
Information and recommendations for paramedics and doctors at the site

- **Before approaching the patient, the paramedics and doctors at the site must make sure that they do not risk exposing themselves to chlorine.**
 - **Patients exposed only to chlorine gas do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid chlorine (boiling point -34°C , -29°F , respectively) can secondarily contaminate rescue and medical personnel by direct contact or through off-gassing chlorine.**
 - **Chlorine gas is rapidly corrosive when it comes in contacts with moist tissue such as the eyes, skin, and upper respiratory tract causing eye irritation, coughing, chest pain and dyspnea. Laryngospasm and signs of pulmonary edema (shortness of breath, cyanosis, expectoration, cough) may occur.**
 - **There is no antidote to be administered to counteract the effects of chlorine. Treatment consists of supportive measures.**
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1. Substance information

Chlorine (Cl₂), CAS 7782-50-5

Synonyms: molecular chlorine

Chlorine is, at room temperature, a yellow-green, noncombustible gas with a sharp or pungent odor. Under pressure or at temperatures below -34°C (-29°F), it is a clear, amber-colored liquid. It is a strong oxidizing agent and can react explosively or form explosive compounds with many common substances. Chlorine is only slightly soluble in water, but on contact with moisture it forms hypochlorous acid (HClO) and hydrochloric acid (HCl); the unstable HClO readily decomposes, forming oxygen free radicals. Water enhances chlorine's oxidizing and corrosive effects. Chlorine is widely used as a chemical reagent in the synthesis and manufacture of metallic chlorides, chlorinated solvents, crop protection products, polymers and synthetic rubbers. It is used as a bleach in the manufacture of paper and cloth; it can be released from hypochlorite-containing household products when they come in contact with acids.

2. Routes of exposure

Inhalation

Most exposures occur by inhalation. Chlorine's odor and irritant properties generally provide adequate warning of hazardous concentrations. However, prolonged low-level exposure may result in olfactory fatigue and tolerance of its irritant effects. Chlorine is heavier than air and may cause asphyxiation in poorly ventilated, low-lying, or enclosed spaces.

Skin/eye contact

Direct contact with liquid chlorine or gas on wet or moist skin causes severe chemical burns, leading to cell death and ulceration.

Ingestion

Ingestion of chlorine is unlikely because it is a gas at room temperature. Solutions that are able to generate chlorine may cause corrosive injury if ingested.

3. Acute health effects

Respiratory

Exposure to low concentrations of chlorine usually causes sore throat and coughing. Rapid development of respiratory distress with chest pain, dyspnea, laryngospasm and pulmonary edema may occur with inhalation of high concentrations of chlorine gas. With exposure to

a high concentration of chlorine gas, nausea and vomiting may occur in association with uncontrolled coughing.

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	Pulmonary injury may progress over several hours. After severe exposure, respiratory and cardiovascular failure may occur.
<i>Dermal</i>	Deep burns of the skin and mucous membranes may be caused by contact with concentrated chlorine; disfiguring scars may result. Contact with less concentrated chlorine gas can cause burning pain, redness, inflammation, and blisters. Contact with liquid chlorine under pressure can result in frostbite.
<i>Ocular</i>	Low gas concentrations cause burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing. Corneal burns may occur at high concentrations.
<i>Dose-effect relationships</i>	Dose-effect relationships are as follows:

<u>Chlorine concentration</u>	<u>Effect</u>
0.31 ppm	- Odor threshold (some tolerance develops)
0.5 ppm	- TLV-STEL (USA, NIOSH)
0.5 ppm	- AEGL I (10 minutes, USA, EPA)
2.0 ppm	- AEGL II (60 minutes, USA, EPA)
2.8 ppm	- AEGL II (10 minutes, USA, EPA)
50 ppm	- AEGL III (10 minutes, USA, EPA)

AEGL I (acute exposure guideline levels): airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL II: airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious long-lasting adverse health effects, or an impaired ability to escape.

AEGL III: airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

4. Actions

Rescuer self-protection

In response situations that involve exposure to potentially unsafe levels of chlorine (see below), pressure-demand, self-contained breathing apparatus and chemical-protective clothing shall be worn.

Patients exposed only to chlorine gas do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid chlorine can secondarily contaminate other people by direct contact or through off-gassing chlorine.

