



Lead and Its Impact On Learning:

What Schools, Parents & Policymakers Need to Know and Do

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Executive Summary

The lead poisoning crisis in Flint, Michigan has shined a light on a persistent, yet often invisible, problem in Pennsylvania. While many think of lead as an issue of the past, it is not. For many of Pennsylvania's children, lead exposure continues to be a silent epidemic that plagues their communities and undermines their ability to learn. According to a study in 2010, Philadelphia ranked among the top five highest risk cities for lead poisoning in the United States.¹ More recently, the Centers for Disease Control (CDC) and Pennsylvania Department of Health found that *18 cities in Pennsylvania have higher levels of lead exposure than Flint, Michigan*. Philadelphia -- which has 15 times Flint's population -- tested 35,863 children under the age of 7 in 2014, finding that 3,655 - or 10.2 percent - had blood lead levels of 5 µg/dL or greater. Testing in cities like

¹ See Pennsylvania Childhood Lead Poisoning Elimination Plan 2010 available at http://www.dsf.health.state.pa.us/health/lib/health/familyhealth/lead_elimination_plan_for_2010.pdf and Impact on Children in Pennsylvania: Reduction of CDC Healthy Homes and Lead Poisoning Prevention Program Funds, Public Citizens for Children & Youth, available at <http://www.nchh.org/Portals/0/Contents/PA%20-%20Impact%20Stmt.pdf>

Allentown and Altoona disclosed alarming exposure rates of over 20%.² By comparison, Flint's rate of lead exposure above 5 µg/dL for 2014 was 3.21 percent.³

There is no safe level of lead exposure for children, according to the Centers for Disease Control and Prevention. Rather, a blood lead level of 5 micrograms per deciliter is considered the threshold to identify children exposed to lead who require case management. A few years ago, 10 micrograms was the designated the federal "level of concern" standard for public health intervention.⁴ What we now know is that *even low levels of lead in blood can adversely affect IQ, the ability to pay attention and focus, and a child's academic achievement.*

Amid a growing recognition of the interplay between a student's environment and academic success, this long-recognized environmental hazard clearly warrants our renewed attention and the thoughtful development of new strategies by schools, teachers, parents and advocates to reduce exposure to lead and to proactively address its impact on learning. We need to understand the nature of this insidious problem and what needs to change so that generations of children are not limited by this preventable problem. We need the engagement of our schools, partnership with health communities, and champions among local and state leadership to address this lingering crisis.

First, we need to *prevent even minimal exposure to lead* which we now know limits educational attainment and can change a child's behavior. We need to consider how schools can play a stronger role in ensuring that *all children are screened* for elevated blood lead levels as part of the enrollment process and how schools might facilitate promptly connecting families with critical interventions. Second, we should consider whether schools should adopt policies to *consider evaluating children* who have a history of elevated blood lead levels for potential eligibility for special education services and/or eligibility for a Section 504 Accommodations Plan. Third, we need to reduce exposure to lead that occurs *in our schools*. Finally, we must recognize that the complex issue of reducing lead exposure is critical to improving life outcomes for our children and demands a cross-systems response -- one that encompasses the input of

² Child Lead Surveillance, Annual Report 2014 available at <http://www.health.pa.gov/My%20Health/Infant%20and%20Childrens%20Health/Lead%20Poisoning%20Prevention%20and%20Control/Documents/2014%20Lead%20Surveillance%20Annual%20Report%20r2.pdf>

³ Pediatric Lead Exposure Flint Water Results, Mona Hanna-Attisha, available at <http://www.scribd.com/doc/282806501/Pediatric-Lead-Exposure-Flint-Water-Results>

⁴ Center for Disease Control and Prevention, Lead Page, available at http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm

educators and school leaders to craft effective, meaningful and comprehensive solutions.

Lead Exposure: What Schools and Parents Need to Know

Every day across Pennsylvania, children impacted by lead exposure struggle to focus and learn in classrooms. It is well documented that exposure to lead can cause direct damage to a child's brain. It can exert a lasting impact on neurocognitive function, emotional regulation, and is even thought to cause a reduction in brain volume.⁵ ***Blood lead levels > 2 µg/dL have been associated with up to 290,000 cases of ADHD among U.S. children.***⁶ Importantly, an emerging body of research highlights the detrimental association of even *minimal* lead exposure linked to lower aptitude, negative behavior, and even future violence. Previous efforts to address the harmful effects of lead have focused on identifying children with elevated blood lead levels (BLLs) above 10 µg/dL and treating them with chelation therapy. However, more recent research argues for the importance of primary prevention – to prevent children from ever being exposed to lead, a strategy endorsed by the CDC⁷ and the American Academy of Pediatrics.⁸ In addition, we must recognize that minimal lead exposure may impact any child's ability to learn and we adopt strategies to proactively address the needs of affected students.

