Educational Interventions for Children Affected by Lead

This paper was developed by an expert panel that included CDC and non-CDC authors.

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National Center for Environmental Health
Division of Emergency and Environmental Health Services

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This document is dedicated to the memory of Dr. Vivian A. Cross of Simsbury, Connecticut, who passed away May 3, 2014. She was an extraordinary educator, community activist, and champion for children with special needs. Dr. Cross implemented major educational and legislative informational forums, media conferences, and professional development training initiatives including the 2012 Legislative Informational Forum titled "A Call To Action to Eliminate a Preventable Contributor to the Achievement Gap—Childhood Lead Poisoning." She was a guiding light on the expert panel and her thoughtful contributions will be deeply missed as the work moves forward.

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Preface

Lead is a neurotoxicant with well documented and lasting adverse health effects. Primary prevention strategies that control or eliminate lead sources before children are exposed remain the pre-eminent public health approach to the problem of lead poisoning and are the only effective way to prevent the neurodevelopmental and behavioral abnormalities associated with lead exposure. Unfortunately, though, hundreds of thousands of children already have experienced blood lead levels known to impair academic performance and affect life success. Thus, tertiary prevention (that is, strategies that restore individuals to an optimal level of functioning after damage is done) is also needed. Recognizing the need to ensure that children affected by lead receive timely and appropriate educational interventions, the Centers for Disease Control and Prevention and the Advisory Committee on Childhood Lead Poisoning Prevention convened a work group of recognized experts to review the existing scientific evidence for adverse effects of blood lead levels on academic performance and describe actionable steps that clinical and public health practitioners, parents, and educators can take to ensure that the children receive such services.

Educational Interventions for Children Affected by Lead outlines available scientific data describing the effects of lead, summarizes in plain language the Individuals with Disability Education Act (IDEA) parts B and C, and provides information on how these provisions relate to children affected by lead. The document also describes major gaps in our scientific understanding of the efficacy of educational interventions for reversing academic problems in children affected by lead. The importance of addressing these gaps could be considered as institutions design their research portfolios.

I wish to thank the members of the Advisory Committee on Childhood Lead Poisoning Prevention, members of the Educational Services for Children Affected by Lead Expert Panel, and consultants who developed this document and acknowledge their contribution to the health of the Nation's children. This document significantly advances our efforts to improve the lives of children negatively affected by lead exposure by providing information on the services designed to improve academic performance to the stakeholders and partners that are most in need it.

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Executive Summary

Lead is a developmental neurotoxicant, and high blood lead levels (HBLLs) in young children can impair intellectual functioning and cause behavioral problems that last a lifetime. Primary prevention of HBLLs remains a national priority and is the only effective way to prevent the neurodevelopmental and behavioral abnormalities associated with lead exposure. Unfortunately, hundreds of thousands of children already have experienced blood lead levels known to impair academic performance. To ensure that such children are provided with the services that may help improve academic and other outcomes, in 2008 the CDC Advisory Committee on Childhood Lead Poisoning Prevention convened a work group charged with describing specific action steps parents, clinicians, educators, lead poisoning prevention programs, and others who work with children may be able to take to ensure that children affected by lead receive timely and appropriate educational interventions. This report was drafted by these experts, who were chosen for their diverse perspectives and technical expertise and reflects their insight, knowledge, and practical expertise.

The body of evidence cited in this document demonstrates the effects that low-level lead exposure has on the brain's learning systems: overall intellectual ability, speech and language, hearing, visual-spatial skills, attention, executive functions, social behavior, and fine and gross motor skills. It details the significant negative consequences of lead on learning and educational attainment found in study after study (see Table 1) and the costs associated with those consequences. It describes the challenges children face as they advance through the school system and how lead interferes with development and learning.

There are no studies that specifically examine the impact of early childhood educational interventions on cognitive or behavioral outcomes for children who have been exposed to lead. However, there are studies of educational interventions improving developmental outcomes for children who have conditions other than lead. This research demonstrates that children with developmental delays or at high risk for developmental delays benefit most from interventions that start at an early age.

This document reviews current knowledge and practice of the early care and educational systems and describes key ways that these systems can support improved outcomes for lead-exposed children, such as

1) Streamlined access to developmental assessment, intervention and special education services, and by conducting a neuropsychological assessment of executive function in addition to a developmental assessment to identify cognitive and functional deficits in lead-exposed children with HBLLs.
2) Consistent interpretation of provisions in the Individuals with Disabilities Education Act (IDEA) and Americans with Disabilities Act (ADA) that require provision of assessment and educational interventions, including mechanisms to ensure that children with a history of HBLLs receive the services to which they are entitled.
3) Technical advice on the implications of the connection between lead exposure and educational results for educators, state and local governments, parents, pediatric health care providers, lead poisoning prevention programs, and others who work with young children.

The document is designed to serve multiple audiences including public health and education professionals, decision makers, health care providers, and others who work with children. It delineates specific strategies for improved collaboration across disciplines and programs in terms of providing services to children affected by lead. In addition, it describes a research agenda to develop the evidence base regarding the effectiveness of educational interventions particularly for children with blood lead levels at or above the Centers for Disease Control and Prevention upper value of the reference range for blood lead in young children established in 2012 as 5 micrograms per deciliter (µg/dL).

Lead poisoning prevention has been correctly characterized as a U.S. public health success story due to the rapid and sustained decreases in the number of children affected by lead. But the rate of decrease in cases has slowed and research shows that no safe blood lead level has been identified. Although efforts continue to successfully shrink the incidence of lead poisoning, continued vigilance and collaboration are necessary to ensure that those children negatively affected by lead exposure receive services designed to compensate for lead's effect on the brain and behavior of children.

Table 1. Studies on Lead and Educational Outcomes

Blood Lead Levels	Educational Impact	Size of Study	Location of Study
≤ 3 µg/dL	Decreased end of grade test scores	More than 57,000 children	North Carolina (Miranda et al. 2009)[1]
4 µg/dL at 3 years of age	Increased likelihood learning disabled classification in elementary school Poorer performance on tests	More than 57,000 children 35,000 children	North Carolina (Miranda et al. 2009)[1] Connecticut (Miranda et al. 2011)
5 µg/dL	30% more likely to fail third grade reading and math tests More likely to be non-proficient in math, science, and reading	More than 48,000 children 21,000 children	Chicago (Evens et al. unpublished data) Detroit (Zhang et al. 2013)
5-9 µg/dL	Scored 4.5 points lower on reading readiness tests	3,406 children	Rhode Island (McLaine et al. 2013)
≥10 µg/dL	Scored 10.1 points lower on reading readiness tests	3,406 children	Rhode Island (McLaine et al. 2013)
10 and 19 µg/dL	Significantly lower academic performance test scores in 4th grade	More than 3,000 children	Milwaukee (Amato et al. 2012)
≥ 25 µg/dL	$0.5 million in excess annual special education and juvenile justice costs	279 children	Mahoning County, Ohio (Stefanak et al. 2005)

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Abbreviations

AAP	American Academy of Pediatrics
ADA	Americans with Disabilities Act
ADAAA	Americans with Disabilities Act Amendments Act
ADHD	Attention-Deficit/Hyperactivity Disorder
AmCHP	Association of Maternal Child Health Programs
BLL	Blood lead level
CDC	Centers for Disease Control and Prevention
CEIS	Coordinated Early Intervention Services
CLPPP	Childhood Lead Poisoning Prevention Program
CPIR	Center for Parent Information and Resources
CPRC	Community Parent Resource Centers
DSM-IV	*Diagnostic and Statistical Manual of Mental Disorder*, Fourth Edition
EPSDT	Early and periodic screening diagnosis and treatment program
fMRI	Functional Magnetic Resonance Imaging
GED	General Educational Development Test
HBLL	High Blood Lead Level
IDEA	Individuals with Disabilities Education Act
IFSP	Individualized Family Service Plan
IQ	Intelligence Quotient
MRI	Magnetic Resonance Imaging
NCPIE	National Coalition for Parent Involvement in Education
NHANES	National Health and Nutritional Examination Survey
OSEP	Office of Special Education Programs
OSERS	Office of Special Education and Rehabilitative Services
PPT	Planning and Placement Team
PTI	Parent Training and Information Center

Chapter 1: Introduction

Childhood lead exposure, even at blood lead levels (BLLs) currently seen in the United States, remains a critical public health issue. It is estimated that tens of millions of U.S. children have been adversely affected by lead over the last 20 years, and these effects can be lifelong. Children are exposed to lead in their homes from deteriorating lead paint and the contaminated dust and soil it generates, to lead in water from lead water pipes or plumbing, and to lead from other sources. Once a child's health or cognition has been harmed by lead, the effects can be permanent and continue into adulthood (Barker 1995; Bellinger et al. 1992; Ris et al. 2004). As no safe blood lead level in children has been identified, the Centers for Disease Control and Prevention (CDC) adopted a reference range for blood lead based on the distribution of blood lead in children 1-5 years old. In 2010 the upper limit of this range was 5 micrograms per deciliter (µg/dL).

The effects of lead are also costly; recent estimates indicate that more than $50 billion in a single year is lost as a result of reduced cognitive potential and associated lost productivity (Gould 2009; Landrigan et al. 2002).

The CDC Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) identified the need to review new evidence of the impact of BLLs on children's academic performance and in 2008 empanelled the Educational Interventions for Lead-Exposed Children Work Group. The group's charge was to

- Compile existing evidence of the neurodevelopmental and cognitive impact of lead.
- Summarize the Individuals with Disabilities Education Act (IDEA) Parts B and C and provide information on how these provisions relate to children affected by lead.
- Describe specific action steps parents, clinicians, educators, lead poisoning prevention programs, and others who work with children may be able to take to ensure that children affected by lead receive timely and appropriate educational interventions.

Children with lead exposures cannot avoid negative impacts on their neurodevelopmental abilities. The only way to prevent lead-induced morbidity is to prevent lead exposure. While sources of lead and ways to avoid lead exposures are known, many children continue to be exposed through unsafe housing, painting or other renovation work that disturbs painted surfaces, water, and other sources. Further, under-identification of unsafe environments and children with past exposures is common.

Exposure to lead hazards is common, and the Healthy People 2020 goal to eliminate blood lead levels of 10 µg/dL or higher has not been met. Therefore, clinicians, public health workers, educators, and other professionals will continue to encounter lead poisoned patients and students in their practices and classrooms for some time to come.

Rigorous clinical trials and other studies have demonstrated that the effects of early exposure to lead on IQ and other measures of cognitive attainment and behavior are not reversible through pharmacologic or nutritional interventions (Dietrich et al. 2004; Kordas et al. 2006; Rico et al. 2006; Rogan et al. 2001). Furthermore, studies that have examined the association between the rate of natural reductions in

blood lead concentrations and neurodevelopment have found that deficits related to early exposure are not reversible in the absence of educational interventions or other deficit related services (Tong et al. 1996). Therefore, the only certain way to avoid lead-associated neurodevelopmental morbidity is to prevent exposure in the first place—primary prevention remains the best course of action (CDC 2012). However, physicians as well as public health and housing agencies often lack the resources needed to fully protect children from lead poisoning (Lanphear 2005). Thus children continue to be exposed to lead in concentrations known to affect academic performance. These children may benefit from available educational interventions.

There is compelling evidence that children benefit from childrearing in an environment that has varied and age-appropriate educational opportunities and early intervention services if provided early in life and at the correct level of intensity prior to elementary school enrollment. An Institute of Medicine (IOM) report (2000) promoted the benefits of early environmental stimulation, stating that "the course of development can be altered in early childhood by effective interventions that change the balance between risk and protection, thereby shifting the odds in favor of more adaptive outcomes."

This report reviews new information on meeting the educational needs of children affected by lead (i.e., those with lead exposure who may manifest developmental delays now or in the future) and updates the Developmental Assessment and Interventions chapter in *Managing Elevated Blood Lead Levels Among Young Children* (CDC 2002). This report includes more-current research and a much expanded focus on the educational needs of children affected by lead. It is intended to inform the development and implementation of seamless processes to provide children whose developmental status or emotional regulation are affected by lead with a continuum of educational and other related services necessary for them to be successful.

This report provides

- Evidence of the impact of blood lead in early childhood on later academic performance and
- Evidence for the impact of delivering the optimal developmental environments, long-term monitoring through high school, care, and education for children who have been exposed to lead.

The early sections of the report provide the research and practice context, including the effects of lead on developmental and educational outcomes and types of interventions and educational resources that foster child learning and educational attainment. In addition, this report provides information on federal programs that can support the continuum of educational needs of children with a history of lead exposure. While this report is intended primarily for the educator, public health professional, and clinician, it is anticipated that this information will prompt the development and dissemination of resource materials for parents seeking services for their children. Finally, the report describes important research gaps on improving academic outcomes for children affected by lead.

Chapter 2: Neurodevelopmental Consequences of Lead Exposure

Blood Lead Levels and IQ

IQ is a measure of relative intelligence determined by an individually administered standardized test. Most IQ tests have a mean of 100 and standard deviation of 15. The range of "normal" on these tests is between 85 and 115. About seven out of ten individuals have IQs in this range. While these tests have been subject to criticism in the past (Montagu 1999), they consistently predict a variety of important social, educational, and vocational outcomes (Sternberg et al. 2001). These instruments have also proven to be highly sensitive and robust in the assessment of the effects lead and other developmental neurotoxicants on global intellectual ability (Dietrich 2010). For lead, IQ has been used as an overall index of neurodevelopmental morbidity by econometricians and policy makers to estimate the social and economic benefits of reducing exposures in the population (Grosse et al. 2002).

Over the past three decades, epidemiologic studies of lead and child development have demonstrated inverse associations between BLLs and other biomarkers and IQ at successively lower levels. In response to these observations, agencies such as CDC and others have repeatedly lowered the blood lead level considered elevated (CDC 1991; IPCS 1995; ACCLPP 2012; CDC 2012). In 2012, CDC adopted the use of an upper limit of the reference range for blood lead in children defined as 97.5% of the U.S. population 1–5 years old, based on the National Health and Nutritional Examination Survey (NHANES). For 2012–2015, the upper limit of the reference range was 5 µg/dL, and BLLs ≥ 5 µg/dL were defined as high (Wheeler and Brown 2013).

Recent epidemiologic studies and quantitative reviews suggest that there is no discernible threshold for lead effects on IQ, and deficits are measureable at least down to BLLs of 5 µg/dL. In a prospective study conducted in Rochester, New York, a decline of more than 7 IQ points was observed from lifetime average blood lead concentration of 1 to 10 µg/dL (Canfield et al. 2003). The Rochester findings of effects on IQ have been replicated in several other studies of children with BLLs below 10 µg/dL (Al-Saleh et al. 2001; Bellinger and Needleman 2003; Chiodo et al. 2004, 2007; Kordas et al. 2006; Téllez-Rojo et al. 2006).

Further evidence of low level lead effects on IQ comes from an international pooled analysis of seven prospective cohort studies (N = 1,333) by Lanphear et al. (2005). Although exposures in some cohorts were high by contemporary standards, by pooling data from these diverse studies a substantial number (N = 244) of children with BLLs that never exceeded 10 µg/dL were included in the analysis. The impact of lead effects on IQ was greater at lower BLLs, as indicated by curves relating BLL to IQ having steeper slopes downward at the lower BLLs. Lanphear et al. (2005) divided the data at two cutpoints *a priori*, a maximal BLL of 7.5 and 10 µg/dL. Additionally, children whose HBLL was < 7.5 µg/dL lost on average 2.94 IQ points (95% CI -5.16, -0.71) per 1 µg/dL increase in BLL compared to children with HBLLs 7.5–10 µg/dL, who on average lost 0.16 points (95% CI -0.24, -0.08) per 1 µg/dL.

