

Childhood Lead Poisoning in Wisconsin

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ABSTRACT

Introduction: In 2016, 4,353 Wisconsin children under 6 years of age were identified with elevated blood lead levels (≥ 5 $\mu\text{g}/\text{dL}$). There is no safe level of lead in the human body; extensive research shows that children with blood lead levels < 5 $\mu\text{g}/\text{dL}$ may still be at risk for adverse health effects including developmental delays.

Discussion: Physicians should follow current guidelines and consider factors such as the child's age, socioeconomic status, and housing situation when determining need for testing. In addition to Wisconsin's screening recommendations, federal requirements exist for testing Medicaid-enrolled children. Under state statute, all blood lead test results and specified demographic information must be reported to the Wisconsin Childhood Lead Poisoning Prevention Program. To eliminate elevated blood lead levels, primary prevention is key. Physicians play an important role by educating parents, prospective parents, and caregivers about lead poisoning risks and prevention measures. Physicians are also vital in secondary prevention—mitigating the adverse effects in children already exposed to lead. Secondary prevention requires first identifying children with elevated blood lead levels through appropriate testing. Use of the Wisconsin Blood Lead Registry can alert providers about children with elevated blood lead levels and reduce duplicate testing. Recent surveillance data show current screening is inadequate; in 2015, only 32% of Medicaid-enrolled children received appropriate testing. Physicians should provide clinical management for children with elevated blood levels and their families.

Conclusions: Physicians are a vital partner in preventing, identifying, and mitigating the effects of elevated blood lead levels for Wisconsin's children.

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INTRODUCTION

Elevated blood lead levels cause serious harm to the physical and mental health of children, with concomitant societal burdens of increased educational and health care costs, higher incarceration rates, and loss of productivity in the workforce. Children exposed to lead even at levels below the Centers for Disease Control and Prevention's (CDC) "reference value" of 5 $\mu\text{g}/\text{dL}$ in blood may be at risk for developing an array of adverse, long-term health effects (reviewed in a recent National Toxicology Program report¹) including neurological and developmental delays. Adverse outcomes of childhood lead exposure are also observed in adulthood.

In this review, we present data on elevated blood lead levels in Wisconsin children, with an emphasis on the most recently available data (2016), as well as information on the physician's role in screening, primary prevention, and secondary prevention of elevated blood lead levels. Use of the Wisconsin Blood Lead Registry and the role of public health in secondary prevention are reviewed.

In Wisconsin, there were 4,353 children under age 6 years identified with elevated blood lead levels (5 $\mu\text{g}/\text{dL}$ or higher) in 2016 alone. The sale of lead-based paint and varnish for household use was banned in the United States in 1978, but this paint is still present on the walls, windows, wood trim, doors, floors, and ceilings of many older homes. While lead in water has been prominent in the media due to the situation in Flint, Michigan, lead-

poisoning remains a significant public health concern. This review discusses the current state of lead poisoning in Wisconsin, the role of the physician in preventing, identifying, and mitigating the effects of lead poisoning, and the role of the Wisconsin Blood Lead Registry in secondary prevention.

based paint remains the primary source of lead exposure for children in Wisconsin. Physicians and other health care providers play a crucial role in screening for and in the prevention of childhood lead exposures and their consequences.

