Finding the Next Flint: The Need to Update the Blood Lead Reference Value

Perry Gottesfeld, MPH

ABOUT THE AUTHOR

Perry Gottesfeld is the Executive Director of Occupational Knowledge International, San Francisco, CA.

In 2012, the US Centers for Disease Control and Prevention (CDC) adopted a blood lead reference value of 5 micrograms per deciliter and recognized that there is no known health-based threshold for effects in children. Previously, the agency had identified a "level of concern" implying that blood lead levels (BLLs) under 10 micrograms per deciliter were not associated with harm. In making the switch, there was purposeful intent to recognize that there is no safe level of lead exposure and therefore a new classification system was needed to identify and prioritize the most highly exposed.[1]
The reference value is an action level at which the CDC recommends environmental investigations to identify sources of lead exposure in a child's home.

The reference value is intended to identify individual children who have greater lead exposures than others in the same population.[1] This serves to inform parents that their children are being exposed to lead at "elevated" levels far in excess of the median level in the United States (0.69 μg/dL in 2015–2016).[2] Collectively, these results also inform communities and public health authorities of patterns in BLLs and provide a warning of the need to identify and reduce specific sources of environmental lead exposure. Comparing results from blood lead testing against the population background levels allows communities to analyze trends, thereby highlighting changes in exposure patterns.[3] Conversely, the success of efforts to remove lead from products and abate environmental lead hazards are measured against BLL benchmarks over time.

In 2014, when the city of Flint, Michigan, changed its drinking water source and failed to control the pH level, the protective mineral layer in pipes was stripped away, allowing more lead into the water. The prevalence of elevated BLLs greater than 5.0 micrograms per deciliter among children aged younger than 6 years went from 2.4% to 4.9% after the change in water source. This increase was detected by physicians and researchers looking at incremental changes in the proportion of children with BLLs greater than the CDC reference value.[4] Had the reference value not been adopted by the CDC, it is likely that this increase would have been underappreciated.

There has long been a false dichotomy between those arguing for increased surveillance with blood lead testing (considered secondary prevention) and the public health paradigm of primary prevention that seeks to eliminate sources of exposure before they cause harm. Although eliminating sources of environmental lead exposure is the ultimate long-term objective to stop childhood lead poisoning, in the interim we also need to prioritize individuals and communities that are overexposed to facilitate actions to reduce harm.

IMPACTS OF LOW-LEVEL LEAD EXPOSURE

There is scientific consensus that lead exposures in children, even at levels less than the CDC reference value of 5 micrograms per deciliter, are associated with adverse neurological and behavioral outcomes in children. Low-level lead exposures are also linked to hypertension and cardiovascular disease in adults.[5]

In 2012, the National Toxicology Program published a comprehensive review on the health effects of lead. The program's consensus was that there is sufficient evidence for neurological effects in children at BLLs less than 5 micrograms per deciliter. In particular, they pointed to reduced cognitive function as measured with standardized tests such as IQ, and increased incidence of attention-related behavioral problems and antisocial behavior at these levels.[5]

At least five epidemiological studies have demonstrated adverse outcomes for children with BLLs less than 5 micrograms per deciliter. These outcomes include lower reading and math scores and attention-related behaviors. The authors of a review of this evidence

AJPH Published online ahead of print September 9, 2021

conclude that these impacts are seen at BLLs as low as 2 micrograms per deciliter.[6]

REVERSING HEALTH INEQUITY

It is well recognized that elevated BLLs are not uniformly distributed in the United States, because of environmental injustice from living in older, poorly maintained housing and in areas closer to industrial emissions. Non-Hispanic Black children are more than twice as likely to have a BLL of 5 micrograms per deciliter or higher and have mean BLLs that are 50% higher than those of White children.[7,8] A recent study shows that this difference starts before birth and persists into childhood.[9] The disparity in BLLs remains even when controlling for known risk factors, including housing age, indoor household smoking, and socioeconomic factors.[8]

Poverty also plays a significant role, especially when combined with race. Black children living in poverty are four times more likely to have an elevated BLL than White or Hispanic children, even after controlling for other known risk factors.[8]

