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# Chemical Emergency Medical Guideline

## Information and recommendations for healthcare professionals

# Ethylene glycol

## CAS No.: 107-21-1

**GHS symbols:**

**GHS07**
Acute toxicity

**GHS08**
Health hazard

**Signal word: Warning**

**Hazard statements:**

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|---|---|
| H302 | Harmful if swallowed. |
| H373 | May cause damage to organs (kidneys) through prolonged or repeated exposure. |

**Overview**

- There is no danger from contact with exposed or intoxicated patients.
- Ingestion of 30ml or more of ethylene glycol can have severe systemic toxic effects, in particular severe depression of the central nervous system with metabolic acidosis. A dose of approximately 100ml of ethylene glycol can be fatal.
- Ethylene glycol may cause mild irritation in contact with the eyes, skin and upper respiratory tract, which may manifest as redness of the eyes and tearing, coughing, and degreasing and inflammation of the skin.
- Inhalation of ethylene glycol vapors/aerosols and ingestion of the liquid can lead to severe systemic poisoning. Absorption through the intact skin is low.
- Ethylene glycol poisoning can be treated by inhibiting the formation of toxic metabolites. This can be achieved by administering the antidotes 4-methylpyrazole (fomepizole IV) or ethanol IV
- If the patient is conscious after ingesting methanol and fomepizole is not readily available, adults should immediately consume 0.7g ethanol/kg body weight in the form of alcoholic beverages, e.g. 150ml whisky or brandy.
- Correct metabolic acidosis and determine the blood ethylene glycol or glycolic acid concentration. If the ethylene glycol concentration is greater than 500mg/l or the glycolic acid concentration is >8mmol/l, or if there are already signs or symptoms of metabolic acidosis (anion gap > 20mmol/l, pH < 7.3), start haemodialysis. Adjust the 4-methylpyrazole or ethanol doses accordingly.

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## 1. Information about the substance

Ethylene glycol ($HOCH_2CH_2OH$), CAS 107-21-1
Synonyms: 1,2-dihydroxyethane, 1,2-ethanediol, 2-hydroxyethanol
At room temperature, ethylene glycol is a colorless, odorless and hygroscopic liquid (boiling point 198°C). It is highly soluble in water, ethanol and acetone, slightly soluble in ether and insoluble in oils and halogenated hydrocarbons.
Ethylene glycol is widely used as a solvent, antifreeze and hydraulic fluid, as a plasticizer and drying agent, and as an intermediate product in the chemical industry.

## 2. Exposition

### 2.1. Inhalation

Ethylene glycol is readily absorbed through the respiratory tract, but the risk is low due to its low volatility. It can be inhaled as an aerosol or vapor from hot products containing ethylene glycol.

### 2.2. Skin/eye contact

Ethylene glycol may cause slight irritation to the skin and eyes. Ethylene glycol is very poorly absorbed through intact skin.

### 2.3. Ingestion

Ingestion of ethylene glycol causes severe systemic poisoning. It is readily absorbed in the gastrointestinal tract.

## 3. Acute health effects

### 3.1. Dose-response relationship

Ingestion of 30ml or more of ethylene glycol should be considered a serious case of poisoning, while ingestion of more than 100ml of ethylene glycol should be considered life-threatening poisoning. Prolonged inhalation of vapors or aerosols can also lead to systemic poisoning. Symptoms of poisoning may be preceded by a latency period of 1 to 4 hours.

Three phases can usually be distinguished:

1) Narcotic phase
Up to 8 hours after methanol intoxication, symptoms of intoxication similar to those of ethanol intoxication may occur, but usually to a lesser degree: mild inhibition of the central nervous system, confusion, ataxia. Irritation of the gastrointestinal tract may lead to nausea, vomiting and epigastric pain.

2) Latency phase

Patients with methanol poisoning, even very severe cases, are often asymptomatic during a latency phase of approximately 6 to 36 hours after exposure.

3) Acidosis/neurotoxicity
The severity of the symptoms of methanol poisoning is often proportional to the metabolic acidosis with anion gap resulting from the oxidation of methanol to accumulating formic acid. Headaches, dizziness, vomiting, periodic breathing and coma with respiratory failure can ultimately lead to death.

### 3.2. Central Nervous System

The initial CNS depression is like that of ethanol, with dizziness, agitation, nystagmus, nausea, tachycardia, increased blood pressure and vomiting. In severe cases, convulsions and coma occur. Hyperventilation exacerbates metabolic acidosis and becomes increasingly prominent. Depending on the amount of ethylene glycol absorbed, individual sensitivity and the initial onset of treatment, generalized convulsions and cerebral oedema may occur.

### 3.3. Cardiovascular effects

Approximately 8-24 hours after ingestion, dyspnea, hyperventilation, tachycardia, cyanosis and increased blood pressure occur. Pulmonary oedema with massive infiltrations develops, especially in cases of oliguria. Death may occur at this stage.

