## Nitric acid

### Toxicological overview

#### Key Points

**Kinetics and metabolism**

- Nitric acid is corrosive at the site of contact and does not elicit systemic toxicity
- On contact with body tissues, nitric acid is rapidly broken down into its constituent ions and excreted in the urine

**Health effects of acute exposure**

- Exposure to nitric acid can occur through all routes
- Nitric acid is irritating and corrosive to all tissues with which it comes into contact. The severity of effects is dependent upon concentration and duration of exposure
- Acute inhalation of nitric acid vapour can lead to symptoms such as ocular and nasal irritation, sore throat, cough, chest tightness, headache, ataxia and confusion
- In severe cases, pulmonary oedema may develop hours or days following exposure
- Acute ingestion may cause burns to the oesophagus and stomach which can include ulceration, haemorrhage and perforation. Abdominal pain, difficulty swallowing, nausea, salivation, vomiting, diarrhoea and haematemesis may also occur, and in some cases may be fatal
- Dermal exposure may result in deep burns, blisters and permanent scarring
- Ocular exposure may cause corneal burns, lacrimation, conjunctivitis, photophobia and, in severe cases, could lead to permanent blindness

**Health effects of chronic exposure**

- Chronic inhalation exposure to nitric acid can cause respiratory irritation, leading to bronchitis and airways hyperreactivity and erosion of dental enamel
- Chronic ingestion is unlikely due to the adverse effect of acute ingestion
- Dermal exposure to low concentrations of nitric acid can result in dermatitis
- Nitric acid is not considered to be carcinogenic or mutagenic

---

Prepared by J C Wakefield  
CHAPD HQ, HPA  
2007  
Version 1
Toxicological Overview

Summary of Health Effects

Concentrated nitric acid is highly corrosive to all tissues with which it may come into contact and exposure can occur via all routes (ingestion, inhalation, dermal and ocular absorption).

The toxicity of nitric acid is due to its effects at the point of contact, it readily dissociates into simple ions and systemic effects are unlikely.

Inhalation exposure to nitric acid is a common occupational hazard as it readily forms a vapour at room temperature. Symptoms of an acute inhalation exposure to nitric acid include dry nose and throat, cough, chest pain, shortness of breath, headache and difficulty breathing. An acute exposure to a high dose of concentrated nitric acid can cause pulmonary oedema, which may take up to 48 hours to develop and can potentially be fatal [1, 2].

Ingestion of nitric acid can cause burns to the lips, tongue, mouth, throat and stomach. Other symptoms can include abdominal pain, nausea, vomiting and diarrhoea. In severe cases, the ingestion of a high dose of nitric acid may be fatal [1, 2].

Dermal exposure to nitric acid can result in severe burns, blisters and permanent scarring depending upon the concentration of the acid and the duration of exposure. Ocular exposure can cause severe eye burns which may lead to permanent injury and possibly blindness [1].

A long term inhalation exposure to nitric acid can lead to chronic respiratory irritation such as bronchitis and may also lead to dental erosion as the nitric acid deposits on the teeth and erodes the outer coating of enamel [1].

Repeated exposure of the skin to low concentrations of nitric acid may cause dermatitis.

Nitric acid and its solutions are not considered to be carcinogenic or mutagenic in humans or experimental animals.
**Kinetics and metabolism**

Nitric acid is a contact irritant that causes adverse effects at the site of exposure. The corrosive effects of nitric acid are due to the low pH. Aqueous solutions and vapours of nitric acid readily dissociate into hydrogen and nitrate ions.

Nitric acid does not accumulate in the body as it is rapidly broken down into its constituent ions which are excreted in the urine. Exposure to nitric acid does not give rise to systemic toxicity as it is broken down at the point of contact and therefore causes adverse effects only at the site of exposure [1].

**Sources and route of exposure**

Nitric acid exposure can occur through all routes [1, 3].

Nitric acid has a range of widespread uses in industry, but is not commonly found in household products. Exposure to nitric acid is therefore most likely to occur in an occupational setting. The most likely routes of occupational exposure are inhalation of nitric acid vapours and skin or eye contact of nitric acid solutions. In such occupations where nitric acid is used, personal protective equipment is recommended to reduce potential exposures [4].

Nitric acid is not expected to accumulate in the environment [1]. Low concentrations of nitric acid may be present in the atmosphere as it may be formed by the conversion of nitrogen dioxide, which is a common air pollutant released into the environment from many commercial and industrial processes [5].
Human Data

**General toxicity**

Nitric acid is irritating and corrosive to any tissue with which it may come into contact. The severity of its effects are dependent upon the concentration of nitric acid and the duration of exposure [1]. The UK workplace exposure limit to nitric acid is 4 ppm (10.3 mg m\(^{-3}\)) [6].

