

Chapter 10

Developmental Assessment and Intervention for a Child with Lead Exposure

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In Brief: Summary of Recommendations for Developmental Assessment and Intervention

For an Individual Child

1. Make long-term developmental surveillance a component of the management plan for any child with lead exposure of 5 mcg/dL or greater.
2. Do not base decisions regarding developmental assessment or intervention on a child's age at the time of the lead exposure.
3. If referring a child for intervention services, e.g., early intervention and stimulation programs, it is recommended that a parent skills development component be included.
4. Include a history of a child's lead exposure in the problem list maintained in the child's medical record.
5. Do not end developmental surveillance when the child reaches 6 years of age or when his/her BLLs are reduced, but continue as the child ages.
6. Be especially vigilant for emerging difficulties at critical transition points in childhood: first, fourth and six to seventh grades.
7. Be alert for behaviors that might interfere with learning.
8. If neurodevelopmental problems are suspected in a child, refer for a thorough diagnostic evaluation (as opposed to a developmental screening test).
9. Be an advocate for the child.

For State and Local Childhood Lead Poisoning Prevention Programs (CLPPPs)

1. Educate parents and health care providers about the need for vigilance in the period following a test result and at critical transition points in educational expectations such as first, fourth and sixth grades, and about the merits of accepting a referral to early intervention programs.
2. Develop interagency agreements to provide the names of children with blood lead above the reference value to the Child Find systems (see page 10.6) for Part C (early intervention services for children under 3) and to the local education agency including Part B (special education for children 3 and above).
3. Add referral to Child Find for Part C early intervention services to their case management protocol and track enrollment results.
4. Develop a system for making contact with families to ensure that they are referred to Early Childhood Enrichment and in-school programs at the time the child becomes eligible (3rd birthday and the year the child reaches school age) even if the child has been discharged from lead case management.
5. Enlist the Child Find agency and early intervention service providers in the screening and surveillance effort so that children identified through those systems and their siblings are screened.
6. Help the Child Find agency and local education agencies target outreach and services to children most likely to have blood lead levels above the reference value.

Introduction

Research on the effects of lead on the neurodevelopment of children has made clear that there is no “safe” level of lead in the human body, especially for young children. Both prospective and retrospective studies have found a link between high blood lead levels (BLLs) and cognitive and behavioral deficits in children. Research shows a strong relationship between early childhood lead exposure and decreased learning proficiency (see Table 10.1). In May 2012, the CDC accepted the recommendations of its advisory committee to lower the reference value to 5 mcg/dL. This decision was based on the large body of research showing effects of lead exposure on children at BLLs below 10 mcg/dL.

Table 10.1 Research Summary on Childhood Lead Exposure and Later Educational Proficiency

Study	Consequences of Lead Exposure on Educational Outcomes
Amato et al., 2012, 2013, Milwaukee, Wisconsin, fourth-grade students	Significantly lower academic performance test scores Rate of three to one more likely to be suspended
Evens et al., 2013, Chicago, Illinois, third- grade students	Lower reading and math test scores
McLaine et al., 2013, Providence, Rhode Island Kindergarten students	Reading readiness scores were 4.5 to 10 points lower
Miranda et al., 2009, 2010, Raleigh, North Carolina fourth-grade students	More likely to score lower on end-of-grade tests Less likely to be placed into advanced and intellectually gifted programs More likely to be classified as learning disabled
Miranda et al., 2011, Connecticut fourth- grade students	Decreased achievement on math and reading tests
Strayhorn and Strayhorn, 2012, New York third- and eighth- grade students	Explained 8 to 16 percent of the variance in reading and math scores adjusting for poverty Using test scores from third grade to eighth grade, scores predictive of lower test performance
Zhang et al., 2013, Detroit students in third, fifth and eighth grades	1.4 to 2.5 times more likely to be non-proficient in math, science and reading

Children with BLLs at or above 5 mcg/dL are at greater risk for developmental delays and behavioral issues that can result in academic failure and diminished life success compared to children who do not have a history of lead exposure. It is important that all children with lead exposure be screened for adverse neurocognitive effects using neuropsychological evaluation tools that provide a complete assessment to identify the complex subsystems in the brain that work differently when affected by lead. This assessment is critical for determining a child’s specific detriments and to identify the most appropriate early interventions or elementary school interventions that are necessary.