Patient recovery

Patients should be removed from the contaminated zone immediately. Patients who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully remove/transport patients with appropriate action to a safe zone, taking into account your self-protection.

Decontamination

Patients exposed only to chlorine gas who have no evidence of skin or eye irritation do not need decontamination. All others require decontamination.

Patients who are able and cooperative may assist with their own decontamination. If the exposure involved liquid chlorine and if clothing is contaminated, remove and double-bag the clothing.

Assure that exposed skin and hair have been flushed with plain water for at least 15 minutes. If not, continue flushing during other basic care and transport. Protect eyes during flushing of skin and hair.

Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 15 minutes. If not, continue eye irrigation during other basic care and transport.

Remove contact lenses if present and easily removable without additional trauma to the eye.

Initial treatment

Therapy will be empiric; there is no antidote to be administered to counteract the effects of chlorine. **The following measures are recommended if the exposure concentration is 2,8 ppm or greater (depending on time exposed), if symptoms, e. g. eye irritation or pulmonary symptoms have developed, or if no exposure concentration can be estimated but exposure has possibly occurred:**

- **Administration of oxygen**
- **Administration of 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler.**

Patients with severe clinical respiratory symptoms (e.g. bronchospasms, stridor) should be treated as follows:

a) Nebulization of adrenaline (epinephrine): 2 mg adrenaline (2 ml) with 3 ml NaCl 0.9% and inhale through a nebulizer mask.

b) Administration of a β 2-selective adrenoceptor agonist, e.g., four strokes of terbutaline or salbutamol or fenoterol (one stroke usually contains 0.25 mg of terbutaline sulfate; or 0.1 mg of salbutamol; or 0.2 mg of fenoterol); this may be repeated once after 10 minutes. Alternatively, 2.5 mg salbutamol and 0.5 mg atrovent may be administered by nebulizer mask.

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

c) If (b) is not effective or sufficient: administration of theophylline (5 mg/kg body weight over 20 to 30 minutes).

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

Patients with clinical signs of a toxic lung edema (e.g. foamy sputum, wet crackles) should be treated as follows:

a) Start CPAP-therapy (Continuous Positive Airway Pressure Ventilation).

b) Intravenous administration of 1000 mg methylprednisolone (or an equivalent steroid dose) is recommended.

Intubation of the trachea or an alternative airway management should be considered in cases of respiratory compromise. When the patient's condition precludes this, consider cricothyrotomy if equipped and trained to do so.

Note: Efficacy of corticosteroid administration has not yet been proven in controlled clinical studies.

Patients exposed to a concentration of 2.8 ppm or greater (depending on time exposed) and patients without available exposure measurements but suspected of being exposed to concentrations of 2.8 ppm or greater (depending on time exposed) should be transferred to a hospital/emergency department.

If chlorine gas or chlorine generating solutions have been in contact with the skin, chemical burns may result; treat as thermal burns: adequate fluid resuscitation and administration of analgesics, maintenance of the body temperature, covering of the burn with a sterile pad or clean sheet. If liquefied compressed gas is released and contacts the skin, frostbite may result.

After eye exposure chemical burns may result; treat as thermal burns. Immediately consult an ophthalmologist.

Note: Any facial exposure to liquid chlorine should be considered as a serious exposure.

*Patient release/
follow-up instructions*

Asymptomatic patients exposed to a concentration of **less than 2.8 ppm** (depending on the period of time exposed) and **without signs or symptoms of toxicity** after an appropriate observation period may be discharged in the following circumstances:

- a) The evaluating physician is experienced in the evaluation of individuals with chlorine exposure.
- b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing. Patients are advised to seek medical care promptly if symptoms develop or recur.
- c) The physician is comfortable that the patient understands the health effects of chlorine and the provided follow-up instructions.
- d) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release.
- e) Heavy physical work should be precluded for 24 hours.
- f) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

In this document BASF has made a diligent effort to ensure the accuracy and currency of the information presented but makes no claim that the document comprehensively addresses all possible situations related to this topic. This document is intended as an additional resource for paramedics and doctors at the site in assessing the condition and managing the treatment of patients exposed to chlorine. It is not, however, a substitute for the professional judgement of a paramedic or a doctor and must be interpreted in the light of specific information regarding the patient available to such a paramedic or doctor and in conjunction with other sources of authority.

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