Elevated Blood Lead Levels in Wisconsin Children

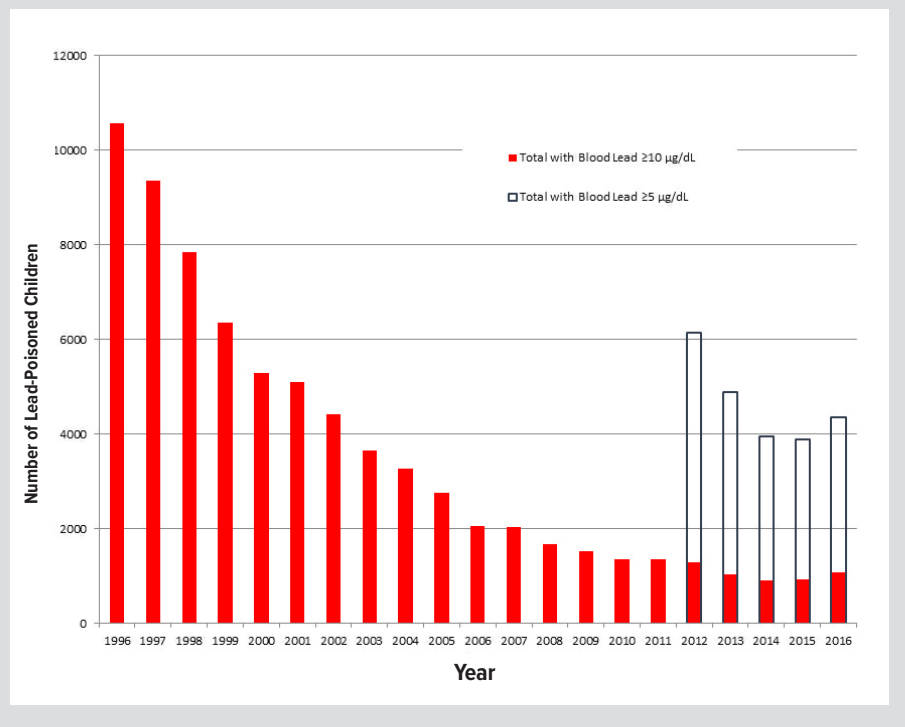
In 1994, the Wisconsin Department of Health Services Childhood Lead Poisoning Prevention Program (WCLPPP) began systematically collecting information on all blood lead tests conducted in Wisconsin. Under the requirements of Wis. Stat. § 254.13, laboratories—including clinics that perform lead testing on site—must report the results and specified demographic information associated with all blood lead tests. The WCLPPP maintains the blood lead testing data in a relational database, which forms the basis for analyses and surveillance activities conducted at the state level.

From 1996 through 2016, more than 200,000 Wisconsin children under age 6 years were identified with elevated blood lead levels using the current CDC reference value of 5 µg/dL, or about one-fifth of all children under age 6 who received a blood lead test during that time period. During 2016 alone, 87,443 children under age 6 years received a blood lead test, and 5% (n=4,353) were identified with elevated blood lead levels. As shown in the Figure, the number of children considered to have elevated blood lead levels had been declining steadily but increased dramatically in 2012 when the CDC changed its “level of concern” of 10 µg/dL to a “reference value” of 5 µg/dL.

Importantly, the number of children tested has decreased over the past 6 years, with 18,000 fewer children tested in 2016 compared with 2010. Further, the number of children tested in 2016 represents only about 22% of children under age 6 years in Wisconsin, and it is likely that some of the children not tested were at risk for lead exposure and elevated blood lead levels. Thus, the data presented here underestimate the true number of children with elevated blood lead.

With the data available, it is not possible to estimate the exact number of children at risk for elevated blood lead levels who should receive testing. However, there are some indicators of the extent of the problem. In 2016, there were an estimated 662,013 housing units built before 1950 in Wisconsin;³ this older housing is the most likely to have lead based paint hazards present. According to the US Department of Housing and Urban Development survey of the prevalence of lead hazards in US housing, about one-third of housing units in the Midwest have lead hazards (compared to 25% for the United States as a whole), and further, older housing was more likely to be occupied by families with children.⁴ With respect to income,

Figure. Number of Children Under Age 6 Years Found to Have Elevated Blood Lead Levels, Wisconsin, 1996-2016



the 2015 American Community Survey indicates that there were over 63,000 children aged under 5 years living in poverty in Wisconsin.⁵ Among the 203,068 children aged under 6 years who were enrolled in Medicaid in 2015, over one-third (n=71,565; 35.2%) had never been tested for lead. These factors indicate that not all physicians are appropriately testing children who are at risk for lead exposure.

Factors Affecting Risk for Elevated Blood Lead Levels and Recommendations for Lead Testing

A number of factors affect a child’s risk for elevated blood lead levels and consequent recommendations for timing and frequency of lead testing. The most important of these are age of housing and the child’s age. In conjunction with screening guidelines discussed below, these factors and others should be considered by physicians when recommending lead testing.

