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Chemical Emergency Medical Guideline

Information and recommendations for healthcare professionals

Phosphorus trichloride

CAS No.: 7719-12-2

GHS symbols:

GHS05
Corrosive

GHS06
Acute toxicity

GHS08
Health hazard

Signal word: Danger

Hazard statements:

H300	Fatal if swallowed.
H312	Harmful in contact with skin.
H314	Causes severe skin burns and serious eye damage.
H330	Fatal if inhaled.
H373	May cause damage to organs through prolonged or repeated exposure.

Overview

- Before paramedics/emergency doctors on site approach a patient, they must ensure that there is no danger to themselves from phosphorus trichloride.
- There is no danger from contact with patients who have only been exposed to phosphorus trichloride gas. A patient who is wet with liquid phosphorus trichloride (boiling point 76°C) or whose clothing is wet with it may endanger other people through direct contact or through phosphorus trichloride gas emissions. Phosphorus trichloride forms hydrogen chloride after contact with moisture.
- Phosphorus trichloride and hydrogen chloride formed with moisture have a strong corrosive effect on moist skin, the eyes and the upper respiratory tract, leading to eye irritation, coughing, chest pain and breathing difficulties. Laryngospasm and signs of toxic pulmonary oedema (shortness of breath, cyanosis, sputum and coughing) may occur.
- 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

Phosphorus trichloride (PCl_3), CAS 7719-12-2
Synonyms: phosphorus chloride, phosphorus-(III)-chloride
At room temperature, phosphorus trichloride is a colorless to slightly yellowish liquid (boiling point 76° C) with a sharp or pungent odor. The vapors formed are corrosive. Phosphorus trichloride forms hydrogen chloride when exposed to moisture.
It is used in the production of pesticides, fuel additives, plasticizers, paints and textile auxiliaries.

2. Exposition

2.1. Inhalation

Exposure to phosphorus trichloride occurs mainly through inhalation. The odor of phosphorus trichloride and its irritating effect on the upper respiratory tract serve as a clear warning of dangerous concentrations. As phosphorus trichloride is heavier than air, there is a risk of suffocation in poorly ventilated, low-lying or enclosed spaces. Phosphorus trichloride forms hydrogen chloride (hydrochloric acid) when exposed to moisture.

2.2. Skin/eye contact

Direct exposure of wet or damp skin or eyes to phosphorus trichloride/hydrogen chloride causes severe chemical burns. Only small amounts are absorbed through the skin.
Low concentrations cause burning, redness, tearing and eyelid closure. Exposure to high concentrations can lead to clouding of the surface of the eye and subsequent permanent damage to the eye.

2.3. Ingestion

Ingestion of phosphorus trichloride in the workplace is unlikely. Aqueous solutions can cause severe chemical burns.

3. Acute health effects

3.1. Dose-response relationship

Phosphorus trichloride concentration		**Effect**
0.2 ppm	-	TWA (NIOSH, USA)
0.5 ppm	-	STEL (NIOSH, USA)
25 ppm	-	IDLH (NIOSH, USA)
0.04 ppm	-	AEGL-1 (10 min, 30 min, 60 min, USA, EPA)
2.9 ppm	-	AEGL-2 (10 minutes, USA, EPA)
2.0 ppm	-	AEGL-2 (30 minutes, USA, EPA)
95 ppm	-	AEGL-3 (10 minutes, USA, EPA)
66 ppm	-	AEGL-3 (30 minutes, USA, EPA)

TWA: Time weighted average
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short-Term Exposure Limit → Average concentration over 15 minutes to which workers may be exposed up to four times per day with at least 60 minutes between successive exposures without adverse health effects
IDLH: Immediately Dangerous to Life and Health
NIOSH: National Institute for Occupational Safety and Health
AEGL-1 (acute exposure guideline levels): Guideline values for acute exposure. Concentration of a substance in the air which, if exceeded, could cause the general population, including sensitive individuals, to experience noticeable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are temporary and reversible after exposure has ended.
AEGL-2: Concentration of a substance in the air above which the general population, including sensitive individuals, can be expected to suffer irreversible or other serious and long-lasting health effects or to be impaired in their ability to escape.
AEGL-3: Concentration of a substance in the air above which life-threatening health effects or death are expected to occur in the general population, including sensitive individuals.
EPA: Environmental Protection Agency