It has been well understood that housing age and conditions are significant predictors of lead exposure. Environmental lead exposures outside the home are also contributing to disparities in BLLs. Findings from a study involving more than 60 000 children in Kansas have shown that proximity to lead-emitting industries, including lead battery manufacturing, is significantly linked to higher BLLs.[10] Another study found that race and poverty were predictors of soil lead levels in both urban and rural areas. Areas of South Carolina with higher proportions of Black children had significantly higher soil lead levels, and the disparities attributable to race were greater than disparities observed with income levels.[11]

Differences in lead exposures by race and economic background have been observed since at least the 1950s and well documented since the 1970s.[12,13] This situation has persisted for decades even as median BLLs have dropped precipitously, highlighting the need to prioritize actions to abate lead hazards in these communities.

RESPONDING TO ENVIRONMENTAL CONTAMINATION

Identifying and responding to children with BLLs above the reference value allows us to investigate, identify, and mitigate environmental lead contamination in and around homes. For example, one study examined the findings from Maine after the state required environmental investigations of homes where children's BLLs exceeded 5 micrograms per deciliter. They concluded that such inspections were nearly as likely to identify lead hazards that required abatement as were inspections in homes where BLLs exceeded 10 micrograms per deciliter.[14]

At the time that the CDC adopted the reference level, there were estimated to be more than 500 000 children in the United States with BLLs exceeding 5 micrograms per deciliter.[7] However, very few of these children had their homes tested for lead or received any public health services. Even today in most states, including California, children with BLLs below 10 micrograms per deciliter generally do not receive environmental inspection services to identify potential sources of exposure.

Responding to environmental lead hazards has been shown to be effective at reducing BLLs among children. The ability to identify and successfully mitigate exposures from paint, dust, and soil has been repeatedly demonstrated to reduce BLLs.[15–17] In addition, occupations that result in "take home" exposures and other sources, including imported food, spices, pottery, and home remedies, are known to contribute to childhood lead exposures that often go undetected in the absence of public health interventions.

NEED FOR ACTION

The CDC blood lead reference value does not inform medical, diagnostic, or treatment protocols for childhood lead poisoning. Instead, it serves a dual purpose: to inform individual cases (e.g., parents) that a child's exposure exceeds background levels and to serve as a public health surveillance tool to warn that children are being overexposed. This was the criterion that alerted physicians in Flint—who in turn notified the general public, which forced authorities to respond to the crisis. In recent years, we have seen similar communitywide elevated BLLs in one area of East Chicago, Indiana, and throughout Newark, New Jersey, serving to inform authorities of the need to respond to lead-contaminated soil and lead in drinking water.[18,19]

Despite the demonstrated importance of revising the blood lead action level in the past, the CDC has failed to follow the advice of its independent expert committees to revise the reference value based on current national surveillance data. In 2012, the Advisory Committee on Childhood Lead Poisoning Prevention set the initial value at 5 micrograms per deciliter, based on the 97.5 percentile of the National Health and Nutrition Examination Survey

AJPH Published online ahead of print September 9, 2021

(NHANES) BLL distribution for children aged younger than 6 years at that time. In 2017, the CDC's Board of Scientific Counselors recommended that the agency adopt a revised blood lead reference value for children, using the most recent NHANES data, that would set the level at 3.5 micrograms per deciliter.[20] In 2021, the CDC's Lead Exposure and Prevention Advisory Committee unanimously recommended that the agency lower the blood lead action level for children to 3.5 micrograms per deciliter.[21] However, to date no action has been taken by the agency.

Concerns have been raised about the expense of public health interventions for a larger number of children who would be identified through an updated reference value.[22] There has been controversy during each of the four times that the CDC lowered the blood lead action level—starting in 1970, when the level was 40 micrograms per deciliter.[23] However, the CDC is not a regulatory agency and its guidance is not mandatory for state or local health departments. In fact, since the last revision in 2012, only 18 states and a small number of local agencies have revised their response criteria to require some action when a child's blood lead test exceeds 5 micrograms per deciliter.[24] Some states, including Maine, Illinois, and New York, have passed laws in accordance with CDC recommendations requiring environmental assessments for children with BLLs above the action level.[25–27]

It is well-known that lead poisoning has consistently affected more vulnerable populations who have greater exposures from residing in low-income areas, living in poorly maintained older homes, and absorbing more lead through poor nutrition. Efforts to prioritize the reduction of exposures in disadvantaged low-income communities require surveillance to identify the most highly exposed. If we fail to update our measure of "overexposure," we are ignoring those who are disadvantaged by living in a contaminated environment or drinking contaminated water. By not conducting environmental investigations and abating identified hazards for all children with exposures well above background levels, we knowingly subject those children to ongoing harm.

