
Information and recommendations for paramedics and doctors at the site

- These guidelines are based on information about the diisocyanates toluene diisocyanate (TDI), diphenylmethane diisocyanate (MDI), and hexamethylene diisocyanate (HDI). Recommendations for other isocyanates might be similar. However, these guidelines do not cover special features potentially related to other isocyanates.
 - Before approaching the patient, the paramedics and doctors at the site must make sure that they do not risk exposing themselves to diisocyanates.
 - Patients exposed only to diisocyanate vapor do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid diisocyanates or solvents containing diisocyanates can secondarily contaminate rescue and medical personnel by direct contact or through evaporation of diisocyanates.
 - Diisocyanates are severely 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.
 - Asthmatic attacks may occur after exposure to very low diisocyanate concentrations.
 - There is no antidote to be administered to counteract the effects of diisocyanates. Treatment consists of supportive measures.
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1. Substance information

Diisocyanates: TDI - $\text{CH}_3\text{C}_6\text{H}_3[\text{NCO}]_2$, CAS 26471-62-5 (mixture), CAS 584-84-9 (2,4-isomer), CAS 91-08-7 (2,6-isomer);
MDI - $\text{CH}_2(\text{C}_6\text{H}_4[\text{NCO}])_2$, CAS 144490-96-0 (mixture), CAS 5873-54-1 (2,4'-isomer), CAS 101-68-8 (4,4'-isomer);
HDI - $\text{C}_6\text{H}_{12}(\text{NCO})_2$, CAS 822-06-0

Synonyms: TDI, diisocyanatotoluene, tolylene diisocyanate;
MDI, methylenediphenyl diisocyanate, methylene bis(phenylisocyanate);
HDI, hexamethylene diisocyanate, diisocyanatohexane
At room temperature, TDI and HDI are colorless to straw-colored liquids while MDI monomer is a colorless solid. Diisocyanates have a fruity, pungent odor. Diisocyanates are highly reactive even to hydroxyl and amino groups in human body cells. When heated to decomposition, they emit toxic fumes of nitrogen oxides.

The major application of diisocyanates is the manufacture of polyurethane foams, various plastic materials, and elastomers. In addition, diisocyanates are used as hardeners for paints, coatings, and adhesives.

2. Routes of exposure

Inhalation

Inhalation is the major route of diisocyanate exposure. The odor does not provide adequate warning of hazardous diisocyanate concentrations. Irritation of the respiratory tract and asthmatic attacks (constriction of the bronchi with severe dyspnea) can occur even at very low concentrations.

Skin/eye contact

Direct contact with diisocyanate liquids and vapor can cause severe irritation to skin or eyes.

Ingestion

Involuntary ingestion of diisocyanates is unlikely but could cause chemical burns of the mouth, throat, esophagus, and stomach.

3. Acute health effects

Diisocyanate exposure causes 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. Non-specific airway hyperresponsiveness may occur and persist after cessation of exposure.

Asthmatic attacks may occur after exposure to very low diisocyanate concentrations. They can be immediate, delayed up to about 8 hours, or both.

Toxic pneumonitis as well as pulmonary edema may develop and may be delayed up to 24 hours after a severe exposure.

Euphoria, ataxia, memory loss, and muscle pain can occur after inhalation exposure.

Skin contact with diisocyanates can cause irritation and redness with blister formation.

Eye contact may result in severe irritation with immediate 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>Diisocyanate concentration</u>	<u>Effect</u>
0.0001 ppm	- Asthmatic reactions in sensitized individuals possible
0.05-1.0 ppm	- Irritation of skin, eyes, upper respiratory tract with conjunctivitis, sore throat, coughing
0.4 ppm	- Odor detection
>1.0 ppm	- Severe irritative and inflammatory reactions with persistent effects possible: bronchial hyperresponsiveness, pneumonitis, pulmonary edema
>2.5 ppm	- Immediately dangerous to life

4. Actions

Rescuer self-protection

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

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

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 diisocyanate vapor 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 diisocyanates or solvents containing diisocyanates 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 diisocyanates.

The following measures are recommended if the airborne exposure concentration is 1.0 ppm or greater, if symptoms, e. g. eye irritation or pulmonary symptoms have developed, or if no exposure concentration 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 inhalation exposure has occurred, humidified air or oxygen should be provided. If signs of hypoxemia are present, humidified supplemental oxygen should be administered.

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 diisocyanates 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.

Patients with persistent respiratory symptoms, patients exposed to an airborne concentration of 1.0 ppm or greater, and patients without available exposure measurements but suspected of being

*Patient release/
follow-up instructions*

exposed to a concentration of 1.0 ppm or greater should be transported to a hospital/emergency department. All asymptomatic patients potentially exposed to an airborne isocyanate concentration of 0.1 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.

Patients exposed to an airborne concentration of less than 0.1 ppm who have no signs or symptoms of toxicity 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:

- a) The evaluating physician is experienced in the evaluation of individuals with diisocyanate 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 diisocyanates 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 diisocyanates. 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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