PHYSICIANS FOR SOCIAL RESPONSIBILITY

NITRATE

What Health Care Providers Should Know

DRINKING WATER FACT SHEET #9

What is Nitrate and Why is There Concern about its Presence in Drinking Water?

The term *nitrate* refers to a large family of nitrogen-containing organic and inorganic compounds. Each year, 12 million tons of nitrogen are applied as commercial fertilizers (1), and some 150,000 tons of nitrate compounds are released into the environment by industrial facilities (2). Smaller quantities are used in heat transfer salts, glass and ceramics, fireworks, explosives and blasting agents.

Fertilizers, livestock manure, and atmospheric sources (from industrial and automobile emissions) are among the top contributors to nitrate contamination of underground water supplies (3). Nitrate is more commonly found in the groundwater of rural and agricultural regions, due to heavy fertilizer use in these areas. In general, domestic wells are more likely to be contaminated with nitrate than public water supplies because they typically draw groundwater from relatively shallow aquifers. Shallow groundwater is more susceptible to nitrate contamination than deeper public supply wells, particularly in areas with more porous, well-drained soils (3).

In the body, nitrate is converted to more toxic nitrites, which can cause serious health effects in infants and pregnant women. People can also be exposed to nitrites via certain foods and drugs, including cured meats (4,5).

What are the Health Effects of Nitrates in Drinking Water?

The main health effect of nitrate ingestion is a blood disorder called methemoglobinemia, also known as *blue baby syndrome* because it occurs most commonly in infants and can cause a characteristic blue-gray skin coloration. Ingestion of nitrate (converted to nitrites in the body) results in the conversion of hemoglobin to methemoglobin, a form of hemoglobin that cannot carry oxygen. Lack of oxygen in the blood can lead to clinical manifestations of cyanosis (bluish skin color, particularly of the mucus membranes) characteristic of methemoglobinemia. Other symptoms of methemoglobinemia may arise from poor delivery of oxygen in the blood. Acutely, these include shortness of breath, hypotension, below-average weight gain, and developmental delays, which may be present in the absence of observable cyanosis. Indications of chronically elevated methemoglobin levels include central nervous system depression (headache, dizziness, fatigue and lethargy); coma; convulsions; abnormal heart rhythms; circulation failure; and hemolytic anemia (5,6). Children exposed to high levels of nitrate in drinking water may also be at increased risk for developing goiter and respiratory tract infections (7,8). Severe methemoglobinemia can quickly lead to death if not recognized and treated immediately. Diagnosis can be made either by laboratory measurement of methemoglobin or by observation of blood turning a chocolate brown color when exposed to room air.

Adults rarely develop methemoglobinemia at nitrate levels typically found in drinking water, but possible associations between long-term consumption of nitrate-contaminated drinking water and increased risk of bladder and ovarian cancer exist (9). Studies have also suggested that nitrate in drinking water may be linked with increased risk for non-Hodgkin's lymphoma, although the evidence is inconclusive (9,10).

Which Populations Are Most Susceptible to the Adverse Effects of Nitrates?

Infants under four months of age are at highest risk of developing methemoglobinemia because their bodies are less able to convert methemoglobin back to normal hemoglobin. Infants fed formula mixed with water from rural domestic wells are at particular risk (5). Parents should investigate the possible presence of nitrates in their drinking water (particularly well water) before using it to prepare infant formula. Miscarriages have also been linked to the consumption of nitrate-contaminated water by expectant mothers (11).

How Are Nitrates Regulated in Drinking Water?

The U.S. Environmental Protection Agency (EPA) has established an enforceable limit (called a maximum contaminant level, or MCL) of 10 milligrams per liter (mg/L) for nitrate and 1 mg/L for nitrites in drinking water. These standards were aimed at preventing methemoglobinemia in infants (5). However, they apply only to community water systems, as EPA does not regulate the quality of water from private wells.

People who obtain drinking water from domestic wells should have it tested for nitrate and other contaminants. This is particularly important in agricultural areas, where nitrate levels can often exceed drinking water standards. Limited sampling of domestic wells by the U.S. Geological Survey (USGS) found that 12% of domestic supply wells in agricultural areas exceeded the MCL (12). Shallow wells in agricultural areas with well-drained soils are at particular risk. In a review of data gathered from across the U.S., the USGS found that more than 25% of wells in such areas exceeded the MCL for nitrate (3).

Consumers of water from domestic wells should also be aware that nitrate levels in groundwater may fluctuate widely throughout the year, depending on precipitation amounts, soil types, and other factors. Consequently, short-term nitrate concentrations can reach levels many times higher than EPA's health-based standard, particularly during the growing season when fertilizers are most heavily applied.

What Can Health Professionals Do to Reduce the Public Health Threat from Nitrates in Drinking Water?

- Advise expectant mothers and parents of newborn infants, particularly those living in agricultural areas, about the health risks of nitrate in drinking water. If nitrate exposure is suspected, talk with your patients to determine likely source(s) of exposure (e.g., drinking water or food).
- Encourage patients with private wells to have their water tested for nitrate contamination. EPA's Safe Drinking Water Hotline at (800) 426-4791 can direct individuals to EPA-certified public health laboratories that can perform such tests. If contamination is found, home water treatment units using ion exchange, reverse osmosis, or electrodialysis can be effective in removing nitrate.
- Tell your patients with nitrate-contaminated water not to use it for mixing infant formula. In addition, advise patients against boiling nitrate-containing drinking water, as boiling can increase nitrate concentrations.
- Educate your peers, your community, and your patients about the health hazards of nitrate and ways to prevent drinking water contamination. PSR's *Safe Drinking Water Advocacy Kit* includes suggestions for becoming involved in advocacy efforts to prevent drinking water contamination.

Sources of Additional Information and Guidance

- Physicians for Social Responsibility: (202) 667-4260 or www.psr.org
- PSR/American College of Preventive Medicine (ACPM) online CME course, "Drinking Water and Disease": www.acpm.org/ehealth/sdw_intro.htm
- NSF International: (800) 673-6275 or www.nsf.com
- U.S. EPA Office of Ground Water and Drinking Water: (202) 260-5543 or www.epa.gov/ogwdw
- Farm*A*Syst/Home*A*Syst Program, University of Wisconsin-Madison, (608) 262-0024 or www.uwex.edu/farmasyst

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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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