



Ammonia Fact Sheet for Clinicians

Introduction:

This fact sheet provides clinicians with basic information about the health impacts from exposure to ammonia gas resulting from the ammonia release incident that occurred in Beach Park, IL on April 25, 2019. Within this document, the initial treatment for acute ammonia exposure and potential long-term health effects are described. During the initial phase of the response to the incident, 36 individuals (residents, motorists, and first responders) were transported via EMS to emergency departments at several area hospitals. Of those, seven individuals required mechanical ventilation to treat their respiratory failure secondary to ammonia exposure. Within 48 hrs, a total of 83 individuals (including 9 children) presented to area hospitals for evaluation and treatment.

What is Ammonia?

Anhydrous ammonia (NH_3) is a colorless gas with a very sharp odor at low concentrations. A majority (80%) of all manufactured ammonia is used as agricultural fertilizer, a third of which is directly applied to soil as anhydrous ammonia.

How were people exposed?

The anhydrous ammonia was released into the air at Beach Park from 4:30 a.m.-10 a.m. Some nearby residents were exposed by breathing contaminated air when they went outside, before a shelter-in-place alert was issued. Others were exposed to the ammonia gas as they were driving on Green Bay Road. No air measurements of ammonia were taken near the mobile fertilizer tanks leaking during the incident. However, computer modeling of currently available data suggests that the ammonia concentration within 100 yards during the first hour of the release could have exceeded several hundred parts per million (ppm). Individuals who were acutely symptomatic and first responders who were exposed were taken to nearby hospitals. Others sought medical care either out of concern or as a precaution.

Toxicokinetics:

The extent of injury produced by exposure to ammonia depends on the duration of the exposure, the concentration of the gas, and the depth and rate of inhalation. Ammonia reacts immediately with mucous membranes in the skin, eyes, oral cavity, and respiratory tract to form caustic ammonium hydroxide. Most of the inhaled ammonia reacts with the upper respiratory system, causing immediate irritation. However, the primary concern of exposure to ammonia gas are the severe effects that can occur with inhalation into the lower respiratory system.

Ammonia odor usually serve as a deterrent to avoid exposure, but the conditions of the ammonia plume with this incident made it difficult for the victims to escape exposure.

How long can it stay in the body after being inhaled?

Most of the inhaled ammonia is exhaled. In a healthy human body, exogenous ammonia is absorbed into the circulation, quickly broken down, and eventually transformed to urea and excreted through urine and/or feces. Therefore, exposure to even high levels of ammonia can be efficiently metabolized and excreted from the circulation without causing harmful systemic effects.

Health Effects from Exposure:

Figure 1 presents a severity of health effects summary that is associated with inhalation of ammonia gas at various concentrations and exposure durations. Current information about the rate of ammonia release from these tanks is too limited to determine the concentration of ammonia that people inhaled during the incident. However, initial computer modeling, discussed above, indicates that the concentration of ammonia was likely to be several hundred ppm. This estimated concentration is consistent with health effects listed in Figure 1 below and the health complaints that residents and first responders reported.

Inhalation: Inhalation of high concentrations of ammonia may cause nasopharyngeal and tracheal burns, bronchiolar and alveolar edema, and airway destruction resulting in respiratory distress or respiratory failure. Lower ammonia concentrations can lead to coughing, and irritation of the nose and throat. Long-term effects from acute inhalation injury may lead to chronic lung disease.

Children's increased risks of inhalation effects: Children are likely to experience the same immediate effects as adults when exposed to high ammonia concentrations. However, children are more sensitive to inhalation exposure than adults when exposed at the same ammonia concentration. The higher sensitivity is because children have a higher respiratory rate and greater lung surface per pound of body weight than adults. These physiological differences result in children receiving larger inhalation doses.

Skin or eye contact: Exposure to high concentrations of ammonia may lead to severe eye injuries and burns. Eye injury can be ongoing and may take up to seven days to reach its full extent. Some patients also experienced cutaneous burns, blisters, or lesions as the skin is particularly sensitive to airborne ammonia or ammonia dissolved in water. Long-term effects of eye injury from ammonia could result in ulceration and perforation of the cornea, with possible blindness weeks or months after exposure. Cataracts and glaucoma have also been reported in persons acutely exposed to ammonia.