Connecting lead-exposed children to early intervention programs is key. An effective intervention program utilizes strategies that are proven to help children with brain dysfunctions similar to those experienced by a lead-poisoned child.

Effects of Low Level Lead Exposure on Cognitive Development

The association of higher BLLs (20 mcg/dL or greater) and impaired cognitive development and aggressive behavior have been known for several decades. Recent studies on the effects of low-level lead exposure have employed protocols that include finer grain assessments of cognitive, language, memory, sensory and neuromotor abilities, uncovering mechanisms by which lead damages the development of these abilities.

Low-level lead exposure experienced during the development of the brain of a young child has been found to be connected to:

- Deficits in IQ.
- Attention difficulties and hyperactivity.
- Speech and language delays.
- Fine and gross motor skills dysfunction.
- Visual-spatial skills impairment.
- Social behaviors, such as impulsivity and aggression.
- Executive function disabilities.

Overall, the literature strongly suggests that early childhood exposure to lead affects central nervous system substrates and behaviors that are best measured in the older child, adolescent, and young adult. This “lag” may be the result of toxicological processes in which some period of time is required for past lead exposure to affect central nervous system function. Another explanation is that lead may primarily affect higher-order neurodevelopmental processes that are best tested or only measureable at later ages when children’s response modalities are more highly differentiated (e.g., the *executive functions* discussed earlier).

One implication of this lag is that neurodevelopmental assessments conducted in young children when a child has an EBLL may fail to identify a child who is at risk for later neurodevelopmental dysfunction. Careful long-term surveillance of behavior and neurodevelopment of children with BLLs greater than or equal to the reference value is thus needed to ensure that these impacts are identified should they appear in the future. The effects of lead exposure on the skills required for academic success and optimal adjustment may not manifest until a child reaches critical transition points in school and the larger social environment. Each of these transition points may present special physical, emotional, social and academic challenges to the lead-poisoned child. The challenges that arise after each transition are described in Table 10.2.

Low Level Exposure Effects Noted in Wisconsin Children

- In 2001, 34% of children with EBLs and documented developmental screening tests were noted to have some behavioral, psychosocial, language, motor, or cognitive delays at the time the EBLL was diagnosed.
- 98% of those children with a noted developmental delay had speech and language delays.
- In 2012-13, studies found that children in Milwaukee who had been lead exposed prior to the age of 3

Table 10.2 Expectations of Learner and Impact of Lead Exposure on the Learner

Phase of Learning	Expectations in a Learning Setting	Outcomes of Lead Exposure
Preschool	<ul style="list-style-type: none"> • Sit quietly for short periods of time • Listen and follow directions • Share supplies, activities, and attention • Relate and adapt to a new set of peers and adult caregivers • Develop listening, attention and memory skills in the context of learning 	<ul style="list-style-type: none"> • Inability to sit still • Decreased hearing function and ability to discriminate sounds • Immature social skills • Short attention span • Difficulty in memorizing new concepts
Early Elementary	<ul style="list-style-type: none"> • Adjust to a longer and more structured school day • Develop the ability to understand and complete assignments and homework • Face more objective rewards and consequences for their behavior • Develop broader social networks and cooperative working skills • Acquire basic academic skills such as reading words and short stories for meaning, performing arithmetic operations, and answering questions 	<ul style="list-style-type: none"> • Less likely to reach proficiency in reading, arithmetic, science, and social studies • More likely to be suspended from school
Upper Elementary	<ul style="list-style-type: none"> • Become more independent in the face of increased physical, social and academic demands • Use basic skills to acquire information and solve problems • Expand social networks (may experience isolation and bullying) • Participate in competitive and team sports • Accept one's own and peers' skills and limitations 	<ul style="list-style-type: none"> • Impaired by poor language skills and attention deficits • More likely to experience difficulty making the transition from "learning to read" to "reading to learn" to learn new material • Less likely to participate in sports due to unstable coordination and other neuromuscular skills
Middle School	<ul style="list-style-type: none"> • Adapt to a more formal and impersonal academic structure with a number of teachers with different teaching styles and expectations • Requires more independence to develop and utilize higher order cognitive and organizational skills • Master several unrelated classes and assignments • Experience mounting social pressures and need for peer acceptance 	<ul style="list-style-type: none"> • Less likely to attain higher order cognitive and organizational skills. • More likely to drop out of school, become pregnant, and commit violent crime
High School	<ul style="list-style-type: none"> • Adapt to a greater number of students and teachers and a more rigorous academic and disciplinary environment • Establish new peer networks and achieve greater independence from family • Balance school and part-time employment • Withstand pressure to experiment with alcohol, drugs, and sexual activities • Develop a more assertive, focused and efficient learning style and apply good study and organizational skills • Make decisions regarding vocation and further education beyond high school 	<ul style="list-style-type: none"> • Less likely to attain higher order cognitive and organizational skills. • More likely to drop out of school, become pregnant, and commit violent crime