### 3.4. Renal effects

After 24-36 hours, severe cases may develop pronounced oliguria if treatment is inadequate. The urine sediment contains various casts and, in many cases, calcium oxalate crystals. This acute oliguria may resolve with appropriate treatment.

### 3.5. Local effects

Ethylene glycol can cause mild irritation after contact with the eyes, skin and upper respiratory tract, which can manifest as redness of the eyes and tearing, coughing, and degreasing and inflammation of the skin.

### 3.6. Possible consequences

In individual cases, damage to the cranial nerves (I-V-VII-XII) can lead to sensory and motor disorders. Convulsions may be followed by rhabdomyolysis.

## 4. Measures

### 4.1. Self-protection for first aiders

There is no danger from patients who have been exposed to ethylene glycol.

### 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 ethylene glycol aerosol/vapor 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 cleaning. If liquid ethylene glycol has been exposed to and clothing is contaminated, it must be removed and securely wrapped.
Patients who have been exposed to high concentrations of vapor/aerosol should be treated in the same way as patients who have swallowed ethylene glycol.

Rinse affected skin and hair with water for at least 15 minutes. Protect eyes while rinsing.
In the event of ethylene glycol exposure, rinse 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. Continue other important first aid measures in the meantime.
Patients who have swallowed ethylene glycol or been exposed to high vapor/aerosol concentrations should be transported immediately to a hospital with intensive care facilities.

### 4.4. Initial (antidote) treatment (preclinical or clinical)

If the patient is conscious, an adult should immediately consume 0.7g ethanol/kg body weight in the form of alcoholic beverages, e.g. 150ml whisky or brandy.

Do not induce vomiting if ethylene glycol has been swallowed.
Only if a significant dose of methanol has been swallowed less than 30 minutes ago should immediate gastric lavage be considered.

4-methylpyrazole (fomepizole), a synthetic and potent inhibitor of alcohol dehydrogenase, is widely considered the antidote of choice:
Immediate intravenous infusion of an initial dose of 15mg/kg body weight in 5% glucose over 30 to 60 minutes. Early administration of 4-methylpyrazole is very likely to reduce the frequency of necessary dialysis treatments.
If 4-methylpyrazole is not available, intravenous infusion of 0.6g ethanol/kg body weight over 30 minutes is an alternative treatment option. If the patient has already ingested ethanol, this ethanol dose must be modified so that the blood ethanol level does not exceed 100 to 130mg/dl (21.7 to 28.2mmol/l).

If there are signs of hypoxia, administer humidified oxygen. In the event of respiratory insufficiency, perform endotracheal intubation or alternative airway management. If this is not feasible, perform a coniotomy if necessary.

### 4.5. Further procedure and treatment

Patients who have ingested ethylene glycol or been exposed to high vapor/aerosol concentrations:

In addition to taking a medical history, performing a physical examination and checking vital signs, the blood concentration of ethylene glycol – and, if ethanol has been administered, ethanol as well – should be determined.
Routine laboratory tests should include blood gas analysis, osmolality determination, complete blood count, glucose and electrolyte determinations, and renal function tests. Determination of ethylene glycol in the blood and glycolate in the urine may be considered.
Determination of the anion gap [sodium - (bicarbonate + chloride); normal 12 +-2 mmol/l] and the osmolality gap (normal value < 10mOsmol/kg). Administration of sodium bicarbonate in the event of metabolic acidosis.

Continue treatment with either 4-methylpyrazole (10mg/kg body weight every 12 hours for up to 3 doses, further dosage depending on the methanol concentration in the blood) or ethanol (0.1g ethanol/kg body weight/hour to maintain an ethanol blood concentration between 1.0 and 1.5g/l). When administering ethanol orally, a target ethanol level of 0.5 to 1 per mille alcohol should be aimed for over a period of at least 24 hours.

**Haemodialysis**
If the ethylene glycol concentration in the blood is higher than 500mg/l or the glycolic acid concentration is >8mmol/l, or if there are already signs or symptoms of metabolic acidosis (anion gap >20 mmol/l, pH <7.3) or visual disturbances, hemodialysis should be initiated. The 4-methylpyrazole or ethanol dosage should be adjusted accordingly.

Patients with probable systemic exposure or patients who have developed serious symptoms should be monitored for an appropriate period and repeatedly re-examined until toxic damage can be ruled out.

Treatment with hemodialysis and 4-methylpyrazole or ethanol should be continued until the ethylene glycol concentration in the blood is less than 200mg/l or the glycolic acid concentration is less than 8mmol/l and the blood pH is normal.

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

Asymptomatic patients who have not ingested ethylene glycol or have only been exposed to low vapor/aerosol concentrations and show no signs of toxic effects of methanol 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 ethylene glycol.
- 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 be avoided for the next 24 hours.

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**Administrative Information**

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