Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Sodium hydroxide

CAS No.: 1310-73-2

GHS symbols:

GHS05
Corrosive

Signal word: Danger

Hazard statements:

H314 Causes severe skin burns and serious eye damage.

Overview

- Before paramedics/emergency doctors on site approach a patient who has been or is exposed to solid sodium hydroxide or caustic soda, they must ensure that there is no danger to themselves from sodium hydroxide.
- Sodium hydroxide and its solutions, mists and aerosols quickly cause burns on contact with the eyes, skin and upper respiratory tract, causing symptoms such as irritation, burning, coughing, chest tightness and shortness of breath. Laryngeal oedema and signs of toxic pulmonary oedema (shortness of breath, cyanosis, sputum, coughing) may occur.
- Ingestion of sodium hydroxide can cause severe chemical burns to the lips, mouth, throat, esophagus and stomach.
- Immediate cleaning is the most important measure: first remove solid sodium hydroxide, then rinse the affected eyes, skin and hair thoroughly.
- 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

Sodium hydroxide (NaOH), CAS 1310-73-2
Synonyms: caustic soda, caustic soda lye
At room temperature, sodium hydroxide is a white, crystalline, odorless, deliquescent solid that absorbs moisture from the air. When sodium hydroxide is dissolved in water, caustic soda is formed, often with simultaneous fog formation. Sodium hydroxide itself is not flammable, but in contact with moisture it can promote the ignition of combustible materials. Heating sodium hydroxide can produce toxic fumes. The solid, solutions, mists and aerosols are all corrosive.
Sodium hydroxide is used in the manufacture of soaps, paper, artificial silk, cotton goods, dyes and mineral oil products. It is also used in the etching and cleaning of metals, in electroplating, in the regeneration of ion exchange resins and for coatings.

2. Exposition

2.1. Inhalation

Inhalation of mists and aerosols is a relevant route of exposure. The irritant effect of sodium hydroxide has a clear warning effect. However, prolonged or repeated exposure may lead to the development of tolerance to the irritant effect.

2.2. Skin/eye contact

Most exposure to sodium hydroxide occurs through skin contact. Direct contact of the eyes or wet or damp skin with liquid sodium hydroxide or concentrated mist or fumes causes severe chemical burns.

2.3. Ingestion

Ingestion of sodium hydroxide can cause severe burns to the lips, mouth, throat, esophagus and stomach.

3. Acute health effects

3.1. Dose-response relationship

Sodium hydroxide concentration		Effect/effects
0.2 – 2 mg/m³	-	Slight temporary irritation of the mucous membranes
10–20 mg/m³	-	Burning eyes and tearing; significant irritation of the respiratory tract
> 50 mg/m³	-	Toxic pneumonia, laryngeal and pulmonary oedema possible
250 mg/m³	-	Immediate danger to life and health
Oral intake of > 2 g	-	Potentially fatal

3.2. Respiratory tract

Exposure to sodium hydroxide usually causes dryness of the nose and throat and coughing. Inhalation of very high concentrations can lead to laryngeal oedema and ultimately to airway obstruction and death. The development of breathing difficulties with chest tightness and toxic pulmonary oedema (shortness of breath, cyanosis, sputum, coughing) may occur with a delay of more than 24 hours.

3.3. Skin contact

Deep chemical burns to the skin and mucous membranes can occur through contact with concentrated sodium hydroxide. Contact with less concentrated sodium hydroxide can cause burning pain, redness and inflammation, which may occur several hours after exposure.
Severe eye burns with clouding of the eye surface and subsequent blindness can result from exposure to liquid sodium hydroxide. Low concentrations of mists or aerosols cause painful discomfort, spasmodic blinking or involuntary closing of the eyelids, redness and tearing.

3.4. Gastrointestinal tract

Abdominal pain, nausea and vomiting may occur. If swallowed, diffuse chemical burns of the mucous membrane with bleeding throughout the gastrointestinal tract may occur. Perforation and strictures may result.

3.5. Kidney

Acid-base balance disorders and acute renal failure may occur.

3.6. Possible consequences

Damage to the skin, eyes and mucous membranes caused by chemical burns may be irreversible, e.g. gangrene, blindness or esophageal stenosis may persist. Complete recovery usually occurs after inhalation; in individual cases, restrictions in lung function may persist.
Permanent restrictive and obstructive lung diseases may remain after bronchiolar damage. Destruction of lung tissue or scarring may lead to chronic bronchial dilation and increased susceptibility to pulmonary infections.

4. Measures

4.1. Self-protection of first aiders

If there is a suspicion that the area to be entered contains sodium hydroxide as a mist or aerosol, a self-contained breathing apparatus and a chemical protection suit must be worn. Contaminated equipment must not be used.
A patient who is wet with sodium hydroxide or its solutions, or whose clothing is wet with it, may endanger other people through direct contact.