Age of House—Children living in older housing, where lead-based paint is more prevalent, are at greater risk for elevated blood lead levels than children who live in newer housing. In Wisconsin, 90% of children first identified with lead poisoning from 1996 to 2006 lived in homes that were built before 1950.⁶ Consequently, while elevated blood lead levels are a risk statewide, significantly higher rates are seen in certain communities or parts of communities with higher prevalence of older housing and other risk factors for elevated blood lead levels. For example, of the Wisconsin cities with at least 100 children tested in 2015, the cities with the 10 highest prevalence rates of elevated blood lead levels were Milwaukee (9.3%), Racine (8.2%), Beloit (8.1%), Sheboygan (7.1%), Hartford (6.9%), Two Rivers (6.5%),

Table. Wisconsin Blood Lead Screening Recommendations

Age	Screening Criteria	Testing Interval
Children living in Milwaukee or Racine		
≤24 months of age	All children	At ages 12, 18, and 24 months
3-5 years of age	≥1 risk factor ^a or no record of prior test	Annually at ages 3, 4, and 5 years
Children living outside Milwaukee or Racine		
≤24 months of age	≥1 risk factor ^a	At ages 12 and 24 months
3-5 years of age	≥1 risk factor ^a and no record or prior test	Once between 36-72 months of age

^a Risk factors for lead poisoning:

- Enrolled in Medicaid or the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) (proxy for low socioeconomic status).
- Lives or spends time in housing unit built before 1950.
- Lives or spends time in housing unit built before 1978 with recent/ongoing renovations.
- Sibling or playmate with lead poisoning.

not sure about certain factors (such as age of home) it is better to err on the side of caution and test the child if he or she may be at risk for lead exposure. In addition to Wisconsin screening recommendations, federal requirements exist for children enrolled in Medicaid.

Children Living in Milwaukee and Racine, Wisconsin—The Wisconsin Blood Lead Screening Recommendations include universal testing of all children living in the cities of Milwaukee and Racine. Because the extremely high proportion of older housing in these communities creates an extremely high risk of elevated blood lead

Watertown (6.5%), Beaver Dam (6.3%), New London (6.0%), and Janesville (5.5%). The prevalence rates of elevated blood lead levels in these cities are higher than the 2015 statewide rate of 4.6% and are calculated as the number of children with a blood lead level ≥5 µg/dL over the number of children tested.

Age of Child—One of the most important determinants of lead exposure is age. A child's blood lead level tends to be highest between 18 and 36 months of age because frequent hand-to-mouth behavior and increased mobility make lead-containing dust more accessible to the child. Additionally, for a given amount of lead exposure, younger children would generally experience a greater impact compared with older children or adults given their smaller size and higher rate of absorption. Although physicians should recommend at-risk children be tested around 1 year of age for early identification and intervention, it is also very important that children be tested again around 2 years of age or later, when they become more mobile and their risk of exposure to lead is greater. According to the American Academy of Pediatrics, a low blood lead concentration in a 1-year-old does not preclude elevation later.⁷ While a normal blood lead test at 1 year of age is reassuring, children are still at risk for elevated blood lead levels as they age and should be retested.

Socioeconomic Factors—Another characteristic affecting lead testing and exposure is family income. Children from low-income families are at greater risk for elevated blood lead levels, largely because they have limited options for selecting housing. In Wisconsin, Medicaid-enrolled children are at a 3 times greater risk of lead poisoning than non-Medicaid-enrolled children.

Wisconsin Blood Lead Screening Recommendations

Clearly, there are many factors that affect risk of lead poisoning for Wisconsin children. These factors have been used to develop the Wisconsin Blood Lead Screening Recommendations⁸ (Table), which recommend targeted screening of children who are at greatest risk for lead poisoning. If the parent or caretaker is

levels, each child should have a blood lead test 3 times before the age of 3 years: around 12 months, 18 months, and 24 months. Children aged 3 through 5 years should be tested annually if they meet one or more of the following risk criteria:

1. Enrolled in Medicaid, enrolled in the Women, Infants and Children Food and Nutrition Service (WIC), or is uninsured (proxy for low socioeconomic status).
2. Live in a housing unit built before 1950.
3. Live in a housing unit built before 1978 with recent or ongoing renovations.
4. Have a sibling or playmate with lead poisoning.
5. Have no record of a prior test.

