Physicians for Human Rights

Recognition and Treatment of Chlorine Gas Exposure

Chemical Warfare Agent Identification Fact Sheet Series

Overview

Chlorine gas is a pulmonary irritant with intermediate water solubility that causes acute damage in the upper and lower respiratory tract.[1] At room temperature, it is a dense, yellow-green gas that settles along the ground. Chlorine gas causes oral, nasal, and ocular discomfort that serves as a warning property to get out of the area of exposure and limit pulmonary damage, which may occur with prolonged exposure. Chlorine gas turns to hydrochloric acid when it makes contact with moisture in airways; it then causes chemical burns to all respiratory tissue it contacts. Although the central airway may appear to be the primary concern for many patients who are coughing and wheezing, medics must always treat the casualty as if they could develop peripheral airway symptoms and take seriously any complaints about chest tightness or difficulty breathing.[2]

For chlorine gas, the U.S. Occupational Safety and Health Administration (OSHA) has set the permissible exposure limit to an eight-hour time period at 1 parts per million (PPM). At 1–3 PPM, chlorine gas starts to cause irritation of mucous membranes. Pulmonary symptoms begin at exposures greater than 15 PPM, and concentrations greater than 430 PPM are fatal within 30 minutes.[3] At concentrations of 1,000 PPM and above, fatality ensues within only a few minutes.[4]

This CWA fact sheet is part of a Physicians for Human Rights (PHR) series designed to fill a gap in knowledge among medical first responders to possible CWA attacks. PHR hopes that, by referencing these fact sheets, medical professionals may be able to correctly diagnose, treat, and document evidence of exposure to CWAs.

The Organization for the Prohibition of Chemical Weapons does not consider chlorine gas a chemical weapon because it has many legitimate uses, such as in the production of pharmaceuticals and for water purification. However, chlorine can be weaponized by releasing it in large quantities. In the cases in Syria, chlorine gas is dispersed through the use of munitions. When chlorine gas is weaponized in this way, it falls under the definition of a chemical warfare agent: a substance that is intended for use in military operations to kill, seriously injure, or otherwise incapacitate people through pathophysiological effects. For more information, please see http://www.opcw.org/about-chemical-weapons/what-is-a-chemical-weapon/.

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Diagnosis of acute chlorine gas toxicity is primarily clinical, based on respiratory difficulties and irritation.

Properties of Chlorine Gas

- Considered a pulmonary irritant
- Can be weaponized in gas form
- Can be lethal in high doses
- Can be identified by its yellow-green color[5] and pungent odor similar to that of bleach
- Denser than air, so it stays close to the ground and can spread rapidly[6]

Test for Chlorine Gas Exposure

- Diagnosis of acute chlorine gas toxicity is primarily clinical, based on respiratory difficulties and irritation.
- If severe exposure has occurred, blood and urine analyses may show whether the lungs, heart, or brain have been injured, and other laboratory testing can be useful for monitoring the patient.[7] Tests may include:[8]
  - Pulse oximetry
  - Serum electrolyte, blood urea nitrogen (BUN) test, and creatinine level tests
  - Arterial blood gases test
  - Chest radiography
  - Electrocardiogram (ECG)
  - CT scan of the chest
  - Ventilation-perfusion scan
  - Pulmonary function testing
  - Laryngoscopy or bronchoscopy
- Testing air and soil for presence of chlorine gas:
  - On-site chlorine gas monitors may provide sufficiently accurate real-time results to determine presence of chlorine gas in the air.[9]
  - For localized "hot spots" where chlorine gas may have been deposited into the soil, surface soil samples may be taken from a non-vegetated area to a depth of less than one inch. These samples should be collected as soon as possible after an event and must be kept in airtight containers until they can be analyzed for pH or tested for the presence of chlorine gas.[10]
  - Tests of soil samples may be insufficient, so concurrent air monitoring is recommended.

Protection against Chlorine Gas

- Move away from the area where the chlorine gas was released and go to higher ground.[11] If possible, stay upwind of the gas release, as wind can push clouds of high concentration chlorine gas several miles from the site of release.[12]
- If chlorine gas was released indoors, get out of the building.[13] If you cannot leave the building, move to upper floors in the building and open windows.
- First responders should use personal protective equipment (PPE), including positive-pressure, self-contained respirators and chemical-protective clothing and eye protection.[14]

Exposure to higher concentrations of chlorine gas can rapidly lead to distress with airway constriction and accumulation of fluid in the lungs.

Recognizing Chlorine Gas Exposure

- Exposure to low concentrations of chlorine gas (1 to 10 PPM) may cause eye and nasal irritation, sore throat, and coughing.[15] Specific symptoms include:
  - Blurred vision
  - Eye tearing, nose and throat irritation
  - Dyspnea (upper airway swelling and obstruction)
  - Chest tightness, difficulty breathing or shortness of breath
  - Wheezing
- Exposure to higher concentrations of chlorine gas (>15 PPM) can rapidly lead to distress with airway constriction and accumulation of fluid in the lungs. Other symptoms include:[16]
  - Corneal burns
  - Burning pain, redness, and blisters on skin exposed to gas
  - Tachycardia and hypertension, followed by hypotension
  - Rales
  - Violent cough
  - Hemoptysis
  - Cardiovascular collapse may occur from lack of oxygen
  - Esophageal perforation
  - Nausea and vomiting
  - Lightheadedness
  - Headache
  - Muscle weakness
  - Pulmonary edema (fluid in the lungs), which will present two to four hours following a moderate exposure and 30 to 60 minutes following a severe exposure
- The lowest lethal concentration for a 30-minute exposure has been estimated at 430 PPM.[17]
- After acute exposure, pulmonary function usually returns toward baseline within 7 to 14 days. While complete recovery generally occurs, symptoms and prolonged pulmonary impairment may persist. Exposure to chlorine gas can lead to reactive airways dysfunction (RADS), a chemical irritant-induced type of asthma.

