

---

 Information and recommendations for doctors at hospitals/emergency departments
 

---

- 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.
  - Patients exposed only to metal carbonyls vapor 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 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.
- 

**1. Substance information**

Metal carbonyls: nickel tetracarbonyl – Ni(CO)<sub>4</sub>, CAS 13463-39-3; iron pentacarbonyl – Fe(CO)<sub>5</sub>, 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 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 carbonyls 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 causes irritation of all tissues. However, often throat and lung irritation are predominant and may lead to chest tightness, coughing, shortness of breath, and 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.

Headache, dizziness, 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 pain, lacrimation, lid edema, inflammation of conjunctiva and cornea, clouding of the eye surface, and secondary glaucoma.

*Dose-effect relationships*

Dose-effect relationships are as follows:

<u>Nickel tetracarbonyl concentration</u>	<u>Effect</u>
0.001 ppm	- PEL (OSHA, USA), as nickel
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)

**Potential sequelae**

Non-specific airway hyperresponsiveness may occur and persist after cessation of exposure. Reduction in lung function and respiratory symptoms related to narrowing of the bronchi may persist.

**4. Actions***Decontamination*

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.

Patients who are able and cooperative may assist with their own decontamination. If the exposure involved 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. 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.

*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  $\beta$ 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 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 chemical burns may result; treat symptomatically. Consult an ophthalmologist for check-up. All asymptomatic patients potentially exposed to a 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 8 hours.** These patients should be observed for at least 8 hours.

*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 to an airborne concentration of 1.0 ppm or greater should be observed for a minimum of 8 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.

In case of worsening clinical signs (especially tachypnea >30/min with a simultaneous decrease of the partial pressure of carbon dioxide) CPAP-therapy (Continuous Positive Airway Pressure Ventilation) should be started within the first 24 hours after exposure.

In case of a 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 methylprednisolone (or an equivalent steroid) should be continued in intervals of 8-12 hours.

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 exposed to an airborne concentration of **less than 0.05 ppm who have no signs or symptoms of toxicity** as well as patients exposed to a concentration of **0.05 ppm or more 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 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.
- d) 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.
- 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. 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 metal carbonyls. It is not, however, a substitute for the professional judgment 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.

**BASF SE**  
Corporate Health Management  
Carl-Bosch-Straße 38  
67056 Ludwigshafen  
Germany

**BASF Corporation**  
Medical Department  
100 Campus Drive, M/S F 221  
Florham Park, NJ 07932  
USA