The effects of lead on IQ of children have been reported with remarkable consistency across numerous studies of various designs, populations, and protocols. The negative impact of lead on IQ persists in most recent studies following adjustment for numerous confounding and covariate factors. In general, there

appears to be a loss of about 4–8 points in full scale IQ as BLLs increase to 10 µg/dL and at least an additional 2–4 point decrement as BLLs reach 20–25 µg/dL (Lanphear et al. 2005). The magnitude of this loss is substantial, amounting to two-thirds of a standard deviation or more.

Blood Lead Levels and Specific Abilities: Lead's "Neurobehavioral Signature"

The focus of lead studies on global measures of intellectual aptitude such as tests of IQ has hampered attempts to identify deficits that may be specific to children with HBLLs. The aggregate or full-scale IQ is based on the sum of performance on multiple subtests that tap a vast array of cognitive and psychomotor functions. Thus, efforts to identify a neurobehavioral signature for children with HBLLs have been largely unsuccessful (Bellinger 1995a).

Nevertheless, findings from studies of specific abilities could help inform strategies for assessment and intervention. Such information would be potentially valuable to educational specialists who are involved in assessment and intervention. Due to the relative insensitivity of IQ tests to the precise effects of brain injury, the use of tests of specific neuropsychological abilities has received increasing attention for the description of the effects of lead exposure in children (Lidsky and Schneider 2006).

Recent studies have employed protocols that include finer grain assessments of cognitive, language, memory, learning, sensory, and neuromotor abilities, and a somewhat clearer picture of lead's impact on neurodevelopment has begun to emerge. Areas of neuropsychological performance that appear to be impacted in particular are within the domains of attention, executive functions, visual-spatial skills, social behavior, speech and language, and fine and gross motor skills. None of these domains are independent of each other, but it is helpful at first to consider them separately.

Attention

The distracted, inattentive, and impulsive child is an old clinical observation in the lead literature (Needleman 2004). Attention is a complex, multifaceted psychological construct, but its various behavioral manifestations have been measured and quantified in a number of childhood lead studies over the past three decades (Bellinger 1994, 1995b; Chiodo et al. 2004; Hansen et al. 1989; Needleman et al. 1979; Needleman et al. 1996; Ris et al. 2004; Silva et al. 1988; Walkowiak et al. 1998; Yule et al. 1984). When measured experimentally or with parent and teacher questionnaires, a significant dose-response relationship has been observed between BLLs and deficits in sustained attention. In some cases, these effects were observed at BLLs well below 10 µg/dL, with no evidence of a threshold (Chiodo et al. 2007).

Deficits in attention are one aspect of attention-deficit/hyperactivity disorder (ADHD), which affects approximately 3%–7% of U.S. children (Polanczyk et al. 2007). Among clinicians who treat lead-poisoned children, it has been suspected for some time that these patients have a higher risk for developing ADHD (NTP 2012). The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V) defines ADHD as inattentive and/or hyperactive/impulsivity symptoms occurring before age 12 years (APA 2013). This disorder has a strong genetic component, but environmental factors such as lead may play a role in increasing the vulnerability of susceptible children.

Lead in blood and/or shed deciduous teeth, even at low levels by current standards, has been associated with parent and/or teacher ratings of hyperactive behavior as well as attentional and behavioral problems in a number of earlier studies (Bellinger et al. 1994; Burns et al. 1999; Fergusson et al. 1988; Hatzakis et al. 1985; Needleman et al. 1979; Silva et al. 1988; Thomson et al. 1989; Wasserman et al. 1998; Yule et al. 1984).

Although attentional deficits and hyperactivity are frequently cited as common problems among children affected by lead, until recently there has been a lack of compelling evidence that directly links lead exposure with most or all of the features of ADHD, including distractibility, poor organization, lack of persistence in completing tasks, and daydreaming. In an investigation that used NHANES data (1999–2002), a significant relationship between concurrent BLLs and parent-reported ADHD diagnosis was observed in 4,704 children 4–15 years of age. Subjects in the fifth quintile for blood lead (>2.0 µg/dL versus <0.8 µg/dL) were four times more likely to have a physician diagnosis of ADHD and be on stimulant medication (Braun et al. 2006). In the first series of studies to examine the association between BLLs and ADHD by verified DSM-IV criteria, a significant relationship was observed in two independent samples between low concurrent BLLs and ADHD combined type in children between 6 and 18 years of age (Nigg et al. 2008, 2010).

Executive Functions

Very closely related to the domain of attention is what neuropsychologists refer to as the *executive functions*. Executive functions refer to strategic planning, control of impulses, organized searching, flexibility of thought and action, and self-monitoring of one's own behavior. Deficits in this area are overrepresented among children with ADHD and can severely impact academic achievement and behavior (Biederman et al. 2004). As previously discussed, lead studies have linked increased exposure with a higher frequency of negative ratings by teachers and/or parents on behaviors such as inattentiveness, impulsivity, distractibility, and less persistence in assigned tasks (Hatzakis et al. 1985; Hunter et al. 1985; Needleman et al. 1979; Raab et al. 1990; Thomson et al. 1989; Winneke et al. 1990).

The part of the brain known as the prefrontal cortex is highly innervated by projections of neurons from the midbrain and has the highest concentration of the neurotransmitter dopamine when compared to all other cortical areas. Dopamine plays a key role in cognitive abilities subsumed under the category of *executive functions* mediated by the prefrontal cortex, and it has been known for some time that the dopamine neurotransmitter system is particularly sensitive to lead (Cory-Slechta 1995). Recent studies have largely confirmed the link between lead and deficits in this cognitive domain. Higher tooth lead concentrations and BLLs have been associated with poorer performance on tasks requiring focused attention and flexibility of thought (Bellinger et al. 1994; Canfield et al. 2003, 2004; Stiles and Bellinger 1993). In a group of preschoolers with BLLs below 13 µg/dL (80% with BLLs <10 µg/dL), Canfield and colleagues (2004) observed a direct association between BLLs and poorer performance on tasks requiring focused attention, cognitive flexibility, and inhibition of automatic response.

Visual-Spatial Skills

The *visual-spatial* domain is also complex and multifaceted. Performance on tests in this area often involves visual perception (not related to sensory acuity), memory, organization, and reasoning with

visually presented nonverbal problems. Fine motor skills are also a component of performance in many of the tests designed to measure these abilities. Deficits in this area can affect a wide range of academic outcomes including reading and mathematics. Skills in this domain have been explored in some investigations.

When studies of lead-exposed children have used global measures of IQ and conducted subscale analyses, it has been observed that performance IQ or subtests contributing to performance IQ (e.g., block design) are frequently among the most strongly associated with biomarkers of lead exposure (Baghurst et al. 1992, 1995; Chiodo et al. 2004; Dietrich et al. 1991, 1992, 1993a, 1993b; McMichael et al. 1988; Wasserman et al. 1994). In addition, studies employing specific measures of visual-motor integration skills, such as the Developmental Test of Visual Motor Integration, the Bender Visual-Motor Gestalt Test, and others, have found visual-motor integration skills to be among the most consistently associated with early lead exposure (al-Saleh et al. 2001; Baghurst et al. 1995; Dietrich et al. 1993b; Ris et al. 2004; Wasserman et al. 2000; Winneke et al. 1990).

Behavioral Challenges

Deficits in IQ and other formal measures of cognitive attainment may not be among the most important and persistent effects of early exposure to lead. It has long been recognized that children presenting with severe symptomatic lead intoxication suffer from neurobehavioral problems such as impulsivity, aggression, and short attention span (Byers and Lord 1943). This is an old observation in the clinical literature. It has been repeatedly observed that disturbances in behavior and social conduct are prototypical sequelae among victims of lead poisoning. Parents have reported that following recovery from an episode of acute poisoning, their child's behavior changed dramatically as the child became more restless, impulsive, inattentive, and aggressive (Needleman 2004).

As previously discussed, lead exposure may be associated with a higher risk for developing ADHD or at least some of its behavioral features. Children with ADHD and related behavioral problems are known to be at increased risk for disorders of conduct and behavior. Prospective studies of lead and child development have linked HBLLs with destructive and aggressive behaviors during the preschool years and early adolescence (Burns et al. 1999; Wasserman et al. 1998). In a nationally representative sample of over 3,000 children (75% with BLL <1.5 μg/dL), a significant association was observed between low concurrent BLLs and an increasing prevalence of conduct disorder symptoms. After adjustment for covariates, compared to children in the first quartile (blood lead 0.2–0.7 μg/dL), those in the second, third, and fourth quartiles had 7- to 12-fold increased odds of meeting DSM-IV conduct disorder criteria (Braun et al. 2008).

Data linking lead exposure with aggressive and disruptive behaviors and poor self-regulation have raised the prospect that early exposure may result in an increased likelihood of engaging in antisocial behaviors in later life. This link has been observed in recent studies of older children and adolescents (Dietrich et al. 2001; Fergusson et al. 2008; Needleman et al. 1996, 2002) as well as young adults (Wright et al. 2008). Ecological studies correlating leaded gasoline sales and atmospheric lead levels with crime rates 20 years later also support and association between lead exposure and criminal behavior (Nevin 2000, 2007; Stretesky and Lynch 2001).

The specific biological mechanisms that may underlie lead effects on aggression, impulsivity, and poor self-regulation are not clearly understood. Lead-related behavioral problems also appear to be relatively independent of IQ (Chen et al. 2007). Lead impacts a large number of sites and processes in the brain (e.g., frontal and prefrontal lobes, dopaminergic systems) involved in impulse control (Lidsky and Schneider 2003). It is noteworthy that a volumetric MRI study of young adults with a history of HBLLs as children linked cortical gray matter loss in the prefrontal cortex with higher exposures to lead (Cecil et al. 2008). Further studies on this cohort have linked earlier exposure to lead with altered myelination and axonal integrity (Brubaker et al. 2009). Needleman et al. (2002) proposed that in addition to direct impacts on brain development and neuronal function, impaired cognitive abilities and subsequent academic failure in children affected by lead children may increase risk for subsequent delinquent behaviors. Students who have difficulties in school and fail to achieve academic goals are more likely to become lawbreakers (Schorr 1989).

Speech and Language

Speech and language deficits in children affected by lead is a relatively old clinical observation (Byers 1959), and some early leading investigators of asymptomatic children suggested that verbal behaviors may be among the more sensitive indices of lead-associated cerebral injury (e.g., de la Burdé and Choate 1975; Needleman et al. 1979). Language is a unique human neurocognitive function, and it is often the earliest marker of a developmental or acquired neurological disorder. The association between lead exposure and speech and language functions has been studied rather extensively (Mayfield 1983), but the majority of these early studies used knowledge-dependent measures of verbal ability that relied heavily on a child's existing vocabulary and comprehension (Campbell et al. 2000).

Some recent studies are of interest in that they focused on the relationship between lead exposure and language processing. For example, among subjects 11–14 years old in the Pittsburgh Youth Study, higher bone lead concentrations were associated with poorer performance on three processing-dependent language measures assessing phonological, lexical, and sentence processing (Campbell et al. 2000). Functional magnetic resonance imaging (fMRI) was used to assess the influence of childhood lead exposure on language processing among a subset of young adults in the Cincinnati Lead Study (Yuan et al. 2006). fMRI is a type of specialized MRI scan that measures the change in blood flow related to neural activity in the brain, often in response to stimuli or engaging in a specific cognitive task. In a verb generation task, higher childhood average BLLs were significantly associated with reduced activation in Broca's area, a recognized region of speech production in the left hemisphere. Higher BLLs were also associated with increased activation in the right temporal lobe, the homologue of Wernicke's area that is associated with speech perception. Results of this study suggest that elevated childhood BLLs influence neurosubstrates of semantic language function, resulting in an atypical reorganization of language function in young adults.

With respect to the relationship between lead exposure and the development of speech and language abilities in children, it is important to keep in mind that HBLLs have also been associated with small but significant deficits in hearing and central auditory processing (Dietrich et al. 1992; Osman et al. 1999; Schwartz and Otto 1987, 1991). However, a recent study did not identify significant relationships between lead level (mean 37.7 μg/dL) and tests of hearing (Buchanan et al. 2011). The control group in

this study had BLLs below 10 μg/dL. In the Osman et al. study (1999), the audiometric results indicated that auditory function in children is impaired at blood lead concentrations even below 10 μg/dL.

Fine and Gross Motor Skills

In the past, clinical investigators have noted unsteadiness, clumsiness, and fine-motor dysfunctions in symptomatic lead-poisoned children (Pueschel et al. 1972). Lead-associated deficits in both gross and fine motor functioning were noted among children residing in the vicinity of a longstanding lead smelter in Greece (Benetou-Marantidou et al. 1988). More recently, two prospective studies have assessed motor development in a comprehensive manner. In Cincinnati, BLLs assessed during infancy and the preschool years were associated with poorer scores on measures of bilateral coordination, visual-motor control, upper limb speed and dexterity, and especially on the fine motor composite score from the Bruininks scales (Dietrich et al. 1993b). These results were largely replicated in another prospective study of children residing in two towns in Kosovo province, Yugoslavia (Wasserman et al. 2000). In the Cincinnati series of studies, postural instability and unsteadiness have also been consistently associated with HBLLs in early childhood (Bhattacharya et al. 1995). Lead affects children's long-term injury risk by harming their balance, coordination, and other neuromuscular skills, resulting in falls and discouraging their participation in sports as teens, which is important in the development of social interactions (Kincl et al. 2006).

Summary

Although the evidence for signature neuropsychological outcomes related to childhood lead poisoning may seem compelling, it is vital to keep these findings in perspective, especially when considering the specific individual needs of children with a history of exposure. The apparent pattern of lead-associated neurodevelopmental deficits described above suggests, if anything, a general dampening of intellectual functioning. This pattern is not uncommon in the general population and can be ascribed to a number of environmental causes other than lead. It is likely that lead, like other causes of brain injury, does not produces the same or similar impairments in every affected child. (Schneider et al. 2001)

Chapter 3: Who Is At Risk? Vulnerable Populations and Risk Factors

Factors Affecting a Child's Risk for Neurologic Sequelae

Lead is an equal opportunity neurotoxicant in the sense that adverse neurobehavioral outcomes have been associated with exposure in studies that vary widely with respect to sociodemographic and other background factors. However, the effect of lead exposure on neurodevelopment might differ as a function of the child's economic and social environment; thus, some children may be at greater risk for poor academic performance compared to other children with similar BLLs. Factors that may affect a child's risk for neurologic sequel include socioeconomic circumstances and gender.

Socioeconomic Circumstance

Socioeconomic status is a complex construct that is typically but only partly captured as a score or ranking calculated from the parents' education and occupation. This variable is routinely treated as a confounding factor in lead studies. However, some investigators have examined the interaction between exposure to lead and socioeconomic status; that is, the extent to which socioeconomic status modifies the impact of lead on children's neurodevelopment.