Symptoms of Chlorine Gas Exposure by Concentration Level

Concentration (PPM)	Symptoms
1–3	Irritation of eyes and oral mucus membranes
> 15	Onset of pulmonary symptoms
≥ 430	Fatal within 30 minutes

A patient exhibiting the above symptoms has not necessarily been exposed to chlorine gas. However, exposure to a yellow-green gas with pungent odor similar to bleach,[18] followed by rapid-onset eye and/or skin irritation and choking, coughing, or wheezing,[19] would strongly indicate exposure to chlorine gas.

Treatment consists of removing chlorine gas from the body as soon as possible and providing supportive medical care.

Initial Treatment[20]

- No antidote exists for chlorine gas exposure. Treatment consists of removing chlorine gas from the body as soon as possible and providing supporting medical care, such as inhaled breathing treatments for wheezing, in a hospital setting.[21]
- Safety
  - If entering the location where chlorine gas was released, first responders should use a self-contained breathing apparatus and a protective suit. This level of protection should be used until the contaminant and concentration are confirmed.[22]
  - Outside the contaminated area, first responders do not need to wear protective gear. The risk of secondary contamination from victims exposed to the attack to caregivers is very low.
- Triage
  - In a mass casualty situation, asymptomatic patients and those with more minor symptoms do not require treatment. In most cases, these patients will be free from symptoms in an hour or less, but they should be advised to seek medical care promptly if symptoms develop or recur.[23]
  - Victims exposed to chlorine gas who have no skin or eye irritation do not need decontamination.[24]
  - Symptomatic patients complaining of persistent shortage of breath, severe cough, or chest tightness should be observed until symptom-free (pulmonary injury may progress for several hours).[25]
  - If medical personnel feel that the patient has been exposed to a significant amount of chlorine gas, despite a relatively benign clinical appearance, he/she should be admitted for observation.[26]
  - Triage is an ongoing process that should be repeated as patients move from the initial point of exposure through decontamination and treatment.[27]
- Decontamination/Treatment
  - Decontamination: Once a patient has been removed from the area of exposure, decontaminate them as follows:[28]
    - Patients exposed only to chlorine gas who have no skin or eye irritation do not need decontamination; they can proceed directly to support in a hospital setting.
    - Patients exposed only to chlorine vapor represent no significant risk of contaminating rescue workers ("off gassing").
    - Patients exposed to gas should remove clothing, cutting off any clothing that would have to go over the head. Clothing and personal belongings should be placed in two layers of plastic bags.
    - Rinse the exposed patient with water for three to five minutes, then wash with mild soap and rinse thoroughly with water.
    - Patients with eye irritation should rinse their eyes with water for 10 to 15 minutes.

continued

When entering the area where chlorine gas was released, first responders should use chemical-protective clothing and respirators.

Initial Treatment[20]

continued

- Treatment: Once patient has been decontaminated, move the patient to support in a hospital setting and provide supportive care, including the following:[29]
  - Evaluate and support airway, breathing, and circulation; in cases of respiratory compromise, secure airway and respiration via endotracheal intubation.
  - Administer supplemental oxygen by mask (or bag-valve-mask device, if necessary) to patients with respiratory symptoms.
  - Patients who have bronchospasm may be treated with aerosolized bronchodilators (i.e. inhalers) if they have not been exposed to other chemical agents. If there is potential that the patient has been exposed to more than just chlorine gas, do not use bronchial sensitizing agents, as they may pose additional risks.
  - Skin wounds should be treated like other chemical burns and require irrigation and local wound care.
  - If eyes appear to have corneal defects after irrigation, provide topical antibiotic prophylaxis to prevent infection and consult an ophthalmologist if possible.
  - Patients who are comatose, hypotensive, having seizures, or have cardiac arrhythmias should be treated in the conventional manner.
- Rescuer protection:
  - When entering the area where chlorine gas was released, first responders should use chemical-protective clothing and respirators to protect themselves from pulmonary and skin trauma.
  - Rescue personnel are at low risk of secondary contamination from victims who have been exposed only to chlorine gas.[30]

Follow-up Treatment

- Follow up is recommended for all hospitalized patients because exposure can result in long-term respiratory problems.[31]
- Patients who have skin or corneal injury should be re-examined within 24 hours.[32]
- The following populations have an increased risk of progression to respiratory failure and should be observed post-treatment, even if they are initially asymptotic:[33]
  - Children
  - Patients with underlying cardiovascular or respiratory conditions, or
  - Patients exposed to high concentrations of gas in a confined space.

Population-wide Precautionary Measures

- The most important aspect of managing a chlorine gas release is identifying wind direction, so as to remain upwind of the affected area while establishing scene safety.[34]
- Avoid low-lying, poorly-ventilated, or confined areas such as basements and sewers.[35]
- Maintain a supply of soap and water in airtight containers. Washing quickly with uncontaminated soap and water can help remove chlorine gas from the body.[36]
- Store spare clothing in airtight containers to have on-hand after decontamination.[37]
- Store non-perishable food and water in airtight containers.[38]

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Endnotes

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