

Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Chlorine

CAS No: 7782-50-5

GHS symbols:



GHS06

Acute toxicity

Signal word: Danger

Hazard statements:

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H330	Fatal if inhaled.
H335	May cause respiratory irritation.

Overview

- There is no danger from contact with patients who have only been exposed to chlorine gas. A patient who is wet with liquid chlorine (boiling point -34°C) or whose clothing is contaminated with liquid chlorine may endanger other people through direct contact or through chlorine gas emissions.
- Chlorine has a strong corrosive effect on moist skin, the eyes and the upper respiratory tract, causing eye irritation, coughing, chest pain and breathing difficulties. Bronchospasm and signs of toxic pulmonary oedema (shortness of breath, cyanosis, sputum and coughing) may occur.
- There is no known specific antidote. Treatment depends on the extent of exposure and the symptoms.

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1. Information about the substance

Chlorine (Cl₂), CAS 7782-50-5

Synonyms: molecular chlorine, chlorine gas

At room temperature, chlorine is a green-yellow, non-flammable gas with a sharp or pungent odor; under pressure or at temperatures below -34°C, it is a clear, amber-colored liquid. It is a strong oxidizing agent and is explosive or can form explosive mixtures with many other substances. Chlorine is only slightly soluble in water, but on contact with moisture it forms hypochlorous acid (HOCl) and hydrochloric acid (HCl); the unstable hypochlorous acid decomposes rapidly to form oxygen radicals. Water increases its oxidative and corrosive effect. Chlorine is an important starting material in the production of many chemicals, such as in the synthesis of metal chlorides, chlorinated solvents, pesticides, plastics and synthetic rubber. It is used as a bleaching agent in the paper and textile industries and can be released from household products containing hypochlorite through the action of acids.

2. Exposition

2.1. Inhalation

Exposure to chlorine occurs mainly through inhalation. The smell of chlorine has a clear warning effect. However, chronic exposure to low concentrations can lead to a dulling of the sense of smell and the irritant effects. As chlorine is heavier than air, there is a risk of suffocation in poorly ventilated, low-lying or enclosed spaces.

2.2. Skin/eye contact

Exposure to chlorine gas on wet or damp skin or eyes causes severe chemical burns with ulceration and scabbing.

2.3. Ingestion

Ingestion of chlorine is unlikely as it is a gas at room temperature.

3. Acute health effects

Chlorine gas causes irritation of the eyes and upper respiratory tract (throat irritation, coughing). At high concentrations, it can quickly lead to breathing difficulties with chest pain, shortness of breath, laryngospasm and the development of pulmonary edema. The symptoms may increase over time. Massive exposure can lead to respiratory arrest and cardiovascular arrest.

Skin contact:

Exposure to high concentrations of chlorine gas on wet or damp skin causes severe chemical burns with ulceration and scabbing, which may lead to disfiguring scars. Lower concentrations can cause burning, redness, inflammation and blistering, while exposure to pressurized liquid chlorine can cause frostbite.

Eye contact:

Redness, tearing and eyelid closure; contact with liquid chlorine can result in clouding of the surface of the eye and subsequent permanent damage to the eye.

3.1. Dose-response relationships

<u>Chlorine concentration</u>	<u>Effect/effects</u>
0.31 ppm	- Odor threshold (tolerance development)
0.5 ppm	- Occupational exposure limit (8-hour and short-term value, Germany, AGS)
0.5 ppm	- AEGL-1 (10 minutes, USA, EPA)
2.0 ppm	- AEGL-2 (60 minutes, USA, EPA)
2.8 ppm	- AEGL-2 (10 minutes, USA, EPA)
50 ppm	- AEGL-2 (10 minutes, USA, EPA)

AEGL-1 (acute exposure guideline levels): Guideline values for acute exposure. Concentration of a substance in the air above which the general population, including sensitive individuals, may experience noticeable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are temporary and reversible after exposure has ended.

AEGL-2: Concentration of a substance in the air above which the general population, including sensitive individuals, can be expected to suffer irreversible or other serious and long-lasting health effects or to be impaired in their ability to escape.

AEGL-3: Concentration of a substance in the air above which life-threatening health effects or death are expected to occur in the general population, including sensitive individuals.

EPA: Environmental Protection Agency

3.2. Possible consequences

If the patient survives the first 48 hours after exposure, further improvement in symptoms can be expected. After acute exposure, lung function usually returns to normal within 7 to 14 days. Complete recovery is usually achieved. Increased sensitivity to irritants may persist and cause bronchospasm or chronic bronchitis. Such chlorine gas-induced reactive airways dysfunction syndrome (RADS) may persist for several years. Destruction of lung tissue or scarring can lead to chronic bronchial dilation and increased susceptibility to infection. Chronic or prolonged exposure may result in an increased risk of chronic airway obstruction and dental erosion.

4. Measures

4.1. Self-protection of first aiders

There is no danger from contact with patients who have only been exposed to chlorine gas. A patient who has come into contact with liquid chlorine, or whose clothing has come into contact with it, may endanger other people through direct contact or through chlorine gas emissions.

4.2. Rescue

Patients should be removed from the danger zone immediately. If they are unable to walk unaided, they should be removed from the danger zone quickly using appropriate means, taking care to protect themselves. The "A, B, C procedure" has absolute priority.

