Chapter 5
Prenatal Lead Testing

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Key Points

- Lead crosses the placenta, adversely affecting the mother and child during pregnancy.
- Most lead in the body is stored in bone. During pregnancy and lactation, increased bone turnover can release lead into the bloodstream, leading to exposure of the fetus.
- Prenatal exposure to lead has been associated with impaired fetal growth and neurodevelopment, even at low blood lead levels. Maternal lead exposure may increase the risk of hypertension in pregnancy and spontaneous abortion.
- Risk factors for lead exposure during pregnancy and lactation include:
    - Renovation/remodeling of a pre-1978 home
    - Recent immigration
    - Living in a high-risk geographic area
    - Having a household member with an elevated lead level
    - Pica (consumption of non-food items)
    - Occupational exposure to lead (patient or other household member)
    - Poor nutritional status (e.g., anemia, calcium, iron or zinc deficiency)
    - Use of Ayurvedic and other traditional medicines and imported pottery, spices and cosmetics
    - Hobbies such as making stained glass, shooting guns or making bullets, and making ceramics using leaded glaze

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- *No* amount of lead is considered safe, but a confirmed blood lead level (BLL) ≥5 µg/dL is the action level recommended by the Centers for Disease Control and Prevention (CDC) for pregnant women and children. A woman with a confirmed BLL ≥10 µg/dL should be removed from work-related exposure.
- The American College of Obstetricians and Gynecologists and CDC recommend risk-based screening rather than universal screening for *most* pregnant and lactating women. Universal screening is recommended by the CDC for women in high-risk geographic areas. A lead and pregnancy risk questionnaire is available

in English and Spanish at the end of this chapter and from the NC Division of Public Health, Women's Health Branch Forms website under Maternity Services: https://whb.ncpublichealth.com/provPart/forms.htm. A positive response to any question should prompt blood lead testing.

- If the mother's BLL is <40µg/dL, she may still breastfeed her baby. However, if the mother's BLL is ≥40µg/dL, her breast milk should be pumped and discarded until the BLL decreases. At-risk women not tested during pregnancy should be tested post-partum if they plan to breastfeed.

Introduction

Testing the blood lead levels (BLLs) of asymptomatic young children has been recommended for decades for secondary prevention of lead poisoning in childhood. The first national public health guidelines for the identification and management of lead exposure in pregnant and lactating women were produced by the Centers for Disease Control and Prevention (CDC) in 2010.[1] The American College of Obstetricians and Gynecologists (ACOG) published a committee opinion paper in 2012 (reaffirmed in 2016) that supported the CDC's recommendations for screening pregnant women.
The assessment of risk factors for lead exposure "should take place at the earliest contact with the pregnant patient."[2]

The purpose of this chapter is to discuss how prenatal exposure to lead can occur, when to order a blood lead test for a pregnant or lactating woman, the harmful effects of lead exposure on the health of mother and baby, and the recommended management of exposed women and resources available through the North Carolina (NC) Division of Public Health. Testing of children is discussed in Chapter 2 of this manual.

Lead absorption, storage and distribution in the body

Lead in the environment enters the human body primarily through ingestion. Lead is absorbed by the gut, then enters the bloodstream and is spread by circulation to organs and bone. Lead readily crosses the placenta, thus exposing the fetus. Umbilical cord blood lead measurements at birth have been shown to correlate with maternal blood lead levels at the time of delivery. Lead in the mother's blood also passes into breastmilk, but at a lower level. It is thought that lead in breast milk reflects approximately 3% of maternal blood lead. [1] Lead can also be inhaled and absorbed by lung tissue. Since lead was removed from gasoline beginning in the 1970s, non-occupational exposure by inhalation is less of a concern. While blood lead is the preferred biomarker for lead exposure, most lead in the body is stored in bone. Pregnancy and lactation are periods when increased

bone turnover may causing leaching of bone lead to the blood. Exposure of the child may occur through cross-placental diffusion or by excretion in breastmilk. Testing bone and breastmilk for lead is not commonly performed unless for research.

Postpartum, breastfeeding is encouraged unless the BLL ≥40µg/dL. If a mother has a BLL ≥40µg/dL, pumping and discarding of breastmilk is recommended until the BLL decreases.

