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## Information and recommendations for doctors at hospitals/emergency departments

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- Patients whose clothing or skin is contaminated with solid sodium hydroxide or its solutions can cause secondary contamination of rescue and medical personnel by direct contact.
  - Sodium hydroxide and its solutions, mists, and aerosols are rapidly corrosive when they come in contact with the eyes, skin, and upper respiratory tract causing irritation, burns, coughing, chest pain and dyspnea. Laryngospasm and pulmonary edema (shortness of breath, cyanosis, expectoration) may occur.
  - Ingestion of sodium hydroxide can cause severe corrosive injury to the lips, mouth, throat, esophagus, and stomach.
  - Immediate decontamination (first removal of solid sodium hydroxide, thereafter extensive flushing of contaminated eyes, skin, and hair) is crucial.
  - There is no antidote to be administered to counteract the effects of sodium hydroxide. Treatment consists of supportive measures.
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### 1. Substance information

Sodium hydroxide (NaOH), CAS 1310-73-2

Synonyms: caustic soda, sodium hydrate, lye.

At room temperature sodium hydroxide is a white crystalline, odorless, deliquescent solid, which absorbs moisture from the air. When sodium hydroxide is dissolved in water, often a mist is formed. Sodium hydroxide itself is nonflammable, but in contact with moisture it may ignite combustibles. Toxic fumes may be formed upon heating. The solid, solutions, mists, and aerosols are all corrosive. It is water-soluble. Sodium hydroxide is widely used in the manufacture of soaps, paper, rayon, cotton, dyestuffs, and petroleum products. Other uses include etching and cleaning of metals, electroplating, ion-exchange resin regeneration, and oxide coating.

### 2. Routes of exposure

#### *Inhalation*

**Inhalation of mists and aerosols is a relevant route of exposure.**

Sodium hydroxide's irritant properties generally provide adequate warning of hazardous concentrations for acute exposures. However, prolonged or repeatedly exposed persons may develop some tolerance of the irritant effects.

#### *Skin/eye contact*

**Most exposures to sodium hydroxide occur by skin contact.** Direct contact with liquid sodium hydroxide or concentrated vapor or fumes on eyes or wet or moist skin causes severe chemical burns.

#### *Ingestion*

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

### 3. Acute health effects

#### *Respiratory*

**Sodium hydroxide exposure usually causes dryness of the nose and throat, and coughing.** Inhalation of very high concentrations may result in laryngeal edema and eventually in obstruction of the airways and death. Development of respiratory distress with chest pain, dyspnea and pulmonary edema (shortness of breath, cyanosis, expectoration) may occur after a delay of up to 24 hours.

#### *Dermal*

Deep painful burns of the skin and mucous membranes may be caused by contact with concentrated sodium hydroxide. Contact with less concentrated sodium hydroxide can cause burning pain, redness, and

inflammation, the onset of which might be delayed for up to several hours after exposure.

*Ocular*

Severe eye burns with clouding of the surface, and ensuing blindness may occur from exposure to liquid sodium hydroxide. Low concentration levels of mists or aerosols cause burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing.

*Gastrointestinal*

Abdominal pain, nausea, and vomiting may occur. In cases of ingestion, diffuse corrosive mucosal injury resulting in hemorrhage, perforation, and strictures can involve the entire intestinal tract.

*Renal*

Acid-base imbalance and acute renal failure may occur.

*Dose-effect relationships*

Dose-effect relationships are as follows:

<u>Sodium hydroxide concentration</u>	<u>Effect</u>
0.2-2 mg/m <sup>3</sup>	- Mild transient mucous membrane irritation
10-20 mg/m <sup>3</sup>	- Burning and tearing of the eyes; marked irritation of the respiratory tract
>50 mg/m <sup>3</sup>	- Toxic pneumonitis, laryngeal and pulmonary edema possible
250 mg/m <sup>3</sup>	- Immediately dangerous to life or health
Oral uptake of about 2 g	- Potentially lethal

*Potential sequelae*

Skin, eye, and mucous membrane damage caused by chemical burns may be irreversible, e.g. gangrene, blindness, or narrowing of the esophagus. After inhalation, complete recovery is usual; however, symptoms and pulmonary deficits may persist. Permanent restrictive and obstructive lung disease may occur from bronchiolar damage. Pulmonary tissue destruction and scarring may result in chronic dilation of the bronchi and increased susceptibility to infection.

#### 4. Actions

*Self-protection*

Patients whose clothing or skin is contaminated with solid sodium hydroxide or its solutions can cause secondary contamination of rescue and medical personnel by direct contact.

*Decontamination*

Patients exposed only to sodium hydroxide mists or aerosols 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 solid or liquid sodium hydroxide 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.

**If any solid sodium hydroxide is present on the patient's skin, hair or clothes, brush it away before flushing. Protect yourself and the patient's eyes.**

**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. **Immediate decontamination is crucial.**

*Initial treatment*

Therapy will be empiric; there is no specific antidote to be administered to counteract the effects of sodium hydroxide.

**The following measures are recommended if the airborne exposure concentration is 10 mg/m<sup>3</sup> or greater, if symptoms, e. g. eye irritation or pulmonary symptoms have developed, or if no**

exposure concentration can be estimated but exposure has possibly occurred:

If not already done, initially, administration of 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler.

The following measures are recommended if the airborne exposure concentration is 50 mg/m<sup>3</sup> or more and/or if patients have respiratory complaints or evidence of systemic toxic effects after inhalation of sodium hydroxide:

- 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<sub>2</sub>-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 inhalation exposure has occurred, humidified air or oxygen should be provided. If signs of hypoxemia are present, humidified supplemental oxygen should be administered.

Intubation of the trachea or an alternative 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.

If sodium hydroxide 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 sodium hydroxide should be considered as a serious exposure.

In case of ingestion of sodium hydroxide, **do not induce emesis, do not perform gastric lavage. Intubate the trachea in cases of stridor resulting from laryngeal edema.**

**If signs or symptoms of esophageal irritation or burns are present, consider endoscopy to determine the extent of the injury; in severe cases surgical intervention should be considered if gastrointestinal necrosis or perforation is suspected.**

*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 to higher concentrations 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.

Should it become clear that pulmonary edema is worsening, positive end-expiratory pressure (PEEP) therapy should be started within the first 24 hours after exposure even if oxygenation can be maintained by mask.

**Early indication for PEEP therapy is tachypnea (>30/min) with a simultaneous decrease of the partial pressure of carbon dioxide.**

An inadequate increase or a relative decrease of the partial pressure of oxygen despite hyperventilation indicates the development of 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 1 g methylprednisolone (or an equivalent steroid dose) 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.

**Irrigation of burns should frequently be repeated up to 24 hours after exposure.**

**Skin and gastrointestinal injury may progress up to days after exposure and increasingly compromise fluid balance.**

*Patient release/  
follow-up instructions*

Clinically asymptomatic patients exposed to a concentration of **less than 10 mg/m<sup>3</sup>** (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 sodium hydroxide or irritant gas 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 sodium hydroxide.
- d) Site physician is informed, 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 sodium hydroxide. 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.

**BASF SE**  
Corporate Health Management  
Carl-Bosch-Straße 38  
67056 Ludwigshafen  
Germany

**BASF Corporation**  
Medical Department  
100 Campus Drive, M/S F 221  
Florham Park, NJ 07932  
USA