Several earlier and some more recent studies reported that higher tooth or BLLs were associated with neurodevelopmental deficits of greater magnitude and/or persistence among children from lower socioeconomic strata (Bellinger et al. 1989, 1990; Dietrich et al. 1987; Harvey et al. 1984; Tong et al. 2000; Winneke and Kraemer 1984). However, these studies fail to provide specific insight into why lower socioeconomic status increases a child's susceptibility. Lower socioeconomic standing is associated with a number of factors that could enhance lead's toxicity, including exposure to other neurotoxicants (e.g., pesticides, environmental tobacco smoke), poorer nutrition (e.g., inadequate calcium and iron intake), inequities in medical coverage, increased stress, and fewer opportunities for stimulation.

Gender

Gender differences in vulnerability to environmental influences on central nervous system development have been posited for some time. It is well known that the prevalence of disorders such as autism and ADHD is higher in males. Men and women have brains of different sizes and have different trajectories of gray matter maturation. Several studies have observed stronger association between lead levels in males than females in both the cognitive (Bellinger et al. 1990; Dietrich et al. 1987; Froehlich et al. 2007; Pocock et al. 1987; Ris et al. 2004) and behavioral (Wright et al. 2008) outcomes, although these findings are not universal (Tong et al. 1996). In the Cincinnati Lead Study, the association between childhood lead exposure and gray matter volume loss in young adults was much more widespread and significant in males than females, despite comparable average childhood BLLs (Brubaker et al. 2010; Cecil et al. 2008).

Inter-Child Variability

One implication of the findings of the impact of demographic factors on the relationship between BLLs and developmental effects is that lead's association with children's neurodevelopment cannot be expressed as a single number because the magnitude of the association may vary depending on the characteristics of a particular child and his or her environment. A more promising implication, however,

is that the effects of lead on a child might be reduced by modifying critical aspects of the environment. This holds promise for the success of interventions to ameliorate effects. Two experimental animal studies have shown that rearing animals in a nurturing physical and social environment can attenuate lead's developmental neurotoxicity (Guilarte et al. 2003; Schneider et al. 2001). These studies suggest that the quality of the early rearing environment might play a role in the magnitude and persistence of neurobehavioral deficits displayed by lead exposed children.

The discussion above implies that the BLLs at which individual children show signs of clinical lead intoxication and/or neurobehavioral deficits will vary. Despite the consistent inverse association between children's BLL and IQ noted above, children will have varying sensitivity to the more subtle functional impairments associated with HBLLs (Lidsky and Schneider 2006). This suggests that not all children with a given BLL should be considered at equivalent neurodevelopmental risk (Bellinger 1995a). In other words, a HBLL should be viewed as a risk factor for neurodevelopmental problems, not a diagnosis.

Importance of Age at the Time of Lead Exposure

Identifying the age at which children are most sensitive to the neurodevelopmental effects of lead is complicated by the relatively high degree of stability in children's BLLs and the frequent confounding of age and peak BLL (Dietrich et al. 1993; McMichael et al. 1985). Data from some prospective cohort studies indicate that children's IQs may be particularly sensitive to lead-associated effects when the children are about 2 years old (e.g., Bellinger et al. 1992). However, more recent analyses (Chen et al. 2005; Hornung et al. 2009; Lanphear et al. 2005) suggest that lead exposure beyond 2 years of age, when BLLs tend to peak, may be even more strongly associated with cognitive development. If concurrent BLLs remain important until early school-age for optimum cognitive development, and if 6- and 7-year-olds are as or even more sensitive than 2-year-olds, then the difficulties in preventing lead exposure are magnified. But the potential benefits of prevention are even greater.

Time Lag in Expression of Neurobehavior Associated with High Blood Lead Levels

Age is also a consideration with respect to when neurotoxic effects are likely to be expressed. Overall, the literature strongly suggests that early 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 HBLL 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 at or above the upper reference range value is thus needed to ensure that these impacts are identified should they appear in the future. The effects of high BLLs 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 child affected by lead. The challenges that arise after each transition are described below.

Preschool

The child is required to sit quietly for short periods of time and listen and follow directions. The group nature of preschool typically requires the child to share supplies, activities, and attention. The child must relate to and adapt to a new set of peers and adult caregivers. The child begins to develop listening, attention, and memory skills in the context of learning (e.g., names of objects, animals, colors, and shapes). Children should be evaluated for speech and language delays at this stage because those affected by lead may have a shorter attention span, immature social skills, and decreased ability to listen and memorize new concepts (HHS National Institute on Deafness and Other Communication Disorders https://www.nidcd.nih.gov/staticresources/health/voice/NIDCD-Speech-Language-Dev-Milestones.pdf).

There is also strong evidence that social and emotional skills are as critical to school success as academic competency is. Left untreated, challenging behaviors such as aggression, tantrums, and noncompliance can develop into more serious conditions and lead to lower high school graduation rates, poor job outcomes, and limited incomes in affected children. Children should be evaluated for these problem behaviors which are often first manifested in preschool settings (Perry et al. 2011).

Early Elementary School (grades K–3)

The child is required to adjust to a longer and more structured school day. The child must develop the ability to understand and complete assignments and homework and face more objective rewards and consequences for their behavior. The child develops broader social networks and cooperative working skills. The child begins to acquire basic academic skills such as reading words and short stories for meaning, performing arithmetic operations, and answering questions. Compelling data indicate that children affected by lead are less likely to reach proficiency in reading, arithmetic, science, and social studies and develop social and working skills. Thus, their progress should be monitored and appropriate support provided if delays are identified (Wolf 2007).

Upper Elementary School (grades 4–5)

The child is challenged to become more independent in the face of increased physical, social, and academic demands. Social networks expand, and the child may experience isolation and bullying. Social and physical challenges include increased participation in competitive and team sports and accepting one's own skills and limitations as well as those of peers. Academic emphasis is no longer solely on acquisition of basic skills. The child must now use basic skills to acquire information and solve problems (e.g., "reading to learn" as opposed to "learning to read") (Wolf 2007).

Lead affects the development of the central nervous system and can affect a child's balance, coordination, and other neuromuscular skills, potentially discouraging his or her participation in sports. Children affected by lead may also experience difficulty making the transition from "learning to read" to "reading to learn" to learn new material because of poor language skills and attention deficits. This is

another time period when monitoring of children with history of HBLL is critical to identify problems early and provide additional support if needed.

Middle School (grades 6–8)

Transition to middle school is further complicated by the normative changes of puberty and its implications for social and emotional development. The adolescent must adapt to a more formal and impersonal academic structure with a number of teachers with different teaching styles and expectations. Academically, more independence is required, and the adolescent is challenged to develop and use higher-order cognitive and organizational skills necessary to master several unrelated classes and assignments. Social pressures mount and peer acceptance becomes critical.

Exposure to lead as a young child can interfere with the proper development of executive functioning, making it difficult for the child to attain these higher-order cognitive and organizational skills (Canfield et al. 2003). Animal models demonstrate that lead interferes with normal development of the brain, resulting in a reduction of volume in the frontal lobe, which is the region of the brain that reasons, judges, solves problems, and controls impulses and emotional response (Marchetti 2003). Serious academic problems at this stage result in a much higher probability of dropping out of school (more U.S. students fail ninth grade than any other grade of school, and many subsequently drop out). Lead exposure has been shown to be a strong predictor of failing in school, resulting in dropping out of high school (Needleman et al. 1990).

High School (Grades 9–12)

The adolescent is further challenged to adapt to a greater number of students and teachers and a more rigorous academic and disciplinary environment. Establishing new peer networks; achieving greater independence from family; managing part-time employment; and pressures to experiment with alcohol, drug, and sexual activities are among the many social challenges now being faced. Academic challenges include developing a more assertive, focused, and efficient learning style and applying good study and organizational skills. The student takes more responsibility for decisions regarding academic tracks, course selections, and making decisions regarding vocation and further education beyond high school. However, a teenager who was exposed to lead as a young child is more likely to smoke, be truant or drop out of high school, commit criminal offenses, and even become pregnant as a teenager (Denno 1990; Lane et al. 2008; Needleman et al. 1996; Nevin 2000).

Some children affected by lead may lack the physical, social, and cognitive skills to cope with the challenges posed by these critical transition periods. Evidence of this comes from the lead literature in the form of a long-term follow-up study of Massachusetts children. In this study, after controlling for other sociodemographic factors, the persistent toxicity of lead—as measured in shed deciduous teeth collected 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). Other studies of lead exposure and academic achievement are discussed in Chapter 4.

Chapter 4: Consequences of Lead on Learning and Educational Attainment

Recent Studies

Several recent studies have explored the specific effects of lead on educational outcomes. These studies show a strong relationship between slightly HBLLs in young children and decreased scores on end-of-grade tests in elementary school. The recent studies summarized below demonstrate that the connection between rising blood lead and poorer educational outcomes remains true for BLLs only 1–2 µg/dL above the 2009–2010 geometric mean BLL of 1.3 µg/dL for U.S. children aged 1–5 years old. (Wheeler and Brown, 2013).

Together, these studies show a consistent link between low-level lead exposure and the reduced ability of children to do well in school and suggest that lead exposure is responsible for a significant and modifiable effect on the achievement gap. They also document that there are substantial costs to local communities to provide services to children.

North Carolina

A series of North Carolina studies of over 57,000 children (57% were white and 43% were black) found that children with a BLL as low as 4 µg/dL at 3 years of age were significantly more likely to be classified as learning-disabled than children with a BLL of 1 µg/dL (Miranda el al. 2009). Researchers also found a dose-response relationship between end-of-grade test scores and BLL—BLLs as low as 2 µg/dL were associated with decreases in test scores (Miranda et al. 2009). Furthermore, children with a higher BLL were less likely to place into advanced and intellectually gifted programs. These results held true even when researchers accounted for factors such as race, family income, and other factors that might affect learning-disabled status. The authors concluded that when HBLL is experienced with these other social factors, the negative impact on academic performance is cumulative.

Connecticut

Researchers in Connecticut observed the same associations between elevated BLL and decreased achievement on reading and math tests (Miranda et al. 2011). A study of approximately 35,000 Connecticut children examined associations of past lead levels with their fourth grade math and reading scores. Only data from non-Hispanic black and non-Hispanic white children with a lead test before age 7 years and who did not have limited English proficiency were analyzed. BLLs as low as 3–4 µg/dL were associated with poorer performance on tests.

Chicago, Illinois

In a study of over 48,000 school children in Chicago, BLLs as low as 5 µg/dL were associated with lower scores on third grade reading and math tests (Evens et al. 2013). Researchers determined BLL had a strong relationship with test scores, similar to factors such as birth weight, maternal education, and race/ethnicity. Non-Hispanic black students in this study had an average BLL more than twice that of non-Hispanic white students.

Detroit, Michigan

In a study of more than 21,000 Detroit children in grades 3, 5, and 8, Zhang et al. (2013) found a strong dose response relationship between BLLs as low as 5 µg/dL and poor performance on academic test scores through junior high school. Compared to children with non-detectable BLLs, children with detectable BLLs were 1.4 to 2.5 times more likely to be nonproficient in math, science, and reading.

Milwaukee, Wisconsin

In a study of more than 3,000 Milwaukee children in grades 4–9, Amato et al. (2012, 2013) found significantly lower academic performance test scores in fourth grade for those children with BLLs 10–19 µg/dL in early childhood compared to children with BLLs <5 µg/dL. The authors concluded that lead should not be considered as just a public health or environmental issue but also an educational issue with direct implications on policy. The same lead exposed children were found to have been suspended from school in the fourth grade at a rate of three to one compared with their peers with little or no exposure (Amato et al. 2013).

Milwaukee and Racine, Wisconsin

In another study of students in Milwaukee and Racine, researchers found that not only was poor school performance directly related to early lead exposure, but also parents were more likely to rate their child's health as "fair" compared to "excellent" (Magzemen et al. 2013). In 2010, the Department of Health Services estimated that if each Wisconsin child age 0–6 today were protected from any lead exposure, the improvement in the state high school graduation rate and the reduction in crime would save $28 billion. These savings would multiply each year as new children are born in Wisconsin.

Providence, Rhode Island

In a study of 3,406 children in Providence, Rhode Island, linking historic BLLs and kindergarten reading readiness scores, McLaine et al. (2013) found that 20% of children had BLLs ≥ 10 µg/dL and 67% had BLLs ≥ 5 µg/dL. Compared to children whose average BLLs were < 5 µg/dL, reading readiness scores for children BLLs of 5–9 µg/dL or ≥ 10 µg/dL were 4.5 and 10 points lower, respectively. The authors recommend greater collaboration between educators and public health agencies and better use of existing data to identify children affected by lead.

New York

In an ecological study of third and eighth grade achievement scores for 57 counties in New York, excluding New York City, researchers found that the percent of children in a county with BLLs ≥ 10 µg/dL explained 8%–16% of the variance in reading and math test scores, even adjusting for country-level indicators of poverty. They also found that for eighth grade scores, the percent of children with a history of BLLs ≥ 10 µg/dL in a county was as predictive of country-level performance on these tests as using tests scores from four years earlier to forecast current scores (Strayhorn and Strayhorn 2012).

Massachusetts

In another ecological study comparing blood lead levels in the 1990s with school cohort test scores in the 2000s in Massachusetts, there was a strong relationship between BLL and elementary school test scores. The authors also found that over the time period under consideration, reductions in lead have yielded a drop of 1 to 2 percentage points in the share of children scoring unsatisfactory on the

standardized test, a change equivalent to what would have resulted from a $1,000–$2,000 increase in income per capita. (Reyes, 2011)

Ohio

Korfmacher has argued that although the societal costs of not preventing HBLLs in children are well documented, these are long-term costs to society as a whole. Thus, they may not be as compelling to local policy makers as more short-term costs such as special education and juvenile justice resources expended on children (Korfmacher, unpublished data). Using methods developed by Korfmacher, researchers in Mahoning County, Ohio, quantified the juvenile justice and special education costs for the 279 children diagnosed with a BLL ≥ 25 µg/dL in the county in 2002. They estimated that each yearly cohort of children of the same size and with similar BLLs costs the county $0.5 million a year. These costs are cumulative across yearly cohorts and do not account for adverse effects of BLLs <25 µg/dL (Stefanak et al. 2005).

Research Gaps

Although some studies have found that a nurturing home environment can have a positive impact on children with HBLLs (see Chapter 5), no studies have been published on the effectiveness of interventions, such as early childhood education, in ameliorating the effects of HBLLs. There is a critical need for better understanding of whether children with BLLs at or near the upper limit of the reference range respond positively to early childhood education and which aspects of early childhood education are most likely to reduce or ameliorate the neurocognitive effects of these BLLs. In addition, since the effects of BLLs at or near the upper limit of the reference range (reference value) re subtle and can vary widely from child to child with the same blood lead concentration, there may be a need to test which assessment tools are most valid and reliable for children with a history of BLLs at or above the reference value. The impact of parenting style and involvement as a therapy to provide enhanced developmental opportunities for these children is also worthy of study.

Learning to read involves the reorganization of brain structures whose specialized regions need to be integrated in order for children to achieve the nearly automatic fluency of the expert reader (Wolf 2007). For this reason, studies of children with reading difficulties including ADHD, traumatic brain injury, and dyslexia, are not helped by a one-size-fits-all approach but are better served by identifying and basing educational interventions that work best for individual children. It seems likely that a generic treatment program for all lead poisoned children is likely to be ineffective (Lidsky and Schneider 2006).

