Possible Phenol Exposure in a Child

In April 2018, the Environmental Epidemiology Program (EEP), Utah Department of Health (UDOH), received a request for technical assistance from an individual concerned that their 3-year-old daughter might have been exposed to phenol. The child experienced vomiting, fatigue, diarrhea, and weakness, and was taken to the emergency room. Phenol was identified in her urine at 69.4 milligrams per liter (mg/L) (corrected to a specific gravity of 1.024). The test was done approximately 24 hours after the suspected exposure. The daughter's urine was retested two weeks later, and phenol had decreased to 1.2 mg/L. The parent requested that the EEP provide information on the adverse health effects of phenol exposure, particularly those that are correlated to child's urine levels.

Phenol is a colorless to white, slightly acidic solid when pure, but it is usually sold or used in solution. It occurs naturally in animal waste and from the decomposition of organic wastes. However, most of it is produced synthetically to make plastics and phenolic resins used in construction, automotive, appliance, and plywood industries. Phenol is used as a slimicide (a chemical that kills bacteria and fungi in slimes) as well as a disinfectant for toilets, floors, and drains, and in medicinal preparations such as mouthwash and sore throat lozenges. In addition, it is a component of tobacco smoke and herbicides (ATSDR, 2008).

Phenol is rapidly absorbed by inhalation, skin contact, and ingestion. Severe toxicity and death can result from effects on the central nervous system, lung, liver, kidneys, and heart. When ingested, it can cause local lesions, nausea, diarrhea, and sweating. Lethargy and vomiting are common signs of toxicity in children who ingest phenol products (ATSDR, 2008). Low concentrations of phenol have been detected in certain foods such as fried chicken, smoked summer sausage, some fish species, mountain cheese, and tap water. However, this does not represent a major source of exposure for most people. Plants can easily break down phenol, so exposure through eating food derived from plants grown in phenol-containing soil is typically minimal (ATSDR, 2008). Accidental and intentional ingestion of phenol have caused death in infants (50 – 500 mg) and adults (100 – 3200 mg). Breathing air containing phenol can cause irritation and swelling of the respiratory tract. Acute toxic effects of phenol occur often by skin contact, which causes irritation. Exposure produces white patches on the skin that later turn red and then brown. (Toxnet, 2003; Todorović, 2003). The ability of phenol to cause cancer cannot be determined due to a lack of data (IARC, 1999).

Phenol is a normally found at low levels in human urine; however, a high concentration may suggest exposure to phenol within the previous one or two days. The average concentration of phenol in urine in unexposed individuals is about 10 mg/L, and usually does not exceed 20 mg/L (ATSDR, 2008). Once in the body, most phenol is transformed into other chemicals that leave the body in the urine within a few days. Phenol is almost completely excreted in urine (90 – 99%) within 24 hours after exposure. Unfortunately, the concentration of phenol in urine cannot

predict future adverse health effects caused by exposure, regardless of the extent of exposure (ATSDR, 2008).

Deaths have been reported after exposure to high concentrations of phenol. A 10-year-old boy died after being hospitalized with serious burns, and treated dermally with a 2% phenol antiseptic solution for almost three days. His urine showed a phenol concentration of 200 mg/L. Another fatal case describes ingestion of phenol and cresol resulting in a urine phenol concentration of 115 mg/L (ATSDR, 2008). A non-fatal incident reports a young woman spilling solid phenol on 40% of her body surface. Five minutes after the exposure, she lost consciousness and was comatose 15 minutes later. The highest phenol concentration in urine (600 mg/L) occurred two days after the accident. After a couple of weeks, urinary phenol concentrations were 100 – 150 mg/L (NAS, 2009).

