PHYSICIANS FOR SOCIAL RESPONSIBILITY

CANCER

What Health Care Providers Should Know

DRINKING WATER FACT SHEET #2

Why Is There Concern about Cancer and Drinking Water?

In the United States, cancer is the second leading cause of death, exceeded only by heart disease. According to recent National Cancer Institute statistics, the incidence of many cancers, including breast, testicular, urinary bladder, and non-Hodgkin's lymphoma, has increased in recent decades.[1] As described in this document, some neoplastic diseases have been linked to drinking water contaminants.

Both public water supplies and private wells can be sources of exposure to carcinogenic chemicals. Surface water sources of drinking water, such as rivers, lakes and reservoirs, are particularly vulnerable to contamination from industrial discharges, agricultural and urban runoff, and chemical spills. Groundwater, which provides drinking water for more than half of the U.S. population, can also be contaminated by a variety of means, including leaking underground storage tanks and landfills, or through hydrologic connections with contaminated surface water. Some carcinogenic chemicals such as arsenic and radon occur naturally in geologic formations and are found in groundwater in many regions of the country. Since the U.S. Environmental Protection Agency (EPA) does not regulate the quality of water from private wells, it is important for homeowners to have their water tested.

Groundwater, which provides drinking water for more than half of the U.S. population, can also be contaminated

Conventional water treatment processes used for municipal supplies do not ensure removal of all chemical contaminants, particularly organic compounds that are soluble in water. In fact, contaminants can be introduced to drinking water through the treatment process itself. There is evidence that the use of disinfectants such as chlorine in drinking water can contribute to the formation of carcinogenic chemicals in tap water.

What Are Some Common Drinking Water Contaminants Linked to Cancer?

Pesticides and Herbicides

In the U.S., about 4.5 billion pounds of pesticides are used in a typical year, including agricultural, commercial, and home use pesticides.[2] Agricultural runoff containing pesticides may lead to local or regional contamination of drinking water sources. Levels and occurrence of pesticides

TABLE 1: PESTICIDE CLASSES ASSOCIATED WITH CANCER

PESTICIDE CLASS	TYPE OF CANCER
Phenoxyacetic acid herbicides (e.g., 2,4-D)	Non-Hodgkin' s lymphoma, soft-tissue sarcoma, prostate
Organochlorine insecticides (e.g., DDT, DDE, aldrin, dieldrin)	Leukemia, non-Hodgkin' s lymphoma, soft-tissue sarcoma, pancreas, lung, breast
Organophosphate insecticides (e.g., malathion)	Non-Hodgkin' s lymphoma, leukemia
Arsenical insecticides	Lung, skin
Triazine herbicides (e.g., atrazine)	Ovary

Adapted from Blair and Zahm(1995) [6]

in surface water and ground water vary considerably with the seasons and local geology, with highest concentrations often occurring in spring and early summer following rainfall.[3, 4]

Of the nearly 900 active ingredients registered as pesticides in the U.S., more than 160 have been classified as known or suspected carcinogens by EPA and other organizations.[5] Pesticide exposure has been linked to a variety of cancers, although few epidemiological studies have focused specifically on drinking water exposures. Table 1 on page 1 summarizes the types of cancers that have been linked to pesticide exposure.

Recent studies have also suggested a possible association between exposure to triazine herbicides (such as atrazine) in drinking water and increased risk for breast cancer[7] and stomach cancer.[8] An epidemiological study in Iowa found elevated incidence of lymphoma in counties served by rivers contaminated with dieldrin.[9] *For additional information, please refer to PSR's fact sheet "Pesticides and Drinking Water".*

Disinfection Byproducts

Disinfection byproducts (DBPs) are among the most ubiquitous contaminants found in drinking water. They are formed by reactions between naturally-occurring organic matter in water and the chlorine that is commonly added to disinfect drinking water supplies. Brominated byproducts are also widely found, and are formed by substitution reactions between chlorinated DBPs and naturally-occurring bromine. Treatment with ozone also results in the formation of bromate.

Several recent epidemiological studies suggest a link between DBPs and bladder cancer,[10, 11, 12] colon and rectal cancer,[13, 14] and brain cancer.[15] In a meta-analysis of cohort and case-control studies, Morris, et al. found an association between consumption of chlorinated drinking water and increased risk for bladder and rectal cancer.[16] The EPA has estimated that 2-17% of bladder cancer cases in the U.S. are attributable to DBP exposure (1100-9300 cases/year).[17] *For additional information, please refer to PSR's fact sheet "Disinfection Byproducts and Drinking Water".*

Solvents and Other Organic Chemicals

Volatile organic chemicals (VOCs), which are common drinking water contaminants, are often found in gasoline and other petroleum fuels, industrial solvents and carriers, metal degreasers, and dry cleaning solvents. They enter water supplies by several routes, including industrial and municipal discharges, chemical spills, leaking underground storage tanks, and contaminant leaching from landfills and hazardous waste sites into groundwater. Table 2 summarizes the types of cancer that have been linked to common solvents in drinking water.

TABLE 2: TYPES OF CANCER ASSOCIATED WITH EXPOSURE TO SOLVENTS IN DRINKING WATER

SOLVENT	CONTAMINANT SOURCE	TYPE OF CANCER
trichloroethylene (TCE)	Industrial sources; used as degreaser	Leukemia, non-Hodgkin' s lymphoma in women 18
trichloroethylene tetrachloroethylene 1,1-dichloroethane	Industrial sources; PVC pipe; dry cleaners	Bladder cancer 19 trichloroethylene
tetrachloroethylene PCE)	Industrial sources	Leukemia 20
tetrachloroethylene	PVC pipes and water mains	Lung cancer; colo-rectal cancer; 21 breast cancer 22

The fuel-associated chemical, methyl tert-butyl ether (MTBE), has been classified by EPA as a possible human carcinogen but is not regulated in drinking water.

