
 Information and recommendations for paramedics and doctors at the site

- These guidelines are based on information about the metal carbonyls nickel tetracarbonyl and iron pentacarbonyl. Recommendations for other metal carbonyls might be similar. However, these guidelines do not cover special features potentially related to other metal carbonyls.
 - Before approaching the patient, the paramedics and doctors at the site must make sure that they do not risk exposing themselves to metal carbonyls.
 - Patients exposed only to vapors of metal carbonyl do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid metal carbonyls or solvents containing metal carbonyls can secondarily contaminate rescue and medical personnel by direct contact or through evaporation of metal carbonyls.
 - Metal carbonyls are irritating to all tissues, in particular to the respiratory tract. Exposure may result in eye and skin irritation, coughing, chest pain, dyspnea. Laryngospasm and signs of pulmonary edema (shortness of breath, cyanosis, expectoration, cough) may occur.
 - There is no antidote to be administered to counteract the effects of metal carbonyls. Treatment consists of supportive measures.
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1. Substance information

Metal carbonyls: nickel tetracarbonyl – Ni(CO)₄, CAS 13463-39-3; iron pentacarbonyl – Fe(CO)₅, CAS 13463-40-6.

Synonyms: nickel carbonyl, tetracarbonyl nickel; iron carbonyl, pentacarbonyl iron.

At room temperature nickel tetracarbonyl and iron pentacarbonyl are colorless to yellow liquids. Metal carbonyls have a musty odor. When heated to decomposition, they emit toxic fumes of metal oxides and carbon monoxide.

Nickel tetracarbonyl is used in the refining of nickel and as a catalyst for organic synthesis. Iron pentacarbonyl has been used as an antiknock agent in gasoline.

2. Routes of exposure

Inhalation

Inhalation is the major route of metal carbonyl exposure. The odor does not provide adequate warning of hazardous metal carbonyl concentrations. Irritation of the respiratory tract, including pulmonary edema, cyanosis, headache and dizziness may occur.

Skin/eye contact

Direct contact with metal carbonyl liquids and vapor can cause irritation to skin or eyes.

Ingestion

Involuntary ingestion of metal carbonyls is unlikely but could cause irritation of the mouth, throat, esophagus, and stomach.

3. Acute health effects

Metal carbonyl exposure may cause irritation of all tissues. However, often throat and lung irritation are predominant and may lead to chest tightness, coughing, shortness of breath, blood-streaked sputum. Inflammation and severe damage of the lungs may occur. Toxic pneumonitis as well as pulmonary edema may develop and may be delayed up to 24 hours after a severe exposure. Dizziness, headache, and muscle weakness can occur after inhalation exposure.

Skin contact with metal carbonyls can cause irritation and redness and inflammation.

Eye contact may result in irritation with immediate pain, lacrimation, lid edema, inflammation of conjunctiva and cornea, clouding of the eye surface, and secondary glaucoma.

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<i>Dose-effect relationships</i>	Dose-effect relationships are as follows:
<u>Nickel tetracarbonyl concentration</u>	<u>Effect</u>
0.001 ppm	- PEL (OSHA, USA), as Ni
0.5 – 3.0 ppm	- Odor threshold, low - high
2.0 ppm	- IDLH (NIOSH, USA)
30 ppm	- estimated lethal dose in humans
<u>Iron pentacarbonyl concentration</u>	<u>Effect</u>
0.1 ppm	- TLV-TWA (ACGIH, USA)
0.2 ppm	- TLV-STEL (ACGIH, USA)

4. Actions

Rescuer self-protection

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

Patients exposed only to metal carbonyl vapors do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid metal carbonyls or solvents containing metal carbonyls can secondarily contaminate other people by direct contact or through evaporation of metal carbonyls.

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.

Decontamination

Patients exposed only to metal carbonyl vapors 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 involves liquid metal carbonyls or solvents containing metal carbonyls 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 metal carbonyls.

For routine recommendation of diethyldithiocarbamate in acute nickel carbonyl poisoning further clinical data are required.

- **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 metal carbonyls were in contact with the skin, irritation may result; treat symptomatically.

After eye exposure irritation may result; treat symptomatically and consult an ophthalmologist for check-up.

Patients with persistent respiratory symptoms, patients exposed to an airborne concentration of 0.1 ppm or greater, and patients without available exposure measurements but suspected of being exposed to a concentration of 0.1 ppm or greater should be transported to a hospital/emergency department.

All asymptomatic patients potentially exposed to an airborne metal carbonyl concentration of 0.05 ppm or more should take 8 puffs of beclomethasone from a metered dose inhaler. Thereafter, 4 puffs should be administered every 2 hours for 24 hours. These patients should be observed for at least 8 hours.

*Patient release/
follow-up instructions*

Patients exposed to an airborne concentration of less than 0.05 ppm who have 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 metal carbonyl exposure.
b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing.
c) The physician is comfortable that the patient understands the health effects of metal carbonyls and the provided follow-up instructions.
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.

Patients who have eye injuries should be reexamined in 24 hours.

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 metal carbonyls. It is not, however, a substitute for the professional judgment 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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