

Formaldehyde and Cancer Risk

Key Points

- Formaldehyde is a colorless, flammable, strong-smelling chemical that is used in building materials and to produce many household products (see Question 1).
- Formaldehyde sources in the home include pressed-wood products, cigarette smoke, and fuel-burning appliances (see Question 2).
- When exposed to formaldehyde, some individuals may experience various short-term effects (see Question 3).
- Formaldehyde has been classified as a known human carcinogen (cancer-causing substance) by the International Agency for Research on Cancer and as a probable human carcinogen by the U.S. Environmental Protection Agency (see Question 4).
- Research studies of workers exposed to formaldehyde have suggested an association between formaldehyde exposure and several cancers, including nasopharyngeal cancer and leukemia (see Question 5).

1. What is formaldehyde?

Formaldehyde is a colorless, flammable, strong-smelling chemical that is used in building materials and to produce many household products. It is used in pressed-wood products, such as particleboard, plywood, and fiberboard; glues and adhesives; permanent-press fabrics; paper product coatings; and certain insulation materials. In addition, formaldehyde is commonly used as an industrial fungicide, germicide, and disinfectant, and as a preservative in mortuaries and medical laboratories. Formaldehyde also occurs naturally in the environment. It is produced in small amounts by most living organisms as part of normal metabolic processes.

2. How is the general population exposed to formaldehyde?

According to a 1997 report by the U.S. Consumer Product Safety Commission, formaldehyde is normally present in both indoor and outdoor air at low levels, usually less than 0.03 parts of formaldehyde per million parts of air (ppm). Materials containing formaldehyde can release formaldehyde gas or vapor into the air. One source of formaldehyde exposure in the air is automobile tailpipe emissions.

During the 1970s, urea-formaldehyde foam insulation (UFFI) was used in many homes. However, few homes are now insulated with UFFI. Homes in which UFFI was installed many years ago are not likely to have high formaldehyde levels now. Pressed-wood products containing formaldehyde resins are often a significant source of formaldehyde in homes. Other potential indoor sources of formaldehyde include cigarette smoke and the use of unvented fuel-burning appliances, such as gas stoves, wood-burning stoves, and kerosene heaters.

Industrial workers who produce formaldehyde or formaldehyde-containing products, laboratory technicians, certain health care professionals, and mortuary employees may be exposed to higher levels of formaldehyde than the general public. Exposure occurs primarily by inhaling formaldehyde gas or vapor from the air or by absorbing liquids containing formaldehyde through the skin.



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3. What are the short-term health effects of formaldehyde exposure?

When formaldehyde is present in the air at levels exceeding 0.1 ppm, some individuals may experience adverse effects such as watery eyes; burning sensations in the eyes, nose, and throat; coughing; wheezing; nausea; and skin irritation. Some people are very sensitive to formaldehyde, whereas others have no reaction to the same level of exposure.

4. Can formaldehyde cause cancer?

Although the short-term health effects of formaldehyde exposure are well known, less is known about its potential long-term health effects. In 1980, laboratory studies showed that exposure to formaldehyde could cause nasal cancer in rats. This finding raised the question of whether formaldehyde exposure could also cause cancer in humans. In 1987, the U.S. Environmental Protection Agency (EPA) classified formaldehyde as a probable human carcinogen under conditions of unusually high or prolonged exposure (1). Since that time, some studies of humans have suggested that formaldehyde exposure is associated with certain types of cancer. The International Agency for Research on Cancer (IARC) classifies formaldehyde as a human carcinogen (2). In 2011, the National Toxicology Program, an interagency program of the Department of Health and Human Services, named formaldehyde as a known human carcinogen in its *12th Report on Carcinogens* (3).

5. What have scientists learned about the relationship between formaldehyde and cancer?

Since the 1980s, the National Cancer Institute (NCI), a component of the National Institutes of Health (NIH), has conducted studies to determine whether there is an association between occupational exposure to formaldehyde and an increase in the risk of cancer. The results of this research have provided EPA and the Occupational Safety and Health Administration (OSHA) with information to evaluate the potential health effects of workplace exposure to formaldehyde.

The long-term effects of formaldehyde exposure have been evaluated in epidemiologic studies (studies that attempt to uncover the patterns and causes of disease in groups of people). One type of epidemiologic study is called a cohort study. A cohort is a group of people who may vary in their exposure to a particular factor, such as formaldehyde, and are followed over time to see whether they develop a disease. Another kind of epidemiologic study is called a case-control study. Case-control studies begin with people who are diagnosed as having a disease (cases) and compare them to people without the disease (controls), trying to identify differences in factors, such as exposure to formaldehyde, that might explain why the cases developed the disease but the controls did not.

