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Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Phosgene

CAS No: 75-44-5

GHS symbols:

GHS05
Corrosive

GHS06
Acute toxicity

Signal word: Danger

Hazard statements:

H314	Causes severe skin burns and serious eye damage.
H330	Fatal if inhaled.

Overview

- Before the first aider approaches a patient, who has been or is being exposed to phosgene, they must ensure that there is no danger to themselves from phosgene.
- There is no danger from contact with patients who have only been exposed to phosgene gas.
- A patient who is wet with liquid phosgene or phosgene-containing solvents, or whose clothing is contaminated, may endanger other people through direct contact or through phosgene gas emissions.
- Phosgene causes severe irritation of the lungs. Due to its delayed effect, symptoms may still occur 24 hours after exposure. Signs of fluid accumulation in the lungs (shortness of breath, blue-red discoloration of the skin, lips and mucous membranes, sputum, coughing) usually only appear several hours after exposure.
- 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

Phosgene ($COCl_2$), CAS 75-44-5
Synonyms: carbonyl chloride, carbonyl dichloride, carbonic acid dichloride.
At temperatures below 8°C, phosgene is a colorless, vaporizing liquid, and at temperatures above 8°C, it is a colorless, non-flammable gas. Phosgene is often used as a solution in organic solvents. In low concentrations, its odor is like that of green grain or freshly mown hay. In high concentrations, the odor can be pungent and suffocating. Phosgene reacts with water to form hydrochloric acid and carbon dioxide. Phosgene is an important starting material in the production of many chemicals such as isocyanates, polyurethanes, polycarbonates, dyes, pesticides and medicines.

2. Exposition

2.1. Inhalation

Inhalation is the main route of exposure to phosgene. Even low concentrations that cannot be detected can pose a hazard. The irritating effect can be mild and delayed, meaning that phosgene can affect the lungs for a long time without being noticed. As phosgene is heavier than air, there is a risk of suffocation in poorly ventilated, low-lying or enclosed spaces.

2.2. Skin/eye contact

Phosgene gas also affects wet or damp skin and eyes.

2.3. Ingestion

Ingestion of phosgene is unlikely as it is a gas at room temperature.

3. Acute health effects

The symptoms immediately after exposure to phosgene due to irritation of the upper respiratory tract may be mild (burning throat, coughing, feeling of pressure). However, severe lung damage (especially toxic pulmonary oedema) can occur up to 24 hours after exposure. Phosgene poisoning can lead to respiratory arrest and cardiovascular arrest. If the skin is wet or damp, contact with gaseous phosgene can cause skin irritation or redness. Contact with pressurized liquid phosgene can result in frostbite. High gas concentrations can cause eye redness and tears, while eye contact with liquid phosgene can result in clouding of the eye surface and later in permanent damage.

3.1. Dose-response relationship

Phosgene concentration		**Effect/effects**
> 0.125 ppm	-	Odor perception
>1.5 ppm	-	Odor detection
>3.0 ppm	-	Irritation of eyes, nose and respiratory tract
Phosgene dose*		**Respiratory effects**
< 50 ppm-min	-	No clinical respiratory effects
50 to 150 ppm-min	-	Subclinical respiratory effects, pulmonary oedema unlikely
150 ppm-min	-	Pulmonary oedema likely
300 ppm-min	-	Life-threatening pulmonary oedema expected

* The dose-response relationships are based on average effects and reliable dose determination, not solely on the dose indications on the labels.

Note: in cases of unknown exposure, exposure of 150 ppm-min or greater should be assumed.

4. Measures

4.1. Self-protection of first aiders

If there is suspicion that the area the helper must enter contains phosgene, a self-contained breathing apparatus and a chemical protection suit must be worn. Contaminated equipment should not be used. There is no danger from contact with patients who have only been exposed to phosgene gas. A patient who is wet with liquid or phosgene-containing solvents, or whose clothing is wet with such substances, may endanger other people through direct contact or through phosgene gas emissions.

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 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 phosgene gas and 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 phosgene or phosgene-containing solvents have contaminated clothing, this must be removed and securely wrapped. Ensure that affected areas of skin and hair are rinsed with water for at least 15 minutes. Continue other important emergency measures during this time. Protect eyes while rinsing. Ensure that eyes are rinsed with water or neutral saline solution for 15 minutes in the event of phosgene exposure. Remove any contact lenses, if possible, without causing additional danger to the eyes. Continue other important first aid measures during this time.

4.4. Estimation of the inhaled dose

If an indicator badge or other measurement is available, the inhaled dose can be estimated from the exposure dose.