Exposure to lead occurs in many ways. It is found in paint, plumbing, soil and dust-based contaminants; it is also prevalent in consumer goods such as imported toys, bracelets, vinyl lunchboxes and even artificial Christmas trees.⁹ Lead exposures from consumer goods, such as vinyl lunchboxes, painting easels, toy sets, necklaces and bracelets, can still be a regular occurrence in the marketplace, despite our consumer safety regulations. As young children routinely exhibit hand-to-mouth behavior, young children often come into contact with lead through ingesting paint chips containing

⁵ Cecil K et al. Decreased Brain Volume in Adults with Childhood Lead Exposure. PLOS Medicine. May 2008: Vol 5. Issue 5. E 112. Pp. 741-750.

⁶ Braun JM, Kahn RS, Freohlick T, Auinger P, Lanphear BP. 2006. Exposures to environmental toxicants and attention deficit hyperactivity disorder in children. Environmental Health Perspectives 114: 1904:1909.

⁷ Blood Lead Levels in Children: What Do Parents Need to Know to Protect Their Children? http://www.cdc.gov/nceh/lead/acclpp/lead_levels_in_children_fact_sheet.pdf

⁸AAP Commends CDC for Recognizing That, for Children, There is No Safe Level of Lead Exposure. <http://www.aap.org/en-us/about-the-aap/aap-press-room/Pages/AAP-Statement-CDC-Revised-Lead-Exposure-Guidelines.aspx>

⁹ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. Environmental Health Perspectives. Vol 116: 10: Oct. 2008.

lead, or soil or dust particles contaminated with lead.¹⁰ Children who live in housing built before 1978 are most susceptible to developing an elevated blood lead level because 1978 was the first year lead-based paint was banned.¹¹

According to Department of Health, the primary source of childhood lead poisoning in Pennsylvania continues to be exposure to aging, deteriorating lead-based paint (chips and dust), and not drinking water.¹² According to 2010 Census data, Pennsylvania ranks third in the nation for having the most housing units identified as having been built before 1950 (when lead was more prevalent) and fourth in the nation for housing units identified as having been built before 1978. In 2009, the U.S. Department of Housing and Urban Development *found that 91.6% of Philadelphia housing units were built prior to 1978*,¹³ and thus likely contaminated with lead-based paint. As a further consequence of years of lead-based paint in housing, lead is also a common contaminant of soil, especially in urban areas such as Philadelphia. Lead “binds tightly” to soil, already contaminated with decades of combustion from lead-based gas as well as past industrial exposures. Old, peeling lead paint from residential buildings can further contaminate soil, an effect magnified by the increased traffic levels and density of housing in urban areas. As a result, the soil in urban areas can have lead levels ranging from 800-1200 µg/g. Produce grown in this soil as part of community garden initiatives can serve as yet another source of exposure for urban children.

Since lead abatement costs thousands of dollars, many families and landlords are unable to pay for the removal of all lead paint from their homes.¹⁴ However, there are mechanisms of support to empower and enable families to undertake abatement efforts and address the collateral consequences of this issue. The Pennsylvania Department of Health provides a **toll-free Lead Information Line (1-800-440-LEAD)** to respond to caller inquiries and provide written materials about childhood lead poisoning and other household hazards. In addition, the Department offers training in lead-abatement and other lead-certified disciplines at no cost to governmental and non-profit employees. The [Lead Hazard Control Program](#) (LHCP) creates lead-safe home environments

¹⁰ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. Environmental Health Perspectives. Vol 116: 10: Oct. 2008.

¹¹ Un-lead Only: Toward a Safer City for Children. A 2002 Report on Childhood Lead Paint Poisoning in Philadelphia. Philadelphia Citizens for Children and Youth. 2002.

¹² Child Lead Surveillance, Annual Report 2014 available at <http://www.health.pa.gov/My%20Health/Infant%20and%20Childrens%20Health/Lead%20Poisoning%20Prevention%20and%20Control/Documents/2014%20Lead%20Surveillance%20Annual%20Report%20r2.pdf>

¹³ US Department of Housing and Urban Development. American Housing Survey 2009. Available at <https://www.census.gov/housing/ahs/data/philadelphia.html>

¹⁴ Un-lead Only: Toward a Safer City for Children. A 2002 Report on Childhood Lead Paint Poisoning in Philadelphia. Philadelphia Citizens for Children and Youth. 2002.

for low-income families with children under age 6. This program operates in four cities and two counties in Pennsylvania.¹⁵ The LHCP assesses high-risk homes, then makes them lead-safe. Program recipients must meet certain income and child eligibility requirements.