Reproductive and developmental: Currently there is no evidence that exposure to environmental ammonia can lead to birth defects or developmental delays. It is unlikely that ammonia is transferred from the pregnant mother to the developing fetus through the placenta, or from a nursing mother. It is likely that if the mother did not experience symptoms within 24 hours there is little risk to the fetus.

Cancer effects: There is no evidence that ammonia causes cancer.

How was the ammonia exposure initially treated?

Exposed individuals were given supportive treatment with diphenhydramine, prednisone, methylprednisolone, and albuterol in the emergency room of nearby hospitals. Some patients were intubated due to swelling of the mouth and throat.

Given the environmental conditions at the time, there is evidence that ammonia gas may have condensed onto skin and clothing of the patients and first responders. Surface contamination may have prolonged exposure for the patients. There were also reports of healthcare workers becoming ill during the treatment of patients who were not decontaminated.

How to follow up with patients exposed?

Patients who were acutely symptomatic are at risk for chronic symptoms. Health effects noted in case reports include persistent dyspnea, cough, wheezing, recurrent bronchospasms, bronchial infections, and expiratory obstruction. Therefore, conducting pulmonary function testing annually is appropriate for these individuals. Asymptomatic patients or those who were treated for mild symptoms are advised to seek medical care if their symptoms are persistent. People who smoke cigarettes are advised to quit. Resources to help patients quit smoking can be found on the CDC Office of Smoking and Health website:

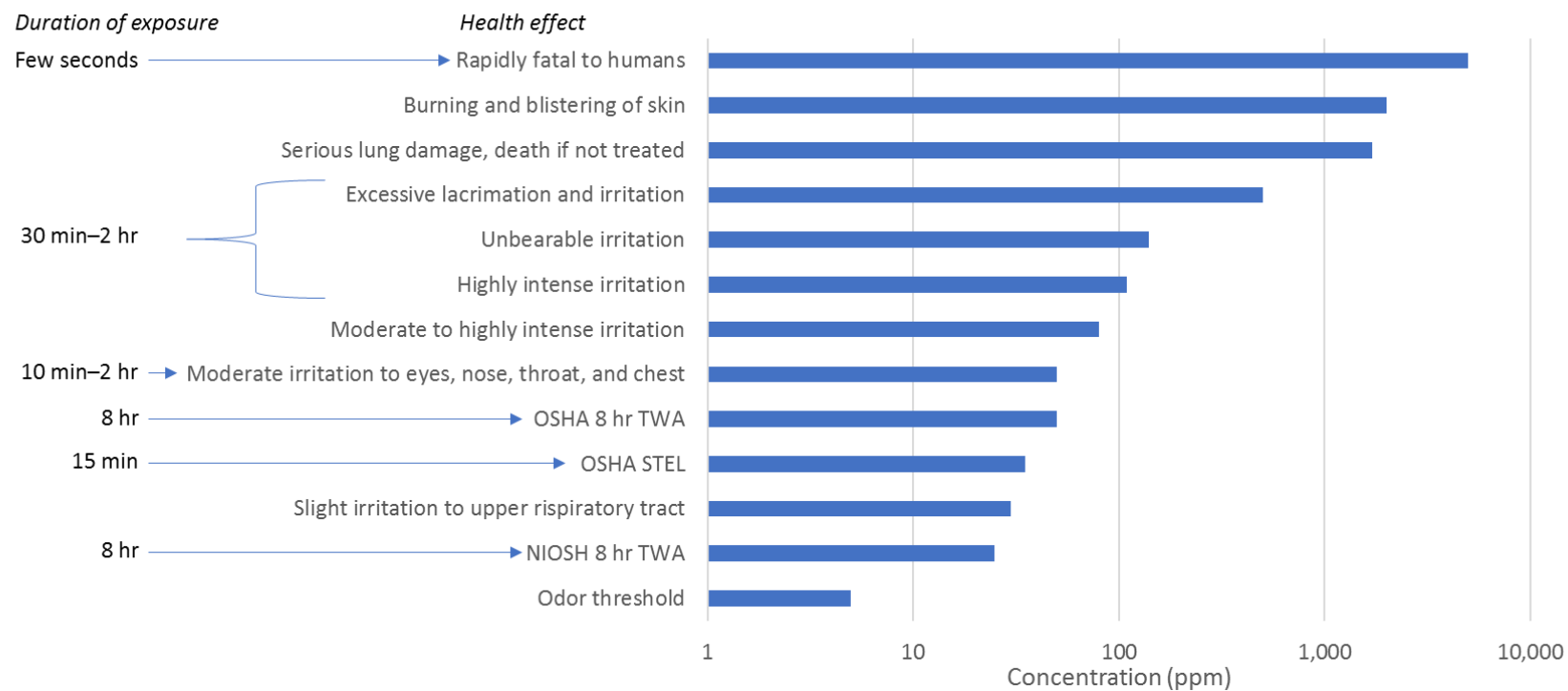
https://www.cdc.gov/tobacco/quit_smoking/how_to_quit/resources/index.htm

