
Information and recommendations for paramedics and doctors at the site

- Patients whose clothing or skin is contaminated with nitrogen dioxide can cause secondary contamination of rescue and medical personnel by direct contact or through evaporation of nitrogen dioxide.
 - Nitrogen dioxide and its vapor are rapidly corrosive when they come in contact with tissues such as the eyes, skin, and upper respiratory tract causing irritation, burns, coughing, chest pain and dyspnea. Laryngospasm and pulmonary edema (shortness of breath, cyanosis, expectoration) may occur.
 - Ingestion of nitrogen dioxide can cause severe corrosive injury to the lips, mouth, throat, esophagus, and stomach.
 - There is no antidote to be administered to counteract the effects of nitrogen dioxide. Treatment consists of supportive measures.
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1. Substance information

Nitrogen dioxide (NO₂), CAS 10102-44-0

Synonyms: dinitrogen tetroxide, nitrogen peroxide, nitrogen tetroxide, and NTO.

Nitrogen dioxide is a colorless to yellow liquid at room temperature. Above 21°C (70°F) it is a gas. The concentrated gas has a dark violet to black color; when rarefied it becomes reddish-brown to yellow. Nitrogen dioxide has an irritating sharp odor at concentrations of 1-5 ppm. Upon contact with water it forms nitric acid. Nitrogen dioxide itself is nonflammable, but it can increase the flammability or cause the spontaneous combustion of other materials.

Nitrogen dioxide is formed naturally when fossil fuels like coal, oil or gas are burned and when stored grain ferments in storage silos. It is also part of airborne smog. Nitrogen dioxide is released in the reaction between nitric acid and any organic material. It is also formed whenever nitric acid acts upon metals, as in bright dipping, pickling, and etching.

2. Routes of exposure

Inhalation

Nitrogen dioxide's odor and irritant properties generally provide adequate warning of acutely hazardous concentrations.

Skin/eye contact

Direct contact with liquid nitrogen dioxide or concentrated vapor on wet or moist skin causes severe chemical burns. Nitrogen dioxide is poorly absorbed through the skin.

Ingestion

Ingestion of nitrogen dioxide can cause severe corrosive injury to the lips, mouth, throat, esophagus, and stomach.

3. Acute health effects

Respiratory

Nitrogen dioxide exposure usually causes dryness of the nose and throat, and coughing. Inhalation of very high concentrations may result in laryngospasm and eventually in obstruction of the airways and death. Development of respiratory distress with chest pain, dyspnea and pulmonary edema (shortness of breath, cyanosis, expectoration) may occur as late as 24 hours after exposure.

Hematologic

Only after high-dose exposure methemoglobinemia may result, but usually to an extent that does not require treatment. For further information on methemoglobinemia see BASF Chemical Emergency Medical Guideline for ANILINE.

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| <i>Gastrointestinal</i> | Epigastric pain, nausea, and vomiting may occur. In cases of ingestion diffuse corrosive mucosal injury can involve the entire intestinal tract. |
| <i>Renal</i> | Acid-base imbalance and acute renal failure may occur. |
| <i>Dermal</i> | Deep burns of the skin and mucous membranes may be caused by contact with concentrated nitrogen dioxide; sometimes yellowing of the skin results. Contact with less concentrated nitrogen dioxide vapor can cause burning pain, redness, and inflammation. |
| <i>Ocular</i> | Severe eye burns with clouding of the surface, perforation of the globe, and ensuing blindness may occur from exposure to liquid nitrogen dioxide. Low concentrations of vapor cause burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing. |
| <i>Dose-effect relationships</i> | Dose-effect relationships are as follows: |

| <u>Nitrogen dioxide concentration</u> | <u>Effect</u> |
|---------------------------------------|--|
| 1-5 ppm | - Odor detection (some tolerance develops) |
| 5-10 ppm | - Mild mucous membrane irritation |
| 25 ppm | - Immediate chest pain, dyspnea, coughing, bronchitis, usually full recovery |
| 50-150 ppm | - Bronchiolitis, focal pneumonitis, may cause irreversible lung lesions |
| >100 ppm | - Pulmonary edema possible |
| 1000 ppm | - Fatal within a few minutes |

4. Actions

Rescuer self-protection

In response situations that involve exposure to potentially unsafe levels of nitrogen dioxide (see below), pressure-demand, self-contained breathing apparatus and chemical-protective clothing is recommended.

Patients whose clothing or skin is contaminated with nitrogen dioxide can secondarily contaminate other people by direct contact or nitrogen dioxide vapor.

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 nitrogen dioxide 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 nitrogen dioxide and if clothing is contaminated, remove and double-bag the clothing.

Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 20 minutes, and that the pH of the conjunctival fluid has returned to normal (7.0). If not, continue eye irrigation during other basic care and transport. If eye irrigation is impaired by blepharospasm, one to two drops of oxybuprocaine 0.4% may be instilled into affected eyes to allow adequate irrigation. Remove contact lenses if present and easily removable without additional trauma to the eye.

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.

Initial treatment

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

The following measures are recommended if the airborne exposure concentration is 10 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 nitrogen dioxide was 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 nitrogen dioxide should be considered as a serious exposure.

In case of ingestion of nitrogen dioxide, **do not induce emesis, do not perform gastric lavage.**

Patients exposed to an airborne concentration of 10 ppm or greater or with ingestion of nitrogen dioxide as well as patients without available exposure measurements but suspected of being exposed to concentrations of 10 ppm or greater should be transferred to a hospital/emergency department.

*Patient release/
follow-up instructions*

Asymptomatic patients exposed to an airborne concentration of **less than 10 ppm 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 nitrogen dioxide exposures.
- b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing. Patients are advised to seek medical care promptly if symptoms develop or recur.
- c) The physician is comfortable that the patient understands the health effects of nitrogen dioxide 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.
- f) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients who have serious skin or 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 nitrogen dioxide. 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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