If no decision is taken over time to lower the blood lead action level, then fewer at-risk children will be identified. This will ultimately impede community efforts to utilize aggregate blood lead testing data to investigate and identify possible sources of lead exposure. It also keeps parents, who may be living in a contaminated environment, unaware of lead hazards in their home. AJPH

CORRESPONDENCE

Correspondence should be sent to Perry Gottesfeld, 4444 Geary Blvd, Suite 208, San Francisco, CA 94118 (e-mail: info@okinternational.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

PUBLICATION INFORMATION

Full Citation: Gottesfeld P. Finding the next Flint: the need to update the blood lead reference value. *Am J Public Health*. Published online ahead of print September 9, 2021:e1–e4.

Acceptance Date: May 29, 2021.

DOI: https://doi.org/10.2105/AJPH.2021.306429

CONFLICTS OF INTEREST

The author serves as an expert witness in litigation regarding lead exposures.

REFERENCES

1. US Centers for Disease Control and Prevention. Low level lead exposure harms children: a renewed call of primary prevention. 2012. Available at: https://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_010412.pdf. Accessed May 11, 2020.
2. US Centers for Disease Control and Prevention. Fourth National Report on Human Exposure to Environmental Chemicals, Updated Table, March 2021. Available at: https://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Volume2_Mar2021-508.pdf. Accessed April 20, 2021.
3. Dignam T, Hodge J, Chuke S, Mercado C, Ettinger AS, Flanders WD. Use of the CUSUM and Shewhart control chart methods to identify changes of public health significance using childhood blood lead surveillance data. *Environ Epidemiol.* 2020; 4(2):e090. https://doi.org/10.1097/EE9.0000000000000090
4. Hanna-Attisha M, LaChance J, Sadler RC, Champney Schnepp A. Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. *Am J Public Health.* 2016;106(2):283–290. https://doi.org/10.2105/AJPH.2015.303003
5. National Toxicology Program (NTP). NTP monograph: health effects of low-level lead. 2012. Available at: https://ntp.niehs.nih.gov/ntp/ohat/lead/final/monographhealtheffectslowlevellead_newissn_508.pdf. Accessed April 20, 2021.
6. Shefa ST, Héroux P. Both physiology and epidemiology support zero tolerable blood lead levels. *Toxicol Lett.* 2017;280:232–237. https://doi.org/10.1016/j.toxlet.2017.08.015
7. Wheeler W, Brown MJ. Blood lead levels in children aged 1–5 years—United States, 1999–2010. *MMWR Morb Mortal Wkly Rep.* 2013;62(13): 245–248.
8. Yeter D, Banks EC, Aschner M. Disparity in risk factor severity for early childhood blood lead among predominantly African-American black children: The 1999 to 2010 US NHANES. *Int J Environ Res Public Health.* 2020;17(5):1552. https://doi.org/10.3390/ijerph17051552
9. Cassidy-Bushrow AE, Sitarik AR, Havstad S, et al. Burden of higher lead exposure in African-Americans starts in utero and persists into childhood. *Environ Int.* 2017;108:221–227. https://doi.org/10.1016/j.envint.2017.08.021
10. Brink LA, Talbott EO, Marsh GM, et al. Revisiting nonresidential environmental exposures and childhood lead poisoning in the US: findings from Kansas, 2000–2005. *J Environ Public Health.* 2016; 2016:8791686.
11. Aelion CM, Davis HT, Lawson AB, Cai B, McDermott S. Associations between soil lead concentrations and populations by race/ethnicity and income-to-poverty ratio in urban and rural areas. *Environ Geochem Health.* 2013;35(1):1–2. https://doi.org/10.1007/s10653-012-9472-0
12. Bradley JE, Bessman SP. Poverty, pica, and poisoning. *Public Health Rep.* 1958;73(5):467–468. https://doi.org/10.2307/4590156
13. Needleman HL, Shapiro IM. Dentine lead levels in asymptomatic Philadelphia school children: subclinical exposure in high and low risk groups. *Environ Health Perspect.* 1974;7:27–31. https://doi.org/10.1289/ehp.74727
14. Cluett R, Fleisch A, Decker K, Frohmberg E, Smith AE. Findings of a statewide environmental lead inspection program targeting homes of children with blood lead levels as low as 5 μg/dL. *J Public Health Manag Pract.* 2019;25(1):S76–S83. https://doi.org/10.1097/PHH.0000000000000869
15. Clark S, Galke W, Succop P, et al. Effects of HUD-supported lead hazard control interventions in housing on children's blood lead. *Environ Res.* 2011;111(2):301–311. https://doi.org/10.1016/j.envres.2010.11.003
16. Dixon SL, Jacobs DE, Wilson JW, Akoto JY, Nevin R, Clark CS. Window replacement and residential lead paint hazard control 12 years later. *Environ Res.* 2012;113:14–20. https://doi.org/10.1016/j.envres.2012.01.005