Some lead-poisoned children may lack the physical, social, and cognitive skills to cope with the challenges posed by these critical transition periods. Evidence of this comes from literature in the form of a long-term follow-up study of Massachusetts children. After controlling for other sociodemographic factors, in this study, the persistent toxicity of lead – as measured in shed deciduous teeth harvested from asymptomatic children – was directly associated with serious impairments in academic success, including a seven-fold increase in failure to graduate from high school, lower class standing, greater absenteeism, and impairment of reading skills, as compared to the group with lowest teeth lead (Needleman et al. 1990).

Factors Affecting Risk of Developmental Effects

There is variability in the effects of lead at various levels on different children. Because of this, it is recommended that lead exposure should be viewed as a risk factor for neurodevelopmental problems, not a diagnosis. Elevated blood lead levels (5 mcg/dL or greater) in a child's medical history should trigger alertness to the potential for learning and behavioral difficulties.

Children most at risk of lead poisoning are often from families living in poverty and have other risk factors for neurodevelopmental delays, including poor nutrition, poor sleep patterns, being transient, lack of regular health care, lack of cognitive stimulation, and living in a single-parent household. For these children, lead poisoning becomes another factor that may inhibit them from reaching their full potential.

Modifications in the child's environment may help mitigate some of the effects of lead poisoning. While there is no specific evidence that early intervention will prevent or diminish the effects of lead poisoning, it is reasonable to hypothesize that children whose neurodevelopmental difficulties are caused by lead poisoning would be helped by interventions that have been shown to assist children with difficulties caused by other etiologies. For those children, participation in early intervention programs is associated with lower rates of grade retention and decreased need for special education.

Evidence suggests that participation in such programs is enhanced if begun prior to age 3, and if the program has a partnering component for developing parenting skills. Because lead exposure is one of the multiple etiologies that can cause developmental delays, referral to such early intervention programs becomes an important piece of case management or medical management of a child with lead poisoning. It may benefit the child to have a referral to such programs even if no delays are noted at the present time.

Developmental Surveillance as a Long-Term Health Intervention

Ongoing developmental surveillance should be included in the long-term management plan for a child with a history of lead poisoning. A decrease in the child's BLL should not be used as an indicator that long-term developmental surveillance is no longer necessary.

The health care provider should be alert to any current or developing behaviors that may interfere with learning and advocate for the child to receive the appropriate developmental assessment and supportive services. This may result in a multi-disciplinary team being involved to identify delays and needed services, possibly including Birth to 3 programs, Child Find agencies, local education agencies (LEAs), Early Childhood Enrichment (ECEs) programs and Children and Youth with Special Health Care Needs (CYSHN) referral centers. Coordination within this team will be important, and the family will need explanation and leadership in guiding

them through the process. Financial assistance may also be required to obtain the services that are needed. Assistance in this area may be available through the Wisconsin CYSHCN Program and referral centers. Contact the Wisconsin First Step Hotline (800-642-7837) or <http://www.mch-hotlines.org> for more information.

