Chlorine (Pulmonary Agents) – *by Steve Albright*

History

After last weeks article depicting worst-case scenarios involving Vulcan, I thought it might be important to review the effects of pulmonary agents, in particular Chlorine. Chlorine gas was first used as a weapon of mass destruction during the First World War. In order to break a stalemate on the front in Belgium in early 1915, the German Army spent two months implanting 6,000 commercial cylinders of chlorine in their trenches along a 7-kilometer salient near Ypres, Belgium. On the 22nd of April the prevailing westerly winds shifted in favor of the Germans. Over a ten-minute period, they released the contents of all 6,000 cylinders and a six-foot tall, yellow-green cloud wafted toward the French lines. Neither side anticipated the effectiveness of this chemical assault. Those allied troops that did not die in place, broke and ran, leaving a four-mile wide gap in the allied line. While it is unlikely that an adversary would use chlorine to attack US Forces on today's battlefield, this agent and related compounds (Phosgene) still pose a serious threat to the US military and the American people. Thousands of tons of Chlorine are produced, stored and transported each year in this country, creating the potential for a large-scale release from an industrial accident. The potential for domestic terrorism is also a significant concern. Terrorists use weapons of opportunity. Simply opening the valve on a chlorine or phosgene tank-car near a large metropolitan area could produce mass casualties. Both chlorine and phosgene are ever-present in the chemical industry. These compounds are used as precursors for more complex chlorinated hydrocarbons, the primary components of modern plastics and dyes.

Recent Events

The second largest release of Chlorine in the United States occurred near Alberton Montana on April 11th, 1996. Around 4:00 AM on that date, a 72-car train derailed approximately 1 mile west of Alberton. At least one tank car of pressurized Chlorine ruptured creating a 24-inch gap in the cylinder, venting approximately 122,000 lbs of Chlorine. Over 1000 people were evacuated from an 8 to 15 square mile area, including the entire town of Alberton (population 374). At least one person died as a result of this release and over 352 people were hospitalized. People exposed to the toxic chemical fumes reported a number of health effects: burning eyes and nose, lung irritation and inflammation, sore throats, difficulty breathing, wheezing, coughing up yellow or green sputum, nose bleeds, coughing up blood, headaches and dizziness, and other symptoms or reactions including, depression, lack of motor skills, hopelessness, and anxiety. Exposed animals and livestock also developed reactions: including eye lesions, difficulty breathing, wheezing, which are indicative of lung irritation.


Alberton, MT.; KPAX TV video; Missoula, MT

Chemical Properties

Chlorine was discovered in 1774 and was named from the Greek word Khloros, when translated, means "green". Because it is highly reactive, chlorine is usually found in nature bound with other elements like sodium, potassium, and magnesium. When chlorine is isolated as a free element, chlorine is a greenish yellow gas, which is 2.5 times heavier than air. It turns to a liquid state at -29°F, and it becomes a yellowish crystalline solid at -153°F. Chlorine can be liquefied under pressure for transport by rail and is slightly soluble in water. When released to air, chlorine will react with water to form hypochlorous acid and hydrochloric acid, which are removed from the atmosphere by rainfall. The hypochlorous acid breaks down rapidly. The hydrochloric acid also breaks down; its breakdown products will lower the pH of the water making it more acidic.

Health Considerations

The toxic effects of chlorine are primarily due to its corrosive properties. The action of chlorine is due to its strong oxidizing capability, in which chlorine splits hydrogen from water in moist tissue, causing the release of nascent oxygen and hydrogen chloride which produce major tissue damage. Alternatively, chlorine may be converted to hypochlorous acid which can penetrate cells and react with cytoplasmic proteins to form N-chloro derivatives that destroy cell structure. Symptoms may be apparent immediately or delayed for a few hours. Respiratory Chlorine is water-soluble and therefore, primarily removed by the upper airways. Exposure to low concentrations of chlorine (1 to 10 ppm) may cause eye and nasal irritation, sore throat, and coughing. Inhalation of higher concentrations of chlorine gas (>15 ppm) can rapidly lead to respiratory distress with airway constriction and accumulation of fluid in the lungs (pulmonary edema). Patients may have immediate onset of rapid breathing, blue discoloration of the skin, wheezing, rales or hemoptysis. In symptomatic patients, pulmonary injury may progress over several hours. Lung collapse may occur. The lowest lethal concentration for a 30-minute exposure has been estimated as 430 ppm. Exposure to chlorine can lead to reactive airways dysfunction syndrome (RADS), a chemical irritant-induced type of asthma. Cardiovascular Tachycardia and initial hypertension followed by hypotension may occur. After severe exposure, cardiovascular collapse may occur from lack of oxygen. Metabolic Acidosis may result from insufficient oxygenation of tissues. Dermal Chlorine irritates the skin and can cause burning pain, inflammation, and blisters. Exposure to liquefied chlorine can result in frostbite injury. Ocular Low concentrations in air can cause

burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, conjunctivitis, and tearing. Corneal burns may occur at high concentrations. Pulmonary function usually returns toward baseline within 7 to 14 days. Although complete recovery generally occurs, symptoms and prolonged pulmonary impairment may persist. Exposure to chlorine can lead to reactive airways dysfunction syndrome (RADS).

If victims show signs and symptoms of skin burning or eye injury, remove clothing and decontaminate with soap and water. Victims who present with signs of respiratory distress, without s/s of skin injury, usually do not need decontamination. There is no antidote for Chlorine poisoning so treatment is mainly supportive. Quickly access for a patent airway, ensure adequate respiration and pulse. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. High flow 02, ventilation assist with bag-valve mask, and intubation may be required to maintain the victims airway. Treat pulmonary edema as required. (Note: Health information obtained from CDC documents).

Personal Protection

EMS personnel should stay upwind and avoid low-lying areas. If entry into the area of contamination is required, ensure that you wear your chemical protective clothing, hood, gloves, and gas mask with a cartridge designed for chlorine (multi-gas) exposure (M-95, 3M P100, etc). Always use the buddy system when working in hazardous areas. Expect to be overwhelmed by the sheer volume of patients if an event as described in last weeks article should occur. Above all else, use your common sense and ensure that you have donned all appropriate gear before entering the area of contamination.

Photographs of Alberton Montana 1996 Chemical Release


Alberton, MT; KPAX TV video; Missoula, MT


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