



Phosgene Oxime September 2003

Introduction

Overview – Phosgene Oxime

Diiodoformoxime, dibromoformoxime, monochloroformoxime and dichloroformoxime make up a class of chemicals called the halogenated oximes. These were first synthesized in the late 1920's, and dichloroformoxime, the most irritating and toxic of the class, became recognized as a potential agent for chemical warfare. It is more commonly known as phosgene oxime, with a military designation of CX, and is different than the pulmonary irritant phosgene, with a military designation of CG. It is one of the least studied chemical warfare agents, so specific information is limited.

Phosgene oxime is a white crystalline powder that can be liquefied at room temperature. It is soluble in water and organic solvents, but hydrolyses fairly rapidly, especially in the presence of alkali. It has a high vapor pressure, can vaporize at ambient temperatures and has an odor that is very unpleasant and irritating. Of special concern is the fact that it can be mixed with other chemicals, such as nerve agents, and the rapid skin damage it causes makes the victim more vulnerable to the second agent.

Although classified with the blistering agents, phosgene oxime does not cause vesicles and is an urticant or nettle agent, rather than a true vesicant. 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.

Overview – Toxicity

In concentrations less than 8%, phosgene oxime causes little biologic damage. However, in higher concentrations, it causes more severe damage than any other agent in the vesicant class. The LD₅₀ for skin exposure is estimated at 25 mg/kg.

For inhalation, irritation occurs at 0.2 mg-min/m³ of air and becomes unbearable at 3 mg-min/m³. Its estimated LC₅₀ is 1500 to 2000 mg-min/m³ of air. In addition to local tissue damage, systemic toxicity from parenteral absorption has been described, including hepatic and vascular necrosis. The exact mode of action is not known, but the effects are believed to be the result of phosgene oxime's reacting with SH (sulfhydryl) and H₂N (amine) groups.

Protective Equipment

Ordinary clothing and surgical gear offer little or no protection against phosgene oxime, so special equipment, including a respirator, military-grade NBC suit, gloves and overboots, are required. It penetrates rubber faster than the mustards, so frequent changes of NBC gear are required.

Detection

There are no automatic detectors of phosgene oxime available for use in the field.

Decontamination (1)

Decontamination must be efficient and immediate since phosgene oxime can be fully absorbed within a minute. Immediate decontamination is even more critical when you consider the possibility that the agent has been mixed with another chemical such as a nerve agent. The rapid skin damage that occurs with phosgene oxime makes the victim more susceptible to that second agent, and the rapid removal of phosgene oxime is necessary to limit exposure to both agents. Unfortunately, in a terrorist strike such rapid decontamination is unlikely to occur and the victims are unlikely to know what hit them. First responders should be aware that clothing and other materials exposed to liquid CX pose an immediate danger by off-gassing toxic vapors. These materials must be removed and double-bagged for later decontamination or destruction.

Decontamination (2)

Exposed skin is decontaminated in a manner similar to that following exposure to the other vesicants, such as mustard. Adsorbing powders such as Fullers earth or talcum powder are used, as are chemicals that can inactivate the agent. Since phosgene oxime is rapidly hydrolyzed in the presence of alkaline agents, an alkaline solution can be used for decontamination. Unlike the mustards, however, chlorinated solutions are ineffective and should not be used. The use of water to dilute and remove phosgene is of questionable value and, since some evidence exists that water can actually spread the chemical, its use in the decontamination of skin is not advised unless there is nothing else available. When water is used, it must be used in large amounts.

Decontamination (3)

Skin decontamination techniques are too irritating for use on mucous membranes and the eyes. It is advised that you flush affected mucous membranes immediately with water, while the eyes can be flushed with copious amounts of water, isotonic sodium bicarbonate, or normal saline.

Signs and Symptoms (1)

The hallmark of exposure to phosgene oxime is instant and intense pain, described as stinging nettle on steroids. Fortunately for those trained in chemical warfare, this signals the need for immediate decontamination and the use of protective gear. Yet, despite training, victims have been known to remove their protective gear in an attempt to alleviate the intense pain.

In an aerosolized liquid or vapor attack, the eyes will be one of the first organs affected. The immediate symptoms, in addition to pain, will be those of a chemical conjunctivitis with blepharospasm, lacrimation, blepharitis, and keratitis. Continued exposure can produce severe damage, including corneal damage and permanent blindness.

Signs and Symptoms (2)

As mentioned, contact with just a few milligrams of CX produces an intense pain and itching, which radiates from the point of application. In the absence of adequate decontamination, full absorption occurs within a minute and the exposed area turns white, surrounded by a circular zone of erythema resembling a target. Within an hour the area becomes edematous. Within 24 hours, the edema resolves, the lesion becomes darkly pigmented, and severe necrosis develops. Then over the next 7 to 10 days, desquamation with additional necrosis of the skin develops, followed by eschar formation and a purulent discharge. The necrotic lesion will extend into the underlying panniculus and muscle, and is surrounded by intense inflammation.

Signs and Symptoms (3)

With inhalation, there is immediate irritation to the respiratory tract and a severe inflammatory response that leads to marked pulmonary edema. In addition, a necrotizing bronchiolitis and pulmonary venule thrombosis may accompany the pulmonary edema. Marked respiratory distress with dyspnea, rales, wheezing, rhonchi and other signs of such distress can be expected. Severe skin exposures may also produce pulmonary edema and thromboses, although with a several hour delay.

Treatment (1)

Since there is no specific treatment available for these injuries, the aim of therapy is to relieve symptoms, prevent infections, and promote healing. Necrotic skin lesions must be treated surgically, and pulmonary edema should be handled appropriately. Recovery typically takes from 1 to 3 months, although some burns can take more than 6 months to heal.

Treatment (2)

There are a few caveats to treating phosgene oxime victims. With eye injuries, 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 dark, protective goggles. Although data on the ingestion of phosgene oxime is scant, do not induce emesis, which risks introducing the chemical directly into the lungs. If the victim is able, give 4 to 8 ounces of milk or water. There is no data on the use of activated charcoal. One final caveat ... with pulmonary injuries, remain vigilant to the potential development of pneumonia and cover the victim with appropriate prophylactic antibiotics.

Long-term Medical Sequelae

The long-term medical sequelae are unknown but would be expected to follow the initial acute injuries. As such, serious corneal damage might result in blindness, and inhalation injuries might result in debilitating long-term pulmonary disease and severe fibrosis. The carcinogenicity and reproductive effects of phosgene oxime are unknown.

Environmental Sequelae

Phosgene oxime is highly reactive and volatile, and is considered a non-persistent agent that is unlikely to produce environmental hazards.

Summary

Phosgene oxime (CX) is an urticant agent that causes skin, eye and pulmonary damage similar to, but more severe than that of the vesicant agents and it can be mixed with other chemicals to cause more severe injury. Immediate decontamination is critical. With exposure, intense pain occurs instantly, soon followed by significant tissue necrosis. With no specific antidote or treatment, the aim of therapy is to relieve symptoms, prevent infection, and promote healing. Recovery in most cases takes 1 to 3 months, although some skin burns can take over 6 months to heal.