**Inhalation**

Nitric acid readily forms a vapour at room temperature and so poses a potential inhalation hazard [1, 3].

Symptoms of inhalation exposure to nitric acid vapours include irritation of the nose, with sore throat, cough, chest tightness, headache, ataxia and confusion. Following these symptoms, dyspnoea and stridor can occur due to laryngeal oedema. After a severe inhalation exposure to nitric acid, pulmonary oedema may develop hours or even days after exposure, which may possibly be fatal, with increasing shortness of breath, wheeze, chest pain and cough [1-3].

**Ingestion**

Ingestion of nitric acid can cause immediate burns to the lips, mouth and throat. Due to the immediate pain, strong nitric acid is not often swallowed. However, if nitric acid is swallowed, it can cause burns to the oesophagus and stomach which can include antral ulceration, haemorrhage and perforation. Extensive areas of the gastrointestinal tract may also be involved [2].

Nitric acid ingestion can also cause retrosternal and abdominal pain, dysphagia, nausea, hypersalivation, vomiting, diarrhoea and haematemesis [1, 2]. Additionally, ingestion of nitric acid may result in metabolic acidosis, shock, collapse, hypotension, acute renal failure and disseminated intravascular coagulation (DIC). Following ingestion of nitric acid, the larynx may also be burned causing oedema, airway obstruction and difficulty clearing bronchial secretions [2].

In some cases, ingestion of a strong solution of nitric acid can prove to be fatal [1].

**Dermal / ocular exposure**

Nitric acid causes superficial coagulation burns (which may be self limiting) and destruction of the surface epithelium [2]. Other effects of dermal exposure to nitric acid may be blisters, ulcers and permanent scarring, dependent upon the concentration of the acid and the duration of exposure. Concentrated solutions of nitric acid cause burns to the skin, whereas dilute solutions can cause discouloration, mild irritation and hyperkeratosis [1, 7].

Eye contact with solutions of nitric acid may cause corneal burns. Symptoms of ocular exposure to nitric acid can also include pain, blepharospasm, lacrimation, conjunctivitis,
palpebral oedema, photophobia and in severe cases could lead to permanent blindness [1, 2].

**Delayed effects following an acute exposure**

Pulmonary oedema may develop 24 to 48 hours after an inhalation exposure to nitric acid, which can potentially be life threatening, with increasing breathlessness, wheeze, chest pain, cough, hypoxia and cyanosis [1, 2].
Health Effects of Chronic / Repeated Exposure

**Human Data**

**General toxicity**

Long term exposure to nitric acid can cause skin and respiratory irritation which may develop into chronic bronchitis. Repeated exposure to vapours, mists or aerosols of nitric acid has been shown to cause dental erosion [1, 7].

**Inhalation**

Long term inhalation exposures to nitric acid can cause chronic respiratory irritation, which may result in chronic bronchitis and airways hyperreactivity [1].

Repeated exposure to nitric acid vapours, mists or aerosols may cause dental erosion. As nitric acid is inhaled, it may be deposited on teeth and cause decalcification resulting in erosion of tooth enamel [1, 2].

**Dermal exposure**

Repeated dermal exposures to low concentrations of nitric acid in solution, vapour or mist can result in dermatitis, characterised by erythema, itching and a dry scaly appearance [1].

**Ingestion**

There is little human data on the effects of chronic or repeated ingestion of nitric acid, as chronic exposure by ingestion is unlikely due to the adverse acute effects.

**Genotoxicity**

There is no relevant human or animal information available regarding the genotoxicity of nitric acid. However, nitric acid dissociates into hydrogen and nitrate ions which can be predicted to be without mutagenic potential. It can therefore be assumed that nitric acid does not have any significant mutagenic potential.

**Carcinogenicity**

There are no relevant human or animal studies to assess the carcinogenicity of nitric acid. However, the toxicity of nitric acid is limited to its irritant and corrosive effects at the point of contact and it does not cause systemic toxicity. Provided that chronic irritant effects are avoided, it would not be expected to have any carcinogenic potential. The International Agency for Research on Cancer (IARC) has not evaluated the carcinogenicity of nitric acid [1].

**Reproductive and developmental toxicity**

There is no human or animal data available on the reproductive and developmental toxicity of nitric acid. However, nitric acid is not expected to cause reproductive or developmental toxicity, as it is a contact irritant and exposure results in adverse effects only at the point of contact and not systemically [1].
References


This document from the HPA Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced in this document.