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Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Ethyleneimine

CAS No: 151-56-4

GHS symbols:

GHS05
Corrosive

GHS07
Acute toxicity

GHS08
Health hazard

Signal word: Danger

Hazard statements:

H302	Harmful if swallowed.
H317	May cause allergic skin reactions.
H318	Causes serious eye damage.
H341	May cause genetic defects (through skin contact, ingestion, inhalation).
H373	May cause damage to organs (digestive system, circulatory system) through prolonged or repeated exposure (through skin contact, if swallowed, if inhaled).

Overview

- There is no danger from contact with patients who have only been exposed to ethyleneimine vapors.
- A patient who is wet with liquid ethyleneimine or whose clothing is contaminated with liquid ethyleneimine may endanger other persons through direct contact or through evaporating ethyleneimine.
- Ethyleneimine can cause immediate irritation to the eyes, skin and respiratory tract, as well as nausea and vomiting. These symptoms, as well as signs of pulmonary oedema (shortness of breath, cyanosis, sputum, coughing), may occur more than 3 hours after exposure.
- Immediate, prompt cleaning by rinsing the affected skin areas or eyes with water is urgently necessary to prevent permanent damage.
- There is no known specific antidote. Treatment depends on the extent of exposure and the symptoms.

Table of Contents

1. Information about the substance

Ethyleneimine (C_2H_5N), CAS 151-56-4
Synonyms: azacyclopropane, aziridine, dimethyleneimine
Ethyleneimine is a colorless liquid at room temperature with a boiling point of 56°C. Vapor and liquid are flammable and explosive. Ethyleneimine has an ammonia-like odor at air concentrations of 1.5 ppm. Ethyleneimine can pose a hazard even at concentrations below the perception threshold. Ethyleneimine is a highly reactive chemical used as an intermediate and monomer for oilfield chemicals, ion exchange resins, paint raw materials, pharmaceutical products, adhesives, polymer stabilizers and surface-active substances. Polymerisation products of ethyleneimine are used in paper manufacturing.

2. Exposition

2.1. Inhalation

Exposure to ethyleneimine occurs mainly through inhalation. Irritation of the eyes and nose has been reported at concentrations of 100 ppm and above. The odor of ethyleneimine does not provide sufficient warning of dangerous exposure.

2.2. Skin/eye contact

Liquid ethyleneimine is readily absorbed through the skin and eyes and quickly causes severe burns and blisters. Fatal poisoning due to predominant absorption of ethyleneimine through the skin has been observed. Ethyleneimine may cause irritation to the eyes and skin.

2.3. Ingestion

Involuntary ingestion of ethyleneimine is unlikely.

3. Acute health effects

3.1. Respiratory

Ethyleneimine vapors can cause severe irritation of the nasopharynx and lungs. Clinical effects generally manifest 30 to 120 minutes after exposure. High concentrations can cause tracheitis, bronchitis, bronchoconstriction and laryngeal oedema. Toxic pulmonary oedema may also develop more than 3 hours after exposure. Coughing may also occur with a delay.

3.2. Skin contact

Even brief skin contact with liquid ethyleneimine can cause chemical burns. Depending on the concentration and duration of exposure, the burns may manifest after as little as 5 minutes or as long as several days. Burning, redness, blistering and slow-healing necrotizing burns may occur. Skin sensitization can lead to contact dermatitis, urticaria and anaphylactic reactions.

3.3. Eye contact

Liquids and vapors can cause eye redness, lacrimation and, in cases of significant exposure, severe corneal damage.

3.4. Other

States of agitation with corresponding neurological symptoms, liver and kidney damage may occur. Exposure to low concentrations of ethyleneimine vapors may cause nausea and vomiting.

3.5. Possible consequences

Skin contact with liquid ethyleneimine can cause slow-healing or necrotizing chemical burns. Exposure to the eyes can result in irreversible corneal damage.

Survivors of high and symptomatic inhalation exposure may develop chronic lung disease. Coughing and signs of inflammation may persist for months.
Liver and kidney damage (tubular; evidence of proteinuria and increased nitrogen concentration in the blood) may occur after massive exposure.

3.6. Carcinogenicity / Mutagenicity

According to Directive EC 1272/2008, ethyleneimine is classified as follows: Carc. 1B (probably carcinogenic to humans; mainly based on animal studies) and Muta. 1B (it is assumed that the substance causes heritable damage to human germ cells).

4. Measures

4.1. Self-protection of the first aiders

If there is suspicion that the area the helper must enter contains ethyleneimine, 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 ethyleneimine vapors. A patient who is wet with liquid ethyleneimine or whose clothing is wet with liquid ethyleneimine may endanger other people through direct contact or through evaporating ethyleneimine.

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 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 ethyleneimine vapor 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 cleaning. If liquid ethyleneimine has been exposed and clothing is contaminated, it must be removed and securely wrapped.
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.
In case of ethyleneimine exposure, rinse eyes with water or neutral saline solution for at least 15 minutes. Remove contact lenses, if present and if possible, without additional risk to the eye. Continue other important first aid measures during this time.

4.4. Initial treatment (preclinical or clinical)

Empirical therapy; no specific antidote available.
The following measures are recommended if respiratory complaints or symptoms or systemic toxic effects occur after inhalation of ethyleneimine:

- 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 adrenaline (epinephrine): mix 2mg adrenaline (2ml) with 3ml 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 ethyleneimine can cause severe damage; this should be treated like burns: adequate fluid administration, analgesic therapy, maintenance of body temperature, covering the affected skin area with a sterile dressing or a clean cloth. If relevant dermal absorption with the risk of systemic toxic effects cannot be ruled out, the examinations and laboratory tests described below should be carried out in addition to taking a medical history. Patients should then be monitored for an appropriate period.
Exposure of the eyes can also result in severe damage; this should also be treated as burns. Consult an ophthalmologist immediately.

In all asymptomatic patients in whom significant inhalation of ethyleneimine cannot be ruled out, the administration of an inhaled steroid (5 puffs of beclomethasone from a metered dose inhaler) should be considered. The dose may then be repeated (2 puffs every 10 minutes). These patients should also be monitored for an appropriate period.

4.5. 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.
Routine laboratory tests should include a complete blood count, liver and kidney function parameters, glucose and electrolytes. As respiratory complaints or symptoms may not appear until 12 hours after exposure, patients with possible significant exposure should be monitored for an appropriate period and re-examined repeatedly. Hospitalization should be considered for patients with evidence of systemic toxic effects, regardless of the route of exposure.

Radiologically clear signs of pulmonary oedema – enlargement of the hili, 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 initial presentation at the hospital, even after inhalation of a relevant dose.
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 toxic pulmonary oedema, oxygen should be administered via a mask. If deterioration becomes apparent (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

Clinically asymptomatic patients who show unremarkable clinical examination findings and no signs of toxic effects after an appropriate follow-up period may be discharged under the following circumstances 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 ethyleneimine.
- 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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