Children Living Outside Milwaukee and Racine—When seeing children from areas outside the cities of Milwaukee and Racine, health care providers are encouraged to use the Four Easy Questions below to determine whether a child is at risk for elevated blood lead levels and, if there is no record of a previous test, whether the child should be tested at around 12 months and 24 months of age and between 36 and 72 months of age:

1. Is the child enrolled in Medicaid or WIC (proxy for low socioeconomic status)?
2. Does the child live in or visit a housing unit built before 1950 (including childcare facilities and homes of friends or relatives)?
3. Does the child live in or visit a housing unit or building built before 1978 with recent or ongoing renovations (including childcare facilities and homes of friends or relatives)?
4. Does the child have a sibling or playmate with elevated blood lead levels?

Children Enrolled in Medicaid—Children enrolled in Medicaid are required to receive blood lead testing as part of their Early and Periodic Screening, Diagnostic and Treatment (EPSDT), ie, HealthCheck services. More specifically, “all children enrolled in Medicaid should receive a screening blood lead test at 12 and 24 months of age ... Children over the age of 24

months, up to 72 months of age, for whom no record of a previous screening blood lead test exists, should also receive a screening blood lead test.”⁹ The Wisconsin Medicaid Program collaborates with the WCLPPP in linking program data to determine blood lead testing and elevated blood lead levels among Medicaid-enrolled children. This data linkage has demonstrated that, despite the federal testing policy, many Wisconsin children enrolled in Medicaid are not tested at the appropriate ages; in 2015, only 32% of Medicaid-enrolled children received the appropriate testing at both 1 and 2 years of age. WIC programs in Wisconsin are strong partners in assuring that children who are at risk for lead poisoning receive the blood lead tests they need. In 2014, 52.1% of Medicaid-enrolled children under 6 years of age who received a blood lead test were tested by a WIC provider rather than their primary health care provider. Many WIC projects have voluntarily established successful testing programs and act as a safety net, testing children who might otherwise be missed. However, while all WIC participants do receive some standard services, not all are tested at WIC for lead. Health care providers maintain primary responsibility for testing children during well-child visits.

Testing Using Point-of-Care Lead Testing Devices—Many health care providers have begun to test children’s blood lead levels using portable point-of-care lead testing devices, such as the LeadCare II. These devices offer increased ease and timeliness in collecting and analyzing blood samples and are a useful tool for increasing testing rates for providers and their patients. However, these blood lead test results are not automatically transmitted to the WCLPPP and must be reported by the clinic staff. WCLPPP staff has worked with the LeadCare manufacturer to maintain a list of clinics and laboratories that have purchased the devices and to inform these sites of the reporting requirements and procedures for Wisconsin. However, challenges remain in obtaining complete and timely reporting of results from these sites. As clinic staff turn over and newly hired staff are oriented to the device, reporting requirements may not be discussed. Clinics also may purchase LeadCare devices from a second party, and reporting requirements normally shared at time of purchase from the manufacturer are not conveyed to the new owner. All blood lead tests must be reported to the WCLPPP per statutory requirement, and physicians are a vitally important partner in ensuring that all lead test results are reported.

Use of the Wisconsin Blood Lead Registry

As children may be tested for lead outside of their medical home, preventing unnecessary duplicate screening by primary care providers is important. The State of Wisconsin provides physicians with access to all blood lead test results through the Wisconsin Blood Lead Registry (Lead Registry) via the Wisconsin Immunization Registry (WIR) portal. The Lead Registry is updated each week with new test results, including tests done at all locations, such as WIC sites, HeadStart, and physicians’ offices. The Lead Registry

also can help physicians to easily identify children who have not yet been tested or are due for another test. Information on how to access the Lead Registry is provided in Appendix A, which can be found at https://www.wisconsinmedicalsociety.org/_WMS/publications/wmj/pdf/118/1/AppendixA-Christensen.pdf.

Eliminating Childhood Lead Poisoning in Wisconsin

Primary Prevention—Because no level of lead is safe, primary prevention is the best way to eliminate childhood elevated blood lead levels. Primary prevention prevents exposure before it happens. Children can be exposed to lead-based paint in their homes, lead-contaminated soil in their yards, and potentially in their water supply if their housing unit has lead pipes or lead-containing solder. To a much lesser extent, other potential sources of exposure include lead in toys, candy, and other products, like imported spices and cosmetics. Physicians play a key role by educating parents and caregivers about elevated blood lead level risks and prevention measures so that they can take corrective action. Primary care physicians should initiate primary prevention as early as possible, ideally at a prenatal visit. If the family or caretakers live in older housing, clinicians should discuss ways to decrease exposure to lead and provide the family with written material to take home. (See Appendix B, which can be found at https://www.wisconsinmedicalsociety.org/_WMS/publications/wmj/pdf/118/1/AppendixB-Christensen.pdf.)