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 appropriate means, taking care to protect yourself. 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)

4.3. Cleaning

Patients who have only been exposed to sodium hydroxide mist or aerosols and 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 decontamination. If liquid or solid sodium hydroxide has been exposed and clothing is contaminated, it must be removed and securely wrapped.
In the event of exposure to sodium hydroxide, rinse the eyes with water or neutral saline solution for at least 15 minutes until the pH of the conjunctival fluid returns to normal (pH=7.0). Continue other important supportive measures during rinsing.

If rinsing is impeded by eyelid spasm, the use of a local anesthetic solution (e.g. lidocaine, oxybuprocaine) may be considered. Remove any contact lenses, if possible, without causing further injury to the eye.

If solid sodium hydroxide is present on a patient's skin, hair or clothing, carefully remove it with a brush, for example, before rinsing. It is essential to ensure adequate self-protection and protection of the patient's eyes.

Then rinse the affected skin and hair areas with plenty of water for at least 15 minutes. Protect the eyes during rinsing. Continue other important emergency measures in the meantime. Immediate cleaning is the most important measure.

4.4. Initial treatment (preclinical or clinical)

Empirical therapy; no specific antidote available.
The following measures are recommended if the concentration is 10mg/m³ 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 relevant exposure is assumed:
Administration of 8 sprays of beclomethasone (800µg beclomethasone dipropionate) from a metered dose inhaler.

The following measures are recommended if the exposure concentration is 50mg/m² or more and respiratory symptoms or systemic toxic effects occur after inhalation of sodium hydroxide vapors:

- Oxygen administration
- Administration of 8 puffs 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 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.

Skin contact with sodium hydroxide 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.
Exposure to the eyes can cause serious damage; this should also be treated as a burn. Consult an ophthalmologist immediately.

Note: Any exposure to liquid sodium hydroxide in the facial area must be considered serious.

If sodium hydroxide is swallowed, do not induce vomiting under any circumstances.
If there are signs or symptoms of esophageal irritation or burns, the patient should be taken to an endoscopy center as soon as possible. An endoscopy should be considered to determine the extent of the damage (suspected gastrointestinal necrosis or perforation?).

Only if a significant dose was swallowed less than 30 minutes before the patient's endoscopic examination and perforation can be ruled out should immediate gastric lavage be considered.

Patients who have been exposed to a concentration of 10mg/m^3 or more or who have ingested sodium hydroxide, as well as patients without exposure measurements but with a high degree of suspicion of relevant sodium hydroxide exposure, should be transported immediately to a hospital with intensive care facilities.

4.5. Further procedure and treatment

In addition to medical history, physical examination and vital signs, pulse oximetry, a p.a. chest X-ray and spirometry should be performed. Routine laboratory tests should include complete blood count, glucose and electrolytes.

Radiological signs of pulmonary oedema – enlargement of the hilar regions, typical, centrally accentuated, patchy opacities on 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 relevant dose.
Patients with possible exposure to higher concentrations or with significant complaints or symptoms should be monitored for an appropriate period and re-examined repeatedly before any adverse health effects can be ruled out. Delayed effects in patients with only mild, rapidly subsiding upper respiratory symptoms (mild burning or coughing) are unlikely.

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 pulmonary oedema, administer oxygen via a mask. If deterioration becomes apparent, treatment with positive end-expiratory pressure (PEEP) should be started within the first 24 hours after exposure, even if oxygen saturation can be maintained via mask ventilation.

An early indication for PEEP therapy is tachypnoea (>30/min) with a simultaneous decrease in carbon dioxide partial pressure. An insufficient increase or a relative decrease in oxygen partial pressure despite hyperventilation indicates the development of pulmonary oedema.
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 are present, intravenous administration of 1.0g methylprednisolone (or an equivalent steroid dose) should be continued at intervals of 8 to 12 hours.

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

Skin/eye irritation or chemical burns should be checked at short intervals during the first 24 hours after exposure. Damage to the skin and gastrointestinal tract can continue to progress for days after exposure and significantly impair fluid balance.

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

Asymptomatic patients who have been exposed to a sodium hydroxide concentration of less than 10mg/m^3, have not swallowed sodium hydroxide and show no abnormal examination findings or 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 instructed to seek immediate medical attention if any health problems arise.
- The patient is aware of and understands the toxic effects of sodium hydroxide.
- 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 around cigarette smoke for at least 72 hours; smoke can worsen lung function.
- Patients with serious skin or eye injuries should be re-examined after 24 hours.

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