Synthetic organic chemicals (SOCs) include pesticides (addressed in previous section), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), plasticizers, petroleum products, and dioxins. Dioxin, PCBs, and PAHs are known or suspected carcinogens, but are infrequently detected in drinking water. There is little epidemiological evidence linking these chemicals to cancer by the drinking water route of exposure. *For additional information, please refer to PSR's fact sheet "Solvents and Drinking Water".*

Inorganics and Radon

Arsenic—This metal has been found in high levels in community drinking water supplies in the United States, often as a result of high concentrations found in regional geologic formations. Arsenic is also used in industrial processes such as in wood preservatives and agricultural chemicals. The health effects of arsenic in drinking water are well documented, and include both cancer and non-cancer endpoints. A recent study by the National Research Council (NRC) concluded that there is sufficient epidemiological evidence linking chronic ingestion of arsenic with skin cancer, lung cancer and bladder cancer.[18] Studies have also found increased risks of other cancers, including kidney and liver cancer, although NRC concluded that the strength of these associations are not as strong as for lung and bladder cancers. *For additional information, please refer to PSR's fact sheet "Arsenic and Drinking Water".*

Other metals, including cadmium, chromium, and nickel have also shown evidence of carcinogenicity, demonstrated

primarily through occupational exposures. Studies of metals (other than arsenic) in drinking water have been limited, but have suggested cancer associations for cadmium[19] and nickel.[20]

Nitrate —Groundwater contamination by nitrate has risen dramatically due to increased agricultural use of nitrogen-based fertilizers and intensive livestock operations. Large areas of the Midwest have nitrate levels significantly higher than natural levels. The Maximum Contaminant Level (MCL) for nitrate established by EPA is 10 milligrams per liter (mg/L) of drinking water.

Ingested nitrate is absorbed in the small intestine, secreted by the salivary glands, and converted to nitrite. In the stomach, nitrite can form N-nitrosoamines and N-nitrosoamides, among the strongest known carcinogens. Recent studies have reported evidence of an association between long-term consumption of nitrate-contaminated drinking water and increased risk of non-Hodgkin's lymphoma,[21] and cancers of the stomach and liver.[22] *For additional information, please refer to PSR's fact sheet "Nitrate and Drinking Water".*

Radon—A known carcinogen, radon is found in the groundwater of many regions of the country as a result of naturally occurring geologic deposits. Groundwater from New England, the Southeast, and Mountain regions has more radon than other regions. Drinking water supplies derived from surface water sources typically have lower radon levels.

Radon in water constitutes a threat to health both from direct ingestion as well as from contribution to indoor air levels and inhalation after water is heated or agitated such as during showering. Alpha particles emitted from radon can ultimately cause cancer of the gastrointestinal tract or lung, depending on the route of exposure.[23, 28] *For additional information, please refer to PSR's fact sheet, "Radon and Drinking Water".*

What Can Health Professionals Do to Reduce The Public Health Threat of Cancer from Drinking Water?

Health care providers can play an important role in helping to reduce exposures to carcinogens by their patients and communities. Following are steps that can be taken by health professionals and consumers:

- Health professionals, citizens and businesses can have profound impacts on drinking water quality by working proactively to *prevent* contamination. This can include concerted efforts to protect local source waters, and use of sustainable alternatives to toxic chemicals.
- Ask your patients about exposures to potentially hazardous chemicals. The Agency for Toxic Substances and Disease Registry (ATSDR) publication *"Taking an Exposure History"* is a valuable source of information on how to take an environmental exposure history. In assessing individual cancer risk, it is important to examine all potential sources of chemical exposure including occupation, lifestyle (e.g., cigarette smoking), consumption of contaminated food and water, and use of household chemicals.
- Advise your patients to read the Consumer Confidence Report issued by their local drinking water utility, and to ask questions about any reported violations of drinking water standards.
- Persons who obtain their drinking water from private wells should be advised to have their water tested for chemical and microbial agents. The local health department can assist in identifying specific chemicals to include in analyses.
- If there are indications of chemical contamination that could affect the health of a patient or family members, patients should be advised to consider alternate sources of water (e.g., bottled water) or home water treatment units. Patients should be advised that bottled water could also contain chemical contaminants. In choosing bottled water, consumers should contact bottler(s) to obtain a copy of chemical testing results.

Sources of Additional Information and Guidance

- Physicians for Social Responsibility: (202) 898-0150 or www.psr.org
- Campaign for Safe and Affordable Drinking Water: www.safe-drinking-water.org
- U.S. EPA's Safe Drinking Water Hotline: (800) 426-4791
- U.S. EPA's Office of Ground Water and Drinking Water: (202) 260-5543 or www.epa.gov/safewater
- ATSDR Case Studies in Environmental Medicine: (888) 422-8737 or www.atsdr.cdc.gov

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This document is one in a series of Drinking Water Fact Sheets developed specifically for health care providers by Physicians for Social Responsibility. These fact sheets provide practical and concise information to assist health care providers in recognition and prevention of disease caused by exposure to drinking water contaminants.

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