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## Information and recommendations for doctors at hospitals/emergency departments

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- Patients exposed only to phosgene gas should not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid phosgene or solvents containing phosgene can secondarily contaminate rescue and medical personnel by direct contact or through off-gassing phosgene.
  - Phosgene is a severe pulmonary irritant. Because of its slow hydrolysis in the alveoli, serious pulmonary effects and, therefore, symptoms of toxicity may be delayed up to 24 hours. Signs of pulmonary edema (shortness of breath, cyanosis, expectoration, cough) do not usually appear for hours after even severely toxic exposures.
  - There is no antidote to be administered to counteract the effects of phosgene. Treatment consists of supportive measures.
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### 1. Substance information

Phosgene (COCl<sub>2</sub>), CAS 75-44-5

Synonyms: carbonic acid dichloride, carbonic dichloride, carbon oxychloride, carbonyl chloride, chloroformyl chloride

Phosgene is a colorless, fuming liquid below 8°C (47°F) and a colorless, nonflammable gas above 8°C. Often it is used as a solution in organic solvents. At low concentrations, its odor is similar to that of green corn or newly mowed hay; at high concentrations, its odor can be sharp and suffocating. Phosgene is hydrolyzed slowly by moisture to form hydrochloric acid.

Phosgene is used as an intermediate in the manufacture of many chemicals including isocyanates, polyurethane, polycarbonates, dyes, crop protection products, and pharmaceuticals.

### 2. Routes of exposure

#### *Inhalation*

**Inhalation is the major route of phosgene exposure.** Phosgene's odor may provide insufficient warning of hazardous exposure which can occur even at low concentrations. Its irritating quality can be mild and delayed, which may allow persons to be exposed for prolonged intervals. Phosgene is heavier than air and may cause asphyxiation in poorly ventilated, low-lying, or enclosed spaces.

#### *Skin/eye contact*

When phosgene gas contacts moist or wet skin or eyes, it may also add to exposure.

#### *Ingestion*

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

### 3. Acute health effects

Phosgene exposure usually causes eye, nose, throat, and pulmonary irritation. **Irritating effects immediately after exposure might be mild, but severe delayed pulmonary damage, primarily edema, can occur as late as 24 hours after exposure.** Phosgene poisoning may cause respiratory and cardiovascular failure.

If the skin is wet or moist, contact with phosgene gas can cause irritation and redness of the skin. Contact with liquid phosgene under pressure can result in frostbite. High gas concentrations cause tearing and conjunctival erythema of the eye. Eye contact with liquid phosgene may result in clouding of the eye surface and delayed perforation.

*Dose-effect relationships*

Dose-effect relationships are as follows:

Phosgene Concentration > 0.125ppm > 1.5 ppm > 3.0 ppm	Effect Odor perception Recognition of odor Irritation of eyes, nose, throat, bronchi
Inhalation Dose of Phosgene*  < 50 ppm-min 50 – 150 ppm-min 150 ppm-min or above 300 ppm-min or above	Pulmonary Effect  No clinical pulmonary effect Subclinical pulmonary reactions. Edema unlikely Pulmonary edema probable Life-threatening pulmonary edema expected
Note: for unknown exposures: assume exposure of 150 ppm-min or greater *Represents dose effect relationships based on average responses and accurate assessment of dose, not badge readings only.	

*Potential sequelae*

If the patient survives the initial 48 hours after exposure, recovery is likely. Sensitivity to irritants may persist, causing bronchospasm and chronic inflammation of the bronchi. Pulmonary tissue destruction and scarring may lead to chronic dilation of the bronchi and increased susceptibility to infection.

**4. Actions**

*Decontamination*

Patients exposed only to phosgene gas should not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid phosgene or solvents containing phosgene can secondarily contaminate other people by direct contact or through off-gassing phosgene.

Patients who are able and cooperative may assist with their own decontamination. If the exposure involved liquid phosgene or solvents containing phosgene and if clothing is contaminated, remove and double-bag the clothing.

**Assure that exposed skin and hair have been flushed with plain water for at least 15 minutes.** If not, continue flushing during other basic care. Protect eyes during flushing of skin and hair.

**Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 15 minutes.** If not, continue eye irrigation during other basic care.

Remove contact lenses if present and easily removable without additional trauma to the eye.

*Estimation of inhaled dose*

If a badge reading or other measurements are available, the inhalation dose is estimated from the exposure dose.

$$\boxed{\text{Exposure dose (ppm min)}} = \boxed{\text{Estimated concentration of phosgene in parts per million (ppm)}} \times \boxed{\text{Duration of exposure in minutes (min)}}$$

*Initial treatment*

Therapy will be empiric; there is no antidote to be administered to counteract the effects of phosgene.

The following measures are recommended if the exposure dose is 150 ppm-min or greater, if symptoms have developed, or if no exposure dose can be estimated but exposure has possibly occurred:

Sedation, e.g. by diazepam, should be seriously considered after significant exposures, such as exposures of 150 ppm-min or greater, or liquid exposures to the facial area. **If not already done, initially, administration of 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler. Thereafter, administration of 4 puffs every 2 hours for 24 hours.**

**If not already done, establishment of intravenous access and intravenous administration of 1.0 g methylprednisolone (or an equivalent corticoid dose).**

*Note: There is no evidence-based requirement to use corticoids in phosgene poisoning. However the use of corticoids for phosgene exposures of 150 ppm-min or greater is recommended by BASF, but left to the discretion of the attending physician(s).*

Oxygen (humified if possible) should be added to inspired air for dyspnea, wheezing, or pulse oximetry indicates hypoxemia.