Randomized controlled trials of teaching modalities and programs that improve parenting skills and their impact on children affected by lead would expand our understanding of the efficacy of these interventions for reversing academic problems in children affected by lead.

Chapter 5: Effectiveness of Early Childhood Education Programs in Reducing Developmental Risks

Effectiveness of Educational Interventions

The effects of lead on a child vary if critical aspects of the environment differ. This holds promise for the success of interventions to ameliorate effects. For every child, a nurturing, supportive home environment can positively influence developmental and behavioral outcomes. Studies that examine the impact of lead on child outcomes—including measures to control for the resources within the home—find that a supportive home environment has a strong positive influence on a child's IQ (Lanphear et al. 2005; Tong et al. 1996). A recent study assessed the conjoint influence of lead exposure and home environment on neurocognitive function and behavior for first-grade children living in a Mexican lead smelter community. The home environment (measured in this study by a mother's support of schoolwork, mother's support of extracurricular activities, and mother's education) had a significant indirect mediation effect between lead and measures of the child's behavior and cognition. Thus, an attentive home environment can lessen the effects of lead and improve educational outcomes (Moodie et al. 2013).

No studies specifically examine the impact of early childhood educational interventions on cognitive or behavioral outcomes for children who have been exposed to lead. However, there are studies of educational interventions improving learning and developmental outcomes for children who have conditions other than lead. This research demonstrates that children with developmental delays or at high risk for developmental delays benefit most from interventions applied at an early age (Anderson et al. 2003; Campbell et al. 2001; Glascoe 2000; Olds et al. 2010).

Early childhood education programs, including high-quality preschool and Head Start, have been shown to benefit both typically developing children and children with disabilities. They also benefit 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).

The High/Scope Perry Preschool Study, a major longitudinal study, demonstrated many of the benefits of early education for young children from preschool until the age of 40. Researchers found that young children in the study had higher rates of high school graduation or GED completion (71% versus 54% of control group participants) and less time spent in special education through age 19 (an average of 16% of the time versus 28% in the control group) (Ju 2009; Schweinhart et al. 1993). Research has also demonstrated behavioral benefits for participants in high quality early childhood education programs (Reynolds et al. 2007; Schweinhart et al. 1993, 2005).

Early Childhood Education

There is a compelling base of evidence that suggests that large scale, short-term public preschool programs have positive impacts on children's academic readiness and mixed impacts on children's

socioemotional readiness. Two recent evaluations of at-scale urban prekindergarten programs in Tulsa and Boston found between a half year and a full year of additional learning in language, literacy, and math (Gormley et al. 2005). Improvements in the long-term outcomes of the participants of these programs indicate that, in terms of reduced criminal justice costs and improve productivity, these programs also save $3 to $7 for every dollar spent on the prekindergarten education (Yoshikawa et al. 2013).

Head Start Program

Among the range of early childhood education programs, the Head Start program has been shown to have modest measurable effects on enrolled children. Head Start is differentiated from the general early childhood education programs without a health focus, in that it focuses on children's health, nutrition, mental health, and social service needs. 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. For example, if a child is experiencing illness or a toothache, or perhaps domestic violence in the home, he may be less able to focus on the academic work at hand (Head Start Bureau 2002). To qualify for enrollment into the Head Start program, children must be low-income, recipients of public assistance, foster children, or homeless, or they must have a diagnosed disability. For these reasons, Head Start children may begin the preschool experience at a disadvantage as compared with their counterparts in other early childhood education programs (Lee et al. 1988).

Children who presented these risk factors were the focus of an assessment of Head Start reported in "The Impact of Head Start on Children, Families and Communities: Final Report of the Head Start Evaluation, Synthesis and Utilization Project" (McKey 1985). The study included both children enrolled in Head Start as well as children enrolled in other early childhood education programs. Head Start participants had below average skills in early literacy and math at the time of enrollment into the study, as compared with control children in other early childhood education programs (Ju 2009; McKey 1985). The study found that Head Start narrowed the gap in academic skills between program participants and all children over the program year in the areas of reading, writing, and vocabulary (Ju 2009; McKey 1985): "Clearly, Head Start has strong immediate effects on the cognitive and socio-emotional development of young children. These effects are both statistically and educationally meaningful." (McKey 1985).

In a review of multiple studies relating to outcomes for children enrolled in Head Start, Ju (2009) found that regardless of research design or outcome measure, Head Start children experienced significant gains in cognitive development. Children who participated in Head Start programs experienced elevated cognitive test scores of about a half standard deviation (Ju 2009).

A randomized controlled study of 4,700 preschool children compared school readiness outcomes such as language, literacy, prewriting, and math each year through the end of the first grade for children enrolled in Head Start with a control group of children who were not enrolled in a Head Start program (ACF 2010). The study found that the early gains in school readiness of the Head Start group "faded out" by the end of the first grade as control group children caught up to their Head Start peers. The long-term positive benefits found in earlier studies can be reconciled to the more recent study in two ways. First,

the long term benefits may reflect noncognitive benefits of Head Start that were not measured in the recent study. Second, as control group children could and did enroll in other early childhood education programs, the lack of positive benefits in the recent evaluation may reflect improvements in contemporary non-Head Start early childhood education programs (Bartik 2011).

Outcomes of Participation in Early Childhood Education Programs for Children with Disabilities

There is some research about the impact of participation in early childhood education services for children with disabilities (OSEP 2013). In a study of children with autism and pervasive developmental disorders who were enrolled in intensive early intervention programs, it was found that participating children had higher IQ scores, improved visual-spatial skills, and increased language development three to four years after the intervention as compared to children who received a parent training intervention alone. In addition, the same study demonstrated that "…many children who receive early intervention make substantial developmental gains and are able to be included in a general education classroom by the time they enter elementary school" (Smith et al. 2000).

The Head Start program has been shown to provide benefits for children with disabilities as well; specifically, for children with developmental, speech/language, and vision disorders. In addition, participation in a Head Start program has been shown to provide greater developmental and behavioral gains for children with physical disabilities, as well as significantly more motor ability for children with mental retardation, than children with similar disabilities who did not participate in a Head Start program (McKey 1985). Head Start programs, along with some other early childhood education programs, strive to create fully blended programs. Blending is defined as more than inclusion to the extent that children with disabilities are not only included in the activities of the classroom, but also "individual learning needs are honored and the curriculum is purposefully blended across ability levels and learning opportunities, which sets the stage for effective teaching and learning for all students" (Grisham-Brown et al. 2009). In a comparison of three very small interventions, children in blended classrooms made and maintained progress on a targeted early learning standard, indicating that using such techniques can assist children with disabilities in gaining important skills (Grisham-Brown et al. 2009).

Children with disabilities have been shown to make academic and developmental gains from their participation in inclusive early childhood education settings (Dickson 2000; Hanline and Daley 2002; Holahan and Costenbader 2000; Mogharreban and Bruns 2009). Mogharreban and Bruns (2009) report that "one of the most positive outcomes of the first 2 years was the successful transition of the majority of [Early Childhood Special Education] ECSE children into general kindergarten classrooms and most without the need of a designated ECSE aide." In short, children with disabilities have been shown to make profound progress with intensive and appropriate early childhood education services. Many of these gains are in the very areas that are the most challenging for children who have experienced lead poisoning and that children who have had lead exposure are most at risk for experiencing.

Costs and Benefits of Early Childhood Education Programs

The economic effects of early childhood education programs have been estimated in the range of $2–$3 in economic development at the state level per dollar of intervention costs and compare favorably with business incentive programs (Bartik 2011). The President's Council of Economic Advisors estimated that each $1 invested in early childhood education would provide $8.60 in benefits to society and that if enrollment increased by 13%, in the long runs these gains translate into an increase in gross domestic product of 0.16%-0.44% (Executive Office of the President 2014). The benefits of early childhood education occur over the long term (i.e., the working life of the children enrolled) and seem to depend largely on the amount of time children spend in the programs and their quality. However, the implied long-term effect on national annual earnings of a well-run universal pre-K education is estimated at about $300 billion (Bartik 2006).

Chapter 6: Applicable Federal Programs and Policies

Overview

Several programs and authorities apply to assessments of disability and the services that can be provided as interventions for children affected by lead (see Appendix 1). For example, the following programs and policies serve children aged 0 to 21:

- Individuals with Disabilities Education Act (IDEA) (20 U.S.C. § 1400 et seq.) Federal Special Education Law, including
    - Child Find: Gateway to Services.
    - Part C: Early Intervention Services for Children Under Age 3.
    - Part B: Special Education for Children 3-21 Years Old, including Section 619 Preschool Programs and Coordinated Early Intervening Services.
- Rehabilitation Act of 1973, Section 504: Federal Civil Rights Protections.
- Americans with Disabilities Act Amendments Act of 2008.
- Medicaid: Early and Periodic Screening, Diagnosis and Treatment (EPSDT) Program.
- Title V: Maternal and Child Health Block Grant.

IDEA: Federal Special Education Law

IDEA is a federal law ensuring that children with disabilities, ages 3 to 21, receive a free appropriate public education (see Tables 2 and 3). Originally called the Education for All Handicapped Children Act of 1975 (Public Law 94-142), IDEA has been amended several times, most recently in 2004 (20 U.S.C. § 1400 et seq.). The U.S. Department of Education, Office of Special Education Programs (OSEP), is responsible for implementing IDEA at the federal level. Although all U.S. states currently participate in IDEA, state and local implementation may vary, resulting in some differences in policies, services, and processes by state. Therefore, it is essential to understand state implementation policies to have a full understanding of the requirements and children's rights. (See http://idea.ed.gov for detailed information about the program provisions and requirements.)

IDEA provides federal funds and oversight for early intervention and special education and related services to infants, toddlers, children, and youth with disabilities. In 2011, an estimated 6.9 million children were eligible for these programs. The law also governs the allocation of these funds to states and public agencies that deliver these services. Part C of IDEA is a $442.7 million (FY 12) program administered by states that serves infants and toddlers through age 2 with developmental delays or who have diagnosed physical or mental conditions with high probabilities of resulting in developmental delays. Part B of IDEA is an $11.58 billion (FY 12) program of grants to state education agencies to partially fund special education and related services for children ages 3–21 with disabilities, including the Section 619 Preschool Program. In addition to the grant programs, IDEA specifies detailed due-

process provisions for parental rights. Both Part B and Part C of IDEA contain explicit requirements for states to actively identify children with disabilities, determine their eligibility, and make referrals to services via a comprehensive Child Find system. The Department of Education requires that states must describe the planning and implementation of their Child Find systems in their grant applications.

In recent years, the U.S. Department of Education issued new federal regulations incorporating the 2004 amendments to IDEA:

- Final Part B regulations took effect on October 13, 2006 (34 C.F.R. Part 300; 71 Fed. Reg. 46540 (Aug. 14, 2006).
- Final Part B regulations were augmented with supplemental regulations in 2008 in response to the No Child Left Behind Act of 2001; (73 Fed. Reg. 231 (Dec. 1, 2008)).
- Final Part C regulations took effect on October 28, 2011 (34 C.F.R. Part 303; 76 Fed. Reg. 73006 (Sept. 28, 2011).

Child Find: Gateway to Services

All children with disabilities must be identified before receiving early intervention or special education services. Child Find is a child identification program that identifies and evaluates children and young people from ages 0 to 21 who are suspected of having disabilities, including those with a history of exposure to lead or a BLL ≥5 µg/dL.

Under IDEA, all states must have a comprehensive, continuous Child Find system with the purpose of identifying, locating, and evaluating all infants, toddlers, and children with disabilities in the state who are eligible for early intervention or special education services. Child Find systems vary by state, but they typically include public awareness activities, screening, referral, and evaluation activities.

The regulations in Part B of IDEA 34 C.F.R. § 300.111 state Child Find policies and procedures must identify all children with disabilities who are in need of special education and related services. This includes children—regardless of the severity of their disability—who are homeless, migrant, or “highly mobile”; wards of the state; attending private schools, as well as those who are advancing from grade to grade. States and local education agencies (i.e., school districts and charter schools) are responsible for compliance. School district offices or websites provide contact information for the personnel responsible for screening and referrals through Child Find (U.S. Department of Education 2010).

Part B Child Find has three primary purposes:

1) To ensure that no children with disabilities are denied a free appropriate public education because they have not been located.
2) To ensure cooperation between educational agencies and others such as health, mental health, and developmental disabilities agencies; social services; corrections departments; private schools; and private agencies.
3) To enable the states and local education agencies to appropriate funds, plan and deliver programs, and be held accountable to all children with disabilities.

The lead agencies for the Part C Early Intervention Program must ensure that all infants and toddlers with disabilities who are eligible for early intervention services are identified, located, and evaluated. These agencies are also required to coordinate Child Find with Part B programs, via referrals and transition planning, as well as with other agencies responsible for relevant education, health, and social service programs. These other agency programs include the Maternal and Child Health program (including the Maternal, Infant, and Early Childhood Home Visiting Program); the Early and Periodic Screening, Diagnostic, and Treatment component of Medicaid; Head Start and Early Head Start; Supplemental Security Income programs; and other appropriate entities.

In most states, there is a designated point of contact for Child Find and early intervention at the state, county, and district levels, but it may not be the same agency responsible for Part B Child Find. Parents concerned about their child's development may request an evaluation at no cost through Child Find. Often, pediatricians or school personnel refer children for evaluation, which requires parental permission.

The following resources provide searchable links for state or local Child Find contacts:

- The Center for Parent Information and Resources (CPIR) provides a listing of all OSEP-funded parent training and information centers by region. Parent centers have information about Child Find procedures and contact information for the states in their regions. Also, CPIR has access to many of the materials produced by the National Dissemination Center for Children with Disabilities (NICHCY), which are available via the Center for Parent Information and Resources (http://www.parentcenterhub.org).
- The Early Childhood Technical Assistance Center provides state contact information for early intervention (Part C) coordinators and for preschool programs (Section 619 coordinators) (http://ectacenter.org).

In addition, there are many other resources for parents seeking information about education and services for children affected by lead. Parent centers provide training and assistance to families with children with disabilities. These centers—which include parent training and information centers (PTIs) and community parent resource centers (CPRCs)—are funded through OSEP under IDEA. Parent centers serve families of children of all ages (birth to 26 years) and with all disabilities (physical, cognitive, behavioral, and emotional). Every state has at least one PTI for underserved families, and those with larger populations may have more. CPRCs provide services to underserved families in smaller geographic areas. There are currently 94 parent centers in the United States (http://www.parentcenterhub.org). Additionally, pediatric health care providers, public schools, and local health departments are familiar with Child Find screening requirements and can refer children.

Part C: Early Intervention Services for Children Under Age 3

Since 1986, the IDEA Part C program has provided for early intervention services to infants and toddlers with disabilities to improve outcomes and prepare them to successfully transition to preschool and kindergarten. Part C authorizes assistance to state and local programs to serve children from birth through age 2 (through the 35th month of age), also known as "zero to three" or "infants and toddlers."

Part C has five main purposes:

1) To enhance the development of infants and toddlers to minimize their potential for developmental delays, recognizing that significant brain development occurs during a child's first three years.
2) To reduce the educational costs to society, including the nation's schools, by minimizing the need for special education and related services after infants and toddlers reach school age.
3) To maximize the potential of individuals with disabilities to live independently.
4) To enhance families' capacities to meet the needs of their children with disabilities.
5) To enhance the capacities of state and local agencies and service providers to identify, evaluate, and meet the needs of all children, particularly minority, low-income, inner-city, and rural children and infants and toddlers in foster care (20 U.S.C. § 1431 (a)).