Potential adverse health effects for mother and baby

No level of blood lead is considered "safe" as lead has no known benefit to human health. The most sensitive target for lead toxicity is the central nervous system. Numerous studies have documented the harmful effects of low-level lead exposure on the developing brain leading to problems with learning and behavior. At high levels of lead exposure, brain inflammation and swelling can lead to seizures, coma and death. In children and adults, lead exposure can cause multiple toxic effects including anemia, constipation, fatigue, kidney disease, gout, vascular disease (including hypertension) and balance problems (ataxia). Pregnant women are vulnerable to all the usual adverse effects of lead exposure as well as pregnancy-specific adverse health effects. Elevated lead levels in pregnancy have been associated with gestational hypertension (hypertension that develops after the 20th week of pregnancy without proteinuria), but not with pre-eclampsia or eclampsia.[7] Studies have shown a relationship between high blood lead levels and spontaneous pregnancy loss (miscarriage) as well as lower birth weights.[2] It is important to remember that most lead is stored in bone and that the blood lead level does not reflect the total body burden of lead.

Risk Factors for Exposure

Known risk factors for exposure to lead are listed below. It is important to realize that new risk factors continue to be identified. In the 1990s, vinyl mini-blinds were identified as a source of lead exposure [3]. Recently, lead in imported spices and traditional medicines has been identified as the cause of elevated blood lead levels in children in North Carolina and other states [4, 5]. It is expected that new sources will continue to be identified.

<u>Renovation/remodeling of an older home</u>

In 1978, lead-based paint for residential use was banned in the U.S. Homes built before this date, especially those built before 1960 probably contain lead paint. When disturbed through renovation, repair or painting or if aged paint is peeling, lead dust is created and can be ingested or inhaled. Encourage clients to follow the Environmental Protection Agency (EPA) recommendations for lead-safe renovation, repair and painting (RRP) and

to hire contractors and painters who are certified. A link to a list of RRP-certified contractors in North Carolina can be found at: http://nchealthyhomes.com/lead- poisoning/; click on “Find a certified lead professional.”

Recent immigration

Lead paint and leaded gasoline are no longer in common use in the U.S. however, other countries may have less stringent environmental standards. Studies have indicated that women born outside the U.S., especially from parts of central and South America, Africa and Asia, are more likely to have an elevated blood lead level compared to U.S.-born women [1].

Living in a high-risk geographic area

Location near a manufacturing facility, battery reclamation facility or lead smelter increases the risk of exposure. Living in a geographic area with higher numbers of children with elevated BLLs, a large immigrant or refugee population or a high percentage of pre-1978 housing increases the risk that a woman may have lead exposure. Consider universal screening of patients from these areas. Data on higher-risk geographic areas and county-level BLL data are available from the NC Childhood Lead Poisoning Prevention Program at https://ehs.ncpublichealth.com/hhccehb/cehu/.

Lead water service lines

While drinking water utilities are required to test for lead in treated water, an individual still may be exposed if the service lines and home water pipes or faucets have lead in the metal or solder. Leaching of lead at the point of use into drinking water may occur if there is corrosion of the supply lines. This was a contributing factor that caused increased lead in drinking water in the city of Flint, Michigan in beginning in 2014.

Occupational exposure to lead

Many people are not aware that there are industries in North Carolina that use or produce lead. Lead dust can be brought into the home or car on contaminated clothing or shoes by the patient or a member of their household. Asking about possible occupational exposure is an important part of the risk assessment. Manufacturing of lead oxide and battery reclamation or manufacture are high-risk industries. [6] Other occupations that are high risk for lead exposure include painting and renovation/remodeling of homes built before 1978, law enforcement, operation or use of shooting ranges and production or use of lead bullets or fishing weights.

Hobbies with a risk of lead exposure

Known hobbies that carry a risk of lead exposure including stained glass making using lead solder, shooting guns (unless lead-free ammunition is used) or making bullets, restoring antique furniture or toys, and making ceramic pottery using leaded glaze. Homeowners living in older homes that are being renovated or DIY (“do it yourself”) renovators are also at risk.

Pica (consumption of non-food items)
Women engaging in pica, the consumption of non-food items, may ingest lead if contaminated soil, painted furniture or metallic items including car keys are chewed or eaten.

Poor nutritional status (e.g., anemia, calcium, iron or zinc deficiency)
Iron deficiency, anemia (lower than normal hemoglobin), calcium and zinc deficiencies can enhance the absorption of lead. Lead can mimic positively charged elements like calcium and insert itself into and disrupt biochemical processes that use these elements. Lead also competes with iron for incorporation into red blood cells.

