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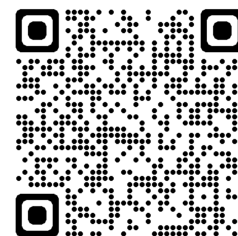

Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Hydrogen chloride, hydrochloric acid

CAS No.: 7647-01-0

GHS symbols:

GHS05
Corrosive

GHS06
Acute toxicity

Signal word: Danger

Hazard statements:

H314	Causes severe skin burns and serious eye damage
H318	Causes serious eye damage
H331	Toxic if inhaled

Overview

- Before paramedics/emergency doctors on site approach a patient who has been or is exposed to hydrogen chloride, they must ensure that there is no danger to themselves from hydrogen chloride.
- There is no danger from contact with patients who have only been exposed to hydrogen chloride gas. A patient who is wet with liquid hydrogen chloride (boiling point –85°C) or whose clothing is contaminated with it may endanger other people through direct contact or through hydrogen chloride gas emissions.
- Hydrogen chloride is highly corrosive to moist skin, the eyes and the upper respiratory tract and causes eye irritation, coughing, chest pain and breathing difficulties. Laryngospasm 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

Hydrogen chloride (HCl), CAS 7647-01-0
Synonyms: anhydrous hydrogen chloride, hydrogen chloride gas.
At room temperature, hydrogen chloride is a colorless gas with a sharp or pungent odor. Under pressure or at temperatures below –85°C, it is a clear liquid. When the gas is released, large quantities of white mist quickly form due to the humidity in the air. The vapors that form are corrosive. It mixes completely with water to form hydrochloric acid. Hydrochloric acid is usually colorless but may also be yellowish in color due to impurities. Hydrochloric acid is used in numerous chemical processes and manufacturing procedures.

2. Exposition

2.1. Inhalation

Exposure to hydrogen chloride occurs mainly through inhalation. The smell of hydrogen chloride and its irritating effect on the upper respiratory tract serve as a clear warning. As hydrogen chloride is heavier than air, there is a risk of suffocation in poorly ventilated, low-lying or enclosed spaces.

2.2. Skin/eye contact

Direct contact with liquid hydrogen chloride or hydrogen chloride gas on wet or damp skin or eyes causes severe chemical burns. Only small amounts are absorbed through the skin.

2.3. Ingestion

Ingestion of hydrogen chloride is unlikely as it is a gas at room temperature. However, aqueous solutions (hydrochloric acid) can cause severe chemical burns.

3. Acute health effects

3.1. Respiratory

Hydrogen chloride causes irritation of the eyes and upper respiratory tract (throat irritation, coughing). At high concentrations, it can quickly lead to chest pain, dyspnea, laryngospasm and pulmonary oedema (shortness of breath, cyanosis, sputum and coughing). The symptoms may increase over time. Massive exposure can lead to respiratory arrest and cardiovascular arrest.

3.2. Skin contact

Exposure to high concentrations of hydrogen chloride 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 hydrogen chloride can lead to frostbite. Concentrated HCl solutions cause severe burns to the skin and mucous membranes, which can result in scarring. Low gas concentrations or HCl mist can cause pain, redness, inflammation and blistering.

3.3. Eye contact

Low concentrations of gas cause burning, redness, tearing and eyelid closure. Exposure to high concentrations or HCl solutions can lead to clouding of the surface of the eye and subsequent permanent damage to the eye.

3.4. Dose-response relationship

Hydrogen chloride concentration		Effect/effects
0.067-0.134 ppm	-	No changes in lung function
5 ppm	-	No organic damage
10 ppm	-	Irritation; ability to work not yet impaired
10 - 50 ppm	-	Throat irritation after brief exposure; ability to work impaired
50 - 100 ppm	-	Irritation unbearable; work impossible
1000 - 2000 ppm	-	Even brief exposure is dangerous; laryngospasm, fatal within a few minutes

Air concentrations of 5 ppm should not be exceeded at any time in the workplace.

3.5. Possible consequences

If the patient survives 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 hydrochloric acid-induced reactive airways dysfunction syndrome (RADS) may persist for several years. Destruction of lung tissue or scarring can lead to chronic bronchial dilation and an increased susceptibility to pulmonary infections. Chronic exposure may result in an increased risk of chronic airway obstruction and tooth erosion.