Part C provides funding for services to infants and toddlers. Infants and toddlers who qualify for the services must meet their state's eligibility definition of developmental delay or have a diagnosed physical or mental condition that carries a high probability of causing developmental delays (20 U.S.C. § 1432(5)). Part C regulations identify required services that may include speech-language services, occupational therapy, physical therapy, and special instruction. There are also services that must be provided at no cost to the family; they include child find, evaluation and assessment, service coordination, individual family service planning, and procedural safeguards. After a child is referred and evaluated to determine eligibility and service needs, a team of professionals and the child's parents meet to develop a written plan for providing early intervention services to the child and family. This document is called the individualized family service plan (IFSP).

Infants and toddlers with disabilities are defined as children who

1) Are experiencing developmental delays, as measured by appropriate diagnostic instruments and procedures, in one or more of the following five areas: cognitive development, physical development, communication development, social or emotional development, or adaptive development **OR**
2) Have a condition of established risk, which is defined as "a diagnosed physical or mental condition which has a high probability of resulting in developmental delay" whether or not a measurable delay has been identified (http://aspe.hhs.gov/hsp/08/devneeds/apa.htm). Children affected by lead may qualify under this definition.

States have the discretion to provide services to infants and toddlers who are at risk for substantial developmental delays if they do not receive appropriate early intervention services (20 U.S.C. § 1432(1); 20 U.S.C. § 1432(5)(B)).

Established risk conditions include (http://aspe.hhs.gov/hsp/08/devneeds/apa.htm), but are not limited to,

- chromosomal abnormalities, genetic or congenital disorders, severe sensory impairments, including hearing and vision;
- inborn errors of metabolism, disorders reflecting disturbance of the development of the nervous system, congenital infections;
- disorders secondary to exposure to toxic substances**,** including fetal alcohol syndrome; and
- severe attachment disorders.

States have considerable discretion in establishing Part C eligibility because they define criteria for the developmental delay that an infant or toddler must be either experiencing or have a high probability of experiencing as a result of a diagnosed established risk condition. The federal regulation does not explicitly mention lead exposure for Part C eligibility. States may include a child who is at risk for experiencing developmental delays because of biological or environmental factors that can be identified (20 U.S.C. § 1432(3)(B); 34 C.F.R. § 303.10). In the discussion of public comments accompanying the final regulation related to optional coverage of at-risk children, mandatory referrals for children who have been exposed to "lead paint," (76 Fed.Reg. 60140) was not included in the regulation, thus allowing states to have flexibility to designate subgroups at risk.

According to a 2012 survey of states' early intervention program documents, eight states explicitly mention lead exposure as an eligible condition for services or tracking (i.e., either by itself or in combination with its adverse effect on educational performance). Another 12 states specify BLL thresholds ranging from >10 µg/dL to >45 µg/dL as a criteria for early intervention eligibility. Thirteen states mention nonspecific "toxic" exposures as eligibility criteria (see Appendix 2).

Although Part C is primarily for children under 3 years of age, states have the option of extending services until the child is eligible under state law to enter kindergarten or elementary school, as appropriate. This option reduces the need for an additional transition to separate preschool services before the transition to primary school.

The state-designated Part C lead agency is typically the agency responsible for health or rehabilitative services and facilitates linkages to Medicaid and early intervention service providers. Also, some state education agencies operate their states' Part C program. Informational resources and research findings about IDEA Part C—including program contact information, state Part C regulations, and state eligibility definitions—can be found at http://ectacenter.org/partc/partc.asp.

Part B: Special Education for Children, 3–21 Years Old

IDEA Part B is the federal special education law for children ages 3–21 with disabilities, whose purpose is

a) To ensure that all children with disabilities have available to them a free appropriate public education that emphasizes special education and related services designed to meet their unique needs and prepare them for further education, employment, and independent living.
b) To ensure that the rights of children with disabilities and their parents are protected.

c) To assist states, localities, educational service agencies, and federal agencies to provide for the education of all children with disabilities.
d) To assist states in the implementation of a statewide, comprehensive, coordinated, multidisciplinary, interagency system of early intervention services for infants and toddlers with disabilities and their families.
e) To ensure that educators and parents have the necessary tools to improve educational results for children with disabilities by supporting system improvement activities; coordinated research and personnel preparation; coordinated technical assistance, dissemination, and support; and technology development and media services.
f) To assess and ensure the effectiveness of efforts to educate children with disabilities.

As noted above, public school districts and charter schools are the lead agencies for Part B, including the Section 619 Preschool Program. Part B requires that schools provide special education and related services to eligible children in the least restrictive environment and to comply with important specifications regarding processes, payment, quality assurance, parental rights, dispute resolution, and other administrative aspects. As with Part C, states issue their own regulations that must comply with federal requirements for Part B, at a minimum, and may contain additional services or requirements. (Links to state Part B regulations can be found at http://idea.ed.gov/explore/home).

Despite the variation by state, the core elements of the Part B process, described below, are consistent.

1. Child is identified as possibly needing special education services. As with Part C, children may be identified by Child Find or by an individual request from a parent/guardian, health care provider, or social service provider. Schools may also initiate an evaluation.
2. Child is evaluated. The purpose of this multidisciplinary evaluation is to determine if the child has a disability that requires special education and related services.
3. Eligibility for special education is decided. School professionals and the parents together review the evaluation findings and make a determination as described in 34 CFR § 300.301-306.
4. Child is determined to be eligible for services.
5. Individualized education program (IEP) meeting is scheduled and must be held within 30 days of eligibility determination.
6. Team meeting is held to write the IEP with parental participation.
7. Services are provided consistent with the developmental problems outlined in Chapter 4.
8. Progress is measured and reported to parents through the report card or as requested at any time by parents. Parents can initiate a process to evaluate progress toward IEP goals more frequently based on their child's needs.
9. IEP is reviewed [at least annually].
10. Child is reevaluated, at least every 3 years, to ensure that academic transitions have been successful as described in Chapter 4.

Students who meet both the following conditions are eligible for Part B special education services under IDEA (20 U.S.C. § 1401(3)(A); 34 C.F.R. § 300.8(a)):

- The student must be determined to have one (or more) of the 13 disabilities listed in the IDEA.
- The student must, as a result of that disability, need special education to make progress in school and to receive benefit from the general educational program.

Children affected by lead maybe eligible because they have "other health impairment," a specific learning disability or, if 3–9 years old, they are experiencing developmental delay as defined by the state. In states where lead poisoning is not specified as a disability, the child may qualify under the "other health impairments" option. If a child is determined to have a disability yet not be in need of special education, he or she may still be eligible under an optional designation known as "developmental delay." Under this designation, states can provide special education services to young children (ages 3–9) who are experiencing developmental delays but do not satisfy the criteria for a disability category. This approach avoids the need to diagnose specific learning disabilities, which some have argued is inaccurate and inappropriate for young children, and avoids labeling them at such a young age and stage of development. [Table 4 summarizes potential eligibility categories.]

States may decide whether to use a developmental delay designation, how to define it, and what age ranges it should apply to. The second Part B condition also applies as well: Even if a developmental delay is identified, a child must be shown to need special education in order to be eligible for services. [For more information, see http://www.ectacenter.org/~pdfs/pubs/nnotes27.pdf].

Children affected by lead may be eligible for Part B special education in several ways. First, they may qualify as having an "other health impairment," which is one of the 13 disability categories listed in IDEA. The federal statute explicitly includes lead poisoning as a covered impairment. Second, a child might have a "specific learning disability," which is another of the 13 IDEA disability categories (see Appendix 3 for a list of the specific disabilities). In both cases, a child would also have to meet the second criterion of needing special education as a result of the health condition. Finally, in some states, children affected by lead might be found to have developmental delays consistent with the state's definition.

Part B: Section 619 Preschool

Young children aged 3 to 5 or, at the state's discretion, those who will turn 3 during the school year and who have been identified as having any of the conditions named in Part B, including developmental delays, are eligible to receive services under the Section 619 (20 U.S.C. § 1419(a)). Just like school-age children, preschoolers with disabilities are entitled to special education and related services in the least restrictive environment (20 U.S.C. § 1412(a)(5). Each state has a designated individual who is responsible for coordinating the state's Section 619 Preschool Grant. (For more information, see http://ectacenter.org/sec619/sec619.asp#contact).

The 2004 reauthorization of IDEA allows local educational agencies to use up to 15% of funds received under Part B to develop and apply coordinated early intervening service (CEIS) for students without disabilities. Unlike Part C early intervention, which provides services for children birth through age 2, Part B CEIS provides non-special education services to students in kindergarten through grade 12 (with primary focus on children in kindergarten through grade 3). In particular, CEIS provides for those who

have not been identified as needing special education or related services, but who need additional academic and behavioral supports to succeed in a general education environment.

CEIS requires that schools use a scientifically based academic and behavioral intervention as emphasized by the No Child Left Behind Act (34 C.F.R. § 300.226(b)). This has resulted in two major intervention models (U.S. Department of Education 2004):

- Response to Intervention for children who are struggling academically.
- Positive Behavioral Support for children who have problem behaviors.

Thus, a local educational agency could possibly explore using CEIS funds to develop a monitoring plan within a scientific research-based intervention framework for addressing the needs of lead-affected students who have reading, math, or behavioral problems but are not identified as having disabilities under IDEA or Section 504.

There are public agencies and private sector organizations that have developed extensive informational, training, and reference materials on special education under IDEA targeted to specific audiences. These agencies may be able to help parents and caregivers assess which services their children would be able to access and which agencies to contact regarding assessments and interventions.

Detailed information on Part B is available from the U.S. Department of Education (http://idea.ed.gov). Guides written for parents are available from various sources, including the Center for Parent Information and Resources (http://www.parentcenterhub.org/). In all cases, parents will need to focus specifically on what their state and local school districts do to administer and implement these regulations.

Rehabilitation Act of 1973, Section 504: Federal Civil Rights Protections

Section 504 of the Rehabilitation Act of 1973 is a federal civil rights law that protects individuals with disabilities in programs that receive federal financial assistance. The regulations provide two additional layers of protection:

1) Ensuring services for children with disabilities who are not eligible for IDEA.
2) Requiring that schools meet the specialized needs of all children with disabilities while providing access to the same resources provided to children who do not have disabilities.

Section 504 provides that, “No otherwise qualified individual with a disability in the United States … shall, solely by reason of her or his disability, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance…” (29 U.S.C. § 794).

While not an education-specific law, Section 504 applies to public school districts, state and local education agencies, and institutions of higher learning, among others. Section 504 regulations require school districts to provide a “free appropriate public education” to each qualified person with a

disability who is in the school district's jurisdiction, regardless of the nature or severity of the person's disability. Under the regulations a free appropriate public education consists of the provision of regular or special education and related aids and services designed to meet the student's individual educational needs as adequately as the needs of nondisabled students are met (34 C.F.R. § 104.33).

Section 504 regulations define a person with a disability[1] as "any person who: (i) has a physical or mental impairment which substantially limits one or more major life activities, (ii) has a record of such an impairment, or (iii) is regarded as having such an impairment" (34 C.F.R. § 104.3). The regulations also define learning as a major life activity. Under Section 504, lead-exposed students may have impairment (lead poisoning) that substantially affects their major life activities, such as learning and attention. Due to a broader definition of disability, Section 504 covers more children than IDEA does. Another important difference between IDEA and Section 504 is that 504 does not provide funding for services.

Under the law, recipients of federal funding are required to eliminate barriers that prevent students with covered disabilities from participating fully in the programs offered. Schools must make necessary accommodations and provide support to allow qualified students to participate. Federal regulations specify that an appropriate education includes the following:

- Education services designed to meet the individual education needs of students with disabilities as adequately as they meet the needs of nondisabled students.
- The education of each student with a disability with nondisabled students, to the maximum extent appropriate to the needs of the student with a disability.
- Evaluation and placement procedures established to guard against misclassification or inappropriate placement of students, and a periodic reevaluation of students who have been provided special education or related services.
- Establishment of due process procedures that enable parents and guardians to receive required notices; review their child's records; and challenge identification, evaluation, and placement decisions.

School districts typically have documented processes that they follow and designated personnel to coordinate and document implementation. The typical process for provision of Section 504 services in schools begins with a team meeting to review a student's circumstances; plan an evaluation (if necessary); and provide services, accommodations, or modifications based upon the student's needs. This plan could include modified schedules, alternative test settings, extra time to complete projects, reasonable modification of policy or procedures, and other reasonable accommodations to the

[1]The regulations actually use the term "handicapped" rather than "disability." However, because the common usage is "disability," we use that term rather than "handicapped."

student's disability. While Section 504 regulations specify various due-process requirements, the law does not contain set time limits for schools to act.

Americans with Disabilities Act

Since 1990, the Americans with Disabilities Act (ADA) has provided federal civil rights protection for people with disabilities. ADA applies to all state and local government programs, including public schools. The Americans with Disabilities Act Amendments Act of 2008 (ADAAA) restored the scope of protections intended in the original 1990 ADA that had been limited by court rulings in the interim. Similar to Section 504, the ADA defines a "disability," in part, as a physical or mental impairment that substantially limits a major life activity of an individual. ADAAA did not revise its definition of disability, but broadened its interpretation to include an expanded list of illustrative major life activities, along with other clarifications about determining impact of disabilities on these activities. Of particular relevance to lead-poisoned children, major life activities now include learning, reading, concentrating, and thinking, among others. These changes may enable more students to be considered eligible under Section 504. The law also made the ADA definition of "individual with a disability" applicable to the Rehabilitation Act.

ADAAA also adds a new category by stating that a major life activity includes "the operation of a major bodily function" including but not limited to neurological and brain functions. In addition, the law makes clear that an impairment that substantially limits a major life activity need not also limit other major life activities in order to be considered a disability. Moreover, it clarifies that impairments that are episodic or in remission are considered disabilities if the impairment would substantially limit a major life activity when the condition is considered in its active status (Pub. L. 110-325, § 4).

ADAAA makes clear that no child should have the door to Section 504 shut because of old, outdated ADA law. ADAAA contains an amendment that amends the Rehabilitation Act of 1973 to ensure that entities such as "public schools, institutions of higher education, childcare facilities, and other entities receiving federal funds" operate under "one consistent standard" because these entities are required to comply with both laws (Congressional Record, Vol. 154, No. 147, Sept. 16, 2008, p. S8843). The). ADA aspects of ADAAA are also relevant as youth with disabilities transition from school into employment. These changes may enable more students, including those who are affected by lead, to be considered eligible under Section 504.

Medicaid: Early and Periodic Screening, Diagnosis, and Treatment (EPSDT)

The EPSDT program is a comprehensive and preventive child health program that emphasizes the early assessment of children's health care needs. The EPSDT program requires state Medicaid agencies to cover necessary health care, diagnostic services, and treatment to correct and ameliorate defects and physical and mental illnesses and conditions discovered by screening of individuals aged 21 years and younger (http://www.medicaid.gov/medicaid-chip-program-information/by-topics/financing-and-reimbursement/downloads/2003_sbs_admin_claiming_guide.pdf). The scope of covered services can be broader than what is otherwise included under a state's Medicaid state plan in general. Covered under EPSDT, children enrolled in Medicaid are required to have a blood lead test at about 12 months and again at about 24 months. If the child is 3 to 5 years of age and does not have a record of any previous

blood lead test, the child should receive a blood lead test. In addition, a child must be tested if the parent, guardian, or provider requests blood lead testing due to suspected exposure.