Professionals in the fields of early intervention, early childhood, and elementary and secondary education need information from lead poisoning prevention programs and health care providers to ensure that they understand and fulfill their unique roles. Affected children may exhibit little to no development difficulty early in life but begin to exhibit learning delays at later transition points. Behavioral difficulties may also become apparent as the child ages when there are higher expectations for self-regulation and interpersonal skills. Listed at the beginning of this chapter are recommendations for interagency collaboration to provide assessment and intervention to serve children and their educational needs.

Agencies Involved in Responding to a Child with Early Lead Exposure

Child Find – Federal regulations require that each state have a "comprehensive child find system" with the purpose of identifying, locating, and evaluating, as early as possible, all infants and toddlers birth to age three with disabilities. The Child Find system has the authority and duty to refer children with disabilities or risk conditions, such as children who have had a blood lead level above the reference value, to needed early intervention services. Services that may be included in this program are family training, counseling, home visits, speech-language services, occupational therapy, physical therapy, and others. Parents concerned about their child's development may request a screening at no cost through Child Find. Pediatricians or school personnel often refer children for screening, which requires parental permission to conduct.

This link will provide more information about how [Child Find works in Wisconsin](#). There is also a referral hotline (800-642-7837) called [Wisconsin First Step](#) staffed by parent specialists with disability expertise and a child with a special need.

Local Education Agencies – Local Education Agencies (LEAs), i.e., school districts and charter schools, are responsible for compliance with Child Find. School district offices or websites can provide contact information for the personnel responsible for screening and referrals through Child Find. These agencies are also required to coordinate with other agencies responsible for relevant education, health, and social service programs, specifically including the Maternal and Child Health program (including the Maternal, Infant, and Early Childhood Home Visiting Program), the Early Periodic Screening, Diagnosis, and Treatment (EPSDT) component of Medicaid, Head Start and Early Head Start, Supplemental Security Income programs, and other appropriate programs.

Early Childhood Enrichment – Early childhood enrichment (ECE) programs, including the Head Start program, have been shown to benefit both typically developing children and children with disabilities, as well as benefitting the parents of enrolled children. In a review of early childhood education programs enrolling typically developing children, researchers found that "within the cognitive domain, consistent improvements were found in measures of intellectual ability (IQ), standardized tests of school readiness, promotion to the next grade level, and decreased placement in special education classes because of learning problems" (Anderson et al., 2003).

Among the range of ECE programs, the Head Start program has been shown to have modest measurable effects on enrolled children. Head Start is differentiated from the traditional ECE program in that it focuses on children's health, nutrition, mental health and social service needs in addition to education and inclusion of children with disabilities. This focus on the whole child is designed to mitigate social and economic factors that may limit a young child's ability to learn in the classroom.

Wisconsin Early Education Initiatives

Wisconsin has a number of initiatives to enhance the social emotional development of children and families in need:

- Wisconsin Collaborating Partners ([website](#))
- Wisconsin CESAs for Serving Children with Disabilities ([contacts](#))
- Wisconsin Pyramid Model for Social Emotional Competence ([website](#), [video overview](#))
- Wisconsin Positive Behavioral, Interventions and Supports ([PBIS](#)) Network
- Wisconsin Family Assistance Center for Education, Training and Support ([WI FACETS](#))
- Wisconsin Supporting Families Together Association ([SFTA](#))

Children and Youth with Special Health Care Needs – For over 75 years, the Federal Title V Maternal and Child Health program has provided a foundation for ensuring the health of the nation's mothers, women, children and youth, including children and youth with special health care needs, and their families. The Maternal and Child Health Block Grant to States programs may look different from state to state but are required to provide services to help parents with diagnosis and follow-up of any health, development and learning concerns. In Wisconsin, the CYSHCN program has regional resource centers that can be accessed to provide information and support to families of lead-exposed children as the child enters elementary school and beyond.

For information: [Children and Youth with Special Health Care Needs regional centers across Wisconsin](#).

