

Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Hydrogen sulfide

CAS No.: 7783-06-4

GHS symbols:



GHS05
Corrosive



GHS06
Acute toxicity

Signal word: Danger

Hazard statements:

- | | |
|------|-----------------------------------|
| H319 | Causes serious eye irritation. |
| H330 | Fatal if inhaled. |
| H335 | May cause respiratory irritation. |

Overview

- Before paramedics/emergency doctors on site approach a patient, they must ensure that there is no danger to themselves from hydrogen sulfide.
- There is no danger from contact with patients who have only been exposed to hydrogen sulfide gas. A patient who is wet with liquid hydrogen sulfide (boiling point -60°C) or whose clothing is wet with it may endanger other people through direct contact or through hydrogen sulfide gas emissions.
- Hydrogen sulfide irritates moist skin, the eyes and the upper respiratory tract and causes headaches, nausea, dizziness, weakness, a drop in blood pressure and confusion. Bronchospasm and signs of pulmonary oedema (shortness of breath, cyanosis, sputum and coughing), loss of consciousness and respiratory arrest may occur. A collapse with loss of consciousness is characteristic of relevant intoxications.
- The most urgent measure after actual or suspected hydrogen sulfide intoxication is ventilation and administration of oxygen.

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1. Information on the substance

Hydrogen sulfide (H₂S), CAS 7783-06-4

Synonyms: hydrogen sulfide

At room temperature, hydrogen sulfide is a colorless, combustible and highly flammable gas with a smell of rotten eggs; under pressure or at temperatures below -60°C, it is a clear, colorless liquid. It is only moderately soluble in water. Hydrogen sulfide is used in agriculture (as a disinfectant), the brewing industry, leather tanning, adhesive production, rubber vulcanization, metal recovery, oil and gas extraction and processing, synthetic fiber production, the printing industry, fur processing, fertilizer production, the sugar industry, paint production and analytical chemistry.

2. Exposition

2.1. Inhalation

Exposure to hydrogen sulfide occurs mainly through inhalation. The odor of hydrogen sulfide and its irritating effect serve as a clear warning, but do not provide reliable protection against harmful concentrations. Chronic exposure to low concentrations can lead to a dulling of the sense of smell and a reduction in the irritant effect. As hydrogen sulfide 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 liquid hydrogen sulfide or gas on wet or damp skin or eyes causes irritation.

2.3. Ingestion

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

3. Acute health effects

3.1. Dose-response relationship

<u>Hydrogen sulfide-concentration</u>	<u>Effect/effects</u>
0.02 - 0.2 ppm	- Odor perception (development of tolerance)
50–150 ppm	- Eye and respiratory tract irritation, paralysis of the olfactory perception
200–500 ppm	- Bronchitis, headaches, dizziness, weakness
500–1000 ppm	- Pulmonary oedema, respiratory depression, unconsciousness
1000 – 1500 ppm	- Sudden unconsciousness, collapse, respiratory arrest, fatal within a few minutes
1800 – 5000 ppm	- Immediately fatal

3.2. Respiratory tract

Hydrogen sulfide gas causes headaches, nausea, dizziness, weakness, confusion, drop in blood pressure and respiratory irritation. Breathing difficulties may increase over time. Hydrogen sulfide can lead to unconsciousness and respiratory and cardiovascular failure. Sudden unconsciousness and collapse after inhaling high concentrations are also characteristic. Afterwards, those affected may be agitated and confused for a while.

3.3. Skin contact

Exposure to high concentrations of hydrogen sulfide gas on wet or damp skin can cause irritation. Exposure to pressurized liquid hydrogen sulfide can cause frostbites.

3.4. Eye contact

Low gas concentrations can cause eye irritation with burning, redness, tearing and eyelid closure. Contact with liquid hydrogen sulfide can result in eye surface clouding and permanent damage to the eye.

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. Hyperresponsiveness to irritants may persist and cause bronchospasm or chronic bronchitis. Such "reactive airways dysfunction syndrome" (RADS) may persist for several years. Destruction of lung tissue or scarring can lead to chronic dilation of the bronchi and increased susceptibility to infections. Oxygen deprivation due to respiratory insufficiency can lead to permanent neurological disorders.