How can I get more information about ammonia exposure or the Beach Park incident?

Call the following numbers, or visit the websites listed under "Resources."

- Occupational Health Services Institute at the University of Illinois at Chicago Health and Hospitals System (312-996-7420)
<https://hospital.uillinois.edu/primary-and-specialty-care/occupational-environmental-medicine/services>
- Great Lakes Center for Children's Environmental Health at the University of Illinois at Chicago (866-967-7337; ChildrensEnviro@uic.edu)
<http://publichealth.uic.edu/great-lakes/childrens-health>
- Lake County Health Department (Dr. Sana Ahmed; SAhmed@lakecountyil.gov; 847-377-8130)
<https://www.lakecountyil.gov/4178/Beach-Park-Ammonia-Spill>
- Regional Poison Control Center (1-800-222-1222)
- Centers for Disease Control and Prevention Public Response Hotline (1-800-CDC-INFO)

Figure 1: Severity of health effects after exposure to anhydrous ammonia and duration of exposure resulting in effect*



Abbreviations: ppm = parts per million; NIOSH = National Institute for Occupational Safety and Health; TWA = Time-Weighted Average Concentration; OSHA = Occupational Safety and Health Administration; STEL = Short-Term Exposure Limit (15 min)

* Reference for health effects: ATSDR Medical Management Guidelines for Ammonia (<https://www.atsdr.cdc.gov/MHMI/mmg126.pdf>) and ATSDR Toxicological Profile for Ammonia (<https://www.atsdr.cdc.gov/toxprofiles/tp126.pdf>)

Resources

- 1) ATSDR 2004a. Agency for Toxic Substances and Disease Registry. **Toxicological Profile for Ammonia**. Division of Toxicology, U.S. Department of Health and Human Services. Public Health Service: Atlanta, GA.
<https://www.atsdr.cdc.gov/toxprofiles/tp126.pdf>
- 2) ATSDR 2004b. Agency for Toxic Substances and Disease Registry. **ToxGuide for Ammonia**. Division of Toxicology, U.S. Department of Health and Human Services. Public Health Service: Atlanta, GA. <https://www.atsdr.cdc.gov/toxguides/toxguide-126.pdf>
- 3) ATSDR 2004c. Agency for Toxic Substances and Disease Registry. **ToxFAQs for Ammonia**. Division of Toxicology, U.S. Department of Health and Human Services. Public Health Service: Atlanta, GA.
<https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=2>
- 4) ATSDR 2004d. Agency for Toxic Substances and Disease Registry
- 5) **Medical Management Guidelines (MMGs) for Ammonia**. Division of Toxicology, U.S. Department of Health and Human Services. Public Health Service: Atlanta, GA. <https://www.atsdr.cdc.gov/MHMI/mmg126.pdf>
- 6) Centers for Disease Control and Prevention. 2003. **Public Health Emergency Preparedness and Response Sheets**. U.S. Department of Health and Human Services. Public Health Service: Atlanta, GA.
https://www.cdc.gov/niosh/ershdb/EmergencyResponseCard_29750013.html
- 7) Centers for Disease Control and Prevention. Office of Smoking and Health.
https://www.cdc.gov/tobacco/quit_smoking/how_to_quit/resources/index.htm

The Ammonia Fact Sheet for Clinicians was developed in collaboration with the Lake County Health Department.