
Information and recommendations for doctors at hospitals/emergency departments

- **Patients exposed only to ammonia gas do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with ammonia-containing liquids can secondarily contaminate rescue and medical personnel by direct contact or through off-gassing ammonia.**
 - **Ammonia gas or solution is highly irritating and can cause serious corrosive burns to eyes or skin.**
 - **Irritation of the respiratory tract can result in rhinorrhea, coughing, and 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 ammonia. Treatment consists of supportive measures.**
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1. Substance information

Ammonia (NH₃), CAS 7664-41-7

Synonyms include ammonia gas, anhydrous ammonia and liquid ammonia. Ammonia dissolves readily in water to form a caustic alkaline solution of ammonium hydroxide.

Ammonia is lighter than air. In case of an accidental release of liquid ammonia under pressure, rapid cooling down causes formation of a dense cloud that hugs the ground.

Ammonia is widely used as a catalyst and reagent in the manufacture of fertilizers, plastics, explosives, pesticides, other chemicals, and as a refrigerant. It is found in many household and industrial-strength cleaning solutions.

2. Routes of exposure

Inhalation

Inhalation is a significant route of exposure. Ammonia's odor and irritant properties may provide adequate warning of hazardous concentrations. However, olfactory fatigue may occur, making the presence of lower concentrations difficult to detect with prolonged exposure.

Skin/eye contact

Fairly low concentrations of ammonia produce rapid irritation of the eye and moist skin. **Direct contact with liquid ammonia or concentrated gas on moist skin or eyes causes severe chemical burns.**

Ingestion

Accidental ingestion of ammonia is unlikely. Ammonia solutions may cause corrosive injury to the mouth, throat, and stomach if ingested.

3. Acute health effects

Ammonia exposure usually causes eye, nose, and throat irritation. Respiratory distress with coughing, dyspnea, upper airway obstruction, laryngeal edema, narrowing of bronchi and pulmonary edema may occur.

If the skin is wet or moist, contact with ammonia can cause burning pain, inflammation, blisters, and ulceration. Contact with liquid ammonia under pressure can result in frostbite.

Low gas concentrations cause burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing. After exposure to higher concentrations or liquid ammonia corneal burns occur and may lead to blindness.

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Dose-effect relationships

Dose-effect relationships are as follows:

<u>Ammonia concentration</u>	<u>Effect</u>
1-20 ppm	- Odor detection (some tolerance develops)
50 ppm	- Mild mucous membrane irritation
300-500 ppm	- Marked irritation of skin, eyes, upper respiratory tract with conjunctivitis, sore throat, coughing Increases of blood pressure and pulse rate Maximal concentration tolerated for up to 1 hour
700 ppm	- Immediate eye injury possible
>1700 ppm	- Chest pain, pulmonary edema, laryngospasm
2500-6500 ppm	- Fatal within 30 minutes
10000 ppm	- Fatal within a few minutes

Potential sequelae

For most exposed individuals, symptoms will resolve over several weeks or months. Survivors of severe inhalation injury, especially if chest x-ray and pulmonary function abnormalities are associated, may suffer residual chronic lung disease. In cases of eye contact, ulceration and perforation of the cornea with ensuing blindness can occur after weeks or months. Cataracts and glaucoma have also been reported.

4. Actions

Self-protection

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

Decontamination

Patients exposed only to ammonia 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 ammonia 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 ammonia.

The following measures are recommended if the exposure concentration is 500 ppm or greater and if symptoms, e. g. eye irritation or pulmonary symptoms, have developed:

- 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 ammonia has been 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. If contact of the skin with liquid ammonia under pressure has occurred, evaluate for the presence of frostbite.

After eye exposure chemical burns may result; treat as thermal burns. Immediately consult an ophthalmologist.

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

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 been exposed to a concentration of 500 ppm or greater, or who develop serious signs or symptoms, should be observed for a minimum of 24 hours and reexamined frequently.

Delayed effects are unlikely in patients who have minor upper respiratory symptoms (mild burning or a slight cough) that resolve quickly.

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.

Patient release/

Clinically asymptomatic patients exposed to a concentration of **less than 500 ppm** (depending on the period of time exposed) **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 ammonia exposure.
- 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 ammonia.
- 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 or serious skin 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 at hospitals/emergency departments in assessing the condition and managing the treatment of patients exposed to ammonia. It is not, however, a substitute for the professional judgement 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.

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