

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about phenol and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Phenol has been found in at least 481 of the 1,467 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance.

As more sites are evaluated, the sites with phenol may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to phenol, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it.

You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS PHENOL?

Phenol is a colorless-to-white solid when pure; however, the commercial product, which contains some water, is a liquid. Phenol has a distinct odor that is sickeningly sweet and tarry. Most people begin to smell phenol in air at about 40 parts of phenol per billion parts of air (ppb), and begin to smell phenol in water at about 1-8 parts of phenol per million parts of water (ppm; 1 ppm is 1,000 times more than 1 ppb). These levels are lower than the levels at which adverse health effects have been observed in animals that breathed air containing phenol, or that drank

1. PUBLIC HEALTH STATEMENT

water containing phenol. Phenol evaporates more slowly than water, and a moderate amount can form a solution with water. Phenol can catch on fire.

Phenol is both a man-made chemical and produced naturally. It is found in nature in some foods and in human and animal wastes and decomposing organic material. The largest single use of phenol is as an intermediate in the production of phenolic resins. However, it is also used in the production of caprolactam (which is used in the manufacture of nylon 6 and other synthetic fibers) and bisphenol A (which is used in the manufacture of epoxy and other resins). Phenol is also used as a slimicide (a chemical toxic to bacteria and fungi characteristic of aqueous slimes), as a disinfectant, and in medicinal preparations such as over-the-counter treatments for sore throats. Phenol ranks in the top 50 in production volumes for chemicals produced in the United States. Chapters 3 and 4 contain more information.

1.2 WHAT HAPPENS TO PHENOL WHEN IT ENTERS THE ENVIRONMENT?

Following small, single releases, phenol is rapidly removed from the air; generally, half is removed in less than 1 day. It is also relatively short-lived in the soil (generally, complete removal in 2-5 days). However, it can remain in water week or more. Phenol can remain in the air, soil, and water for much longer periods of time if a large amount of it is released at one time, or if it is constantly released to the environment. Levels of phenol above those found naturally in the environment are usually found in surface waters and surrounding air contaminated by phenol released from industrial activity and from the commercial use of products containing phenol. Phenol has been detected, however, in the materials released from landfills and hazardous waste sites, and it has been found in the groundwater near these sites. The levels of phenol found in indoor environments as a part of environmental tobacco smoke (ETS) are usually below 100 ppb, although much higher levels have been reported. One ppb or less of phenol has been found in relatively unpolluted surface water and groundwater, and low levels are also found in indoor environments and are principally derived from ETS. Only low levels of phenol are found in the organisms that live in water which also contains low levels of phenol. Chapters 4 and 5 contain more information.

1. PUBLIC HEALTH STATEMENT

1.3 HOW MIGHT I BE EXPOSED TO PHENOL?

Since phenol is used in many manufacturing processes and in many products, as well as being naturally produced, exposure may take place where you work or at home. Phenol is present in a number of consumer products which are swallowed, rubbed on, or added to various parts of the body. These include ointments, ear and nose drops, cold sore lotions, mouthwashes, gargles, toothache drops, analgesic rubs, throat lozenges, and antiseptic lotions. Phenol has been found in drinking water, tobacco smoke, air, and certain foods, including smoked summer sausage, fried chicken, mountain cheese, and some species of fish. It is also found in urine of children and adults.

The magnitude, frequency, and likelihood of exposure, and the relative contribution of each exposure route and source to total phenol exposure cannot be estimated using information currently available. Nonetheless, for persons not exposed to phenol in the workplace, possible routes of exposure include: breathing industrially contaminated air; inhaling cigarette, cigar, or pipe smoke, or ETS polluted air; drinking water from contaminated surface water or groundwater supplies; swallowing products containing phenol; changing diapers; and coming into contact with contaminated water and products containing phenol through bathing or skin application.

Populations residing near phenol spills, waste disposal sites, or landfill sites may be at risk for higher exposure to phenol than other populations. If phenol is present at a waste site near homes that have wells as a source of water, it is possible that the well water could be contaminated. If phenol is spilled at a waste site, it is possible for a person, such as a child playing in dirt containing phenol, to have skin contact or to swallow soil or water contaminated with phenol. Skin contact with phenol or swallowing products containing phenol may lead to increased exposure. This type of exposure is expected to occur infrequently and generally occurs over a short time period.