4. Measures

4.1. Self-protection of first aiders

If there is a suspicion that the area which the helper must enter contains hydrogen chloride, a self-contained breathing apparatus and a chemical protection suit must be worn.
There is no danger from contact with patients who have only been exposed to hydrogen chloride gas. A patient who is wet with liquid hydrogen chloride or whose clothing is wet with liquid hydrogen chloride may endanger other people through direct contact or through hydrogen chloride 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 suitable 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 on any person who does not respond to verbal commands and is not breathing normally)

"CRASH" decontamination

- Rescue patients contaminated with hydrogen chloride who are unconscious or unable to move (critically ill/injured patients according to the ABCDE scheme) from the immediate danger zone, taking care to protect yourself with suitable personal protective equipment
- If necessary, perform emergency measures ("basic life support"; e.g. bleeding control using tourniquets, chest compressions, etc.)
- At a suitable location outside the danger zone, completely undress the contaminated patient using an emergency rescue knife, taking care to protect yourself (duration: approx. 1 minute).
- Shower/rinse with plenty of water (duration: approx. 1 minute).
- Transfer to a clean stretcher. Ensure body heat is maintained. Transport/handover to the emergency services/emergency doctor (duration: approx. 1 minute)

4.3. Cleaning

Patients who have only been exposed to hydrogen chloride 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 in their own cleaning.
If liquid hydrogen chloride has been exposed to and clothing is contaminated, it must be removed and securely wrapped.

Rinse affected skin and hair with water for at least 15 minutes. Other important first aid measures must be continued during this time. Protect eyes while rinsing.

In the event of exposure to hydrochloric acid, rinse the eyes with water or neutral saline solution for at least 15 minutes until the pH value of the conjunctival fluid returns to normal (pH7).
If eye rinsing is impeded by spasmodic eyelid closure, the use of a local anesthetic solution (e.g. lidocaine, oxybuprocaine) may be considered. Remove any contact lenses, if possible, without additional risk 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 the hydrogen chloride gas concentration is 10ppm or more (depending on the duration of exposure), symptoms are present (e.g. irritation of the eyes or upper respiratory tract) or if no concentration can be estimated but exposure is assumed:

- 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 adrenalin (epinephrine): Mix 2mg adrenalin (2ml) with 3ml NaCl 0.9% and administer via a nebulizer mask.
- Administration of a ß2-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 (0.25mg to 0.5mg) 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 edema (e.g. frothy sputum, moist rales)

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

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

Patients with an exposure concentration of 10ppm or more (depending on the duration of exposure) and patients for whom no exposure can be estimated but exposure is very likely to be transported immediately to a hospital with intensive care facilities.

Skin contact with hydrogen chloride can cause severe damage; this should be treated as burns: adequate fluid administration, analgesic therapy, maintenance of body temperature, covering the affected skin area with sterile dressing or clean cloth. Pressurized liquid hydrogen chloride gas can cause frostbite.

Exposure to the eyes can also cause severe damage; this should also be treated as a burn. An ophthalmologist should be consulted immediately.

Note: Any contact with liquid hydrogen chloride 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 carried out.
Clear radiological signs of pulmonary edema – enlargement of the hila, typical, centrally emphasized, 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 normal on initial presentation at the hospital, even after inhalation of a larger dose.
Patients with possible exposure should be monitored for an appropriate period and re-examined repeatedly before any consequential damage to health can be ruled out. In cases of mild irritation of the upper respiratory tract that subsides quickly, no long-term effects are usually to be expected.

If oxygen saturation falls below 90%, arterial blood gas concentrations must be checked immediately and the chest X-ray repeated. If blood gas concentrations deteriorate and/or the chest X-ray shows signs of toxic pulmonary oedema, oxygen should be administered via a mask. If deterioration manifests (especially in the case of tachypnoea (>30/min) and a simultaneous decrease in carbon dioxide partial pressure), CPAP therapy should be started within the first 24 hours after exposure.

In the event of pulmonary oedema developing, fluid intake and excretion as well as electrolytes should be closely monitored. A positive balance should be avoided. To optimize fluid management, the insertion of a central venous catheter should be considered.
If signs of pulmonary oedema persist, intravenous administration of methylprednisolone (or an equivalent steroid) should be continued at intervals of 8 to 12 hours.

Prophylactic antibiotic administration is not routinely recommended but may be considered based on the results of sputum cultures. Pneumonia may occur as a complication of severe pulmonary edema.

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

Asymptomatic patients who have been exposed to a hydrogen chloride concentration of less than 10ppm (depending on the duration of exposure) and who show no abnormal clinical findings and no signs of toxic effects after an appropriate follow-up period may be discharged under the following circumstances:

- Information and recommendations for patients with instructions for further action were provided verbally and in writing. The patient was advised to seek immediate medical attention if any health problems arise.
- The patient is aware of and understands the toxic effects of hydrochloric acid.
- The attending physician has been informed that regular contact between the patient and the physician is possible in the following 24 hours.
- No heavy physical work for the next 24 hours.
- Do not smoke and avoid cigarette smoke for at least 72 hours; smoke can impair lung function.

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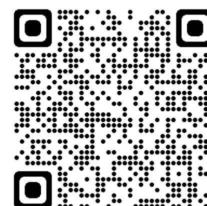

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