Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Sulfur dioxide

CAS No.: 7446-09-5

GHS symbols:

GHS05
Corrosive

GHS06
Acute toxicity

Signal word: Danger

Hazard statements:

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

Overview

- Before paramedics/emergency doctors on site approach a patient, they must ensure that there is no danger to themselves from sulfur dioxide.
- There is no danger from contact with patients who have only been exposed to sulfur dioxide gas. A patient who is wet with liquid sulfur dioxide (boiling point –10°C) or whose clothing is wet with it may endanger other people through direct contact or through sulfur dioxide gas emissions.
- Sulfur dioxide has a strong corrosive effect on moist skin, the eyes and the upper respiratory tract, causing eye irritation, coughing, chest pain, breathing difficulties and bronchoconstriction. 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

Sulfur dioxide (SO_2), CAS 7446-09-5
Synonyms: sulfurous acid anhydride, sulfuric spirit
At room temperature, sulfur dioxide is a colorless, non-flammable gas with a sharp, pungent and sulfurous odor; under pressure or at temperatures below –10°C, it is a clear liquid. Sulfur dioxide is water-soluble and forms sulfurous acid (H_2SO_3). Sulfur dioxide is used in metalworking, in the manufacture of chemicals, in wood processing and paper production, in the extraction of lubricants, as a preservative, disinfectant, reducing agent, antioxidant in magnesium extraction, bleaching agent, fungicide, insecticide and as a preservative and additive in foodstuffs.

2. Exposition

2.1. Inhalation

Exposure to sulfur dioxide occurs mainly through inhalation. The smell of sulfur dioxide 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 sulfur dioxide 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 sulfur dioxide or gas on wet or damp skin or eyes causes severe chemical burns with ulceration and scabbing.

2.3. Ingestion

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

3. Acute health effects

3.1. Dose-response relationship

Sulfur dioxide-concentration		Effect/effects
0.5 – 2 ppm	-	Changes in lung function in asthmatics
3–5 ppm	-	Odor perception (tolerance development possible)
8–20 ppm	-	Irritation of the upper respiratory tract and eyes, lacrimation
50–100 ppm	-	Severe irritation of the eyes and the entire respiratory tract, tolerable for 30–60 minutes
400–500 ppm	-	Fatal after 1 minute

3.2. Respiratory tract

Sulfur dioxide 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 toxic pulmonary oedema. The symptoms may increase over time. Massive exposure can lead to respiratory arrest and cardiovascular arrest.

3.3. Skin contact

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

3.4. Eyes

Low gas concentrations can cause eye irritation with burning, redness, tearing and eyelid closure. Contact with liquid sulfur dioxide or high concentrations can cause clouding of the eye surface and subsequent 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 common. Hyperresponsiveness to irritants may persist and cause bronchospasm or chronic bronchitis. Such sulfur dioxide 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 increase the risk of chronic airway obstruction.

4. Measures

4.1. Self-protection of first aiders

If there is a suspicion that the area the first responder must enter contains sulfur dioxide, 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 sulfur dioxide gas. A patient who is wet with liquid sulfur dioxide or whose clothing is wet with liquid sulfur dioxide may endanger other people through direct contact or through sulfur dioxide 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 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 sulfur dioxide 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 decontamination. If liquid sulfur dioxide has been exposed and clothing is contaminated, it must be removed and securely wrapped.
In the event of exposure to sulfur dioxide, 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 eye. Other important first aid 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 eyes while rinsing.

4.4. Initial treatment (preclinical or clinical)

Empirical therapy; no specific antidote available.

The following measures are recommended if the sulfur dioxide gas concentration is 10ppm or more (depending on the duration of exposure), if respiratory complaints or symptoms or systemic toxic effects (e.g. irritation of the eyes or upper respiratory tract) are present after inhalation of sulfur dioxide, or if no concentration can be estimated but relevant 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 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 oedema (e.g. frothy sputum, moist rales)

- CPAP therapy
- Intravenous administration of 1000 mg 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 10 ppm or more (depending on the duration of exposure) and patients for whom no exposure dose can be estimated but for whom relevant exposure is likely should be transported immediately to a hospital with intensive care facilities.

Skin contact with sulfur dioxide 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 a sterile dressing or a clean cloth. Pressurized liquid sulfur dioxide can cause frostbite.
Exposure to the eyes can also cause serious damage; this should also be treated as a burn. Consult an ophthalmologist immediately.

Note: Any contact with liquid sulfur dioxide in the facial area can have serious consequences.

4.5. Further action and treatment

In addition to taking a 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 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 on initial presentation at the hospital, even after inhalation of a relevant dose.

Patients with possible exposure should be monitored for an appropriate period of time and undergo repeated follow-up examinations before any consequential damage to their 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.

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

Asymptomatic patients who have been exposed to a sulfur dioxide concentration of less than 10 ppm (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 sulfur dioxide.
- 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 carried out 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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