Several NCI surveys of professionals who are potentially exposed to formaldehyde in their work, such as anatomists and embalmers, have suggested that these individuals are at an increased risk of leukemia and brain cancer compared with the general population. However, specific work practices and exposures were not characterized in these studies. An NCI case-control study among funeral industry workers that characterized exposure to formaldehyde also found an association between increasing formaldehyde exposure and mortality from myeloid leukemia (4). For this study, carried out among funeral industry workers who had died between 1960 and 1986, researchers compared those who had died from hematopoietic and lymphatic cancers and brain tumors with those who died from other causes. (Hematopoietic or hematologic cancers such as leukemia develop in the blood or bone marrow. Lymphatic cancers develop in the tissues and organs that produce, store, and carry white blood cells that fight infections and other diseases.) This analysis showed that those who had performed the most embalming and those with the highest estimated formaldehyde exposure had the greatest risk of myeloid leukemia. There was no association with other cancers of the hematopoietic and lymphatic systems or with brain cancer.

A number of cohort studies involving workers exposed to formaldehyde have recently been completed. One study, conducted by NCI, looked at 25,619 workers in industries with the potential for occupational formaldehyde exposure and estimated each worker's exposure to the chemical while at work (5). The results showed an increased risk of death due to leukemia, particularly myeloid leukemia, among workers exposed to formaldehyde. This risk was associated with increasing peak and average levels of exposure, as well as with the duration of exposure, but it was not associated with cumulative exposure. An additional 10 years of data on the same workers were used in a follow-up study published in 2009 (6). This analysis continued to show a possible link between formaldehyde exposure and cancers of the hematopoietic and lymphatic systems, particularly myeloid leukemia. As in the initial study, the risk was highest earlier in the follow-up period. Risks declined steadily over time, such that the cumulative excess risk of myeloid leukemia was no longer

statistically significant at the end of the follow-up period. The researchers noted that similar patterns of risks over time had been seen for other agents known to cause leukemia.

A cohort study of 11,039 textile workers performed by the National Institute for Occupational Safety and Health (NIOSH) also found an association between the duration of exposure to formaldehyde and leukemia deaths (7). However, the evidence remains mixed because a cohort study of 14,014 British industry workers found no association between formaldehyde exposure and leukemia deaths (8).

Formaldehyde undergoes rapid chemical changes immediately after absorption. Therefore, some scientists think that formaldehyde is unlikely to have effects at sites other than the upper respiratory tract. However, some laboratory studies suggest that formaldehyde may affect the lymphatic and hematopoietic systems. Based on both the epidemiologic data from cohort and case-control studies and the experimental data from laboratory research, NCI investigators have concluded that exposure to formaldehyde may cause leukemia, particularly myeloid leukemia, in humans.

In addition, several case-control studies, as well as analysis of the large NCI industrial cohort (6), have found an association between formaldehyde exposure and nasopharyngeal cancer, although some other studies have not. Data from extended follow-up of the NCI cohort found that the excess of nasopharyngeal cancer observed in the earlier report persisted (9).

Earlier analysis of the NCI cohort found increased lung cancer deaths among industrial workers compared with the general U.S. population. However, the rate of lung cancer deaths did not increase with higher levels of formaldehyde exposure. This observation led the researchers to conclude that factors other than formaldehyde exposure might have caused the increased deaths. The most recent data on lung cancer from the cohort study did not find any relationship between formaldehyde exposure and lung cancer mortality.

6. What has been done to protect workers from formaldehyde?

In 1987, OSHA established a federal standard that reduced the amount of formaldehyde to which workers can be exposed over an 8-hour workday from 3 ppm to 1 ppm. In May 1992, the standard was amended, and the formaldehyde exposure limit was further reduced to 0.75 ppm.

7. How can people limit formaldehyde exposure in their homes?

The EPA recommends the use of "exterior-grade" pressed-wood products to limit formaldehyde exposure in the home. These products emit less formaldehyde because they contain phenol resins, not urea resins. (Pressed-wood products include plywood, paneling, particleboard, and fiberboard and are not the same as pressure-treated wood products, which contain chemical preservatives and are intended for outdoor use.) Before purchasing pressed-wood products, including building materials, cabinetry, and furniture, buyers should ask about the formaldehyde content of these products. Formaldehyde levels in homes can also be reduced by ensuring adequate ventilation, moderate temperatures, and reduced humidity levels through the use of air conditioners and dehumidifiers.

