
Information and recommendations for paramedics and doctors at the site

- Before approaching the patient, the paramedics and doctors at the site must make sure that they do not risk exposing themselves to chloroformates.
 - Patients exposed only to chloroformates gas do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid chloroformates or solvents containing chloroformates can secondarily contaminate rescue and medical personnel by direct contact or through off-gassing chloroformates.
 - Chloroformates are severe pulmonary irritants. 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 chloroformates. Treatment consists of supportive measures.
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1. Substance information

Methyl chloroformate (CH₃-OCOCl), CAS 79-22-1

Synonyms: chloroformic acid methyl ester, methoxycarbonyl chloride

Methyl chloroformate is a colorless-yellow clear liquid at room temperature with a melting point of -61 °C and a boiling point of 71 °C.

Ethyl chloroformate (C₂H₅-OCOCl), CAS 541-41-3

Synonyms: chloroformic acid ethyl ester, ethoxycarbonyl chloride

Ethyl chloroformate is a colorless-yellow clear liquid at room temperature with a melting point of -80 °C and a boiling point of 93 °C.

2-Ethylhexyl chloroformate (C₈H₁₇-OCOCl), CAS 24468-13-1

Synonyms: chloroformic acid 2-ethylhexyl ester, 2-ethoxyhexylcarbonyl chloride

2-Ethylhexyl chloroformate is a colorless-yellow clear liquid at room temperature with a melting point of -55 °C and a boiling point of 100 °C.

Isopropyl chloroformate (C₃H₇-OCOCl), CAS 108-23-6

Synonyms: chloroformic acid isopropyl ester, isopropoxycarbonyl chloride

Isopropyl chloroformate is a colorless-yellow clear liquid at room temperature with a melting point of -70 °C and a boiling point of 34 °C.

Butyl chloroformate (C₄H₉-OCOCl), CAS 592-34-7

Synonyms: chloroformic acid butyl ester, butoxycarbonyl chloride

Butyl chloroformate is a colorless-yellow clear liquid at room temperature with a melting point of -70 °C and a boiling point of 138 °C.

Methyl chloroformate is the methyl ester of chloroformic acid, a phosgene derivative. Methyl chloroformate should not be confused with methyl chloroform (1,1,1-trichloroethane).

Often chloroformates are used as a solution in organic solvents. Their odor is pungent and can be sharp and suffocating. Chloroformates are hydrolyzed slowly by moisture to form hydrochloric acid.

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

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2. Routes of exposure

Inhalation

Most exposures occur by inhalation or by skin/eye contact.

Chloroformates' odor may provide insufficient warning of hazardous exposure that can occur even at low concentrations. Its irritating quality can be mild and delayed, which may allow persons to be exposed for prolonged intervals. Chloroformates are heavier than air and may travel along the ground.

Skin/eye contact

Chloroformates can cause irritation and burns of moist or wet skin and the eyes. Dermal absorption may occur.

Ingestion

Accidental ingestion of chloroformates may occur and may cause irritation of the mouth, throat and stomach.

3. Acute health effects

Chloroformates 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.** Chloroformates poisoning may cause respiratory and cardiovascular failure.

If the skin is wet or moist, contact with chloroformates gas can cause irritation and redness of the skin.

High gas concentrations may cause tearing and conjunctival erythema of the eye. Eye contact with liquid chloroformates may result in clouding of the eye surface and delayed perforation.

Dose-effect relationships

Dose-effect relationships are as follows:

<u>Methyl chloroformate concentration</u>	<u>Effect</u>
0.2 ppm	- occupational exposure limit (Germany, AGS)
4 ppm for 10 min	- AEGL II (acute exposure guidance level, USA, EPA)
12 ppm for 10 min	- AEGL III (acute exposure guidance level, USA, EPA)
<u>Ethyl chloroformate concentration</u>	<u>Effect</u>
1 ppm	- occupational exposure limit (United, Kongdom)
2.9 ppm for 10 min	- AEGL II (acute exposure guidance level, USA, EPA)
8.8 ppm for 10 min	- AEGL III (acute exposure guidance level, USA, EPA)
<u>Ethylhexyl chloroformate concentration</u>	<u>Effect</u>
1 ppm	- occupational exposure limit (United Kingdom)
1.2 ppm for 10 min	- AEGL II (acute exposure guidance level, USA, EPA)
3.6 ppm for 10 min	- AEGL III (acute exposure guidance level, USA, EPA)
<u>Isopropy chloroformate concentration</u>	<u>Effect</u>
1 ppm	- occupational exposure limit (United Kingdom)
6 ppm for 10 min	- AEGL II (acute exposure guidance level, USA, EPA)
18 ppm for 10 min	- AEGL III (acute exposure guidance level, USA, EPA)
<u>n-Butyl chloroformate concentration</u>	<u>Effect</u>
0.2 ppm	- occupational exposure limit (Germany, AGS)
4 ppm for 10 min	- AEGL II (acute exposure guidance level, USA, EPA)
12 ppm for 10 min	- AEGL III (acute exposure guidance level, USA, EPA)

AEGL (acute exposure guidelines levels) II: airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious long-lasting adverse health effects, or an impaired ability to escape

AEGL III: airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death

4. Actions

Rescuer self-protection

In response situations that involve exposure to potentially unsafe levels of chloroformates (see below), pressure-demand, self-contained breathing apparatus and chemical-protective clothing shall be worn.

