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Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Lithium hydroxide;
Lithium hydroxide monohydrate

CAS No.: 1310-65-2; 1310-66-3

GHS symbols:



GHS05
Corrosive

GHS06
Acute toxicity

Signal word: Danger

Hazard statements:

H301	Toxic if swallowed.
H314	Causes severe skin burns and serious eye damage.
H318	Causes serious eye damage

Overview

- A patient who has lithium hydroxide - in the form of dust or aqueous solutions - on their person or clothing may endanger others through direct contact.
- Lithium hydroxide and its aqueous solutions, vapors, and aerosols cause chemical burns upon contact with the eyes, skin, and upper respiratory tract even after brief exposure. Lithium hydroxide causes symptoms such as irritation, a burning sensation, coughing, chest tightness, and shortness of breath.
- Ingestion of lithium hydroxide can lead to severe chemical burns of the lips, mouth, throat, esophagus, and stomach. Systemic effects of lithium ions have been reported following oral ingestion (muscle fasciculations, hyperreflexia, drowsiness, confusion, coma).
- Immediate decontamination is the most important measure: First, remove any powdered or solid lithium hydroxide, followed by thorough rinsing of the affected eyes, skin, and hair.
- 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

Lithium hydroxide (LiOH), CAS 1310-65-2
Lithium hydroxide monohydrate (LiOH-H2O); CAS 1310-66-3.
Lithium hydroxide monohydrate has a toxicity profile similar to that of lithium hydroxide. Therefore, both substances are grouped together in a CEMG. For the sake of simplicity and readability, the guideline uses only the term “lithium hydroxide” in the text.

Synonyms: Lithium hydrate
At room temperature, lithium hydroxide is a white, crystalline, odorless, hygroscopic solid that can absorb moisture and carbon dioxide from the air. Lithium hydroxide itself is not flammable, but it can promote the ignition of flammable materials when it comes into contact with moisture. Heating lithium hydroxide can produce toxic fumes. Both the solid (powder) and solutions, mists, and aerosols are corrosive.
Lithium hydroxide is used, for example, in the production of cathodes with a high nickel content (NMC, NCA), in the manufacture of high-performance greases, and for air purification (absorption of CO_2). Its primary application is in the production of lithium-ion batteries, such as those used in electric vehicles.

2. Exposure

2.1. Inhalation

Inhalation of mists and aerosols is a major route of exposure to lithium hydroxide. The irritating effects of lithium hydroxide serve as a clear warning. However, with prolonged or repeated exposure, sensitivity to these irritating effects may decrease.

2.2. Skin/eye contact

Another major route of exposure to lithium hydroxide is skin contact. Direct contact of the eyes or wet, damp, or sweaty skin (exacerbated by mechanical friction) with lithium hydroxide powder or its aqueous solutions can cause severe chemical burns.

2.3. Swallowing

Ingestion of lithium hydroxide can cause severe chemical burns to the lips, mouth, throat, esophagus, and stomach. In a workplace setting, oral poisoning is likely to occur only through hand-to-mouth contact resulting from poor hygiene practices.

3. Acute health effects

3.1. Respiratory tract

Exposure to lithium hydroxide causes severe irritation of the skin and mucous membranes due to the formation of hydroxide ions. Typical symptoms include irritation of the nose and throat, pain (especially in the throat), watery eyes, and coughing. The irritant effect is concentration-dependent; a derived no-effect level (DNEL) of 10 mg/m³ has been established for the local inhalation effect.

Inhalation of very high concentrations can cause shortness of breath and edema of the glottis or epiglottis, which can ultimately lead to airway obstruction and death. Dyspnea and pulmonary edema (with cyanosis of the skin, lips, and mucous membranes) may also occur several hours later. Nausea and dizziness have also been reported following inhalation.

3.2. Skin/eye contact

Upon contact with water, lithium hydroxide dissociates into lithium ions and hydroxide ions. These hydroxide ions are responsible for the primary effects on the skin, mucous membranes, and eyes. Lithium hydroxide causes severe tissue damage, including deep necrosis (saponification of fats, denaturation of proteins). As a result, the affected skin area can extend far beyond the initially wet area.
Deep, extensive chemical burns with severe damage to the skin and mucous membranes can result from contact with lithium hydroxide in powder form or its highly concentrated aqueous solutions. This damage is particularly severe when lithium hydroxide comes into prolonged contact with damp, wet, or sweaty skin

and is accompanied by mechanical irritation. Consequently, severe and deep skin injuries and erosions have been observed in the workplace in the axillary or inguinal regions when lithium hydroxide was able to act on moist skin for an extended period - for example, while wearing a full-body chemical protective suit and experiencing heavy sweating. Even contact with lower concentrations can lead to a burning sensation, redness, skin erosions, blistering, and deep skin defects (ulcers), which may occur even several hours after exposure.

