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Drinking Water: Lead

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University of Nebraska–Lincoln Extension and the Nebraska Department of Health and Human Services place a high priority on water quality and jointly sponsor this series of educational publications.

Small quantities of lead can be a serious health concern, especially for infants, children, and developing fetuses. This NebGuide discusses how to safely manage lead in a domestic water supply.

Lead in Drinking Water

Lead rarely occurs naturally in drinking water. Most lead contamination takes place at some point in the water delivery system. This occurs as a result of corrosion, the reaction between the drinking water and lead that has been used to construct parts of the water delivery system. Materials in the water delivery system which may contain lead include service connections, pipes, solder, and brass fixtures.

The characteristics of water vary greatly depending on the source of the water. Some water is naturally more corrosive. Several factors cause water to be corrosive including low pH (pH less than 8.0), high temperature, low total dissolved solids (TDS) content and high amounts of dissolved oxygen or carbon dioxide. Generally, naturally soft water is more corrosive than hard water because it is more acidic and has low TDS. Treating naturally hard water with an ion exchange water softening unit, reverse osmosis unit, or distillation unit may change the water chemistry significantly enough to have an effect on the water's ability to dissolve lead.

Lead in drinking water from plumbing or fixtures is most often a problem in either very old or very new homes and buildings. However, any home or building may be susceptible.

Through the early 1900s it was common in some areas of the country to use lead pipes for interior plumbing. Lead piping was also used for service connections to join residences and establishments to public water supplies. Lead piping is most likely found in homes and buildings built before 1930. Copper piping replaced lead piping, but lead-based solder was used to join copper piping. It is likely lead-based solder was used in any home or building built before 1988. The U.S. Environmental Protection Agency (EPA) published a public drinking water rule in 1991 that emphasized eliminating lead from components of the water delivery system.

Today, brass materials are used in nearly 100 percent of all residential, commercial, and municipal water distribution systems. Many household faucets, plumbing fittings, check valves and well pumps are manufactured with brass parts. Brass contains some lead to make casting easier and the machining process more efficient. As of January 2014, federal regulations allow no more than 0.25 percent lead content of brass plumbing components labeled "lead free." "Lead free" brass components manufactured before that date could have as much as 8.0 percent lead content.

Often, hard water minerals deposit on the interior of plumbing. These deposits form a mineral scale lining, such as calcium carbonate, inside pipes and fittings, which protects against lead contamination. It may take up to five years for an effective mineral scale lining to form. Treating naturally hard water with an ion exchange water softening unit, reverse osmosis unit, or distillation unit can either prevent or dissolve the scale, eliminating its possible protective effect.

Some private wells may have submersible pumps containing brass or bronze capable of leaching lead. Some well screens also may contain lead or were installed with a "lead packing collar." Potential lead contamination also exists if the well is a driven, sandpoint well and has been "shot" to clear the screen. Lead shot was sometimes poured into a well to keep out sand. In other wells, lead wool was used. While these were acceptable practices at the time, none of these practices are recommended, and sandpoint wells driven into

the ground are not approved for drinking water purposes under Nebraska well construction regulations.

Older water coolers with lead-lined tanks are another possible source of lead in drinking water. The Lead Contamination Control Act of 1988 required the repair or recall of lead-lined tanks and prohibited manufacturing and sale of such coolers. As with any repair or recall notice, it is possible that less than 100 percent compliance was achieved and coolers with lead-lined tanks may remain in use.

The primary source of lead exposure for most children is not from lead-contaminated water. Instead, it is most often from lead-based paint in older homes. Lead-based paint was commonly used for home interiors and exteriors prior to 1978 when it was banned from residential use. Additional sources of lead in the environment include lead-contaminated soil, air, and dust; lead-contaminated food; imported food in lead-soldered cans; non-FDA regulated ceramics with lead glazes; and leaded crystal. This is not a complete list of possible lead sources and exposure to lead is a cumulative process, so multiple small sources of exposure can have a large impact. Questions or concerns related to sources of lead or potential health effects from lead exposure should be directed to a physician.

Indications of Lead

Lead does not noticeably alter the taste, color, or smell of water. The effects of low levels of lead toxicity in humans may not be obvious. There may be no symptoms present or symptoms may be mistaken as other illnesses. The only way to know the concentration of lead in water is through sampling and laboratory testing which is described in greater detail in a subsequent section.

Potential Health Effects

Lead has no known benefits to humans. Lead is a cumulative poison, meaning it accumulates in the body until it reaches toxic levels. It can be absorbed through the digestive tract and lungs and is carried by the blood throughout the body. The severity of the effects of lead poisoning varies depending on the concentration of lead in the body. This concentration can be determined with a blood test.