Each year significant numbers of children in Philadelphia suffer the irreparable harm of lead poisoning because of exposure to deteriorated lead paint and lead dust in their homes. More than half of these children are living with their families in rental units. The Philadelphia Lead Disclosure & Certification Law (Philadelphia Code Section 6-800), which went into effect in December 2012, applies to any landlord who rents Philadelphia properties built before 1978 to new tenants who will be living in the property with a child 6 years or under. While the Philadelphia Property Maintenance Code previously required landlords to correct any peeling paint, cracked or loose plaster, decayed wood, and other defective surface conditions in a rental unit, the Philadelphia Lead Disclosure & Certification Law requires a landlord to go further and certify that a property is lead safe before children 6 years old and younger may move in.

In addition, lead has been found as a contaminant of drinking water, through older, eroded plumbing materials, particularly prevalent in older homes.¹⁶ *Lead exposure through drinking water in schools is of particular concern.* Some city school systems have proactively addressed this issue by eliminating water fountains in schools. More information is needed to determine if this is a critical issue in Pennsylvania.

After detecting elevated levels of lead in water from school drinking fountains, the Baltimore City Public School system decided to turn off all school drinking fountains and switch to a purely plastic bottle-based system.

http://www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/87/PDF/Lead_in_Water110707.pdf

Risk Factors for Elevated Blood Lead Levels

Recent studies have attempted to elucidate the risk factors inherent in a child's development of elevated blood lead levels. Age is a significant risk factor as *BLL's reach their peak at 15-24 months of age.*¹⁷ A young child's gastrointestinal absorption of lead is greater, and a young child has increased hand-to-mouth behaviors; thus, the effects of minimal exposures are compounded in children as compared

¹⁵ The program operates in Allentown, Bethlehem, Johnstown and Lancaster and the counties of Berks and Fayette.

¹⁶ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. Environmental Health Perspectives. Vol 116: 10: Oct. 2008.

¹⁷ Tong SL, Baghurst PA, McMichael AL, Sawyer MG, Mudge J. 1996. Lifetime exposure to environmental lead and children's intelligence at 11-13 years: the Port Pirie Cohort Study. BMJ 312: 1569-1575.

to adults, who may not experience any adverse effects from the same level of exposure.¹⁸ Blood lead levels have been found to vary among children from different ethnic and racial groups, which may be correlated with poverty or urban living. According to the National Health and Nutrition Examination Survey data from 1999-2002, “46.8% of non-Hispanic black children and 27.9% of Mexican-American children have BLL’s greater than 5 µg/dL compared with 18.7% of white children.”¹⁹ While this gap is narrowing, it nevertheless highlights that the increased risk facing children in Philadelphia who remain among the most vulnerable with regard to lead exposure.

Poverty is another risk factor. The mean BLL for children on Medicaid exceeds that of their non-Medicaid counterparts (2.6 vs 1.7 ug/dL).²⁰ In addition, children in foster care are nearly twice as likely to have elevated blood lead levels (EBLLs) as children in the general population. A 2001 study found 50% of children in foster care had EBLLs greater than or equal to 20 ug/dL before placement, while 90% of the same group had EBLLs greater than or equal to 10 ug/dL.²¹

Importantly, refugee, internationally adopted and recent immigrant children are at an increased risk to develop elevated blood lead levels. While many refugee children arrive in the USA with elevated BLL’s as a result of exposures in their countries of origin, their BLL’s may continue to increase due to exposures in the communities that they settle in and through contact with unregulated, imported products containing lead. Refugee children have a greater likelihood of developing iron-deficiency anemia, which is known to cause increased gastrointestinal absorption of lead, thus further predisposing them to the development of elevated BLLs. In particular, elevated BLL’s have been found in children from Africa, Cuba, China, Russia, and Thailand, among a host of other countries. ***In light of this increased risk, the CDC calls for screening on arrival to the US with repeat screening performed 3-6 months later.***²²

Smoking status and parental occupation are also correlated with increased BLLs. Children may be exposed to lead through dust on their parent’s clothes as they return

¹⁸ Tong SL, Baghurst PA, McMichael AL, Sawyer MG, Mudge J. 1996. Lifetime exposure to environmental lead and children’s intelligence at 11-13 years: the Port Pirie Cohort Study. *BMJ* 312: 1569-1575.

¹⁹ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. *Environmental Health Perspectives*. Vol 116: 10: Oct. 2008.

²⁰ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. *Environmental Health Perspectives*. Vol 116: 10: Oct. 2008.

²¹ Chung, EK, Webb D, Clampet-Lundquist S and Campbell C. A Comparison of Elevated Blood Lead Levels Among Children Living in Foster Care, Their Siblings, and the General Population. *Pediatrics*. Volume 107, No. 5. May 2001.

²² Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. *Environmental Health Perspectives*. Vol 116: 10: Oct. 2008.

from the workplace, a workplace that may not be subject to occupational safety regulations, such as transportation employees, public employees, and workers who are self-employed.²³

Why is Lead Still A Problem?