In addition to exposure to phenol itself, a high concentration of phenol in the urine could be due to recent exposure to other substances that are transformed into phenol in the body. Phenol is one derivative of benzene metabolism, and urine phenol tests have been traditionally used to estimate benzene exposure. Studies have shown that phenol concentration in urine is proportional to benzene concentration in the air. About 13% of benzene absorbed through the lungs is converted to phenol and excreted into the urine (Inoue et al., 1986). Benzene is made mostly from petroleum and is used to make Styrofoam, plastic resins, nylon, and synthetic fibers, as well as rubbers, dyes, and pesticides. A common source of low level benzene exposure is tobacco smoke. Benzene is a component in most formulations of gasoline and is present in the exhaust from motor vehicles, vapors associated with automobile service stations, and industrial emissions. Acute exposure may cause headache, dizziness, confusion, loss of consciousness, and skin irritation. Chronic exposure can cause anemia and leukemia (ATSDR, 2007).

The federal government has made recommendations to protect human health. The U.S. Environmental Protection Agency (EPA) has an advisory for phenol in drinking water of 4 parts per million (ppm). The Occupational Safety and Health Administration (OSHA) has a limit of 5 ppm in air during an 8-hour work shift, and the National Institute for Occupational Safety and Health (NIOSH) has set a recommendation of 5 ppm in air over a 10-hour work shift (ATSDR, 2008). OSHA has a standard regulation for benzene exposure as well. Employees shall have a urinary phenol test performed in case of a benzene exposure emergency. If the result of the urine test is equal or greater than 75 mg/L of phenol, the employer should provide the employee with a complete blood count every month for three months after exposure (OSHA, 2012). However, as mentioned above, this urine concentration cannot be related to specific adverse health effects. In addition, occupational limits are intended for healthy adults and are typically not appropriate for sensitive populations such as children.

The EEP recommends caution with products containing phenol. Medications and household products should be stored out of reach of young children to avoid excessive exposure. Contact your health care provider or the Utah Poison Control Center with immediate concerns about

possible exposures. Additional resources regarding phenol, its exposure, and related health effects are below.

- ToxFAQs or phenol at www.atsdr.cdc.gov/toxfaqs/tf.asp?id=147&tid=27. A fact sheet prepared by the Agency for Toxic Substances and Disease Registry (ATSDR) that summarizes the health effects of phenol exposure.
- Pediatric Environmental Health Specialty Units at www.pehsu.net. A system of specialists that provide information and advice on environmental conditions that could affect children's health.
- The Rocky Mountain Center for Occupational and Environmental Health at medicine.utah.edu/rmcoeh. A comprehensive occupational and environmental safety and health program serving the intermountain west.
- The Occupational and Environmental Health and Safety division at the University of Utah at oehs.utah.edu. A division that provides guidance and support on occupational and environmental health and safety issues.
- ToxGuide for phenol www.atsdr.cdc.gov/toxguides/toxguide-115.pdf. A quick reference guide for health professionals that summarizes sources and routes of exposure, health effects, chemical information, and environmental levels.

Report prepared by:
Evelyn G. Reátegui Zirena, Ph.D.
Toxicologist
Environmental Epidemiology Program
Bureau of Epidemiology
Utah Department of Health

References

ATSDR, 2007. Public Health Statement Benzene. CAS#: 71-43-2. Available online at www.atsdr.cdc.gov/ToxProfiles/tp3-c1-b.pdf

ATSDR, 2008. Toxicological Profile for Phenol. Available online at www.atsdr.cdc.gov/toxprofiles/tp115.pdf

IARC, 1999. Monograph on Phenol. International Agency for Research on Cancer. Volume 71. Available online at monographs.iarc.fr/ENG/Monographs/vol71/mono71-33.pdf

Inoue et al., 1986. Quantitative relation of urinary phenol levels to breathzone benzene concentrations: a factory survey. British Journal of Industrial Medicine 43, 692-697.

NAS, 2009. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 7. National Academies of Science. Available online at www.epa.gov/sites/production/files/2014-11/documents/phenol_final_volume7_2009.pdf

OSHA, 2012. Occupational Safety and Health Standards, Benzene. 1910.1028. Available online at www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10042

Toxnet, 2003. Phenol. Toxicology Data Network. Available online at toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+113

Todorović, 2003. Acute phenol poisoning. Medicinski Pregled 56, 37-41.