2\,H_3O[SnCl_3]$$

Its odor is very unpleasant and irritating. It can be mixed with other agents, such as nerve agents, and its rapid skin damage makes the victim more susceptible to the second agent. Phosgene oxime is chemically very reactive.

ANALYTICS

Phosgene oxime has been estimated by colorimetrically (9) or by pyrolysis-gas chromatoghraphy method (8).

TOXICITY

Experimental toxicological data are not available but the LD_{50} of phosgene oxime in human for skin exposure is estimated at 25 $mg.kg^{-1}$. Phosgene oxime is unlikely to have direct adverse effects on reproductive function (6). People's risk for exposure depends on how close they are to the place where the phosgene oxime was released. If phosgene oxime gas is released into the air, people can be exposed by breathing air that contains this gas or through skin contact or eye contact. If phosgene oxime liquid is released into water or comes into contact with food, people can be exposed by drinking water or eating the contaminated food.

POISONING

Phosgene oxime in both liquid and vapor forms causes severe pain and local tissue destruction on contact with eyes, skin, and mucous membranes. Although phosgene oxime is classified as the blistering agents, this compound does not cause vesicles and is an urticant or nettle agent, rather than a true vesicant (17). It has also been called a corrosive agent because of the extreme damage it can do. It is categorized with these agents because it produces eye, lung, and skin damage similar to the other vesicant agents. In concentrations less than 8% causes little biologic damage. In higher concentrations, however, it causes more severe damage than any other vesicant and lesions are similar to those caused by mustard gas. Its pain is instantaneous and severe enough that victims are likely to remove protective gear in an effort to relieve the pain. Tissue necrosis rapidly follows the pain after exposure.

SIGNS AND SYMPTOMS

Although the immediate pain of contact to phosgene oxime leads to the rapid use of protective gear and decontamination, the eyes can be severely damaged by very low concentrations with lacrimation, inflammation, and temporary blindness, while high concentrations can cause permanent corneal lesions and blindness. Analogous to the other vesicants, the immediate symptoms are those of conjunctivitis, blepharitis, blepharospasm, lacrimation, and keratitis (18).

Dermal lesions are erythematous and extremely painful. Skin irritation is immediate and resembles stinging nettle. Mere short contact with just a few milligrams produces very intense pain and itching. Within a minute the exposed area turns white and is surrounded by a circular zone of erythema to resemble a target. By this time the phosgene oxime is fully absorbed by the skin. Within an hour the area becomes edematous, and within 24 hours the edema resolves, the lesion becomes darkly pigmented, and severe necrosis develops. Desquamation with necrosis of the skin followed by eschar formation and a purulent discharge develops over the next 7 – 10 days. The necrotic lesion will extend into the underlying panniculus and muscle, and is surrounded by intense inflammation (17).

Inhalation exposure may cause immediately respiratory tract irritation, dyspnoe, and leads to pulmonary edema. Complete absorption occurs in inhalational exposure within seconds. Edema may be accompanied by a necrotizing bronchiolitis and pulmonary venule thrombosis. Irritation to exposure occurs at 0.2 mg $min.m^{-3}$ and becomes intolerable at 3 $mg.min.m^{-3}$. The estimated LC_{50} is 1500 – 2000 $mg.min.m^{-3}$ (17). Oral exposure by phosgene oxime is very similar to the course of inhalation poisoning.

PROTECTION

Quickly moving to an area where fresh air is available is highly effective in reducing exposure to phosgene oxime. If the phosgene oxime release was outdoors, move away from the area where the phosgene oxime was released. Go to the highest ground possible, because phosgene oxime is heavier than air and will sink to low-lying areas. If the phosgene oxime release was indoors, get out of the building (10).

MILITARY AND TERRORISTIC IMPROVEMENT

Misuse of phosgene oxime for military or terroristic purpose is small possible but is not excluded (16). Most chemical agents are capable of causing serious injuries or death and phosgene oxime is not exception. The severity of injuries depends on the type and amount of the chemical agent used, and the duration of exposure (14).

TREATMENT

There is no specific treatment available for injuries due to phosgene oxime. The aim of therapy is to relieve symptoms, prevent infections, and promote healing (4). Dilution with water or milk is recommended for oral ingestion. Emesis as well as activated charcoal is not recommended due to the irritant and corrosive effects of phosgene oxime. Necrotic skin lesions must be treated surgically, and pulmonary edema should be handled appropriately. Recovery typically takes from 1 to 3 months, but some burns can take more than 6 months to heal (5).

Irrigate eyes should be rinsed with tepid water until pH returns to neutral. Time until decontamination after ocular exposure is important since phosgene oxime is absorbed very quickly – within seconds. Corneal ulcers should be treated with atropine drops to prevent major damage (3). The use of topical anesthetics for pain relief is not recommended as they may increase corneal damage. On the contrary systemic use of narcotic analgetics may be helpful as well as residing in dark (7).

DECONTAMINATION

Decontamination of the skin is based on physical adsorption or on the combination of physical adsorption and chemical inactivation. Physical adsorption is achieved by adsorbing powders (talcum powder, Fullers earth), while chemical inactivation is achieved with all alkaline agents. Chlorinated agents such as household bleach do not work on phosgene oxime. Vesicants should not be decontaminated with water, except for the eyes, as this may spread the agent. Skin decontamination must take place immediately, as full absorption by the skin occurs within minutes. Phosgene oxime reacts quickly with tissue and decontamination is not expected to be effective after pain has been produced (10).

The substances used for skin decontamination are too irritating for use on the eyes. In this case the eyes should be flushed immediately with copious amounts of water or isotonic sodium bicarbonate (1.26%).

Clothing contaminated by liquid phosgene oxime poses an immediate danger. Therefore all parts of clothes must be removed and must be put into a plastic bag to prevent exposure to off-gassing vapors.

ENVIRONMENTAL HAZARDS

Phosgene oxime is nonpersistent in the environment. Its lifetime in soil and water is short, compounds is hydrolyzed rapidly in aqueous solutions, mainly in alkaline milieu (2). Phosgene oxime is highly reactive and volatile, and that is unlikely to produce environmental hazards.

CONCLUSIONS

Phosgene oxime is a manufactured chemical warfare agent which never been used on the battlefield. Nevertheless, its is dangerous and very corrosive agent with military and terrorist potential, which produces intense itching and a rash similar to hives. Therefore it is considered an urticant or nettle agent. No antidote exists for phosgene oxime. Treatment consists of removing the phosgene oxime from the body as soon as possible and providing supportive medical care in a hospital setting. Specific information on this chemical is very limited. No toxicological data exits and no information is available on the long-term health effects of phosgene oxime in humans.

ACKNOWLEDGMENTS

This work was supported by the project of Ministry of Defence (Czech Republic) – FVZ0000604.

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