Chapter 9

Nutrition and Childhood Lead Poisoning

Contents

Wisconsin Department of Health Services

(P-00660, 11/2014)

Introduction

Nutrition is an important factor in the prevention and treatment of lead poisoning. The nutrients received from certain foods and supplements play a role in minimizing absorption of ingested lead. Children with an adequate amount of calcium, iron, and zinc in their diets absorb less lead than children with dietary deficiencies. In addition, a compromised nutritional state makes one more susceptible to the damaging effects that result from increased absorption of ingested lead. For example, there is evidence that dietary deficiencies of calcium, iron and zinc enhance the effects of lead on cognitive and behavioral development. (Goyer, R. 1995)

In addition, adults who have calcium deficiency and simultaneously experience other conditions that would normally mobilize calcium from the bones may mobilize lead that has been stored in bone tissue into the blood. These conditions include essentially healthy and normal conditions such as pregnancy, lactation, menopause, and aging as well as conditions such as physiologic stress, broken bones, hyperthyroidism, kidney disease and other chronic diseases. For example, a pregnant woman who has a low dietary calcium intake may release stored lead from her bones into her blood, where it becomes available to the fetus. (See Chapter 11 for detailed information for pregnant and lactating women.)

Children with elevated blood lead levels are often at risk for poor nutrition, and their caregivers should receive nutritional counseling to help these children obtain a well-balanced and age-appropriate diet.

Lead Exposure from Water and Food

Water – Lead in water contributes about 10 to 20 percent of the total lead exposure for the average young child. Infants and young children may consume large quantities of water in formula and other liquids.

Lead levels in drinking water can increase when the water is heated and/or remains in contact with lead-containing plumbing for extended periods of time, especially in areas where water is corrosive (soft). Water can be the source of lead in reconstituted juices and beverages, and foods that are boiled or prepared using large amounts of lead-contaminated water.

Because of the volume consumed, formula made with lead-contaminated water is especially dangerous to infants. Steps should be taken to avoid using water that is: (1) first-draw morning water; (2) drawn from the hot water tap; (3) boiled longer than 10 minutes (causing lead to concentrate); and/or (4) boiled in lead-containing vessels.

To minimize lead exposure from water, use only water from the cold water tap. If tap has not been used for six hours or longer, run the tap water for two to three minutes or until icy cold before beginning formula or food preparation. If the lead level in tap water is of concern, bottled water should be used for mixing formula. If water for formula is boiled, boiling time should be limited to five minutes.

Lead contaminated water is rarely identified as a source of lead for Wisconsin children, where the primary source is deteriorated lead-based paint. However, to rule out lead as a source of exposure, water testing can be done through the Wisconsin State Laboratory of Hygiene (WSLH). Sampling kits can be ordered by calling the WSLH at 800-442-4618 or 608-224-6202.

Food Containers – Containers that contain lead can contaminate food that is cooked, stored or transported in the container. Lead-soldered cans, lead-glazed pottery, cracked or chipped pottery, and leaded crystal can all be sources of lead in food. The longer the food or beverage is exposed to a leaded container, the more contaminated it will become. Hot or acidic liquids also promote the leaching of lead from containers. In 1995 the U.S. banned the use of lead solder in food containers and regulates lead content in pottery glaze. However, imported foods or dishes may continue to be a source of lead contamination of food.

Supplements – Natural calcium supplements such as bone meal, oyster shells, and dolomite can also be contaminated with lead. Pregnant women should especially be cautious of these sources of calcium supplement. Several recent studies found that many commercially available calcium supplements do not meet acceptable limits for lead intake (less than 1 microgram of lead per day). Antacids and infant formulas had less lead contamination than other calcium supplements.

Herbal supplements may contain lead. A population based (NHANES) study of 6,712 women found that women who used herbal supplements had blood lead levels 10 percent higher than non-users; women of reproductive age (aged 16 to 45) who used herbal supplements had blood lead levels 20 percent higher than non-users (Buettner C., et al. 2009).

Soil – Lead can enter the food chain when vegetables and fruits are grown in soil that is contaminated with lead. Lead-contaminated soil is most often found next to old painted buildings, near roadways, near manufacturing and renewal/demolition sites, and in old orchards (from the use of fertilizers or pesticides containing lead). Leafy or root vegetables are more likely to be lead-contaminated than fruiting plants (Sharma et al, 2005, Spitler and Feder, 1979). Dust from sources such as remodeling, demolition, manufacturing and roadways can contaminate garden produce. If food preparation surfaces and foods are near such lead sources and are not protected from dust by covers or wrappings, they can also become lead-contaminated.

Lead from soil and dust can also be ingested by infants and very young children who mouth objects or their hands. It is normal, developmentally-appropriate behavior for children to put their hands and other objects in their mouths as they grow up. Careful handwashing before eating and after play can reduce potential lead exposure if the child lives in an older house with deteriorated paint, varnish or contaminated soil.

Nutrients and Eating Patterns Minimize Lead Absorption

The timing and types of nutrients in the diet can minimize absorption of ingested lead into a child's body. Adequate intake of certain vitamins and minerals, especially calcium, iron and vitamin C, beyond their requirement for overall good nutrition, can specifically minimize absorption of ingested lead (see Table 9.1).