Excess lead in the human body can cause serious and irreversible damage to the brain, kidneys, nervous system, and red blood cells. A child's mental and physical development can be irreversibly stunted by lead poisoning. Lead poisoning can contribute to lower IQ levels, shortened attention spans, and increased behavior problems. While some effects of lead poisoning may diminish if exposure is reduced, others are irreversible. Young children, infants, and fetuses are particularly vulnerable to lead poisoning. An amount of lead that would have little effect on an adult can greatly affect a child. Also, growing children more rapidly absorb any lead consumed. Lead in drinking water is not the predominant source of lead poisoning, but it can increase total lead exposure, particularly the exposure of infants who drink baby formulas and juices mixed with water. The Centers for Disease Control and Prevention recommend all children be tested for lead with a blood test. Parents or guardians should consult their physicians.

Testing

Testing Public Water Supplies

Water supplied by Public Water Systems is regulated by the U.S. Environmental Protection Agency (EPA) and Nebraska Department of Health and Human Services (DHHS).

Public water systems must complete a distribution system materials evaluation and/or review other information to target homes at high risk of lead contamination. A percentage of at-risk homes are then monitored at the tap, with the number of tap-sampling sites based on the number of people served by the public water supply. Additional monitoring for other water-quality parameters affecting corrosion is required to optimize any required treatment and determine compliance with lead standards.

If water comes from a public water supply, consumers can contact the water utility to inquire about the lead concentration in the water.

Testing Private Water Supplies

Water quality from private wells is not currently regulated at the federal level or by Nebraska state government. Thus, the regular testing of a private water supply is not required under state or federal law. If consumers want to know the concentration of lead in a private water supply, they will need to have the water tested at their own expense.

Although private water supplies are not subject to any regulations concerning lead contamination, users of private water supplies may want to test their water supply. This is especially true if a problem is suspected or if children or pregnant women consume the drinking water.

Tests to determine the presence of lead in drinking water should be done by a laboratory approved for lead testing. The Nebraska DHHS approves laboratories to conduct tests for drinking water supplies. An approved laboratory might not be approved to test for all potential drinking water contaminants. Rather, approval must be obtained for each specific contaminant. This approval means that recognized, standard tests and quality control procedures are used. See *Drinking Water: Approved Water Testing Laboratories in Nebraska* (G1614) for a list.

Laboratories not specifically approved to test for lead may use the same equipment and procedures as approved laboratories. Such laboratories may provide accurate analysis, but there is no independent information about the laboratory's ability to obtain reliable results.

Test kits and dip strips are available for do-it-yourself lead testing outside of a laboratory environment. These kits can be difficult to use due to the need for color matching, and may not provide accurate and reliable lead measurement.

To determine if lead is present in a private drinking water supply and to determine the possible source of the

contamination, water must be tested using specific sampling procedures. Carefully follow all directions provided by the laboratory and use provided containers when collecting water samples.

In general, water that comes in contact with lead in the plumbing will continue to dissolve lead over time. For this reason, the highest lead concentration in drinking water will result from water that has sat motionless in the plumbing system, in contact with lead-containing components, for an extended period of time (e.g., several hours or overnight). To evaluate the household's or building's highest lead concentration, collect a sample of the water that has sat motionless in the plumbing system, in contact with suspected lead-containing components for six or more hours. This is sometimes called a "first-draw" sample.

The length of time the tap should be run prior to collecting the water sample will depend on where the suspected lead-containing components are located in relation to the tap being used. Collect the very first water drawn if suspected lead-containing components are close to the tap. Collect water drawn after the tap was run for a few seconds to a minute or two if suspected lead-containing components are present in the water delivery system farther away from the tap (e.g., in pipes, water meters, well pumps, etc.). Try to time the water collection process to obtain a sample representative of the highest contamination. If it is not known if or where lead-containing components might be located, collect the first water drawn. If there is a great concern, one can collect multiple samples from the tap that span a time frame from first water drawn to water that takes a few minutes to pass through the system.

Collect a second or subsequent sample after the tap has run for at least five minutes and the water has become noticeably colder. This sample will indicate the lead concentration in water that has not been in contact with the plumbing system for an extended period of time. This is sometimes called a "purged-line sample."

If the first-draw sample contains a higher amount of lead than the purged-line sample, the water is leaching lead from the plumbing system. If both samples contain nearly equal amounts of lead, the water is being contaminated by a source other than the household plumbing system.

Interpreting Test Results

Public Water Supply Test Results

The quality of water supplied by public water systems is regulated by the EPA and the Nebraska DHHS. This includes any well with 15 or more service connections or that regularly serves 25 or more people.

Public drinking water standards established by EPA fall into different categories, including action levels. An action level is the concentration of a contaminant in water which, if exceeded in a specified percentage of water samples tested, triggers actions which a water system must follow. Those required actions may include additional monitoring, treatment, or other.