In the wake of federal reforms dating back to 1978, we have largely eradicated airborne contaminants as a source of lead exposure, as we no longer use lead-based paint and gasoline. However, these effective legal reform efforts did not eliminate the problem but rather, lulled us into a false sense of security. We therefore need to heighten our efforts to address the lead in paint, soil and dust that our children continue to be exposed to, both at home and at school.

In addition to absorbing higher levels of lead due to their immature gastrointestinal systems, a “greater proportion” of lead in the blood enters the brain of young children (especially those less than 5 years of age) as compared to adults.²⁴ Iron deficiency, prevalent in many urban children, further compounds the adverse effects of lead poisoning.²⁵ Lastly, lead is more damaging to the developing brain of young children than it is to the fully developed adult brain. Therefore, lead exerts a particularly devastating effect on the developing brain of young children.²⁶

How Lead Exposure Impacts Health

The medical effects of lead poisoning have been well-known to physicians for decades. They include such nonspecific symptoms as “headaches, abdominal pain, loss of appetite, and constipation and [children may] display clumsiness, agitation, and/or decreased activity and somnolence.”²⁷ These symptoms are indicative of involvement of the central nervous system.²⁸ In adults, lead exposure has been linked to chronic diseases such as “cardiovascular disease, renal disease, cognitive decline, and

²³ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. *Environmental Health Perspectives*. Vol 116: 10: Oct. 2008.

²⁴ Lidsky TI and Schneider JS. Lead neurotoxicity in children: basic mechanisms and clinical correlates. *Guarantors of Brain* 2003: 126, 5-19.

²⁵ Levin R, Brown MJ et al. Lead Exposures in US Children, 2008: Implications for Prevention. *Environmental Health Perspectives*. Vol 116: 10: Oct. 2008.

²⁶ ²⁶ Lidsky TI and Schneider JS. Lead neurotoxicity in children: basic mechanisms and clinical correlates. *Guarantors of Brain* 2003: 126, 5-19.

²⁷ Lead Exposure in Children: Prevention, Detection and Management. Committee on Environmental Health. *Pediatrics* Vol 116. Number 4. October 2005.

²⁸ Lead Exposure in Children: Prevention, Detection and Management. Committee on Environmental Health. *Pediatrics* Vol 116. Number 4. October 2005.

cataracts.”²⁹ In addition, as described below, lead exposure can have many long-term impacts on brain processing and behavior.

As of 2012, both the CDC and the American Academy of Pediatrics have strongly asserted that there is no safe level of exposure. This conclusion signaled a change in thinking about lead exposure and emanated from research establishing that even minimal elevated blood lead levels damage a young child’s brain and poses significant health risks.

How many children are impacted by low-level lead exposure? This is not known because young children may have the same level of exposure and some will be adversely impacted by low lead levels in their blood while others are not impacted at all. Using data from the National Health and Nutrition Examination Survey, it has been estimated that, in 2006, among one to five year old children, the average blood lead level remained 1.7 µg/dl while that same year 24.7% of US children less than 6 years of age have BLL’s in the range of 2-10 µg/dl.

Lead poisoning is preventable. Screening for elevated blood lead levels of at-risk children is an essential component of routine well-child care; however many of our most at-risk children may not have access to the routine medical care needed to undergo lead screening. For example, in 2001, only 42% of the 98,161 children ages 0-5 residing in Philadelphia were screened during that year.³⁰ Nationwide, “only 24% of young children and 33% of children living in poverty are screened.”³¹ While some states, such as Maryland, Rhode Island and Massachusetts have opted for mandatory universal testing of toddlers, Pennsylvania has not and this approach should be considered.

Importantly, medical treatment is advised only for children with extremely high blood lead exposure levels: chelation therapy is considered when a child has a blood lead test result ≥ 45 µg/dl).³² Tragically, there is no intervention for children with low levels of exposure to lead. Accordingly, we must identify all children at risk for the

²⁹ Tarr H, Raymond RE and Tufts M. The Effects of Lead Exposure on School Outcome Among Children Living and Attending Public Schools in Detroit, MI.

³⁰ Un-lead Only: Toward a Safer City for Children. A 2002 Report on Childhood Lead Paint Poisoning in Philadelphia. Philadelphia Citizens for Children and Youth. 2002.

³¹ Un-lead Only: Toward a Safer City for Children. A 2002 Report on Childhood Lead Paint Poisoning in Philadelphia. Philadelphia Citizens for Children and Youth. 2002.

³² Lead Exposure in Children: Prevention, Detection and Management. Committee on Environmental Health. *Pediatrics* Vol 116. Number 4. October 2005.

development of elevated BLL's and mitigate their exposure to lead in their home and school environments.