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

Patient recovery

Patients should be removed from the contaminated zone immediately. Patients who are unable to walk may be removed on backboards or stretchers; if these are not available, carefully remove/transport patients with appropriate action to a safe zone, taking into account your self-protection.

Immediate priorities must follow the "A, B, C's" (Airway, Breathing, Circulation) of resuscitation.

„CRASH“-Decontamination

- a) Rescue with chloroformates contaminated, unconscious patients or patients who are unable to move (critically ill/injured patients according to the ABCDE approach) from the danger zone immediately. The use of appropriate personal protective equipment and self-protection have top priority
- b) Start Basic Life Support if necessary (e.g. bleeding control with Tourniquet, cardiac massage etc.)
- c) In a safe zone: fast and complete removal of clothing using a rescue knife or trauma shears (approx. 1 minute)
- d) Short rinsing off with plenty of water (approx. 1 minute)
- e) Place patient on a clean rescue sheet. Consider heat preservation. Transport the patient to the handover area to emergency medical services (approx. 1 minute)

Decontamination

Patients exposed only to chloroformates gas who have no evidence of skin or eye irritation do not need decontamination. All others require decontamination.

Patients who are able and cooperative may assist with their own decontamination. If the exposure involved liquid chloroformates or solvents containing chloroformates 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 and transport. 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 and transport.

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

Initial treatment

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

The following measures are recommended if the exposure is AEGL II or above, if symptoms, e. g. eye irritation or pulmonary symptoms have developed, or if no exposure can be estimated but exposure has possibly occurred:

- **Administration of oxygen**
- **Administration of 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler.**

Patients with severe clinical respiratory symptoms (e.g. bronchospasms, stridor) should be treated as follows:

a) Nebulization of adrenaline (epinephrine): 2 mg adrenaline (2 ml) with 3 ml NaCl 0.9% and inhale through a nebulizer mask.

b) Administration of a β 2-selective adrenoceptor agonist, e.g., four strokes of terbutaline or salbutamol or fenoterol (one stroke usually contains 0.25 mg of terbutaline sulfate; or 0.1 mg of salbutamol; or 0.2 mg of fenoterol); this may be repeated once after 10 minutes. Alternatively, 2.5 mg salbutamol and 0.5 mg atrovent may be administered by nebulizer mask.

If inhalation is not possible, administration of terbutaline sulfate (0.25 mg to 0.5 mg) subcutaneously or salbutamol (0.2 mg to 0.4 mg over 15 minutes) intravenously.

c) Intravenous administration of 250 mg methylprednisolone (or equivalent steroid dose).

Patients with clinical signs of a toxic lung edema (e.g. foamy sputum, wet crackles) should be treated as follows:

a) Start CPAP-therapy (Continuous Positive Airway Pressure Ventilation).

b) Intravenous administration of 1000 mg methylprednisolone (or an equivalent steroid dose) is recommended.

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.

Note: Efficacy of corticosteroid administration has not yet been proven in controlled clinical studies.

If chloroformates were in contact with the skin, 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, chemical burns may result; treat as thermal burns. Immediately consult an ophthalmologist.

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

Patients with an exposure of AEGL II or above and patients without available exposure measurements but suspected of being exposed to an exposure of AEGL II or above should be transported to a hospital/emergency department.

*Patient release/
follow-up instructions*

Patients with an exposure of **less than AEGL II** as well as patients **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:**

- The evaluating physician is experienced in the evaluation of individuals with chloroformates exposure.
- Information and recommendations for patients with follow-up instructions are provided verbally and in writing.
- The physician is comfortable that the patient understands the health effects of chloroformates and the provided follow-up instructions.

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- d) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release.
 - e) Heavy physical work should be precluded for 24 hours.
 - f) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

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 paramedics and doctors at the site in assessing the condition and managing the treatment of patients exposed to Chloroformate. It is not, however, a substitute for the professional judgement of a paramedic or a doctor and must be interpreted in the light of specific information regarding the patient available to such a paramedic or doctor and in conjunction with other sources of authority.

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