Severe eye burns, accompanied by clouding of the eye's surface and subsequent blindness, can result from exposure to lithium hydroxide or its concentrated aqueous solutions. Even low concentrations (including vapors, mists, or aerosols) cause painful sensations, spasmodic blinking, conjunctival irritation, or involuntary closure of the eyelids, redness, and tearing. Cases of corneal opacity and ulceration, as well as damage to the iris and vitreous body, have been reported.

3.3. Gastrointestinal tract

Significant oral exposure to lithium hydroxide is unlikely in a workplace setting. However, it can occur, for example, in the event of an accidental release of the substance, when working without respiratory protection, or through hand-to-mouth contact due to poor hygiene. Abdominal pain, nausea, dysphagia, and vomiting may occur. If swallowed, diffuse chemical burns of the mucous membranes with bleeding throughout the gastrointestinal tract may occur. This can lead to perforations and strictures. In cases of severe oral poisoning, bleeding may occur, potentially leading to esophageal or gastric perforation.

Lithium ions are well absorbed through the gastrointestinal tract. The symptoms of acute intoxication are similar to those of an overdose of lithium therapy for bipolar disorder (e.g. treatment with lithium carbonate). Toxicity varies depending on plasma lithium levels. Severe symptoms of significant lithium intoxication include fasciculations, muscle contractions, hyperreflexia, and hypertension, as well as drowsiness and confusion. Epileptiform seizures and hypotension, ranging up to coma and collapse, have also been reported.

3.4. Possible consequences

Damage to the skin, eyes, and mucous membranes caused by exposure to lithium hydroxide may be irreversible; for example, ulcers resulting in scarring, blindness, or esophageal strictures caused by chemical burns may persist. Following inhalation, full recovery usually occurs; in isolated cases, impaired lung function may persist.

4. Measures

4.1. Self-protection of first aiders

If there is any suspicion that the area the rescuer must enter contains lithium hydroxide in the form of vapor or mist, a self-contained breathing apparatus and a chemical protective suit must be worn. Contaminated equipment must not be used.
A patient who is wet with lithium hydroxide or its aqueous solutions - or whose clothing is wet with these substances - may endanger others 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

Exposed individuals who have been exposed to lithium hydroxide dust or mist and are experiencing symptoms of skin, eye, or mucous membrane irritation require special decontamination procedures. Immediate decontamination is the most important step.

Appropriate personal protective equipment must be used. This includes wearing chemical-resistant gloves and, when decontaminating the victim from extensive, powdery contamination, a chemical-resistant suit and respiratory protection. If the victim is extensively contaminated, the decontamination area should be professionally cleaned afterward.

If possible, those affected should assist with their own decontamination. If there has been exposure to liquid (in the form of splashes or widespread wetting) or solid lithium hydroxide powder, and if clothing is contaminated, it must be removed and securely packaged.

If the eyes have been exposed to lithium hydroxide or if eye irritation is present, rinse the eyes with water or a neutral saline solution for 15 minutes. Continue other important first-aid measures while 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 - provided this can be done without posing an additional risk to the eye.

If powdered lithium hydroxide is present on a patient's skin, hair, or clothing, it must be carefully removed - for example, with a vacuum cleaner or a brush - before rinsing. Be sure to wear appropriate personal protective equipment and protect the patient's eyes during this process. Then rinse the affected areas of skin and hair with water for at least 15 minutes. Protect the eyes during rinsing. Continue other important first-aid measures throughout this process.

4.4. Initial treatment (preclinical or clinical)

Empirical treatment; no specific antidote is available.
The following measures are recommended if the concentration is 10 mg/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 (800 µg beclomethasone dipropionate) from a metered dose inhaler.

The following measures are recommended if the exposure concentration is 50 mg/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 (800 µg beclomethasone dipropionate) from a metered dose inhaler.

If there are signs of airway constriction (e.g. bronchospasm or stridor)

- Nebulization of adrenalin (epinephrine): mix 2 mg adrenalin (2 ml) 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 0.25 mg terbutaline sulphate; or 0.1mg salbutamol; or 0.2 mg fenoterol); this can be repeated once after 10 minutes.

Alternatively, 2.5 mg salbutamol and 0.5 mg ipratropium bromide can be administered via a nebulizer mask.
If inhalation is not possible, administer terbutaline sulphate (0.25 mg to 0.5 mg) subcutaneously or salbutamol (0.2 mg to 0.4 mg over 15 minutes) intravenously.
Intravenous administration of 250 mg 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.