IMPACT OF LEAD IN THE CLASSROOM

Effects of Lead on Learning

Through its toxic effect on developing neurons, lead exposure has a profound, sadly irreversible effect on learning. In a groundbreaking 1979 study by pediatrician Herbert Needleman and other researchers, first and second grade children with high levels of lead in their teeth were found to have decreased scores on “intelligence [tests], speech and language processing, attention and classroom performance.”³³ When they were reexamined in the fifth grade, those children with increased lead levels (in their teeth) relative to their peers were found to have “lower IQ scores, needed more special education services, and had a significantly higher rate of failure in school³⁴” than children whose teeth did not contain elevated lead levels. In a comprehensive, eleven-year follow-up study, the researchers found that these same children had a “seven-fold increase in failure to graduate high school, lower class standing, greater absenteeism, impairment of reading skills sufficiently extensive to be labeled reading disability (indicated by scores two grades below the expected scores), and deficits in vocabulary, fine motor skills, reaction time, and hand-eye coordination.”³⁵ Furthermore, among 10 children with the highest levels of lead in their blood, five students had reading disabilities and almost half of the students had stopped attending high school before graduating.³⁶ Thus, Needleman’s pioneering study further substantiated earlier claims that lead had wide-ranging effects on learning and behavior that merited early intervention.

The Port Pirie Cohort study, conducted from 1979-1982, examined the cognitive effects of lead exposure on infants in an Australian town with high industrial exposure to lead; it employed a similar methodology to further explore lead’s detrimental effects on the neurocognitive development of young children. The study’s authors found that, *as blood lead concentration increased in children at 2 and 4 years of age, respectively, scores on children’s mental development tests decreased.* This inverse relationship

³³ Needleman, HL, et al. The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-Up Report. *New England Journal of Medicine*. Vol 322; No. 2, pg. 83 – 88.

³⁴ Needleman, HL, et al. The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-Up Report. *New England Journal of Medicine*. Vol 322; No. 2, pg. 83 – 88.

³⁵ Needleman, HL, et al. The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-Up Report. *New England Journal of Medicine*. Vol 322; No. 2, pg. 83 – 88.

³⁶ Needleman, HL, et al. The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-Up Report. *New England Journal of Medicine*. Vol 322; No. 2, pg. 83 – 88.

persisted even when the children were later retested, highlighting the fact that “children who scored poorly initially have not had great improvements in their overall ranking by the age of seven years.”³⁷ Furthermore, researchers in the Port Pirie study further confirmed the earlier finding that lead’s most devastating impact on IQ is seen in infants, toddlers, and preschool-aged children.³⁸

As a consequence of the results of these early studies, which specifically highlighted the effects of elevated blood lead levels ($> 10 \mu\text{g/dL}$) on cognition and behavior, the Centers for Disease Control and Prevention lowered their level of concern to $10 \mu\text{g}$ per deciliter; the CDC and WHO also called for further investigation into the effect of levels less than $10 \mu\text{g/dL}$. In a 2003 article by Canfield et al in the *New England Journal of Medicine*, researchers attempted to further explore the impact of chronic blood lead levels of less than $10 \mu\text{g/dL}$ on cognitive outcomes. Even after controlling for confounding factors that might influence children’s scores on IQ tests, researchers found that “children’s intellectual functioning at three and five years of age is inversely associated with blood lead concentrations, even when their peak concentrations remain below the CDC and WHO level of concern ($10 \mu\text{g/dL}$).” Furthermore, researchers observed a 4.6 decrease in IQ points for each $10 \mu\text{g/dL}$ increase in the blood lead concentration. Moreover, researchers concluded that, “*for children whose lead concentrations remained below $10 \mu\text{g}$ per deciliter, the estimated loss in IQ was considerably greater.*”³⁹

While the results of these comprehensive, well respected studies called attention to lead’s detrimental effects on lowering a child’s IQ, and thus their aptitude, soon other researchers began to recognize that elevated lead levels may influence educational achievement. Using end-of-grade testing as a marker of educational outcome, Miranda et al found that “higher blood lead levels [in early childhood] are associated with lower test scores [in elementary school].”⁴⁰ More specifically, “*a blood lead level of $5 \mu\text{g/dL}$ is associated with a decline in end-of-grade reading and mathematics scores that is*

³⁷ Baghurst, PA et al. Environmental Exposure to Lead and Children’s Intelligence at the Age of Seven Years: the Port Pirie Cohort Study. *New England Journal of Medicine*. Vol 327: No. 18. Pg. 1279 – 1284.

³⁸ Baghurst, PA et al. Environmental Exposure to Lead and Children’s Intelligence at the Age of Seven Years: the Port Pirie Cohort Study. *New England Journal of Medicine*. Vol 327: No. 18. Pg. 1279 – 1284.

³⁹ Canfield RL et al. Intellectual Impairment in Children with Blood Lead Concentrations below $10 \mu\text{g}$ per Deciliter. *The New England Journal of Medicine*. Vol. 348: 16. April 17, 2003. 1517-1526.

