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Well Water, Nitrates and the “Blue Baby” Syndrome Methemoglobinemia

by Ann Ziebarth, Extension Housing Specialist

The Environmental Protection Agency (EPA) has set a maximum contaminant level (MCL) of 10 parts-per-million (ppm) for nitrate-nitrogen in public water supplies. This level provides a margin of safety regarding a significant risk for human health. EPA believes that water containing nitrate-nitrogen at or below this level is acceptable for drinking every day over the course of one's lifetime and does not pose any health concerns.

Nitrate is relatively non-toxic substance that occurs naturally as part of the nitrogen cycle. However, nitrate can be converted readily by bacteria into nitrite. This occurs in the environment, in foods, and in the human mouth and gastrointestinal tract. Once nitrogen is converted into nitrate it can have harmful health effects. For example, high nitrates in drinking water can cause methemoglobinemia resulting from the reaction of nitrites with hemoglobin in red blood cells affecting the ability of the blood to carry sufficient oxygen to individual cells of the body.

Methemoglobinemia Health Risks

Until infants reach about six months of age their digestive system has a diminished capability to secrete gastric acid, thus the pH level can rise to 5-7. At this pH level bacteria proliferates increasing the transformation of nitrate to nitrates. Thus, exposure to nitrate at levels in excess of 10 ppm can result in higher risk of methemoglobinemia. Methemoglobinemia, also known as blue baby syndrome, is characterized by a reduced ability of the blood to carry oxygen. The higher risks associated with nitrate contamination for infants is related to the pH levels in the gastrointestinal tract, greater total fluid intake per unit of body weight, the larger amounts of nitrate relative to the total hemoglobin for a given nitrate concentration in water.

Health professionals often advise pregnant women and those who are breast feeding to not use water with nitrate-nitrogen levels above the recommended maximum contaminant levels. This is a precautionary measure. It is unlikely

that human or bovine milk is a source of infant methemoglobinemia. One study showed that cows drinking from water with 177 ppm nitrate produced milk with less than 0.5 ppm nitrate concentration.

Most adults have the ability to rapidly convert methemoglobin back to oxyhemoglobin so that even with relatively high levels of nitrate/nitrite intake the red blood cells can still carry enough oxygen to the body's cells. However adults with an hereditary predisposition, those being treated for peptic ulcers, and persons with chronic gastritis, or dialysis patients are at a higher risk of methemoglobinemia.

Older persons may be at a higher risk for methemoglobinemia as their gastrointestinal systems again produces a pH level which allows for increased bacterial growth in the gastrointestinal tract. While the research is less certain regarding the possible increased risk to older persons of high nitrate levels in drinking water older Nebraskans should use water which meets the health standards.

Signs and Symptoms

Infants suffering from methemoglobinemia may seem healthy but show intermittent signs of blueness around the mouth, hands and feet. They may have episodes of breathing trouble, and some diarrhea and vomiting. In some cases an infant with methemoglobinemia has a peculiar lavender color but shows little distress. If blood samples are taken they will be chocolate brown and won't turn pink when exposed to air. If the methemoglobin level is over 60 percent there is a marked lethargy, excessive salivation, and loss of consciousness. Convulsions are also common at extreme levels.

Case Histories

A number of cases of infant methemoglobinemia have been reported in the U.S. A Nebraska survey of physicians reported in the Nebraska Medical Journal in 1981 indicated that at least eight cases of infant methemoglobinemia were

treated in Nebraska between 1973 and 1978 (Grant, 1981). More recently, two South Dakota infants with the blue baby syndrome were identified by the State Department of Health. In one case the farm's well water was found to have 150 ppm nitrate-nitrogen concentration while the level was 54 ppm in the other. Although these levels of nitrate-nitrogen are extremely high, a case of methemoglobinemia in Colorado involved an infant ingesting municipal system water containing 13.3 ppm nitrate-nitrogen (Fan, et al. 1987). No cases have been identified with water testing below the MCL of 10 ppm for nitrate-nitrogen.

Treatment and Prevention

If the condition is identified early and is not life-threatening, no treatment is needed other than a change to drinking water with less than 10 ppm nitrate-nitrogen. The methemoglobin will be reduced spontaneously to hemoglobin within two to three days. For severely affected infants treatment with an intravenously administered solution of methylene blue usually brings prompt recovery.

Testing the drinking water for nitrate-nitrogen levels is a good precautionary step when providing an infant with mixed formula. Infants under six months of age are at the highest risk. Providing water from a uncontaminated source, using bottled water, or treating the water with a distiller, ion exchange unit or reverse osmosis system are alternatives to consider if the water test indicates the nitrate-nitrogen levels are above 10 ppm.

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