8. Where can people find more information about formaldehyde?

The following organizations can provide additional resources that readers may find helpful:

The EPA offers information about the use of formaldehyde in building materials and household products. The EPA can be contacted at:

Address: U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Indoor Environments Division
Mail Code 6609J
1200 Pennsylvania Avenue, NW.
Washington, DC 20460

Telephone: 202-554-1404 (EPA Toxic Substance Control Act (TCSA) Assistance Line)

Web site: <http://www.epa.gov/iaq/formalde.html>

The U.S. Consumer Product Safety Commission (CPSC) has information about household products that contain formaldehyde. CPSC can be contacted at:

Address: U.S. Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814
Telephone: 1-800-638-2772 (1-800-638-CPSC)
TTY: 301-595-7054
Web site: <http://www.cpsc.gov>

The U.S. Food and Drug Administration (FDA) maintains information about cosmetics and drugs that contain formaldehyde. FDA can be contacted at:

Address: U.S. Food and Drug Administration
10903 New Hampshire Avenue
Silver Spring, MD 20993-0002
Telephone: 1-888-463-6332 (1-888-INFO-FDA)
Web site: <http://www.fda.gov>

The Federal Emergency Management Agency (FEMA) has information about formaldehyde exposure levels in mobile homes and trailers supplied by FEMA after Hurricane Katrina. FEMA can be contacted at:

Address: Federal Emergency Management Agency
Post Office Box 10055
Hyattsville, MD 20782-7055
Telephone: 1-800-621-3362 (1-800-621-FEMA)
Web site: <http://www.fema.gov>

The Occupational Safety and Health Administration (OSHA) has information about occupational exposure limits for formaldehyde. OSHA can be contacted at:

Address: U.S. Department of Labor
Occupational Safety and Health Administration
200 Constitution Avenue
Washington, DC 20210
Telephone: 1-800-321-6742 (1-800-321-OSHA)
Web site: <http://www.osha.gov>

The National Toxicology Program (NTP) is an interagency program of the Department of Health and Human Services that was created to coordinate toxicology testing programs within the federal government; to develop and validate improved testing methods; and to provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public. NTP is headquartered at the National Institute of Environmental Health Sciences, which is part of NIH. NTP can be contacted at:

Address: National Toxicology Program
111 TW Alexander Drive
Building 101
Research Triangle Park, NC 27709
Telephone: 919-541-0530
Web site: <http://ntp.niehs.nih.gov>

Selected References

1. U.S. Environmental Protection Agency, Office of Air and Radiation. *Report to Congress on Indoor Air Quality, Volume II: Assessment and Control of Indoor Air Pollution*, 1989.

2. International Agency for Research on Cancer (June 2004). *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 88 (2006): Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol*. Retrieved June 10, 2011, from: <http://monographs.iarc.fr/ENG/Monographs/vol88/index.php>.
3. National Toxicology Program (June 2011). *Report on Carcinogens, Twelfth Edition*. Department of Health and Human Services, Public Health Service, National Toxicology Program. Retrieved June 10, 2011, from: <http://ntp.niehs.nih.gov/go/roc12>.
4. Hauptmann M, Stewart PA, Lubin JH, et al. Mortality from lymphohematopoietic malignancies and brain cancer among embalmers exposed to formaldehyde. *Journal of the National Cancer Institute* 2009; 101(24): 1696–1708. [[PubMed Abstract](#)]
5. Hauptmann M, Lubin JH, Stewart PA, Hayes RB, Blair A. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries. *Journal of the National Cancer Institute* 2003; 95(21): 1615–1623. [[PubMed Abstract](#)]
6. Beane Freeman L, Blair A, Lubin JH, et al. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute Cohort. *Journal of the National Cancer Institute* 2009; 101(10): 751–761. [[PubMed Abstract](#)]
7. Pinkerton LE, Hein MJ, Stayner LT. Mortality among a cohort of garment workers exposed to formaldehyde: An update. *Occupational Environmental Medicine* 2004; 61:193–200. [[PubMed Abstract](#)]
8. Coggon D, Harris EC, Poole J, Palmer KT. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. *Journal of the National Cancer Institute* 2003; 95(21):1608–1615. [[PubMed Abstract](#)]
9. Hauptmann M, Lubin JH, Stewart PA, Hayes RB, Blair A. Mortality from solid cancers among workers in formaldehyde industries. *American Journal of Epidemiology* 2004; 159(12):1117–1130. [[PubMed Abstract](#)]

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Related NCI materials and Web pages:

- *Understanding Cancer Series: Cancer*
(<http://www.cancer.gov/cancertopics/understandingcancer/cancer>)
- *What You Need To Know About™ Cancer*
(<http://www.cancer.gov/cancertopics/wyntk/overview>)
- *What You Need To Know About™ Leukemia*
(<http://www.cancer.gov/cancertopics/wyntk/leukemia>)
- Leukemia Home Page
(<http://www.cancer.gov/cancertopics/types/leukemia>)

How can we help?

We offer comprehensive research-based information for patients and their families, health professionals, cancer researchers, advocates, and the public.

- **Call** NCI's Cancer Information Service at 1–800–4–CANCER (1–800–422–6237)
- **Visit** us at <http://www.cancer.gov> or <http://www.cancer.gov/espanol>
- **Chat** using LiveHelp, NCI's instant messaging service, at <http://www.cancer.gov/livehelp>
- **E-mail** us at cancergovstaff@mail.nih.gov
- **Order** publications at <http://www.cancer.gov/publications> or by calling 1–800–4–CANCER
- **Get help** with quitting smoking at 1–877–44U–QUIT (1–877–448–7848)

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