AJPH Published online ahead of print September 9, 2021

17. Laidlaw MA, Filippelli GM, Brown S, et al. Case studies and evidence-based approaches to addressing urban soil lead contamination. *Appl Geochem.* 2017;83:14–30. https://doi.org/10.1016/j.apgeochem.2017.02.015

18. Agency for Toxic Substances and Disease Registry. Health consultation: historical blood lead levels in East Chicago, Indiana neighborhoods impacted by lead smelters. August 16, 2018. Available at: https://www.atsdr.cdc.gov/HAC/pha/USSmelterandLeadRefinery/US_Smelter_Lead_Refinery_HC_2018-508.pdf. Accessed May 11, 2020.

19. New Jersey Dept of Health. Childhood lead exposure in New Jersey: annual report 2018. Available at: https://nj.gov/health/childhoodlead/documents/reports/childhoodlead2018.pdf. Accessed May 11, 2020.

20. US Centers for Disease Control and Prevention. 2017. Board of Scientific Counselors Meeting, January 17–18, 2017, record of proceedings. Available at: https://www.atsdr.cdc.gov/science/docs/BSC_MEETING_MINUTES_JANUARY_2017_508.pdf. Accessed May 11, 2020.

21. US Centers for Disease Control and Prevention. Lead Exposure and Prevention Advisory Committee (LEPAC) Meeting, May 14, 2021. Available at: https://www.cdc.gov/nceh/lead/advisory/docs/LEPAC-transcript-05-14-2021-508.pdf. Accessed July 21, 2021.

22. Schmidt C. America's misguided war on lead exposure in children. Undark. March 21, 2018. Available at: https://undark.org/2018/03/21/lead-testing-child-blood-levels. Accessed August 10, 2020.

23. Berney B. Round and round it goes: the epidemiology of childhood lead poisoning, 1950–1990. *Milbank Q.* 1993;71(1):3–9. https://doi.org/10.2307/3350273

24. US Centers for Disease Control and Prevention. State blood lead testing laws requiring 5 ug/dL & CDC Reference Rule. 2018. Available at: https://www.cdc.gov/phlp/docs/laws-bll.pdf. Accessed May 11, 2020.

25. Maine Affordable Housing Coalition. Comparative assessment of lead poisoning screening practices in Maine and New England. March 2019. Available at: https://mainehousingcoalition.org/wp-content/uploads/2019/08/Lead-Screening-Report-Final-Full-Report.pdf. Accessed May 11, 2020.

26. Illinois Dept of Public Health. Lead rules. January 15, 2019. Available at: http://www.ilga.gov/commission/jcar/admincode/077/077008450A00200R.html. Accessed May 11, 2020.

27. New York Dept of Health. Lead poisoning prevention program. Report 2018-S-12. August 2019. Available at: https://www.osc.state.ny.us/audits/allaudits/093019/sga-2019-18s12.pdf. Accessed May 11, 2020.

AJPH Published online ahead of print September 9, 2021