⁴⁰ Miranda et al. The Relationship between Early Childhood Blood Lead Levels and Performance on End-of-Grade Tests. *Environmental Health Perspectives*. Vol 115; Number 8. August 2007. 1242-1247.

roughly equal to 15% of the interquartile range."⁴¹ This association was particular evident in examining the effect of lead on tests of reading ability, congruent with the results of prior studies. The consequence of this posited 15% decrease in performance has far-reaching implications, as "some students, who would have otherwise passed the test, will fail. *This in turn has implications for retention in grade.*"⁴²

In a recent study by Tarr et. al, researchers in Detroit used a geographic database to correlate blood lead level surveillance testing with educational and behavioral outcome measures. Using a sample that included 48% of students in the Detroit Public School system, researchers examined the correlation between special education status and Michigan Educational Assessment Program (MEAP) scores with blood lead levels (BLL). The MEAP is an educational assessment taken by students in the 3rd, 5th, and 8th grade. Over 99% of the children whose BLL's were examined in the study had a mean BLL of at least 1 µg/dL. In fact, over 25% of students had a BLL greater than 5 µg/dL. In regard to special education status, the researchers found that "*there is a significant difference in the mean blood lead level between children in special education and those children not in special education*"⁴³;" children in special education classes had a higher mean blood lead level (9.7 µg/dL vs 7.3 µg/dL) that was statistically significant. In regards to MEAP scores, researchers found that "mean blood lead levels increase as MEAP proficiency decreases" on reading, mathematics, science and writing MEAP tests. Although this research has not yet been published, this correlation raises significant concerns about the impact of elevated blood lead levels on our children's ability to learn as measured by end-of-grade testing.⁴⁴

Recognizing that lead may impact behavior independent of its effects on IQ, researchers in the Treatment of Lead Exposed Children study examined the effect of lead on behavior in a group of urban children ages five to seven who had significantly elevated blood lead concentrations of 20 – 44 µg/dL at the time of their enrollment in the study. Using a multimodal approach incorporating IQ, neuropsychological and behavioral test scores, researchers concluded that lead exposure was indeed associated with behavior problems in this group of children. Among the five-year-old children

⁴¹ Miranda et al. The Relationship between Early Childhood Blood Lead Levels and Performance on End-of-Grade Tests. Environmental Health Perspectives. Vol 115; Number 8. August 2007. 1242-1247.

⁴² Miranda et al. The Relationship between Early Childhood Blood Lead Levels and Performance on End-of-Grade Tests. Environmental Health Perspectives. Vol 115; Number 8. August 2007. 1242-1247.

⁴³ Tarr H, Raymond RE and Tufts M. The Effects of Lead Exposure on School Outcome Among Children Living and Attending Public Schools in Detroit, MI. <http://www.edweek.org/media/detroitlead.pdf>

⁴⁴ Tarr H, Raymond RE and Tufts M. The Effects of Lead Exposure on School Outcome Among Children Living and Attending Public Schools in Detroit, MI. <http://www.edweek.org/media/detroitlead.pdf>

under study, lead exerted its effects on behavior primarily through its effects on IQ. Conversely, amongst those children seven years of age, lead exerted statistically significant, direct effects on behavior, externalizing problems (aggression, anger) and problems in the school setting. This association was evident in both teacher and parent-reported assessments of behavior. In addition, researchers in this study found that the correlation between elevated blood lead concentrations and behavior was greatest when blood lead levels were examined at the present (five- to seven years of age) instead of at their peak (around age 2).⁴⁵

Lead's Effect on Behavior

Using NHANES data, researchers found that lead exposure is also associated with attention deficit hyperactivity disorder (ADHD); as the BLL increased, the likelihood of developing ADHD increased. According to the researchers, "compared with the lowest quintile of blood lead levels, children with blood lead levels > 2.0 µg/dL were at a 4.1 fold increased risk of ADHD" (Braun). This association persisted even amongst children whose BLLs were less than or equal to 5 µg/dL. Thus, researchers concluded that "290,000 cases of ADHD among US children 4-15 years of age are attributable to environmental lead exposure", thus representing about 21% of cases of ADHD in the United States.^{46 47}

Correlating these observed behavioral effects with their biological underpinnings, a recent paper published by Cecil et al showed that lead does, in fact, have a permanent effect on the developing brain. Chronic lead exposure as a child may even be associated with decreased brain volumes in certain areas of the brain responsible for decision-making, mood regulation, fine motor control and higher thought and behavior processes. Researchers found that these effects on brain volume were more marked for the males under study. Thus, this functional decrease in brain volume may mediate some of the adverse cognitive and behavioral effects engendered by persistently elevated blood lead levels.⁴⁸

⁴⁵ Chen A, Cai B Dietrich KN Radcliffe J Rogan WJ. Lead Exposure, IQ and Behavior in Urban 5- to 7-year olds: Does Lead Affect Behavior Only by Lowering IQ?" *Pediatrics* 2007: 119; e 650-e658.