References

- Amato M, Moore CF, Magzamen S, Imm P, Havlena JA, Anderson HA, Kanarek MS. Lead exposure and educational proficiency: moderate lead exposure and educational proficiency on end-of-grade examinations. *Annals of Epidemiology* 2012; 22:738-743
- Amato MS, Moore CM, Magzamen S, Imm P, Havlena JA, Anderson HA, Kanarek MS. Early lead exposure less than 3 years old prospectively predicts fourth grade school suspension in Milwaukee, Wisconsin. *Environmental Research* 2013; 126: 60-65.
- Anderson, LM, Shinn, C, Fullilove, MT, Scrimshaw, SC, Fielding, JF, Normand, J, Carande-Kulis, V.G., and the Task Force on Community Preventive Services (2003). The effectiveness of early childhood development programs: A systematic review. *American Journal of Preventive Medicine*, 24(3S), 32-46. doi:10.1016/S0749-3797(02)00655-4
- Bellinger, D, Stiles, K, and Needleman, H. "Low Level Lead Exposure, Intelligence and Academic Achievement: A Long Term Follow-Up Study." *Pediatrics*. 90, 6 p. 855-861 December 1992.
- Centers for Disease Control and Prevention, *Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention*, Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention, January 4, 2012 (http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_030712.pdf)
- Centers for Disease Control and Prevention; *CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention,"* June 7, 2012 (http://www.cdc.gov/nceh/lead/ACCLPP/CDC_Response_Lead_Exposure_Recs.pdf)
- Centers for Disease Control and Prevention, "Managing Elevated Blood Lead Levels Among Young Children," March, 2002. (http://www.cdc.gov/nceh/lead/CaseManagement/caseManage_main.htm)
- Evens A, Hryhorczuk D, Lanphear B, Lewis D, Forst L, Rosenberg D. *The Effect of Childhood Lead Exposure on School Performance in Chicago Public Schools*. Forthcoming work. Chicago, IL: University of Illinois at Chicago.22. U.S. Department of Education. 34 CFR Parts 300 and 301. Assistance to States for the Education of Children with Disabilities and Preschool Grants for Children with Disabilities. Available at: <http://idea.ed.gov/download/finalregulations.pdf>. Accessed June 4, 2012.
- Lanphear, B, Dietrich, K, Auinger, P, Cox, C. "Cognitive Deficits Associated With Blood Lead Concentrations <10mcg/dL in US Children and Adolescents," *Public Health Reports*, Vol. 115, November/December 2000.
- Lidskya TI and Schneiderb JS. Adverse effects of childhood lead poisoning: The clinical neuropsychological perspective *Environmental Research* 2006;100:284–293.
- McLaine P, Navas-Acien A, Lee R, Simon P, Diener-West M, Agnew J. Elevated Blood Lead Levels and Reading Readiness at the Start of Kindergarten. *Pediatrics* 2013;131:1081–1089.

Magzamen S, Imm P, Amato, M, Havlena, J, Anderson, HA, Moore C, Kanarek M. Moderate lead exposure and elementary school end-of-grade exam performance. *Annals of Epidemiology* 2013; 23(1): 700-707.

Miranda ML, Maxson P, Kim D. Early childhood lead exposure and exceptionality designations for students. *Int J Child Health Hum Dev.* 2010;3(1):77–84.

Miranda ML, Kim D, Reiter J, Overstreet Galeano MA, Maxson P. Environmental contributors to the achievement gap. *Neurotoxicology.* 2009;30(6):1019–1024.

Miranda ML, Dohyeong K, Osgood C, Hastings C. *The Impact of Early Childhood Lead Exposure on Educational Test Performance among Connecticut Schoolchildren, Phase 1 Report.* Durham, NC: Children's Environmental Health Initiative, Duke University; 2011.

Strayhorn JC and Strayhorn JM. Lead exposure and the 2010 achievement test scores of children in New York counties *Child and Adolescent Psychiatry and Mental Health* 2012; 6:4

Zhang N, Baker HW, Tufts M, Raymond RE, Salihi H, Elliott MR. Early Childhood Lead Exposure and Academic Achievement: Evidence From Detroit Public Schools, 2008–2010. *AJPH* 2013;113:e72-e77.