Use of Ayurvedic and other traditional medicines, imported pottery, spices and cosmetics
An emerging source of lead exposure in North Carolina is the use of imported spices, powders and cosmetics (e.g., surma, kohl) and traditional remedies (e.g., Balguti kesaria). Imported ceramic pottery with lead glaze has been a known source of exposure for some time--use of such items for food storage or preparation is discouraged. Environmental health investigations of children with elevated BLLs in North Carolina 2011-2018 revealed lead contamination of sampled herbal remedies, imported spices and imported ceremonial powders. These findings were published in the CDC Morbidity and Mortality Weekly Report (https://www.cdc.gov/mmwr/volumes/67/wr/mm6746a2.htm?s_cid=mm6746a2_e).

Screening for lead exposure during pregnancy and lactation

The CDC and ACOG recommend the use of a risk assessment tool to identify women who should be screened for lead exposure. If any risk factor is identified, a blood lead test should be ordered. The North Carolina **"Lead and Pregnancy Risk Questionnaire"** for prenatal care patients can be found at the end of this chapter and online at https://nchealthyhomes.com/lead-poisoning/ and https://whb.ncpublichealth.com/Forms/4116S-LeadandPregnancyRisk-062618.pdf in both English and Spanish.

The CDC recommends *universal* screening of pregnant or lactating women who live in a known high-risk geographic area, including those living in an area with a manufacturing facility that produces lead.

Blood lead testing should also be performed if a woman has symptoms that could be explained by lead poisoning. Some symptoms of lead poisoning, such as constipation and fatigue, are non-specific and common in pregnancy [1].

Management of blood lead test results

The recommended public health action level for pregnant women is a *confirmed* BLL ≥5 µg/dL. If an initial BLL is elevated, a second venous sample should be drawn and sent to a reference laboratory for confirmation as skin contamination or improper sample collection can lead to falsely elevated blood lead results. The NC Public Health Follow- Up Schedule is found in **Table 1**. Beginning in July 2017, any pregnant woman with a *confirmed* BLL at or above the action level of 5µg/dL is eligible for a free environmental health assessment to identify the source of lead exposure. These assessments are done by registered environmental health specialists based at the state and local health departments. Prenatal care providers must refer patients for the environmental assessments using the referral form at the end of this chapter and online at https://whb.ncpublichealth.com/provPart/docs/matHealthManual/PrenatalLeadInvestigationReferralForm-FINAL-Dec2017.pdf

Chelation

Using a chelating agent to rapidly lower the blood lead level may be considered on an individual case basis for women with a confirmed BLL ≥45µg/dL. These cases should be considered as high-risk pregnancies and specialists in high-risk obstetrics and medical toxicology should be consulted regarding management. [1] The most immediate action should be intervention(s) to stop further lead exposure. In some cases, hospitalization of the patient may be required. BLLs ≥70µg/dL may cause significant toxicity, including cerebral edema (brain swelling), and should be treated as a medical emergency.

Medical providers can contact **NC CLPPP** at **(919) 707-5950** or call NC Poison Control at (800) 222-1222 if urgent medical toxicology consultation is needed.

Nutrition and Lead Poisoning

For women with a BLL ≥5µg/dL, the CDC recommends a total daily calcium intake of 2,000mg through diet and supplementation. Women should also be screened for iron deficiency and treated as per usual recommendations for pregnancy. Zinc deficiency is uncommon in the U.S. and no routine testing is recommended.

Ordering Prenatal Blood Lead Tests in North Carolina

- Any prenatal care provider can order a prenatal blood lead test. All tests should be from venous (not capillary) samples and analysis should be done at a reference laboratory (not on a point-of-care lead analyzer).