Deep, extensive chemical burns with severe damage to the skin and mucous membranes can result from contact with lithium hydroxide in powder form or its highly concentrated aqueous solutions. These injuries should be treated like severe burns: adequate fluid replacement, analgesic therapy, maintenance of body temperature, and covering the affected skin area with a sterile dressing.

In cases of extensive, large-area skin erosion, blistering, and deep skin defects (ulcers), the patient must be referred to a center for severe burn injuries, a center for plastic surgery, or a dermatology center.

Exposure of the eyes can lead to severe damage, including blindness; these injuries should also be treated as burns. Consult an ophthalmologist immediately.

Note: Any exposure to lithium hydroxide or its aqueous solutions in the facial area must be considered serious.

If lithium hydroxide is swallowed, do not induce vomiting under any circumstances.
If there are signs or symptoms of esophageal irritation or chemical burns, the patient should be referred promptly to an endoscopy center. Endoscopy to determine the extent of the damage (suspected gastrointestinal necrosis or perforation?) should be considered.

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

All symptomatic patients with significant dermal or inhalational exposure to lithium hydroxide, as well as patients who have ingested lithium hydroxide, should be transported immediately to a hospital with intensive care facilities.

4.5. Further procedure and treatment

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

Radiologically definitive signs of toxic pulmonary edema - enlarged hila and typical, centrally concentrated, patchy opacities on a chest X-ray - are late signs that become apparent only 6 to 8 hours or even later after exposure. Typically, the X-ray is still unremarkable at the time of initial presentation at the hospital, even after inhalation of a significant dose.

Patients with possible inhalation exposure to higher concentrations of lithium hydroxide or with significant complaints or symptoms should be monitored for an appropriate period of time and undergo repeated follow-up examinations before long-term health complications can be ruled out. Delayed effects are unlikely in patients with only mild, rapidly resolving upper respiratory tract symptoms (mild burning sensation or cough).
If oxygen saturation falls below 90 %, arterial blood gas levels should be checked immediately, and a chest X-ray should be repeated.

If blood gas levels deteriorate and/or the chest X-ray shows signs of toxic pulmonary edema, administer oxygen via a mask. If deterioration becomes apparent, noninvasive ventilation (CPAP) is recommended within the first 24 hours after exposure, even if oxygen saturation can be maintained with mask ventilation.

An early indication for CPAP therapy is tachypnea (>30/min) accompanied by a decrease in partial

pressure of carbon dioxide. An inadequate increase or a relative decrease in partial pressure of oxygen despite hyperventilation indicates the development of pulmonary edema.
If toxic pulmonary edema develops, fluid intake and output, as well as electrolyte levels, should be closely monitored. A positive fluid balance should be avoided. To optimize fluid management, placement of a central venous catheter should be considered.

If signs of toxic pulmonary edema are present, intravenous administration of 1.0 g of methylprednisolone (or an equivalent dose of a steroid) should be continued at 8- to 12-hour intervals.

Prophylactic antibiotic therapy 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.

Skin or eye irritation or chemical burns should be monitored at frequent intervals during the first 24 hours following exposure. In cases of skin or eye damage, the patient should be referred to a dermatologist or ophthalmologist, as appropriate. Following oral ingestion, the patient should be referred to a gastroenterologist.

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

Asymptomatic patients who have not ingested lithium hydroxide and who show no abnormal findings on examination (in particular, no clinical symptoms of mucosal irritation or serious skin lesions) after an appropriate period of observation may be discharged under the following circumstances:

- Information and recommendations for the patient, including instructions on how to proceed, were provided both verbally and in writing. The patient was instructed to seek immediate medical attention if any health symptoms arise.
- The physician believes that the patient is aware of and understands the toxic effects of lithium hydroxide.
- The patient’s primary care physician has been notified, ensuring that regular contact between the patient and the physician is possible over the next 24 hours.
- The patient should avoid heavy physical labor for the next 24 hours.
- Do not smoke and avoid cigarette smoke for at least 72 hours; smoke can impair lung function.
- Patients with minor skin or eye injuries should be re-examined no later than 24 hours after the incident.

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BASF has taken every possible care to ensure that the information presented in this document is accurate and up to date but does not claim that this document comprehensively covers all possible situations in this regard. This document is intended as an additional source of information for doctors in hospitals and is designed to assist in the assessment of the condition and treatment of patients exposed to lithium hydroxide. However, it does not replace the professional assessment of the respective situation by physicians in hospitals and must be interpreted in accordance with legal regulations and provisions as well as specific information available about the respective patients.