In many states, schools play a large role in many EPSDT activities, particularly with respect to outreach, screening, diagnosis, and treatment.

School-based health services are important to ensuring that children and adolescents receive needed health care in a setting that is appropriate and with minimum disruption of education. Many school-based health programs deliver services that are covered by Medicaid. For Medicaid to cover these services, they must be primarily medical and not educational in nature, medically necessary for the child, and provided by a qualified Medicaid provider to families that meet income eligible requirements (i.e., not provided free of charge to non-Medicaid children). These can include

- Routine and preventive screenings and examination including blood lead testing and follow-up for BLLs,
- Diagnosis and treatment of acute uncomplicated problems,
- Monitoring and treatment of chronic medical conditions, and
- Provision of medical services to children with disabilities under the IDEA.

States and schools have flexibility in how they choose to implement these services. To gain access to the most appropriate services for their child, parents and caregivers will have to determine how the services are implemented in their jurisdiction.

American Academy of Pediatrics Recommendations

- If a child has had a venous BLL ≥ 5 µg/dL before age 6 years, that child should have annual developmental surveillance and screening at ages 3, 4 and 5 years.
- For children with a venous BLL ≥ 5 µg/dL at any age, developmental surveillance during medical visits should continue annually (no age limit) to identify emerging or unaddressed behavioral/developmental/cognitive concerns.
- For children of any age, if problems/issues arise between annual visits, parents should be encouraged to bring them to attention of the appropriate school personnel or clinician.

(http://www.health.state.mn.us/divs/fh/mch/ctc/factsheets/lead.pdf)

Every child less than 3 years old should have developmental surveillance (also called “developmental monitoring”) and screening as proposed by the American Academy of Pediatrics (AAP)—surveillance at every well-child visit and screening at 9 months, 18 months, and either 24 or 30 months (AAP 2006). CDC’s *Learn the Signs. Act Early* program provides information and tools to help parents of all young children, healthcare providers, and early educators monitor young children’s development and act early

if there is a concern. (www.cdc.gov/actearly). Developmental screening is now considered a covered preventive health service under the Patient Protection and Affordability Act (ACA 2010).

Title V: Maternal and Child Health Services Block Grant Program

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 their families. At least 30% of the federal Title V funds are designated for services for children with special health care needs. States can use these funds to provide education and counseling to families with BLLs at or above 5 µg/dL (for example, Louisiana 2013). Specifically, the Title V Maternal and Child Health program seeks to

- Assure access to quality care, especially for those with low-incomes or limited availability of care,
- Reduce infant mortality,
- Provide and ensure access to comprehensive prenatal and postnatal care to women (especially low-income and at-risk pregnant women),
- Increase the number of children receiving health assessments and follow-up diagnostic and treatment services,
- Provide and ensure access to preventive and child care services as well as rehabilitative services for certain children,
- Implement family-centered, community-based systems of coordinated care for children with special healthcare needs, and
- Provide toll-free hotlines and assistance in applying for services to pregnant women with infants and children who are eligible for Title XIX (http://mchb.hrsa.gov/programs/titlevgrants/).

States and jurisdictions use their Title V funds to design and implement a wide range of activities that address national and state needs. Unique in its design and scope, the Maternal and Child Health Block Grant

- Focuses exclusively on the entire maternal and child health population;
- Encompasses infrastructure, population-based, enabling, and direct services for the maternal and child health population;
- Requires a unique partnership arrangement between federal, state, and local entities;
- Requires each state to work collaboratively with other organizations to conduct a statewide comprehensive needs assessment every 5 years;

- Requires each state—based on the findings of the needs assessment—to identify priorities to comprehensively address the needs of the maternal and child health population and guide the use of the Maternal and Child Health Block Grant funds; and
- May serve as the payer of last resort for direct services for the maternal and child health population that are not covered by any other program.

IDEA/ADA Resources

Resources on understanding and using IDEA and ADA can be found at the following websites:

- National Dissemination Center for Children with Disabilities (http://www.parentcenterhub.org/).
- IDEA Parent Guide (https://www.understood.org/en/tools/through-your-childs-eyes).
- Free Appropriate Public Education for Students with Disabilities: Requirements under Section 504 of the Rehabilitation Act of 1973 (http://www2.ed.gov/about/offices/list/ocr/docs/edlite-FAPE504.html)
- Coordinated Early Intervention Services (CEIS) (http://www2.ed.gov/policy/speced/guid/idea/ceis_pg3.html).

Table 2: Summary of Educational Resources: The Individuals with Disabilities Education Act (IDEA)

This table displays federal statute and grant funding that ensures free and appropriate education for children with a specific disability as defined by IDEA.

Provision	Population	Services	Key Element	Activities
IDEA: Child Find	Children from birth–21 years of age, including those enrolled in all public and private schools.	Policies and procedures to identify, locate, and evaluate children suspected of having a disability.	Coordination with referral sources such as physicians and agencies.	Public awareness, referral, screening, eligibility determination, tracking, and interagency coordination.
IDEA: Part B	Children 3–21 years of age.	Provides for special education and related services.	Individualized education program (IEP) specifying services and supports the child will receive.	Education in the least restrictive environment appropriate. Early intervening services provide additional support to struggling students in general classroom.
IDEA: Part B, Section 619	Children 3–5 years of age (Section 619 preschool program).	Provides grants for preschool services.	Children with disabilities receiving services in inclusive settings.	Transition activities between IDEA Part C and Part B.
IDEA: Part C	Children birth through third birthday. State option—extended Part C service from third birthday through kindergarten.	Provides early intervention services for infants and toddlers with developmental delays or diagnosed conditions with high probabilities of resulting in developmental delays.	Uses an individualized family service plan (IFSP) specifying services for a child and his/her family.	Provides services and education to children in their natural environment.
IDEA: Part B, CEIS	Students from kindergarten through grade 12 (with a focus on kindergarten through grade 3).	Provides scientifically based academic and behavioral interventions.		Professional development for teachers and other school staff in scientifically based academic and behavioral interventions, including literacy instruction and, where appropriate, instruction on the use of adaptive and instructional software. Providing educational and behavioral evaluations, services, and supports, including scientifically based literacy instruction.

Table 3: Summary of Educational Resources: Provisions under Section 504, ADAAA, EPSDT

This table displays federal statute and grant funding that ensures free and appropriate education for children with a specific disability as defined by Section 504, ADAAA, and EPSDT.

Provision	Population	Services	Key Element	Activities
Section 504 of the Rehabilitation Act of 1973	Individuals with disabilities in any institution, school, or agency receiving federal funding. *Children with disabilities eligible under Section 504 are not necessarily eligible under IDEA because of the broader disability definitions under Section 504.*	Protects rights of those in the Population column. Requires a school district to provide a "free appropriate public education" to each qualified person with a disability who is in the school district's jurisdiction, regardless of the nature or severity of the person's disability.	Generally regarded as the basis for disability protection in the schools. Schools provide accommodations, supports, and aides necessary for child to receive education comparable to the one provided to general students.	No additional funds are provided to state or local school districts. IDEA funds may not be used for children eligible under 504 only.
Americans with Disabilities Act, as amended by the Americans With Disabilities Act Amendments Act of 2008 (ADAAA)	People with disabilities. *Title II makes ADAAA applicable to all state and local government programs, including public schools.*	Provides federal civil rights protection for those in the Population column. Restored the scope of protections intended in the original 1990 ADA that were limited by court rulings in the interim. Made the ADA definition of "individual with a disability" applicable to the Rehabilitation Act.	ADAAA left unchanged the definition of disability but broadened its interpretation to include an expanded list of illustrative major life activities to show limitation and removes consideration of mitigation measures.	These changes may enable more students to be considered eligible under Section 504.

Provision	Population	Services	Key Element	Activities
Medicaid: EPSDT	Children eligible for Medicaid	EPSDT screening may identify children with disabilities needing special education services or accommodations. Requires screening for blood lead level at specified ages. Agencies implementing IDEA must coordinate with Medicaid. Schools may be reimbursed for certain medical services under Medicaid; IDEA is funder of last resort for medical services.		

Table 4: Potential Eligibility of Children with Lead Exposure/Poisoning

Provision	Requirement for Disability	Basis for Eligibility of Lead Poisoned Children	Comment
IDEA: Part B (including Section 619 Preschool)	Child aged 3 to 21 must have one (or more) of 13 disabilities listed in IDEA and, as a result of that disability, need special education (20 U.S.C. §§ 1401(3)(A), 1412(a)). In some states, a child aged 3–9 who is experiencing developmental delays, as defined by the state (20 U.S.C. § 1401(3)(B)).	Other health impairment is one of the 13 disabilities in IDEA, with lead poisoning explicitly included in statute as a covered impairment (34 C.F.R. § 300.8(c)(9)(i)). Specific learning disability is also one of the 13 disabilities listed in IDEA (34 C.F.R. § 300.8(c)(10)). In some states, children affected by lead with lead poisoning might be eligible if they are determined to have developmental delays (20 U.S.C. § 1401(3)(B)).	Note that lead poisoning is not sufficient alone; the condition must also adversely affect the child's educational performance (20 U.S.C. § 1401(3)(A)(ii)). Also, neither the statute nor the regulation specifies a definition for lead poisoning.

Provision	Requirement for Disability	Basis for Eligibility of Lead Poisoned Children	Comment
IDEA: Part C	Infants and toddlers are eligible for early intervention if they meet the State's definition of developmental delay or have a condition with a high probability of developmental delays (20 U.S.C. §§ 1432(5)(A), 1435 (a)(2)).	Examples of these conditions include disorders reflecting disturbance of the development of the nervous system and disorders secondary to exposure to toxic substances. (http://aspe.hhs.gov/hsp/08/devneeds/apa.htm).	Under the most recent regulations, states must develop rigorous definitions of developmental delay (34 C.F.R. § 303.111).
ADA and Section 504 of the Rehabilitation Act	Individuals who have or had a physical or mental impairment that substantially limits a major life activity such as walking, seeing, hearing, thinking, reading, learning, or concentrating (42 U.S.C. § 12102(1)-(3)).	Federal regulations have expanded the interpretation of the term "major life activities" to include learning and reading, among others (45 C.F.R. § 84.3; 28 C.F.R. § 104).	Does not require that a child needs special education to qualify (45 C.F.R. § 84.33(b)).

Figure 1: The Connecticut Model for Providing Education Services to Preschool Children Affected by Lead

(Connecticut Department of Education 2012)

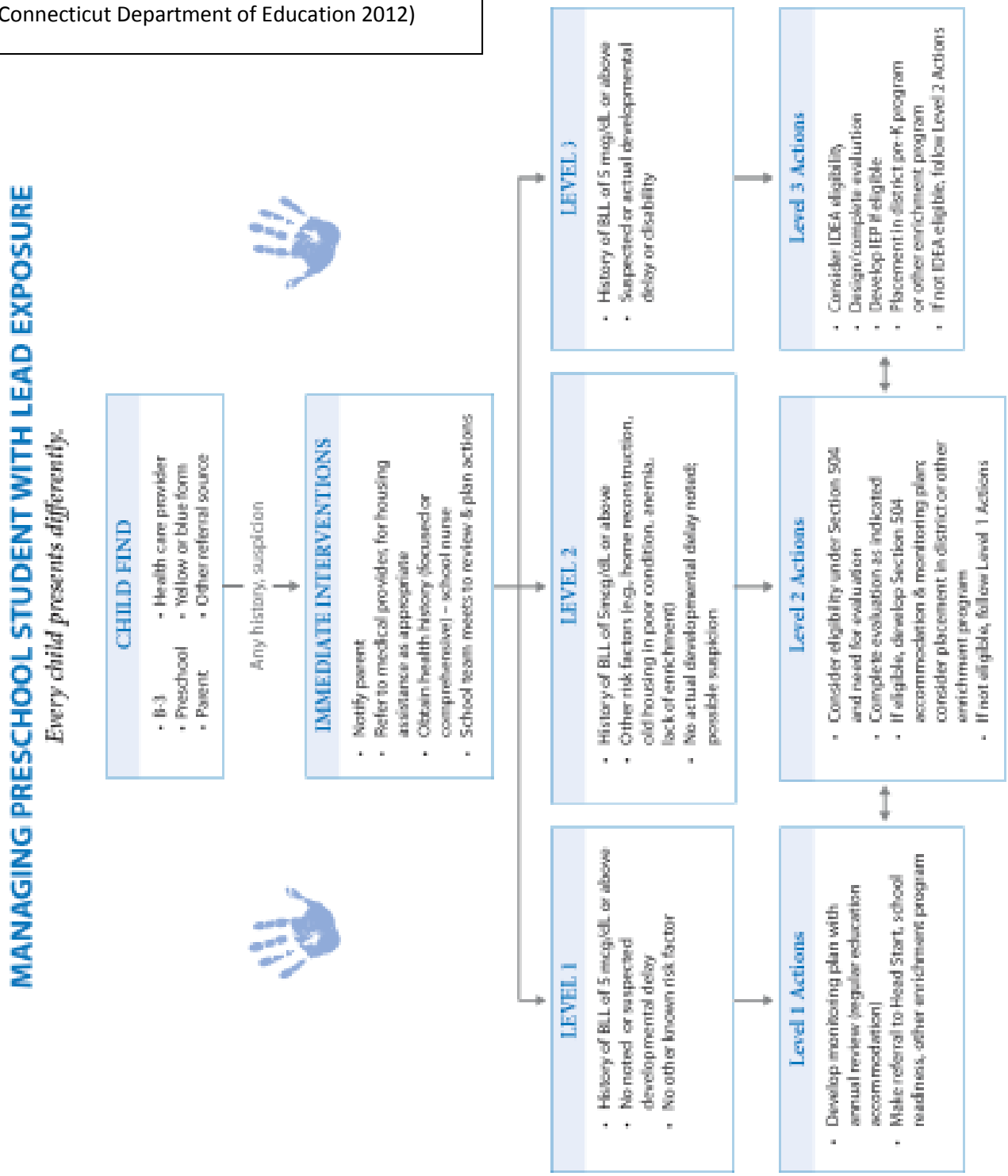
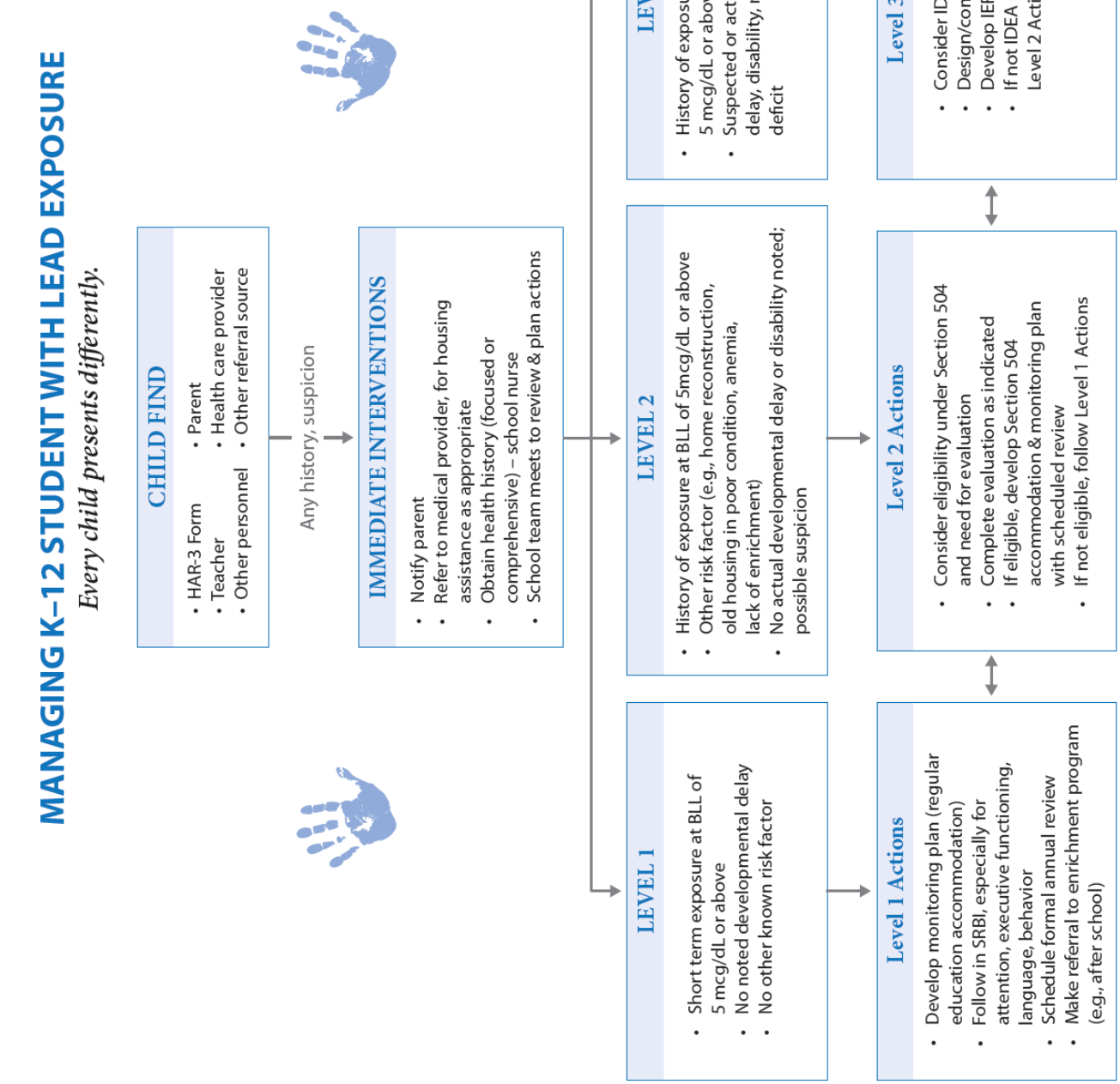