Special Considerations for Physicians Who Provide Prenatal Care and Services—Primary prevention should begin even before a child is born. Not only is prenatal care an important time to educate future parents about lead exposure, mothers who are themselves exposed may pass this lead to their fetus during gestation and through breast milk. The fetal blood lead level approximates the maternal blood lead level. The CDC has published guidelines for care of pregnant and lactating women,¹⁰ which include models of screening questionnaires to determine a woman’s risk for lead exposure. In brief, the most important action is to identify and remove potential sources of lead exposure. In addition, women should be assessed for dietary adequacy and counseled about breastfeeding options at higher levels of exposure. Physicians should ask about occupation, hobbies, home remedies, folk medicine, pica, and imported candies and ceramics to identify potential environmental sources. However, even with no current exposure, lead stored in bone from childhood exposure may be mobilized along with calcium during pregnancy and lactation, leading to an increased blood lead level. It is critical to counsel pregnant and lactating women on recommended intake of calcium, iron, and Vitamin C, as proper nutrition can reduce the absorption of lead and the mobilization of lead stored in bone (from previous lead exposure). However, these nutritional efforts are meant to mitigate some of the harmful effects of lead and are *not* a substitute for primary prevention.

Secondary Prevention—Physicians also play a key role in secondary prevention, or mitigating the adverse effects in children already exposed to lead. The first step is identifying children with elevated blood lead levels through blood lead testing. Elevated blood lead

levels in young children are primarily asymptomatic, therefore testing is the only way to detect them. As described above, many children are never tested for lead, including those at high risk for lead exposure. Consequently, many children with elevated blood lead levels are never identified and do not receive interventions, increasing their risk for the myriad health, educational, and social problems associated with prolonged exposure to lead. Although the reasons for not receiving required testing have not been identified fully, they include a mistaken belief that the child is not at risk or has been tested elsewhere (eg, WIC), lack of awareness of the Medicaid testing requirements, a decision by parents/guardians not to have their child tested, and logistical barriers (eg, the child is referred to an outside lab for the blood draw or the child changes health care providers).

Physicians are a vital partner in ensuring that children receive appropriate blood lead testing and that children identified with elevated blood lead levels receive appropriate care. The American Academy of Pediatrics has published "Prevention of Childhood Lead Toxicity,"⁷ which is one resource physicians may use to determine the course of follow-up, and other resources are listed in Appendix A. The CDC also has some specific advice for children with a blood lead level ≥ 5 $\mu\text{g}/\text{dL}$.¹¹

- Confirm an elevated capillary blood lead test with a venous sample.
- Provide follow-up blood lead monitoring according to the CDC recommended schedule.
- Conduct a complete history and physical exam on the child.
- Conduct the appropriate laboratory tests to assess iron status.
- Assess the child's growth and development (including neurological development¹²) and continue to monitor as the child ages and enters school.
- Provide education to the family on the sources of lead and how to reduce any possible lead hazards.
- Abdominal x-ray (if particulate lead ingestion is suspected) with bowel decontamination if indicated.
- Environmental investigation conducted by local health department and lead hazard remediation conducted by certified lead professional.
- Oral chelation therapy for blood lead levels of ≥ 45 $\mu\text{g}/\text{dL}$ or higher; consider hospitalization if lead-safe environment cannot be assured.

Public health plays a key role in secondary prevention. Local health departments provide nursing case management and environmental investigations for children with elevated blood lead levels. These services can identify and eliminate lead sources in the home and prevent future exposures to people living in the same residence. Providers can contact the local health department in their community for more information about available services and refer children with elevated blood lead levels for further assessment.

CONCLUSIONS

Wisconsin is making significant progress in protecting children from the harmful lasting effects of elevated blood lead levels, but much work remains to eliminate childhood elevated blood lead levels forever. Health care providers maintain primary responsibility for testing children, thus physicians are a vital partner in preventing elevated blood lead levels, identifying children already affected by lead, and reducing the adverse effects of lead exposure throughout the lifespan and across generations.

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