⁴⁶ Braun JM, Kahn RS, Freohlick T, Auinger P, Lanphear BP: 2006. Exposures to environmental toxicants and attention deficit hyperactivity disorder in children. *Environmental Health Perspectives*. 114: 1904-1909.

⁴⁷ Elise Gould. Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. *Environmental Health Perspectives*. Vol. 117. Number 7. July 2009. 1162-1167.

⁴⁸ Cecil K et al. Decreased Brain Volume in Adults with Childhood Lead Exposure. *PLoS Medicine*. May 2008: Vol 5. Issue 5. E 112. Pp. 741-750.

We are only just beginning to learn about the effects of lead on other behaviors. Sociological and criminological research is ongoing as to the effects of childhood lead exposure on future violence as an adolescent. Much of this research builds on the Pittsburgh Youth Study, in which researchers studied the behavior of 301 first grade students who scored in the upper percentiles on a self-reported antisocial behavior scale. In comparison to those students who had lower scores on this self-reported assessment, the boys with elevated scores were more likely to have higher blood lead levels. In particular, the children with elevated blood lead levels were more likely to exhibit “anxious/depressed behavior, social problems, attention problems, and delinquent, aggressive behavior.” Children with elevated blood lead levels were more likely to exhibit difficulties with attention, aggression and delinquency on a clinical assessment of these behaviors.⁴⁹ The results of this study lead researchers to conclude that exposure to lead “should be included when considering the many factors contributing to delinquent behavior.”⁵⁰ *In a further exploration of this association, researchers examining the effect of lead exposure on Philadelphia children concluded “a history of lead poisoning was among the most significant predictors of adolescent delinquency and adult criminality in males.”*^{51 52} Extending the follow-up period even further, researchers in Cincinnati, Ohio conducted a prospective study in which pre- and postnatal blood lead concentrations were obtained around the time of birth of children living in parts of Cincinnati with older, lead-contaminated housing. Following this cohort of children over time, researchers found that, among those children with elevated blood lead concentrations at the time of their birth, they were more likely to exhibit higher rates of total arrests and violence-related arrests as an adult.⁵³ Thus, the results of these studies further substantiate that exposure to lead has an association with behavior during childhood, adolescence, and even as an adult.

Economic Impact of Preventing Exposure to Lead

While lead’s demonstrated effects on health, aptitude, behavior, and even future propensity to engage in negative behaviors remains the primary driver of continued initiatives to eradicate lead, the economic benefits of these efforts merit further

⁴⁹ Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB. Bone lead levels and delinquent behavior. JAMA. 1996; 275: 363-369.

⁵⁰ Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB. Bone lead levels and delinquent behavior. JAMA. 1996; 275: 363-369.

⁵¹ Denno, D (1990). *Biology and Violence*. New York: Cambridge University Press.

⁵² Wright, JP et al. Association of Prenatal and Childhood Blood Lead Concentrations with Criminal Arrests in Early Adulthood. PLoS Medicine. May 2008; Vol. 5: Issue 5. 732-740.

⁵³ Wright, JP et al. Association of Prenatal and Childhood Blood Lead Concentrations with Criminal Arrests in Early Adulthood. PLoS Medicine. May 2008; Vol. 5: Issue 5. 732-740.

discussion. According to a cost-benefit analysis from Elise Gould of the Economic Policy Institute, “each dollar invested in lead paint hazard control results in a return of \$117-\$221 or a net savings of \$181-269 billion.”⁵⁴ These benefits are reaped in several ways: a reduction in health care costs, social and behavioral costs, and the high cost and collateral consequences of educational attainment. In examining special education in particular, Gould concluded that, at an average annual cost of \$14,317 per child in 2006, children *known* to be impacted by lead exposure likely impose costs of \$30-\$146 million on our educational system. As some cases of ADHD may be attributed, in part, to lead exposure, Gould estimates that we spend at least \$267 million annually as a consequence of this association. Lastly, Gould estimates that “the total direct cost of lead-linked crimes is approximately 1.8 billion, including direct victim costs, costs related to the criminal justice system through legal proceedings and incarceration, and lost earnings to both criminal and victim.”⁵⁵

ELC’s Recommendations

The results of these aforementioned studies highlight what many experts have known for many years: elevated lead levels in growing children – even minimal blood lead levels -- are not only harmful to their health, but also directly impact their brain at its most crucial stage of growth. This can result in lifelong effects on children’s aptitude, achievement, and behavior. Prevention is an important strategy. But in addition, we must intervene during the early years of exposure and also during school-age years with intensive school-based supports and interventions to inhibit the development of these untoward effects. It is only through such proactive measures that we can offer all of our children their best opportunity to succeed.