Figure 2: The Connecticut Model for Providing Education Services to K–12 Students Affected by Lead

(Connecticut Department of Education 2012)



Chapter 7: Services Available for Lead-Exposed Children

This chapter provides a summary of the services available for children with learning disabilities under IDEA. The expert panel identified some opportunities to increase access to these services for children affected by lead.

The Education Community and the Child Affected by Lead

The specific effects of lead on children's academic and behavioral outcomes are not well known within education and other fields responsible for achieving the nation's ambitious academic goals. Similar to children with traumatic brain injury (Wayne et al. 2013), children who have been exposed to lead may not be identified in school records or appropriately tracked. Therefore, problems triggered by lead may never receive the appropriate response. Professionals in the fields of early intervention, early childhood, and elementary and secondary education need information from lead poisoning prevention programs and providers to ensure that they understand and fulfill their unique roles.

Children with BLLs at or above the CDC reference value for lead (5 µg/dL in 2012) are at greater risk for developmental delay and behavioral issues that result in academic failure and diminished life success compared to children who do not have a history of HBLLs. Some children are more affected than others by a given blood lead concentration, will experience different levels of delay, and require different interventions (CDC 2002). Thus it is important that children are screened for adverse neurocognitive effects using the appropriate screening tools. Connecting at-risk children to early intervention services is likely key to reducing long term effects. Also, educators, parents, and health care providers can identify delays at critical transition points in educational expectations such as first, fourth, and sixth grades (see Chapter 3). Affected children may exhibit little to no development difficulties early in life but begin to exhibit learning delays at these transition points. Behavioral difficulties may also become apparent as the child ages and higher expectations for self-regulation and interpersonal skills are expected.

Identifying children with HBLLs is critical to determining their specific detriments and then identifying the most appropriate early or elementary school interventions necessary. Thus it is important that all children with HBLLs are 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. While no specific intervention programs have been demonstrated to improve outcomes for children affected by lead, there are interventions proven to help children with brain dysfunctions who have not had HBLLs and lack lead poisoning.

U.S. Department of Education

OSEP, within the Department of Education's Office of Special Education and Rehabilitative Services (OSERS), is responsible for administration, implementation, and monitoring of state and local service delivery under the laws described in Chapter 6.

Additionally, OSERS funds parent training and information centers to provide technical assistance and education to parents and other involved with children with developmental delays.

States' IDEA Child Find Programs

Federal regulations require that each state have a comprehensive Child Find system with the purpose of identifying, locating, and evaluating all infants and toddlers with disabilities birth to age 3 as early as possible (U.S. Department of Education OSER 2010). The Child Find system has the authority and obligation to refer children with disabilities or risk conditions—such as children who have ever had a BLL at or above the reference value—to needed early intervention services. This gateway to services could be expanded formally to better meet the needs of lead-exposed children:

- States can consider adding a member from the state's childhood lead poisoning prevention program to the required interagency coordinating council with designees who administer the Title V Maternal and Child Health, Early and Periodic Screening, Diagnosis and Treatment program (EPSDT), Medicaid, Head Start, and Developmental Disabilities programs.
- Child Find programs can consider requesting that the state's childhood lead poisoning prevention and Medicaid programs, managed care organizations, hospitals, primary care physicians, and other health care providers refer children who have ever had a BLL at or above reference value to Child Find and/or inform the parents that they can request a screening at no cost through Child Find.
- Child Find programs can consider collaborating with parent centers in outreach to parents of lead-exposed children.
- Child Find programs may consider using a neuropsychological assessment of executive function (in addition to a developmental evaluation) to identify cognitive and functional deficits in all lead-exposed children with BLLs at or above the reference value.

States' IDEA Part C Programs (for Children under Age 3)

Congress established the Part C program in recognition of "an urgent and substantial need" to enhance the development of infants and toddlers with disabilities and minimize the need for special education at older ages because of the early intervention. Although the state education agency is responsible for administering Part B of IDEA, some also manage the Part C program as well. However, most Part C programs are housed in state health departments and human/social services departments. A few are operated by other entities (http://ectacenter.org/partc/ptclead.asp).

States can consider classifying the neurocognitive and developmental deficits associated with BLLs above the current reference value as conditions that qualify for early intervention in Part C services in order to ensure that children affected by lead receive the services they need. Since some developmental problems do not manifest until later years, early intervention could be provided to fortify a child's early learning even if a developmental assessment does not yet indicate that services are needed.

States' IDEA Part B Programs (for Children and Young People Ages 3–21 Years)

Congress enacted Part B to ensure that all children and young people with disabilities, including those who have been identified as "other health-impaired" due to lead poisoning, have available to them a free appropriate public education that emphasizes special education and related services designed to

meet their unique needs and prepare them for further education, employment, and independent living. State education departments are responsible for Part B implementation and compliance.

The Part B program could also work with the childhood lead poisoning prevention programs to ensure that local education agency staff members understand the scope of the childhood lead poisoning problem in their locale, geographic areas where risk is highest, and other important information to help target resources such as additional early childhood education programs.

The State Education Department could develop and ensure delivery of training and appropriate programming for educators, including special educators, in identifying lead-exposure related disabilities and behaviors that impede educational success.

Local Education Agencies

Boards of education, school superintendents, principals, teachers, school nurses, and counselors can work with parents to ensure that children affected by lead are identified, assessed and receive educational support. School districts can develop policy and procedures regarding services for children who may be affected by lead, with the following possible components (See Figure 3 for a decision chart):

- Request that parents provide results of all blood lead tests and developmental assessments (or authorize the child's health care provider to provide this information), maintain these reports in the child's confidential school record, and consider this information in any future developmental assessment.
- Ensure that each teacher new to a child affected by lead is aware at the beginning of each school year that this lead exposure may affect health, learning, and behaviors and monitors progress of at-risk children lacking a documented BLL.
- Use Child Find processes to identify and refer as early as possible students and their families who are in need of special education under Part C or Part B of IDEA or refer to Section 504 team or planning and placement team (PPT) for determination of a disability and eligibility under Section 504.
- Develop a monitoring plan within a Scientific Research-Based Intervention (SRBI) framework to address the needs of all students ages 3–21 affected by lead, including follow-up developmental assessments annually or at least at the first and fourth grade levels, for any such children who were determined ineligible for any special education services at an earlier age. Use SRBI for students with cognitive and/or behavioral problems but not determined as having a disability under IDEA or Section 504 and monitor for progress.
- Refer students to a Section 504 team or PPT for determination of disability and eligibility under Section 504 or IDEA when indicated.
- Provide comprehensive interventions that match the needs of individual students and families for students who do not respond to the initial evidence-based interventions and follow up developmental assessment especially in executive function, language, and behavior.
- Educate school personnel about the adverse effects of HBLLs on academic performance and behavior.

- Collaborate with parent centers, parents, and other community partners to educate families and students about the adverse effects of HBLLs on academic performance and behavior.
- Obtain census tract level blood lead data from the childhood lead poisoning prevention programs, use the data to identify populations where the risk for HBLLs is disproportionately high, and prioritize these areas for early childhood education referrals and resources.
- Communicate with the managed care organizations and other providers who serve their students regarding the needs of children affected by lead.

Pediatric Health Care Providers

The medical home and other pediatric health care providers might consider ways to optimize the identification of children affected by lead by testing children at 12 and 24 months of age (or as recommended by their state health department) and by following AAP recommendations for developmental surveillance and referral.

The medical home model shares many of the same goals and purposes with state IDEA programs. Health care providers can proactively provide services and tools to support optimal development that is family centered and collaborates with early intervention services and services provided through the local school system (Adams et al. 2013).The medical home early intervention referral form is available at http://www.medicalhomeinfo.org.

Pediatric health care providers and practices might also

- Encourage parents or other caregivers to be involved in monitoring their child's development (www.cdc.gov/actearly).
- Maintain developmental and behavioral surveillance throughout childhood and adolescence, as impacts of lead may manifest remotely from the exposure period.
- Initiate an early intervention referral (i.e., they need not wait for a specific diagnosis).
- Implement a system for referral tracking and obtain family permission at the time of the referral to facilitate communication between the early intervention program or school and the medical home.
- Become knowledgeable about state eligibility criteria and the definition of developmental delay.
- Proactively plan for children to transition from IDEA Part C programs to IDEA Part B programs.
- Submit requests to local school districts for developmental evaluations and services for children ages 3 years and older, as needed, and assist families with obtaining needed services.

Childhood Lead Poisoning Prevention Programs

In many areas, state and local health departments provide services for children with BLLs meeting regulatory or programmatic thresholds. The BLLs that trigger services vary by jurisdiction, as does the location of the program that may be in a health department or an environmental quality department.

State and local childhood lead poisoning prevention programs (CLPPPs) can educate parents and health care providers. Parents and providers may need to be informed about the importance of age-appropriate blood lead testing and of primary prevention efforts. They may also need to be informed about the need for vigilance in the period after a test result and at critical transition points in educational expectations such as first, fourth, and sixth grades, and about early intervention programs and the merits of accepting a referral to them. Providers might consider performing developmental assessments known to identify the deficits associated with HBLLs and referring families of children with BLL above the reference value to Child Find and early childhood education.

CLPPPs might also

- Develop interagency agreements to provide the names of children with blood lead at or above the CDC reference value, currently 5 µg/dL, to the Child Find system for Part C (AAP 2006) and local education agency including Part B. [The National Early Childhood Assistance Center posts contact information for state coordinators at http://www.nectac.org/search/mapfinder.asp.]

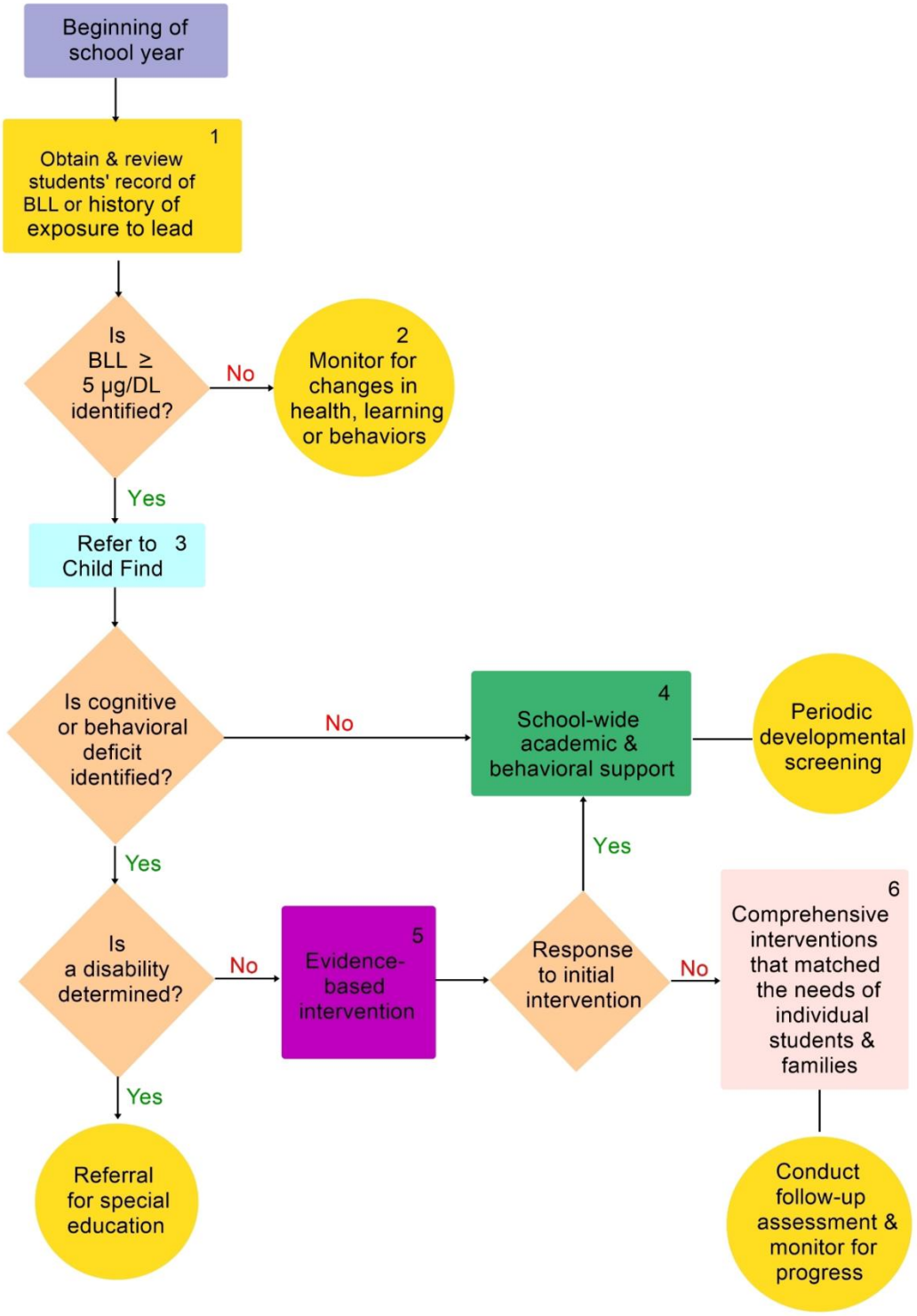
- Consider adding referral to Child Find for Part C early intervention services to their case management protocol and track enrollment results.