A) Clear the airways (check for blockages caused by the tongue or foreign objects)

B) Ventilation (check the patient's breathing, if necessary, begin ventilation with adequate self-protection, e.g. breathing mask)

C) Circulation (begin resuscitation for any person who does not respond to verbal commands and is not breathing normally)

4.3. Cleaning

Patients who have only been exposed to chlorine gas and show no signs of skin or eye irritation do not require any special cleaning measures, unlike all others. If possible, patients should assist with their own cleaning.

If liquid chlorine has been exposed and clothing is contaminated, it must be removed and securely wrapped. Rinse affected skin and hair with water for at least 15 minutes. Continue other important first aid measures during this time. Protect eyes while rinsing.

In the event of chlorine exposure, rinse the eyes with water or neutral saline solution for at least 15 minutes. Remove any contact lenses, if possible, without causing further injury to the eye. Continue other important first aid measures during this time.

4.4. Initial treatment (preclinical or clinical)

Empirical therapy; no specific antidote available.

The following measures are recommended if respiratory complaints or symptoms or systemic toxic effects are present after inhalation of chlorine:

- Oxygen administration
- Administration of 8 sprays of beclomethasone (800µg beclomethasone dipropionate) from a metered dose inhaler.

If there are signs of airway constriction (e.g. bronchospasm or stridor)

- Nebulization of adrenaline (epinephrine): mix 2mg adrenaline (2ml) with 3ml 0.9% NaCl and administer via a nebulizer mask.
- Administration of a β 2-selective adrenoceptor agonist, e.g. four puffs of terbutaline or salbutamol or fenoterol (one puff usually contains 0.25mg terbutaline sulphate; or 0.1mg salbutamol; or 0.2mg fenoterol); this can be repeated once after 10 minutes.

Alternatively, 2.5mg salbutamol and 0.5mg ipratropium bromide can be administered via a nebulizer mask.

If inhalation is not possible, administer terbutaline sulphate (0.25 mg to 0.5 mg) subcutaneously or salbutamol (0.2mg to 0.4mg over 15 minutes) intravenously.

Intravenous administration of 250mg methylprednisolone (or an equivalent steroid dose).

If there are signs of toxic pulmonary oedema (e.g. frothy sputum, moist rales)

- CPAP therapy (continuous positive airway pressure)
- Intravenous administration of 1000mg methylprednisolone (or an equivalent steroid dose)
- In case of (increasing) respiratory insufficiency, advanced airway management, e.g. endotracheal intubation or, if necessary, coniotomy.

Note: The efficacy of corticosteroid administration has not yet been proven in controlled clinical trials.

Skin contact with chlorine can result in severe damage; this should be treated as burns: adequate fluid administration, analgesic therapy, maintenance of body temperature, covering the affected skin area with a sterile dressing or a clean cloth. Exposure of the eyes can also result in severe damage; this should also be treated as burns. Consult an ophthalmologist immediately.

Note: Any exposure to liquid chlorine in the facial area can have serious consequences.

4.5. Further procedure and treatment

In addition to taking medical history, performing a physical examination and checking vital signs, pulse oximetry, a chest X-ray and spirometry should be performed.

Radiological signs of pulmonary oedema – enlargement of the hila, typical, centrally accentuated, patchy shadows on the chest X-ray – are late signs that only become apparent 6 to 8 hours or even later after exposure. The X-ray is typically still normal at initial presentation at the hospital, even after inhalation of a relevant dose.

If peripheral oxygen saturation falls below 90%, arterial blood gas concentrations must be checked immediately and the chest X-ray repeated.

If blood gas concentrations begin to deteriorate and/or the chest X-ray shows signs of pulmonary oedema, high-dose oxygen therapy adjusted to saturation is indicated. If the findings deteriorate, therapy with positive end-expiratory pressure (PEEP) should be started early within the first 24 hours after exposure, even if oxygen saturation can initially be maintained via mask ventilation.

An early indication for PEEP therapy is, for example, tachypnoea (>30/min) with a simultaneous decrease in carbon dioxide partial pressure. An insufficient increase or a relative decrease in oxygen partial pressure despite hyperventilation indicates the development of pulmonary oedema. Fluid intake and excretion as well as electrolytes should be closely monitored. A positive balance should be avoided. Invasive volume monitoring should be considered to optimize fluid management.

If signs of pulmonary oedema are present, intravenous administration of 1.0g methylprednisolone (or an equivalent steroid dose) should be continued at intervals of 8 to 12 hours. Pneumonia may occur as a complication of severe pulmonary edema.

Prophylactic antibiotics are not routinely recommended but may be considered based on the results of sputum cultures.

4.6. Discharge of the patient / instructions for further rules of conduct

Clinically asymptomatic patients who have been exposed to a concentration of less than 2.0ppm (depending on the duration of exposure) and patients who show normal clinical examination findings and no signs of toxic effects after an appropriate follow-up period may be discharged from hospital under the following circumstances:

- Information and recommendations for patients with instructions for further action were provided verbally and in writing.
- The patient is aware of and understands the toxic effects of chlorine.
- The attending physician has been informed that regular contact between the patient and the physician is possible in the following 48 hours.
- Heavy physical work should not be performed in the following 48 hours.
- Do not smoke or be exposed to cigarette smoke for at least 72 hours; smoke can impair lung function.
- Patients with serious skin or eye injuries should be re-examined after 24 hours.
- Spirometry should be repeated at regular intervals after discharge until the values have returned to the patient's baseline values prior to exposure.

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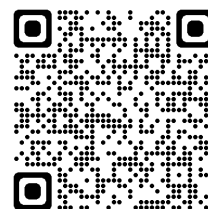
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