
Information and recommendations for doctors at hospitals/emergency departments

- Patients exposed only to hydrogen chloride gas (boiling point -85°C , -121°F , respectively) do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with hydrochloric acid can cause secondary contamination of rescue and medical personnel by direct contact or through off-gassing hydrogen chloride.
 - Hydrogen chloride gas is rapidly corrosive when it comes in contact with moist tissue such as the eyes, skin, and upper respiratory tract causing eye irritation, coughing, chest pain and dyspnea. Laryngospasm and pulmonary edema (shortness of breath, cyanosis, expectoration, cough) may occur.
 - There is no antidote to be administered to counteract the effects of hydrogen chloride. Treatment consists of supportive measures.
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1. Substance information

Hydrogen chloride (HCl), CAS 7647-01-0

Synonyms: anhydrous hydrochloric acid, hydrochloric acid gas

At room temperature hydrogen chloride is a colorless gas with a sharp or pungent odor. Under pressure or at temperatures below -85°C (-121°F), it is a clear liquid. On exposure to air dense white vapor is formed, due to condensation with atmospheric moisture. In contact with moisture, it forms hydrochloric acid. The vapor formed is corrosive.

Hydrogen chloride is available as anhydrous gas or aqueous solution (hydrochloric acid). Aqueous solutions are usually colorless but may be yellow due to trace impurities. Hydrogen chloride is widely used in chemical processes and production.

2. Routes of exposure

Inhalation

Most exposures occur by inhalation. Hydrogen chloride's odor and upper respiratory irritant properties generally provide adequate warning of hazardous concentrations. Hydrogen chloride is heavier than air and may cause asphyxiation in poorly ventilated, low-lying, or enclosed spaces.

Skin/eye contact

Direct contact with liquid hydrogen chloride or concentrated gas on wet or moist skin causes severe chemical burns. It is poorly absorbed through the skin.

Ingestion

Ingestion of hydrogen chloride is unlikely because it is a gas at room temperature. Aqueous solutions (hydrochloric acid) cause severe corrosive injury if ingested.

3. Acute health effects

Respiratory

Hydrogen chloride exposure usually causes sore throat and coughing. Rapid development of respiratory distress with chest pain, dyspnea, laryngospasm and pulmonary edema (shortness of breath, cyanosis, expectoration, cough) may occur. Pulmonary injury may progress over several hours. Hydrogen chloride poisoning may cause respiratory failure.

Dermal

Deep burns of the skin and mucous membranes may be caused by contact with concentrated hydrochloric acid; disfiguring scars may result. Contact with less concentrated hydrogen chloride gas or hydrochloric acid mist can cause burning pain, redness, inflammation, and blisters. Contact with liquid hydrogen chloride under pressure can result in frostbite.

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Ocular Low gas concentrations cause burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing. Corneal burns, cataracts and glaucoma may occur from exposure to high concentrations.

Dose-effect relationships Dose-effect relationships are as follows:

<u>Hydrogen chloride concentration</u>	<u>Effect</u>
0.067-0.134 ppm	- No change in respiratory pattern
5 ppm	- No organic damage
10 ppm	- Irritation; work undisturbed
10-50 ppm	- Work difficult; throat irritation after short exposure
50-100 ppm	- Intolerable; work impossible
1000-2000 ppm	- Brief exposures dangerous; laryngospasms; lethal after a few minutes

The concentration that should not be exceeded during any part of the working exposure is 5 ppm.

Potential sequelae If the patient survives the initial 48 hours after exposure, recovery is likely. After acute exposure, pulmonary function usually returns to normal in 7 to 14 days. Complete recovery is usual; however, symptoms and pulmonary deficits may persist. Airways hyperreactivity to non-specific irritants may persist, resulting in bronchospasm and chronic inflammation of the bronchi. Sequelae of the pulmonary tissue destruction and scarring may result in chronic dilation of the bronchi and increased susceptibility to infection. Chronic or prolonged exposure to hydrogen chloride gas or mist has been associated with abnormal pulmonary function, chronic bronchial inflammation, nasal ulceration, skin and eye inflammation, and corrosion of the teeth.

4. Actions

Self-protection

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

Decontamination

Patients exposed only to hydrogen chloride 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 hydrogen chloride and if clothing is contaminated, remove and double-bag the clothing.

Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 20 minutes, and that the pH of the conjunctival fluid has returned to normal (7.0). If not, continue eye irrigation during other basic care and transport. If eye irrigation is impaired by blepharospasm, one to two drops of oxybuprocaine 0.4% may be instilled into affected eyes to allow adequate irrigation. Remove contact lenses if present and easily removable without additional trauma to the eye.

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.

Initial treatment

Therapy will be empiric; there is not a specific antidote to be administered to counteract the effects of hydrogen chloride.

The following measures are recommended if the exposure concentration is 10 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) 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.

If hydrogen chloride was 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.

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

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

Further evaluation and treatment

To the standard intake history, physical examination, and vital signs add pulse oximetry monitoring and a PA chest X-ray.

Spirometry should be performed. Routine laboratory studies should include a complete blood count, blood glucose and electrolyte determinations.

Evidence of pulmonary edema - hilar enlargement and ill-defined, central-patch infiltrates on chest radiography - is a late finding that may occur 6 to 8 hours or later after exposure. The chest X-ray is typically normal on first presentation to the emergency department even with severe exposures.

Patients who have possible exposure or who develop serious signs or symptoms should be observed for a minimum of 24 hours and reexamined frequently before confirming the absence of toxic

effects. Delayed effects are unlikely in patients who have minor upper respiratory symptoms (mild burning or a slight cough) that resolve quickly.

If oxygen saturation is less than 90 % or if it appears to drop, immediately check arterial blood gasses and repeat the chest X-ray.

If blood gasses begin to show deterioration and/or if the chest X-ray begins to show pulmonary edema start oxygen supplementation.

In case of worsening clinical signs (especially tachypnea >30/min with a simultaneous decrease of the partial pressure of carbon dioxide) CPAP-therapy (Continuous Positive Airway Pressure Ventilation) should be started within the first 24 hours after exposure.

In case of a pulmonary edema fluid intake/output and electrolytes should be monitored closely. Avoid net positive fluid balance. Central line or Swan-Ganz catheterization might be considered, to optimize fluid management.

As long as signs of pulmonary edema are present, intravenous administration of methylprednisolone (or an equivalent steroid) should be continued in intervals of 8-12 hours.

Prophylactic antibiotics are not routinely recommended but may be used based on the results of sputum cultures. Pneumonia can complicate severe pulmonary edema.

*Patient release/
follow-up instructions*

Clinically asymptomatic patients exposed to a concentration of **less than 10 ppm** (depending on the period of time exposed) as well as patients who have a normal clinical examination and no signs or symptoms of toxicity may be discharged after an appropriate observation period in the following circumstances:

- a) The evaluating physician is experienced in the evaluation of individuals with hydrogen chloride 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 hydrogen chloride.
- d) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release from the emergency department.
- e) Heavy physical work should be precluded for up to 24 hours.
- f) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients who have serious skin or eye injuries should be reexamined in 24 hours.

Post discharge spirometry should be repeated until values return to the patient's baseline values.

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 doctors at hospitals/emergency departments in assessing the condition and managing the treatment of patients exposed to hydrogen chloride. It is not, however, a substitute for the professional judgement of a doctor and must be interpreted in the light of specific information regarding the patient available to such a doctor and in conjunction with other sources of authority.

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