EPA has established an enforceable lead concentration action level for public water supplies. The lead action level is 15 micrograms per liter (µg/l) which can also be expressed as 15 parts per billion (ppb). This amount is equivalent to 0.015 milligrams per liter (mg/l) which can also be expressed as 0.015 parts per million (ppm). When the lead concentration exceeds 15 ppb in over 10 percent of the homes tested, the public water supplier must initiate the actions described in the "Options" section.

Private Water Supply Test Results

Since EPA and Nebraska regulations do not apply to private drinking water wells, users of private drinking water may consider the EPA established action level of 15 ppb as a guideline in assessing the risk associated with their water supply. If lead concentrations are found to be above 15 ppb, private drinking water users might voluntarily consider EPA guidelines, and try to reduce the lead concentration in the water, taking into account health risks, costs, and benefits.

As discussed earlier, if results show higher levels of lead in the first-draw sample than the flushed sample, the lead is likely coming from components of the household plumbing (lead piping, lead-based solder or brass fixtures and fittings). On the other hand, if test results show nearly equal amounts of lead in both the first-draw and flushed samples, the lead is probably coming from a source outside the house.

Options

Options for Public Water Supplies

All water systems exceeding the EPA's lead action level are required to complete additional monitoring. The lead action level is discussed in the "Interpreting Test Results" section.

A public water system exceeding the EPA action level in more than 10 percent of sampled homes is required to take action to reduce lead levels. The system must initiate corrosion control treatment, source water treatment and public education. If a system continues to exceed the lead action level following these three steps, lead service lines must be replaced over a 15-year period.

Options for Private Water Supplies

If water tests indicate lead is present in drinking water and testing determines the source is household plumbing, users should first try to identify and eliminate the lead source. If it is neither possible nor cost-effective to eliminate the lead source, flushing the water system before using the water for drinking or cooking may be an option.

Flushing the system involves disposing the water that has sat motionless in the plumbing system, in contact with lead-containing components, for an extended period of time. Anytime the water has not been used for several hours, the water should be run until it becomes as cold as it will get.

This could take as little as thirty seconds or longer than five minutes depending on the system. Each faucet must be flushed individually before using the water for drinking or cooking. Water run from the tap during flushing can be used for nonconsumption purposes such as watering plants, washing dishes or clothes, or cleaning.

Flushing may not be effective in reducing the lead concentration of water in apartment, office, or other similar large buildings with large-diameter supply pipes joined with lead-based solder. In addition, individuals should avoid cooking with or consuming water from hot-water taps. Hot water dissolves lead more readily than cold water. **Consumer should especially avoid using water from a hot water tap for making baby formula.**

If water tests indicate the presence of lead, and the source was determined to be beyond the household plumbing, again the first course of action is to identify and eliminate the source if possible. The well and the pump should be checked for potential lead sources. A licensed water well contractor may be able to help determine if any of the well components are a source of lead contamination.

In addition to identifying potential lead sources, consumers should consider the corrosivity factor. One practice that may increase corrosion is the grounding of electrical equipment (including telephones) to water pipes. Electric current traveling through the ground wire accelerates the corrosion of lead in the pipes. In this case, a qualified electrician should be consulted.

If not possible or cost-effective to eliminate the source of lead in drinking water, water treatment or an alternative drinking water source, such as bottled water should be considered.

Several treatment methods are suitable for removing lead from drinking water, including reverse osmosis, distillation, and carbon filters specially designed to remove lead. Typically these methods are used to treat water at only one faucet. Reverse osmosis units can remove approximately 85 percent of the lead from water. Distillation can remove approximately 99 percent. Simply boiling water does not remove lead. A water softener can be used to pretreat water for either a reverse osmosis or distillation unit when water is excessively hard. Low flow rates are required when using lead selective carbon filters. Typically they have flow controllers which limit the system to 0.25 to 0.5 gallons per minute. For additional information on these treatment options see *Drinking Water Treatment: Reverse Osmosis* (G1490), *Drinking Water Treatment: Distillation* (G1493), and *Drinking Water Treatment: Activated Carbon Filtration* (G1489).

Summary

Lead rarely occurs naturally in drinking water. It is more common for lead contamination to occur at some point in the water delivery system. Too much lead in the human body can cause serious damage to the brain, kidneys, nervous system, and red blood cells. Young children, infants, and fetuses are especially vulnerable to lead poisoning. To determine the presence of lead in drinking water and its possible source, a specific procedure must be used to collect samples and a certified laboratory should be used for testing. Public water supplies must comply with the EPA action level of 15 ppb lead. Management of a private drinking water well for lead is a decision made by the well owner and/or water user. A water test is the only way to determine the lead concentration. If drinking water exceeds the EPA lead standard of 15 ppb, steps can be taken voluntarily to reduce the risk. Options include removing the lead source, managing the water supply used for drinking and cooking by flushing water with high lead concentrations from the water system, using water treatment equipment, or using an alternative water source. Options selected must be based on the specific situation.

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