Hydrogen chloride concentration		Effect/effects
0.067 - 0.134 ppm	-	No changes in lung function
5 ppm	-	No organic damage
10 ppm	-	Irritation; ability to work not yet impaired
10–50 ppm	-	Throat irritation after brief exposure; ability to work impaired
50 – 100 ppm	-	Irritation unbearable; work impossible
1000 – 2000 ppm	-	Even brief exposure is very dangerous: laryngospasm, fatal within a few minutes

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3.2. Respiratory tract

Hydrogen chloride (HCl) produced by hydrolysis causes irritation of the eyes and upper respiratory tract (throat irritation, coughing). At high concentrations, it can quickly lead to chest pain, dyspnea, laryngospasm and pulmonary oedema (shortness of breath, cyanosis, sputum and coughing). The symptoms may increase over time. Massive exposure can lead to respiratory arrest.

3.3. Skin contact

Exposure to high concentrations of phosphorus trichloride gas on wet or damp skin causes severe chemical burns with ulceration and scabbing, which may lead to disfiguring scars. Low concentrations can cause burning, redness, inflammation and blistering.

3.4. Eye contact

Low gas concentrations cause burning, redness, tearing and eyelid closure. Exposure to high concentrations or HCl solutions can lead to clouding of the eye surface and subsequent permanent damage to the eye.

3.5. Possible consequences

If the patient survives 48 hours after exposure, further improvement in symptoms can be expected. After acute exposure, lung function usually returns to normal within 7 to 14 days. Complete recovery is usually achieved. Increased sensitivity to irritants may persist and cause bronchospasm or chronic bronchitis. Such hydrochloric acid-induced reactive airways dysfunction syndrome (RADS) may persist for several years. Destruction of lung tissue or scarring can lead to chronic bronchial dilation and increased susceptibility to infection. Chronic or prolonged exposure may result in an increased risk of chronic airway obstruction and tooth erosion.

4. Measures

4.1. Self-protection of first aiders

If there is a suspicion that the area the helper must enter contains phosphorus trichloride/hydrogen chloride (see below), 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 phosphorus trichloride gas. A patient who is wet with liquid phosphorus trichloride, or whose clothing is wet with it, may endanger other people through direct contact or through phosphorus trichloride 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 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 phosphorus trichloride 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 decontamination. If liquid phosphorus trichloride has been exposed to 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.
Rinse the eyes with water or neutral saline solution for at least 15 minutes until the pH value of the tear fluid returns to normal (pH=7). Remove any contact lenses, if possible, without causing additional danger 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 the hydrogen chloride gas concentration is 10 ppm 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:

- 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 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 0.25mg 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 the event of (increasing) respiratory insufficiency, advanced airway management, e.g. endotracheal intubation or, if necessary, coniotomy.

Note: The efficacy of corticosteroid administration has not yet been proven in controlled clinical trials.

Skin contact with phosphorus trichloride can cause severe damage; this should be treated as burns: adequate fluid administration, analgesic therapy, maintenance of body temperature, covering the affected skin area with a sterile dressing.
Exposure of the eyes can also cause severe damage; this should also be treated as a burn. An ophthalmologist should be consulted immediately.

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.

Clear radiological signs of pulmonary oedema – enlargement of the hilar regions, 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.

Patients with possible exposure should be monitored for an appropriate period and undergo repeated follow-up examinations before any adverse health effects can be ruled out. In cases of mild irritation of the upper respiratory tract that subsides quickly, no long-term effects are usually to be expected.

If oxygen saturation falls below 90%, arterial blood gas concentrations must be checked immediately and the chest X-ray repeated.
If blood gas concentrations begin to deteriorate and/or the chest X-ray shows signs of toxic pulmonary oedema, oxygen should be administered via a mask. If deterioration manifests (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 treatment

Asymptomatic patients who have been exposed to concentrations of less than 0.5ppm phosphorus trichloride or 10ppm hydrogen chloride (depending on the duration of exposure) and who have normal clinical examination findings and no signs of toxic effects after 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 complaints arise.
- The patient is aware of and understands the toxic effects of phosphorus trichloride and hydrogen chloride.
- The attending physician has been informed that regular contact between the patient and the physician is possible in the following 24 hours.
- No heavy physical work for the next 24 hours.
- Do not smoke and avoid cigarette smoke for at least 72 hours; smoke can impair lung function.
- Spirometry should be repeated at regular intervals after discharge until the values have returned to the patient's baseline values prior to exposure.

5. References

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