- ***New*** - Lead testing will be provided *at no charge* by the State Laboratory of Public Health for women tested at local health departments. The policy and a useful reference chart for follow-up testing and interventions based on BLL can be found at the end of this chapter and online at the Women's Health Branch website in the *Maternal Health Policy Manual* section under "Lead and Pregnancy": https://whb.ncpublichealth.com/provPart/docs/matHealthManual/NC-LeadPregnancyPolicyFINAL2018V9-July27-2018.pdf

- ***New*** - *Any* provider can make a referral for a home lead investigation by the local health department environmental health staff when a pregnant woman is found to have two consecutive venous blood lead levels ≥5µg/dL within a 12-month period. To make a referral, the provider should fax the completed **Prenatal Lead Investigation Referral** form to the NC Childhood Lead Poisoning Prevention Program at 919- 841-4015. This form can be found at the end of this chapter and at the Women's Health Branch website in the *Maternal Health Policy Manual* section under "Lead and Pregnancy": https://whb.ncpublichealth.com/provPart/docs/matHealthManual/PrenatalLeadInvestigationReferralForm-FINAL-Dec2017.pdf

Table 1: Clinical Follow-Up for Pregnant Women

Initial Blood Lead Results	Frequency of Follow-Up Testing	Recommended interventions according to BLL in Pregnancy
<5 µg/dL	No confirmatory or follow-up testing necessary	• Educate about lead exposure sources and risk reduction
5-9 µg/dL	Conduct confirmatory testing within 1 month and follow-up testing every 3 months for the duration of the pregnancy until 2 consecutive BLLs are <5µg/dL ***Recommend that the baby's medical provider be alerted to the maternal elevated blood lead level.***	*Above actions in addition to:* • Provide case management • Attempt to determine source of lead exposure (home, work, pica) • Counsel on strategies to reduce exposure • Assess for adequacy of patient's diet • Provide prenatal vitamins and nutritional guidance emphasizing adequate Calcium and Iron intake with Vitamin C to enhance absorption For occupationally exposed patients (yes to question #6 on questionnaire) review safe work practices: hand washing, showering before going home, proper laundering of work clothes • Provide patient with the following: "**Lead Facts**" and "**Lead and Your Occupation"** • If required by employment, encourage wearing a clean/well-fitted respirator • Consider contacting the employer about assistance with safe work practices
10-24 µg/dL	Conduct confirmatory testing within 1 month and follow-up testing monthly for the duration of the pregnancy until 2 consecutive BLLs are <5µg/dL	*Above actions in addition to:* • Recommend removal from workplace lead exposure

25-44 µg/dL	Confirmatory test within 1-4 weeks and follow-up testing monthly for the duration of the pregnancy until 2 consecutive BLLs are <5µg/dL	*Above actions in addition to:* • Advise not to breastfeed and discard breastmilk if BLL ≥40µg/dL • Testing milk is not recommended
≥ 45 µg/dL	Confirmatory test within 24 hours and then at frequent intervals for the duration of the pregnancy depending on clinical interventions and trend in BLLs Should be considered and treated as high-risk pregnancy Patient may require hospitalization or transfer of care to a high-risk obstetrical practice	*Above actions in addition to:* • Consult a provider (e.g., medical toxicologist) specializing in lead poisoning treatment before considering chelation for the patient

References

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7. Rabinowitz M, Bellinger D, Leviton A, Needleman H, Schoenbaum S. Pregnancy hypertension, blood pressure during labor, and blood lead levels. Hypertension. 1987;10(4):447–51. doi: 10.1161/01.HYP.10.4.447.

FORMS AND EDUCATIONAL RESOURCES

Lead and pregnancy risk questionnaire (English)
https://whb.ncpublichealth.com/Forms/4116E-LeadandPregnancyRisk-062618.pdf

Bilingual lead and pregnancy risk questionnaire (English/Spanish)

https://whb.ncpublichealth.com/Forms/4116S-LeadandPregnancyRisk-062618.pdf

Prenatal lead investigation referral form

https://whb.ncpublichealth.com/provPart/docs/matHealthManual/PrenatalLeadInvestigationReferralForm-FINAL-Dec2017.pdf

NC Public Health, Maternal Health, "Lead and Pregnancy" policy (includes table of recommended follow-up testing intervals and interventions based on blood lead level; Table 1)

https://whb.ncpublichealth.com/provPart/docs/matHealthManual/NC-LeadPregnancyPolicyFINAL2018V9-July27-2018.pdf

Summary of Actions based on Maternal and Infant Blood Lead Levels

https://whb.ncpublichealth.com/Manuals/SummaryChart-clinics.pdf

PATIENT EDUCATION

Lead and Pregnancy brochure (English)

https://nchealthyhomes.com/files/2017/07/Prevent-Lead-in-Pregnancy_July-2017_English_for-web.pdf

Lead and Pregnancy brochure (Spanish)

https://nchealthyhomes.com/files/2017/07/Prevent-Lead-in-Pregnancy_July-2017_Spanish_for-web.pdf