At the workplace, exposure to phenol can occur from breathing contaminated air. However, skin contact with phenol during its manufacture and use is considered the major route of exposure in the workplace. It has been estimated that about 584,000 people in the United States are exposed

1. PUBLIC HEALTH STATEMENT

to phenol at work. Total exposure at the workplace is potentially higher than in non-workplace settings. Chapter 5 contains more information on sources of exposure.

1.4 HOW CAN PHENOL ENTER AND LEAVE MY BODY?

Phenol can enter the body when a person drinks contaminated water or other liquids such as tea and coffee, eats contaminated food, or swallows products containing phenol. Phenol spilled on the skin easily penetrates the skin and enters the body. Phenol also enters the body through the lungs when a person breathes in air or inhales smoke from tobacco which contains phenol.

The amount of phenol that enters the body from skin contact with water containing phenol depends on the concentration of phenol in the water, the length of time of skin contact, and the amount of skin that makes contact with the contaminated water. Greater amounts of phenol will enter the body if large areas of skin come into contact with weaker solutions of phenol than if small areas of skin come into contact with the solutions of phenol. If a person is exposed to air containing phenol, phenol can enter the body through the skin and lungs. It has been determined that entry through the skin can account for as much as one-half of the phenol that enters the body when a person is exposed to phenol in air. Although it is possible for a person to be exposed to air contaminated with phenol at a waste site, such an exposure is not likely because spilled phenol will mostly remain in soil or water rather than evaporate into air. If a person swallows phenol, the intestines will change much of it to a less harmful substance. If phenol enters through the skin, it may reach organs and cause adverse effects before it is changed into a less harmful substance.

Studies in humans and animals indicate that most of the phenol that enters the body through skin contact, breathing contaminated air, eating food or drinking water, or using products containing phenol, leaves the body in the urine within 24 hours. Chapter 2 contains additional information about how phenol enters and leaves the body.

1. PUBLIC HEALTH STATEMENT

It is also clear that phenol is produced by the body and excreted independent of external exposure to the compound. The normal range of phenol in the urine of unexposed individuals is 0.5-80 milligrams of phenol per liter of urine (mg/L).

1.5 HOW CAN PHENOL AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

A number of effects from breathing phenol in air have been reported in humans. Short-term effects reported include respiratory irritation, headaches, and burning eyes. Chronic effects of high exposures included weakness, muscle pain, anorexia, weight loss, and fatigue; effects of chronic low-level exposures included increases in respiratory cancer, heart disease, and effects on the immune system. Virtually all of the workplace exposures associated with these effects involved exposures to other chemicals, thus it is difficult to determine whether these are solely due to phenol, or are the result of mixed, multiple, or other chemical exposures.

In animals, exposure to high concentrations of phenol in air for a few minutes irritates the lungs, and repeated exposure for several days produces muscle tremors and loss of coordination. Exposure to high concentrations of phenol for several weeks results in paralysis and severe injury to the heart, kidneys, liver, and lungs, followed by death in some cases. When exposures involve

1. PUBLIC HEALTH STATEMENT

the skin surface, the size of the total surface area of exposed skin can influence the severity of the toxic effects.

The seriousness of the effect of a harmful substance can be expected to increase as both the level and duration of exposure increase. Repeated exposure to low levels of phenol in drinking water has been associated with diarrhea and mouth sores in humans. Ingestion of very high concentrations of phenol has resulted in death. In animals, drinking water with extremely high concentrations of phenol has caused muscle tremors and loss of coordination.

Effects reported in humans following dermal exposure to phenol include liver damage, diarrhea, dark urine, and red blood cell destruction. Skin exposure to a relatively small amount of concentrated phenol has resulted in the death of humans. Small amounts of phenol applied to the skin of animals for brief periods can produce blisters and burns on the exposed surface, and spilling dilute phenol solutions on large portions of the body (greater than 25% of the body surface) can result in death.

It is not known if phenol causes cancer in humans. However, cancer has been shown to occur in mice when phenol was applied to the skin several times each week during the whole lifetime of the animal. When it is applied in combination with certain cancer-causing chemicals, a higher rate of cancer occurs than when the carcinogens are applied alone. Phenol did not cause cancer in mice or rats when they drank water containing phenol for 2 years. The International Agency for Research on Cancer (IARC) considers phenol not classifiable as to its carcinogenicity in humans.