Regular Meals and Snacks Decrease Lead Absorption – Stomachs that are full are less able to absorb lead. Gastrointestinal (GI) absorption of lead is three to four times greater during periods of fasting than during periods of feeding. Infants, young children, and pregnant women should consume well-balanced meals and snacks at regular intervals during waking hours to help minimize lead absorption. Infants and young children should be fed at least every three to four hours, or six smaller meals per day, to keep stomachs full and less likely to absorb lead.

Calcium – The more calcium a child consumes, the less of the ingested lead is retained by their body. Calcium and lead seem to compete for absorption in the GI tract and storage sites in the bones. Remobilization and subsequent elevation of blood lead levels occurs most readily when dietary calcium intakes are low and/or when calcium needs are increased, as during pregnancy, periods of bone growth, lactation, and following bone fractures. A combination of calcium and phosphorus in the diet further reduces lead absorption, making plant sources of calcium especially effective in minimizing lead absorption.

Iron – Iron deficient individuals absorb two to three times more lead than individuals with adequate levels of blood iron. Iron and lead interact and compete in heme synthesis. Even slight decreases in hematocrit allow increased lead absorption. In addition, more severe anemia occurs when blood lead levels reach approximately 40 mcg/dL. However, there is strong evidence that iron supplements are not effective at reducing lead levels once exposure has occurred (Rosado J., L., et al, 2006 and Gulson, B.,L., et al., 2006). See Chapter 8: Medical Management of Lead Poisoned Children for more information on diagnosing iron deficiency.

Vitamin C – Diets rich in Vitamin C enhance iron absorption and may decrease the absorption of lead. Decreased lead retention has been shown in rats fed Vitamin C and exposed to lead (Goyer and Cherian, 1979; Suzuki and Yoshida, 1979; Flora and Tandon, 1986) but less is known about children exposed to lead and benefitting from additional supplements of Vitamin C beyond what they get from an adequate diet (CDC, 2002).

Table 9.1. Adequate intake of these foods can help protect children from lead absorption and retention

Calcium	Milk, cheese, yogurt, kale, collards, turnip greens, canned salmon, sardines with bones
Iron	Lean meats and poultry, seafood, cereals and breads fortified with iron, peanut butter, nuts, dried beans and peas, raisins, prunes, prune juice, greens such as broccoli and spinach
Vitamin C	Tomatoes, oranges, grapefruits, juices, juices fortified with vitamin C, strawberries, kiwi, green peppers, watermelon, cantaloupe, potatoes

Iron Deficiency and Lead Poisoning

Iron deficiency can enhance lead absorption and often co-exists with lead poisoning. In addition, research indicates that iron deficiency in young children can be an independent neurotoxin, as well as enhancing the effects of lead poisoning on the central nervous system.

Adequate iron intake lowers lead absorption, and should be considered an essential secondary tool to protect children from absorbing lead they ingest from their environments. While the effect of lead on red blood cell production rarely occurs until BLLs reach approximately 40 mcg/dL, low iron stores promote absorption of lead at any blood lead level. Many U.S. children aged 1 to 2 have daily iron intake below recommended amounts. When exposed to lead hazards, these children may see the lasting effects on cognitive development due to both iron deficiency in infancy and the long lasting negative effects due to lead.

All children with BLLs $\geq$5 mcg/dL should be evaluated for iron deficiency. Serum iron and iron binding capacity are the tests of choice, as they are the most sensitive indicators of iron status.

If iron deficiency is diagnosed, treatment should begin along with treatment of the lead exposure. (*Note: Children receiving BAL (dimercaprol) as a chelating agent should not be treated for iron deficiency until the drug therapy is completed.)*

Testing for Lead Poisoning and Providing Education in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

WIC clinics are opportune sites for blood lead testing and nutrition counseling related to lead poisoning. Wisconsin children who are enrolled in WIC have a higher prevalence of lead poisoning than children who are not enrolled. Children regularly receive capillary (fingerstick) blood tests for hematocrit or hemoglobin levels as part of the WIC certification process. Including a blood lead sample requires only a few more drops of blood. Because of the close tie between nutrition and lead poisoning, WCLPPP has worked closely with the Wisconsin WIC program and Wisconsin Medicaid Program to facilitate blood lead testing at WIC project sites. As a result, many local WIC projects in Wisconsin currently offer blood lead testing in partnership with the local health department and managed care organizations. It's important to note that federal WIC funds cannot be used to obtain blood lead tests. See Chapter 12 for information on Medicaid reimbursement for blood lead testing and Medicaid certification for WIC projects.

The WIC data system, ROSIE, includes fields for documentation of blood lead test results. WIC projects that perform blood lead tests must assure the test results are reported to the WCLPPP. See Chapter 5 for information on blood lead reporting requirements. WIC providers can request access to the Wisconsin Blood Lead Registry to assist in determining whether a child is in need of testing (see Chapter 5: Screening and Diagnosis).

The WIC nutrition education card series includes a card entitled "Eating Right: Preventing Childhood Lead Poisoning" [P-44968 (English) and P-44968S (Spanish)] that provides nutrition and other tips to decrease lead absorption. WIC and local health departments can order this card using a form requisition from the Department of Health Services Forms and Publications Center.

A publication from the Environmental Protection Agency, *Fight Lead Poisoning with a Healthy Diet,* can be ordered from the National Lead Information Center, 1-800-424-LEAD (5323). This pamphlet includes fun recipes for young children to encourage healthy eating.

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