Exposure dose (ppm-min)	**=**	**Estimated concentration of phosgene in parts per million (ppm)**	**x**	**Duration of exposure in minutes (min)**

If a person exposed to phosgene is not wearing a badge, a dose of at least 150ppm-min must automatically be assumed.
If the face area is contaminated, an inhalation dose of more than 150 ppm-min must be assumed, regardless of the badge. This also applies to badges that cannot be evaluated.

4.5. Initial treatment (preclinical or clinical)

≤ 50 ppm-min:

An exposure dose of 50 ppm-min or less with symptoms (irritation of the respiratory tract, burning throat, coughing, etc.) requires at least outpatient treatment. After examination and initial treatment, patients may be discharged or admitted to hospital for observation at the discretion of the outpatient doctor.

50 ppm-min to 150 ppm-min:

Patients who have been exposed to a dose of 50ppm-min to 150ppm-min should undergo an outpatient medical examination. If the patients have no symptoms, they can be discharged at the discretion of the attending physician. If symptoms occur (irritation of the respiratory tract, burning throat, coughing, etc.), transport to a hospital is recommended (if possible, a maximum care facility with ECMO therapy capabilities). Patients should be monitored there for at least eight hours.

≥ 150 ppm-min:

The following measures are recommended if the exposure dose is 150 ppm-min or more, symptoms are present, or if no exposure dose can be estimated but exposure is likely to have occurred:

If not already done, first administer 8 sprays of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler. Then administer 4 more sprays every 2 hours for 24 hours. If not already done, establish intravenous access and administer 1.0 g methylprednisolone (or an equivalent dose of steroid) intravenously.

Note: The efficacy of corticosteroid administration (inhaled or intravenous) has not yet been proven in controlled clinical trials. However, corticosteroid administration is recommended for phosgene exposures of 150 ppm-min or more. The indication for administration is at the discretion of the treating physician.

After inhalation of phosgene, administer humidified air or, if available, oxygen. If there are signs of hypoxia, administer humidified oxygen. In case of respiratory insufficiency, perform endotracheal intubation or alternative airway management. If this is not feasible, perform a coniotomy if necessary.

Skin contact with phosgene can result in severe damage; this should be treated as burns: adequate fluid administration, analgesic intravenous therapy, maintenance of body temperature, covering the affected skin area with a sterile dressing or a clean cloth.

Exposure to the eyes can also result in serious damage; this should also be treated as a burn. Consult an ophthalmologist immediately.

Sedation, e.g. with diazepam, should be considered in cases of significant exposure, 150ppm-min or more, or if the face has been splashed.

Note: Any exposure to liquid phosgene in the facial area should be considered critical exposure.

4.6. Further procedures and treatment

In addition to taking a medical history, performing a physical examination and monitoring vital signs, pulse oximetry, a chest X-ray and spirometry should be performed.

Radiological signs of pulmonary oedema – e.g. enlargement of the hila, typical, centrally accentuated, 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 image is typically normal at the initial presentation at the hospital, even after inhalation of a larger dose. Patients with potentially relevant exposure should be clinically observed for a minimum of 24 hours and repeatedly re-examined before ruling out any damage to health.

If oxygen saturation falls below 90%, arterial blood gas concentrations should be checked immediately and the chest X-ray repeated.

If blood gas concentrations continue to deteriorate and/or the chest X-ray shows signs of pulmonary oedema, high-dose oxygen should be administered via a mask. If the findings worsen, 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.

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. For phosgene exposures of 150ppm-min or more, treatment with N-acetylcysteine (NAC) aerosol (0.5 to 1.2g) should be considered.

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

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

Alternatively, 2.5mg of salbutamol and 0.5mg of 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 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.

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

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

Clinically asymptomatic patients who have been exposed to a concentration of less than 150ppm-min (depending on the duration of exposure) and who show no abnormal clinical findings and no signs of toxic effects of phosgene after an appropriate follow-up period may be discharged under the following circumstances:

- The attending physician is experienced in assessing patients after phosgene exposure.
- The patient's indicator badge indicates exposure below 150ppm-min, was worn by the patient at the time of exposure, and the attending physician and staff agree that the reading is representative of the actual dose inhaled.
- Information and recommendations for patients with instructions for further action have been provided verbally and in writing.
- The patient has been fully informed about the toxic effects of phosgene and understands them.
- Heavy physical work should not be done in the following 24 hours.
- Do not smoke and avoid cigarette smoke; smoke can impair lung function.

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