Phenol can have beneficial effects when used for medical reasons. It is an antiseptic (kills germs) when applied to the skin in small amounts and may have antiseptic properties when gargled as a mouthwash. It is an anesthetic (relieves pain) and is a component of certain sore-throat lozenges and throat sprays or gargles. Small amounts of phenol in water have been injected into nerve tissue to lessen pain associated with certain nerve disorders. Phenol destroys the outer layers of skin if allowed to remain in contact with skin, and small amounts of concentrated solutions of

1. PUBLIC HEALTH STATEMENT

phenol are sometimes applied to the skin to remove warts and to treat other skin blemishes and disorders.

Chapter 2 contains a more thorough discussion of the health effects of phenol.

1.6 HOW CAN PHENOL AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

The exposure of children to phenol is likely to occur by most of the same routes experienced by adults, the major exception being that children are unlikely to be exposed due to their parents' occupations. There is clear evidence, however, that at least with certain products, children are at greater risk of accidental ingestion than adults. In the case of one product, a disinfectant containing 26% phenol, children under the age of 5 represented 60 of 80 (75%) of the poisoning cases associated with this product reported to a major poison control center between 1987-1991.

In humans, the effects of exposure to phenol on reproduction and the developing fetus are unknown. Several studies have not shown phenol to be active in developmental toxicity. However, in others, pregnant animals that drank water containing high concentrations of phenol gave birth to offspring with low birth weights and minor birth defects. The implications of these findings for humans is unclear, although it seems likely that any adverse developmental effects would require much higher doses than would normally be encountered at hazardous waste sites.

It is unknown whether infants or children are more susceptible than adults to the adverse effects of phenol; as stated above, developmental studies are inconclusive. Most of the information available on the toxic effects of phenol in infants and children comes from the use of phenol in medical treatments. Phenol was once used as an antiseptic in wound dressing products and there are several reports of deaths in children and infants following overzealous application of such

1. PUBLIC HEALTH STATEMENT

products to burns or open wounds. All of these cases occurred decades ago, however, and there is little indication that such products, which contained relatively high levels of phenol, are still in use.

Other phenol-containing products are used as “chemical peels” to remove skin lesions, and in the treatment of chronic pain or spasticity. These uses have occasionally been associated with adverse outcomes, like cardiac arrhythmias, that have been seen in both adults and children. These effects do not appear to occur more frequently in children than adults; however, the information on such effects in children is very limited.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO PHENOL?

If your doctor finds that you have been exposed to significant amounts of phenol, ask if children may also be exposed. When necessary your doctor may need to ask your State Department of Public Health to investigate.

Since ETS contains phenol, reducing the amount of smoking indoors will reduce phenol exposures. Household products and over-the-counter medications containing phenol should be stored out of reach of young children to prevent accidental poisonings and skin burns. Always store household chemicals in their original labeled containers. Never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center’s number next to the phone.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO PHENOL?

Urine can be tested for the presence of phenol. This test can be used to determine if the urine has a higher than normal concentration of phenol, thus suggesting recent exposure to phenol or to substances that are converted to phenol in the body (e.g., benzene). There is no test available that will tell if a person has been exposed only to phenol since many substances are converted to phenol in the body. Because most of the phenol that enters the body is excreted in the urine

1. PUBLIC HEALTH STATEMENT

within 24 hours, this test can only detect exposures that have occurred within 1 or 2 days prior to the test. The test results cannot be used to predict what health effects might result from exposure to phenol. Measurement of phenol in urine requires special laboratory equipment and techniques that are not routinely available in most hospitals or clinics. Chapters 2 and 6 contain more information on tests for exposure to phenol.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for phenol include the following:

OSHA has set a limit of 5 ppm in air to protect workers during 8-hour workshifts of a 40-hour workweek. NIOSH recommends that the concentration in workroom air be limited to 5 ppm over

1. PUBLIC HEALTH STATEMENT

a 10-hour work shift, and that the workroom air concentration should not exceed 16 ppm during a 15-minute period. Note that these workplace air limits assume no skin contact with phenol.

Phenol is listed on the Food and Drug Administration's EAFUS (Everything Added to Foods in the United States) List (FDA 1998a), and is approved as a component of food packaging materials (FDA 1998b, 1998c, 1998d).

The EPA lifetime health advisory for phenol in water is 4 mg/L. EPA has determined that the level of phenol in ambient water (lakes, streams) should be limited to 3.5 mg/L in order to protect human health from the potential toxic effects of exposure to phenol through ingestion of water and contaminated aquatic organisms.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-800-447-1544

Fax: (404) 639-6359

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

1. PUBLIC HEALTH STATEMENT

*To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 487-4650