- Develop a system for making contact with families to ensure that they are referred to early childhood education and in-school programs at the time the child becomes eligible (i.e., third birthday and the year the child reaches school age) even if the child has been discharged from lead case management. For example, CLPPPs can engage with the Title V Children with Special Health Care Needs state program to identify strategies for long-term follow up of lead-exposed children; parent centers and health information centers can play an advocate role with families, especially as the child and parents try to negotiate the school system.

- 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.

- Help the Child Find agency and local education agencies to target outreach and services to children most likely to have BLLs at or above the reference value. Blood lead surveillance data can be used to determine which districts or individual schools or school feeder areas have large populations of children with BLLs ≥ the reference value.

Figure 3: Decision Chart for Children Affected by Lead



Appendix 1: Resources for Obtaining Services and Improving Systems

The Early Childhood Technical Assistance Center

http://ectacenter.org/partc/partc.asp.

The Early Childhood Technical Assistance Center coordinates and delivers intensive technical assistance for implementing, sustaining, and scaling up evidence-based practices and serves as a national resource for states and school districts. It is a program of the Child Development Institute of the University of North Carolina at Chapel Hill. This center maintains up-to-date listings of the state agencies that coordinate Part C (e.g., the lead agencies can be found at http://ectacenter.org/partc/ptclead.asp and the coordinators' contact information can be found at http://ectacenter.org/contact/ptccoord.asp).It also provides materials that can help families and health care and social service providers learn more about the effectiveness of early intervention and early education for young children with disabilities (http://www.ectacenter.org/topics/effective/effective.asp).

Parent Centers

http://www.parentcenterhub.org/

Parent training and information centers (PTIs) and community parent resource centers (CPRCs) provide training and assistance to the families of the nation's 7 million children with disabilities. There are currently 94 parent centers in the United States funded through the U.S. Department of Education's Office of Special Education Programs under IDEA. Every state has at least one PTI, and those with larger populations may have more. CPRCs provide services to underserved families in smaller geographic areas.

Parent centers serve families of children of all ages (birth to 26) and with all disabilities (physical, cognitive, behavioral, and emotional). The majority of parent center staff members and board members are parents of children with disabilities so they are able to bring personal experience, expertise, and empathy when working with families. Through the provision of one-to-one support and assistance, workshops, publications, and websites, the centers help families to better understand their children's disabilities and educational, developmental, and transitional needs; understand their rights and responsibilities under IDEA; and obtain appropriate services for their children through participation in the individualized education program and individualized family service plan decision making process. Parent centers work collaboratively with other local, state, and national resources that assist children with disabilities to improve outcomes for children with disabilities. They also collect and share data.

National Coalition for Parent Involvement in Education (NCPIE)

http://www.ncpie.org

NCPIE's mission is to advocate the involvement of parents and families in their children's education and to foster relationships among home, school, and community to enhance the education of all of the nation's young people. NCPIE seeks to serve as a visible representative for strong parent and family

involvement initiatives at the national level and conducts activities that involve the coalition's member organizations and their affiliates and constituencies in efforts to increase family involvement.

NCPIE was founded in 1980 at the initiative of what was then the National School Volunteer Program [now the National Association for Partners in Education] with funding from the Ford Foundation and Union Carbide. From the outset, the participating organizations included parent organizations and advocacy groups as well as national education organizations representing teachers and administrators. NCPIE is a member of the IDEA Partnership, which is dedicated to improving outcomes for students and youth with disabilities by joining state agencies and stakeholders through shared work and learning. The IDEA Partnership reflects the collaborative work of more than 50 national organizations, technical assistance providers, and organizations and agencies at the state and local level. Together with OSEP, the partner organizations form a community with the potential to transform and improve outcomes for students and youth with disabilities. For more information IDEA Partnership, go to http://www.ideapartnership.org.

Association of Maternal and Child Health Programs (AMCHP)

http://www.amchp.org

AMCHP is a national resource, partner, and advocate for state public health leaders and others working to improve the health of women, children, youth, and families, including those with special health care needs. AMCHP also provides a forum for state leaders to improve policy, systems, services, and quality of care for maternal and child health populations.

AMCHP's members come from the highest levels of state government and include directors of maternal and child health programs, directors of programs for children with special health care needs, and other public health leaders who work with and support state maternal and child health programs. AMCHP's members administer critical public health education and screening services and coordinate preventive, primary, and specialty care. The central framework for these services is the Title V Maternal and Child Health Services Block Grant to states. Within a vast array of other services, state Title V programs ensure family-centered, community-based coordinated care for children with special health care needs, including chronic conditions and disabilities (http://mchb.hrsa.gov/programs/titlevgrants/.

Family-to-Family Health Information Centers

http://mchb.hrsa.gov/programs/familytofamily/

These centers assure that families of children with special health care needs are able to participate in decision-making at all levels and be satisfied with the services they receive. These statewide centers are staffed by families who have children with special health care needs and, therefore, have firsthand experience navigating the maze of health care services and programs. With expertise in federal and state public and private health care systems, staff at each center assist families to make informed choices about health care in order to promote good treatment decisions, cost effectiveness, and improved health outcomes. They also provide information, training, and guidance regarding children's special health care needs; identify successful health delivery models; and model collaborations between

families and health care providers, managed care organizations, health care purchasers, and appropriate state agencies.

Appendix 2: State Summary of Early Intervention Eligibility, 2013

General Mention of Lead	Mention of Specific Elevated Blood Lead Level	General Mention of Exposure to Toxic Substances	No Reference to Lead Exposure
Delaware: Lead poisoning with elevated blood levels requiring chelation.	Connecticut: ≥ 45 µg/dL	Arizona	Alabama
Idaho: Illness of a chronic nature with prolonged convalescence (e.g., lead poisoning…).	Georgia: ≥ 20 µg/dL	Arkansas	Alaska
Louisiana: Elevated blood lead level requiring chelation	Iowa: ≥20 µg/dL	Hawaii	California
Nebraska: Lead poisoning	Kansas: ≥ 45 µg/dL	Indiana	Colorado
New Hampshire: Lead poisoning	Michigan: ≥ 10 µg/dL	Maryland	Florida
New Mexico: Central nervous system toxins, e.g., lead poisoning	Minnesota: ≥ 15 µg/dL	Missouri	Illinois
Wisconsin: Central nervous system toxins, e.g., lead poisoning	Ohio: ≥ 10 µg/dL	Montana	Kentucky
	Oregon: ≥ 10 µg/dL	New Jersey	Maine
	Rhode Island: ≥ 15 µg/dL	New York	Massachusetts
	Tennessee: ≥ 10 µg/dL	North Dakota	Mississippi
	Vermont: ≥ 20 µg/dL	Oklahoma	Nevada
	West Virginia: ≥ 15 µg/dL	Virginia	North Carolina
		Wyoming	Pennsylvania
			South Carolina
			South Dakota
			Texas
			Utah
			Washington

Part C eligibility is determined by each state's definition of developmental delay and includes children with established physical or mental conditions with a high probability of resulting in developmental delay. States may choose to include children at risk for disabilities in the eligible group (http://ectacenter.org/topics/earlyid/partcelig.asp).

Federal Regulation:

34 C.F.R. § 303.21 Infant or toddler with a disability.

(a) *Infant or toddler with a disability* means an individual under three years of age who needs early intervention services because the individual—

(2) Has a diagnosed physical or mental condition that—

(i) Has a high probability of resulting in developmental delay; and

(ii) Includes conditions such as chromosomal abnormalities; genetic or congenital disorders; sensory impairments; inborn errors of metabolism; disorders reflecting disturbance of the development of the nervous system; congenital infections; severe attachment disorders; and disorders secondary to exposure to toxic substances, including fetal alcohol syndrome.

Appendix 3: Federal Definitions of Child with a Disability

IDEA Part B - Assistance to States for the Education of Children with Disabilities

34 C.F.R. §300.8 Child with a disability.

(a) *General.*

(1) *Child with a disability* means a child evaluated in accordance with §§300.304 through 300.311 as having mental retardation, a hearing impairment (including deafness), a speech or language impairment, a visual impairment (including blindness), a serious emotional disturbance (referred to in this part as "emotional disturbance"), an orthopedic impairment, autism, traumatic brain injury, another health impairment, a specific learning disability, deaf-blindness, or multiple disabilities, and who, by reason thereof, needs special education and related services.

(2)(i) Subject to paragraph (a)(2)(ii) of this section, if it is determined, through an appropriate evaluation under §§300.304 through 300.311, that a child has one of the disabilities identified in paragraph (a)(1) of this section, but only needs a related service and not special education, the child is not a child with a disability under this part.

(ii) If, consistent with §300.39(a)(2), the related service required by the child is considered special education rather than a related service under State standards, the child would be determined to be a child with a disability under paragraph (a)(1) of this section.

(b) *Children aged three through nine experiencing developmental delays. Child with a disability* for children aged three through nine (or any subset of that age range, including ages three through five), may, subject to the conditions described in §300.111(b), include a child—

(1) Who is experiencing developmental delays, as defined by the State and as measured by appropriate diagnostic instruments and procedures, in one or more of the following areas: Physical development, cognitive development, communication development, social or emotional development, or adaptive development; and

(2) Who, by reason thereof, needs special education and related services.

(c) *Definitions of disability terms.* The terms used in this definition of a child with a disability are defined as follows:

(1)

(i) *Autism* means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age three, that adversely affects a child's educational performance. Other characteristics often associated with autism are

engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences.

(ii) Autism does not apply if a child's educational performance is adversely affected primarily because the child has an emotional disturbance, as defined in paragraph (c)(4) of this section.

(iii) A child who manifests the characteristics of autism after age three could be identified as having autism if the criteria in paragraph (c)(1)(i) of this section are satisfied.

(2) *Deaf-blindness* means concomitant hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational needs that they cannot be accommodated in special education programs solely for children with deafness or children with blindness.

(3) *Deafness* means a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification, that adversely affects a child's educational performance.

(4)

(i) *Emotional disturbance* means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a child's educational performance:

(A) An inability to learn that cannot be explained by intellectual, sensory, or health factors.

(B) An inability to build or maintain satisfactory interpersonal relationships with peers and teachers.

(C) Inappropriate types of behavior or feelings under normal circumstances.

(D) A general pervasive mood of unhappiness or depression.

(E) A tendency to develop physical symptoms or fears associated with personal or school problems.

(ii) Emotional disturbance includes schizophrenia. The term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance under paragraph (c)(4)(i) of this section.

(5) *Hearing impairment* means an impairment in hearing, whether permanent or fluctuating, that adversely affects a child's educational performance but that is not included under the definition of deafness in this section.

(6) *Mental retardation* means significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child's educational performance.

(7) *Multiple disabilities* means concomitant impairments (such as mental retardation-blindness or mental retardation-orthopedic impairment), the combination of which causes such severe educational needs that they cannot be accommodated in special education programs solely for one of the impairments. Multiple disabilities does not include deaf-blindness.

(8) *Orthopedic impairment* means a severe orthopedic impairment that adversely affects a child's educational performance. The term includes impairments caused by a congenital anomaly, impairments caused by disease (e.g., poliomyelitis, bone tuberculosis), and impairments from other causes (e.g., cerebral palsy, amputations, and fractures or burns that cause contractures).

(9) *Other health impairment* means having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that—

(i) Is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder, diabetes, epilepsy, a heart condition, hemophilia, lead poisoning, leukemia, nephritis, rheumatic fever, sickle cell anemia, and Tourette syndrome; and

(ii) Adversely affects a child's educational performance.

(10) *Specific learning disability*—

(i) *General.* Specific learning disability means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.

(ii) *Disorders not included.* Specific learning disability does not include learning problems that are primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

(11) *Speech or language impairment* means a communication disorder, such as stuttering, impaired articulation, a language impairment, or a voice impairment, that adversely affects a child's educational performance.

(12) *Traumatic brain injury* means an acquired injury to the brain caused by an external physical force, resulting in total or partial functional disability or psychosocial impairment, or both, that adversely affects a child's educational performance. Traumatic brain injury applies to open or closed head injuries resulting in impairments in one or more areas, such as cognition; language; memory; attention; reasoning; abstract thinking; judgment; problem-solving; sensory, perceptual, and motor abilities; psychosocial behavior; physical functions; information processing; and speech. Traumatic brain injury does not apply to brain injuries that are congenital or degenerative, or to brain injuries induced by birth trauma.

(13) *Visual impairment including blindness* means an impairment in vision that, even with correction, adversely affects a child's educational performance. The term includes both partial sight and blindness.

(Authority: 20 U.S.C. 1401(3); 1401(30)) [71 FR 46753, Aug. 14, 2006, as amended at 72 FR 61306, Oct. 30, 2007]

IDEA Part C – Early Intervention Program for Infants And Toddlers with Disabilities

34 C.F.R. §303.21 Infant or toddler with a disability.

(a) *Infant or toddler with a disability* means an individual under three years of age who needs early intervention services because the individual—

(1) Is experiencing a developmental delay, as measured by appropriate diagnostic instruments and procedures, in one or more of the following areas:

(i) Cognitive development.

(ii) Physical development, including vision and hearing.

(iii) Communication development.

(iv) Social or emotional development.

(v) Adaptive development; or

(2) Has a diagnosed physical or mental condition that—

(i) Has a high probability of resulting in developmental delay; and

(ii) Includes conditions such as chromosomal abnormalities; genetic or congenital disorders; sensory impairments; inborn errors of metabolism; disorders reflecting disturbance of the development of the nervous system; congenital infections; severe attachment disorders; and disorders secondary to exposure to toxic substances, including fetal alcohol syndrome.

(b) *Infant or toddler with a disability* may include, at a State's discretion, an *at-risk infant or toddler* (as defined in §303.5).

(c) *Infant or toddler with a disability* may include, at a State's discretion, a child with a disability who is eligible for services under section 619 of the Act and who previously received services under this part until the child enters, or is eligible under State law to enter, kindergarten or elementary school, as appropriate, provided that any programs under this part must include—

(1) An educational component that promotes school readiness and incorporates pre-literacy, language, and numeracy skills for children ages three and older who receive part C services pursuant to §303.211; and

(2) A written notification to parents of a child with a disability who is eligible for services under section 619 of the Act and who previously received services under this part of their rights and responsibilities in determining whether their child will continue to receive services under this part or participate in preschool programs under section 619 of the Act.

(Authority: 20 U.S.C. 1401(16), 1432(5))

References

Chapter 1: Introduction

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