4. Measures

4.1. Self-protection of first aiders

If there is a suspicion that the area the helper must enter contains hydrogen sulfide, 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 sulfide gas. A patient who is wet with liquid hydrogen sulfide or whose clothing is wet with liquid hydrogen sulfide may endanger other people through direct contact or through hydrogen sulfide 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" then 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 sulfide who are unconscious or immobile (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 a tourniquet, 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 sulfide gas 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 hydrogen sulfide has been exposed and clothing is contaminated, it must be removed and securely wrapped.

In the event of hydrogen sulfide exposure, rinse the eyes with water or neutral saline solution for at least 15 minutes. Remove any contact lenses, if possible, without causing additional danger to the eyes. Other important emergency measures must be continued during this time.

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

4.4. Estimation of inhaled dose

Patients with an exposure concentration of 50 to 150ppm or more (depending on the duration of exposure) and patients for whom no exposure dose can be estimated but exposure is very likely to be transported immediately to a hospital with intensive care facilities.

4.5. Initial treatment (preclinical or clinical)

The most urgent measure in the event of actual or suspected hydrogen sulfide poisoning is ventilation and administration of 100% humidified oxygen.

Immediate endotracheal intubation under sedation with benzodiazepine and morphine derivatives is recommended for all unconscious patients. Regardless of the availability of blood gas analysis, ventilation should be started with a FiO₂ of 1.0 (100% oxygen). Very high paO₂ (up to 200mmHg) can be tolerated for several hours. Oxygen should be considered the antidote for hydrogen sulfide poisoning.

The following measures are recommended if the hydrogen sulfide gas concentration is 50 to 150ppm or more (depending on the duration of exposure), if symptoms are present (e.g. irritation of the eyes or upper respiratory tract) or if no concentration can be estimated but exposure is very likely:

- 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 3 ml NaCl 0.9% and administer via a nebulizer mask
- Administration of a β₂-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 oedema (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 cricothyrotomy if necessary.

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

Skin contact with hydrogen sulfide can cause irritation; this should be treated as a burn. Pressurized liquid hydrogen sulfide gas can cause frostbite.

Exposure to the eyes can also cause irritation; this should also be treated as a burn. Consult an ophthalmologist.

Note: Any contact with liquid hydrogen sulfide in the facial area can have serious consequences.

4.6. Antidote treatment

The effectiveness of antidotes for hydrogen sulfide poisoning has not yet been proven in controlled clinical trials. There have been isolated reports of the use of 4-DMAP, nitrite and hydroxycobalamin as antidotes following hydrogen sulfide poisoning. From a toxicological and biochemical perspective, it is conceivable that the antidotes (analogous to cyanides) could have a protective effect on the function of cytochrome C oxidase in the respiratory chain and that sulphmethemoglobin could be formed or a complex could be formed with hydroxycobalamin. Sodium thiosulphate should not be used under any circumstances.

However, all data published to date and individual case reports indicate that critical, unconscious patients with a high probability of hydrogen sulfide poisoning could benefit from very prompt (within a maximum of 30 minutes after exposure) administration of an antidote. Therefore, the administration of an antidote after suspected hydrogen sulfide poisoning remains a last resort and is an individual, situation-dependent decision to be made by the attending emergency physician on a case-by-case basis. There is no clear and general recommendation for its administration.

4.7. 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 hilar regions, 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 still normal at the initial presentation at the hospital, even after inhalation of a relevant dose.

Patients with possible exposure should be monitored for an appropriate period and undergo repeated follow-up examinations before any consequential damage to health can be ruled out.

If oxygen saturation falls below 93%, 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.

Sedation (e.g. with benzodiazepines) may be necessary in agitated and confused patients.

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

Clinically asymptomatic patients who have been exposed to hydrogen sulfide concentrations of less than 50ppm (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 hydrogen sulfide.
- The attending physician has been informed that regular contact between the patient and the physician is possible in the following 24 hours.
- Heavy physical work should not be done in the following 24 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.

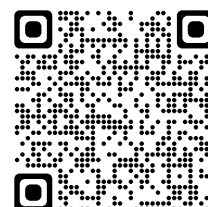
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