In light of what we now know, our recommendations for schools, parents and policymakers are as follows:

Schools can and should play a role in ensuring that ALL children are screened for elevated blood lead levels: In light of clear deficiencies in screening children for elevated blood lead levels, we need to engage schools in ensuring that ALL our children are screened. One way to accomplish this is to require documentation of screening upon a young child’s entry into a pre-school program. A second check on the system would be to require evidence of screening as part of a school-age child’s required immunization record -- which could be particularly important in ensuring that immigrant students are screened. Young children who have been screened and have

⁵⁴ Elise Gould. Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. Environmental Health Perspectives. Vol. 117. Number 7. July 2009. 1162-1167.

⁵⁵ Elise Gould. Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. Environmental Health Perspectives. Vol. 117. Number 7. July 2009. 1162-1167.

had elevated blood lead levels (2-10) should be re-screened every six months and schools can help facilitate that re-screening process.

Policymakers should consider mandatory universal testing of young children.

Pennsylvania lawmakers should consider adopting legislation to require mandatory universal testing of toddlers as has occurred in Maryland, Rhode Island and Massachusetts.

Schools staff should be made aware of the dangers of lead exposure, its impact on academic achievement and behavior, and the importance of linking families with services. Schools can play an important role in creating awareness as to the harmful effects of lead among school staff and families. Schools can help to call attention to the importance of reducing exposure to lead through participation in lead housing abatement programs, testing and abating soil, avoiding lead exposure in drinking water and in making different purchasing decisions regarding consumer goods.

Schools can play a vital role in facilitating abatement of lead in housing: Schools can connect families with services to address lead abatement and make families aware of current rights of tenants and resources to support abatement.

We must eliminate sources of exposure to lead in school buildings and drinking water: If elevated levels are found in drinking water, schools should consider replacing water fountains with alternative sources of drinking water such as bottled alternatives as occurred in Baltimore. Schools must also be provided with the resources to abate lead in school buildings.

We should consider adopting regulations or policies to ensure that students with a history of elevated blood lead levels are considered for possible evaluation for special education services or eligibility for a 504 Plan. Because lead exposure often occurs with no obvious symptoms, it frequently goes unrecognized and even undocumented as a potential source of impairment that impacts learning. As a result, children may not be identified as needing to be evaluated under this eligibility criterion for special education services. The classification “other health impairment” under the IDEA regulations is a catch-all category for eligibility and includes a specific reference to “lead poisoning” 34 CFR §300.8(c)(9). Classically, “lead poisoning” -- as referenced in the IDEA regulations -- has been understood as synonymous with exposure to very high levels of lead typically associated with severe health effects and “lead poisoning.” Because we know that lead can impact learning at low levels of exposure and without symptoms, we propose that a child with a blood lead level of 1.7 or higher be considered for screening and potential evaluation for special education services or

accommodations in school, particularly children whose exposure has resulted in behavioral issues.

Amend Pennsylvania's Early Intervention Regulations. Several states, including Pennsylvania have added references to lead in state law as a basis for screening young children for eligibility for Early Intervention services under the discretionary authority of Part C of the IDEA. In Pennsylvania, the category "*At-risk child*" includes a child under 3 years of age who was of low birth weight, cared for in a neonatal intensive care unit, born to a chemically dependent mother, seriously abused or neglected or "(v) who has confirmed dangerous levels of lead poisoning as set by the Department of Health." 55 PA Code Chap. 4266 § 4226.5. However, as we now know, based on more recent guidance by the CDC and other studies, low levels of lead exposure can significantly impact development. Accordingly, it is important to screen all children who either have elevated blood lead levels or are at high risk of exposure to lead as these children may be negatively impacted by lead exposure and should be promptly screened and receive critical cost-effective EI services if subsequently found eligible for services following a full evaluation.

Participate in state and local cross-system efforts to address this issue and develop a comprehensive cross-system strategy for addressing the lead problem. Schools across the Commonwealth have not been an active partner in addressing lead prevention strategies or addressing the impact of lead exposure. Schools can and should play a critical role in any effective cross-systems strategy to tackle this issue.

Conclusion

Lead exposure is a much-overlooked health condition that disproportionately harms low-income and minority children. While the ban on leaded gasoline has largely eliminated the risk among the general population, young children living in older and/or dilapidated apartments, those exposed to lead through industrial soil, lead-based plumbing and consumer goods as well as immigrant children still face significant risks. Our schools can play an essential role in ensuring that children are screened for elevated blood lead levels, connecting families to important prevention and abatement resources, eliminating potential exposure to lead in schools and providing additional needed academic support and interventions to children impacted by exposure to lead. We urge schools, local, state and federal leaders, parents and communities to join forces and knowledge in addressing this ongoing problem and supporting all children to succeed.

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