Intubation of the trachea or an alternative airway management should be considered in cases of respiratory compromise. When the patient's condition precludes this, consider cricothyrotomy if equipped and trained to do so.

If phosgene was in contact with the skin or eyes chemical burns may result; treat as thermal burns: adequate fluid resuscitation and administration of analgesics, maintenance of the body temperature, covering of the burn with a sterile pad or clean sheet.

**After eye exposure immediately consult an ophthalmologist.**

*Note: Any facial exposure to liquid phosgene should be considered as a serious exposure.*

#### *Further evaluation and treatment*

**To the standard intake history, physical examination, and vital signs add pulse oximetry monitoring and a PA chest X-ray.**

Spirometry should be performed. Routine laboratory studies should include a complete blood count, blood glucose and electrolyte determinations.

**Evidence of pulmonary edema** - hilar enlargement and ill-defined, central-patch infiltrates on chest radiography - **is a late finding that may occur 6 to 8 hours or later after exposure. The chest X-ray is typically normal on first presentation to the emergency department even with severe exposures.**

**Patients who have possible exposure should be observed for a minimum of 24 hours and reexamined frequently before confirming the absence of toxic effects.**

If oxygen saturation is less than 90 % or if it appears to drop, immediately check arterial blood gasses and repeat the chest X-ray.

If blood gasses begin to show deterioration and/or if the chest X-ray begins to show pulmonary edema start oxygen supplementation.

Should it become clear that pulmonary edema is worsening positive end-expiratory pressure (PEEP) therapy should be started within the first 24 hours after exposure even if oxygenation can be maintained by mask.

**Early indication for PEEP therapy is tachypnea (>30/min) with a simultaneous decrease of the partial pressure of carbon dioxide.**

An inadequate increase or a relative decrease of the partial pressure of oxygen despite hyperventilation indicates the development of pulmonary edema. Fluid intake/output and electrolytes should be monitored closely.

Avoid net positive fluid balance. Central line or Swan-Ganz catheterization might be considered, to optimize fluid management.

As long as signs of pulmonary edema are present, intravenous administration of 1 g methylprednisolone (or an equivalent steroid dose) should be continued in intervals of 8-12 hours.

In phosgene exposure cases with exposures of 150ppm-min or greater, treatment with nebulized NAC (0.5 – 1-2 g) should be considered.

Beta-agonists such as salbutamol 5 mg by nebulizer every 4 hours should be used for bronchospasm, but may also be considered in the absence of bronchospasm for exposures of 150 ppm-min or greater, in an effort to reduce lung inflammation. If it is to be used, early post exposure use is recommended.

Prophylactic antibiotics are not routinely recommended, but may be used based on the results of sputum cultures. Pneumonia can complicate severe pulmonary edema.

*Patient release/  
follow-up instructions  
patients*

Clinically asymptomatic patients exposed to a concentration of **less than 150 ppm x min** (depending on the period of time exposed) as well as who have a normal clinical examination and no signs or symptoms of toxicity may be discharged after an appropriate observation period in the following circumstances:

- a) The evaluating physician is experienced in the evaluation of individuals with phosgene exposure.
- b) The patient's exposure badge reading indicates less than 150 ppm-min, was on the patient at the time of the exposure, and the treating physician and the patient agree that the badge reading is representative of the actual inhalation exposure.
- c) Information and recommendations for patients with follow-up instructions are provided verbally and in writing.
- d) The physician is comfortable that the patient understands the health effects of phosgene.
- e) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release from the emergency department.
- f) Heavy physical work should be precluded for 24 hours.
- g) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients with an exposure dose of **150 ppm-min or more** who have a **normal examination and no signs or symptoms of toxicity after observation for 24 hours** may be discharged from the emergency department in the following circumstances:

- a) The evaluating physician is experienced in the evaluation of individuals with phosgene exposure.
- b) **Even if there has not been clinical deterioration, the patient's chest X-ray should be repeated prior to release. The patient should not be released if any degree of pulmonary edema is demonstrated.**
- c) Information and recommendations for patients with follow-up instructions are provided verbally and in writing.
- d) The physician is comfortable that the patient understands the health effects of phosgene and the provided follow-up instructions.
- e) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release from the emergency department.
- f) Heavy physical work should be precluded for 24 hours.
- g) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients who have eye injuries should be reexamined in 24 hours. Post discharge spirometry should be repeated until values return to the patient's baseline values.

In this document BASF has made a diligent effort to ensure the accuracy and currency of the information presented but makes no claim that the document comprehensively addresses all possible situations related to this topic. This document is intended as an additional resource for doctors in assessing the condition and managing the treatment of patients exposed to phosgene. It is not, however, a substitute for the professional judgement of a doctor and must be interpreted in the light of specific information regarding the patient available to such a doctor and in conjunction with other sources of authority.

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