Get the Lead Out

A Proposal for a LEAD Innovation Fund

By Ulrich Boser and Read Holman January 17, 2019

Although overall U.S. lead exposure rates have steadily declined over the past few decades, lead persists in our environment and continues to affect the health of individuals around the country. Indeed, at the height of the Flint, Michigan, lead contamination and water crisis in 2016, a Reuters report found that, in the United States, 3,810 communities had lead poisoning levels at least double those in Flint.[1]

Lead poisoning is completely preventable. But, because lead has no smell, taste, or color, communities and public health officials have significant challenges finding and measuring the presence of the toxic metal. One force driving this dynamic is technology: Accurately and reliably testing for the presence of lead in water, paint, soil, dust, and elsewhere requires the use of expensive technologies and advanced methods in analytical chemistry. This makes managing, reducing, and ultimately eliminating lead exposure incredibly difficult.

Meanwhile, recent research and early-stage technological developments point to promising new testing methods that would amount to a paradigm shift in how lead exposure is addressed.

This issue brief provides background on the U.S. lead crisis and summarizes legislative efforts to combat it. The brief then presents a new proposal for Congress to provide funding to advance these new testing innovations, accelerate their commercialization through competition, and bring forth 21st century approaches to environmental monitoring and public health.

Called the Lead Exposure Activity Detection (LEAD) Innovation Fund, the proposal is as necessary as it is timely. Currently, Congress is also working on an infrastructure bill that could go a long way toward tackling the persistent issue of lead.[2] And while President Donald Trump's administration recently released the Federal Action Plan to Reduce Childhood Lead Exposure, the plan lacks the needed action steps proposed in this brief.[3]

Background on the U.S. lead crisis

Lead has long been known to be a toxin to humans. Seizures, coma, and even death can occur with high exposure rates to lead. Moderate levels of exposure can have lasting health implications, causing intellectual and developmental disabilities, emotional and behavioral problems—including ADHD and criminal behavior—as well affecting hearing, speech, and other growth and development issues.[4]

But there are no safe levels of lead exposure; any amount is harmful. Indeed, these health effects can occur even with minuscule amounts of lead in the blood stream, including below the blood-lead level of 5 micrograms per deciliter—the reference point at which the Centers for Disease Control and Prevention recommends the initiation of public health actions.[5]

Children under the age of 5 are particularly vulnerable because their body, brain, and metabolism are still developing. However, low-dose lead exposure affects adults as well. A recent study estimates that, every year, 412,000 adult cardiac-related deaths in the United States can be attributed to low-level lead exposure.[6] Another study within the past year demonstrated that low-level lead exposure from topsoil resulted in decreased fertility.[7] In this sense, lead contamination is also a disability rights issue that requires a fundamental rethinking of supports and services, from early childhood education to care for aging residents.

Lead was once widely used across a number of major industries. It is a metal that occurs naturally, predominantly in the form of ore, in the Earth's crust. Because of its malleability, low melting point, and resistance to corrosion, lead has been called the "useful metal" by various industries.[8] Lead became ubiquitously used in paints, pipes and plumbing, gasoline, food containers, cosmetics, and many other everyday items.

As the health implications of lead became more widely known, however, industries ran campaigns to counter the growing body of criticism. For example, paint companies used to espouse the benefits of leaded paint.[9] In many cities, leaded pipes were actually mandated due to highly effective lobbying campaigns by the lead industry.[10]

Eventually, laws and regulations caught up. Through the Lead-Based Paint Poisoning Prevention Act (LBPPPA), lead paint for use inside homes was banned in the 1970s, with important updates occurring in 1987 and 1992. Lead's use in pipes was initially curtailed in the 1980s, with further legislative restrictions on the use of lead across plumbing systems occurring in 1996 and 2011 through amendments to the Safe Drinking Water Act. And leaded gasoline, which becomes airborne before settling in nearby soil, was ended through a phased ban in the 1990s, though some small airplanes continue to use leaded fuel.[11] Meanwhile, the Food and Drug Administration (FDA) has been addressing the use of lead in food, food wares, supplements, and cosmetics. For example, in October of 2018, the FDA issued a rule to limit the use of lead in hair dyes commercially sold.[12]

Each regulatory action limited the amount of lead being newly contributed to the environment, and public health benefits have followed: Elevated blood lead levels in children have declined significantly over the past two decades.[13] Unfortunately, a heavy metal such as lead does not just disappear. And, given the complexity and costs involved, efforts to remove lead are slow going and unequally applied. Legacy lead thus persists in millions of homes and water systems as well as in the soil of playgrounds, gardens, and parks across the country. Indeed, more than one-third of all U.S. homes have lead somewhere in them.[14] In 2015, water systems that were cited for lead violations served 18 million people.[15]

While lead exposure cuts across demographics, those affected by it are more likely to be low income communities of color living in substandard housing. Communities of color remain at increased risk for higher blood lead concentration.[16]

New efforts to gather data on lead exposure have led to startling results. A recent study of Chicago found that out of nearly 3,000 water samples, 70 percent contained lead.[17] Two years ago, Pittsburgh—and, just within the last two months, Newark, New Jersey—made headlines by having highly visible lead-in-water situations.[18] Chattanooga, Tennessee, residents recently learned of significant lead levels in their soil, while an Environmental Protection Agency (EPA)-led "first of its kind" effort is studying the same issue in Oakland, California.[19]

Moreover, many of the buildings meant to protect children are sources of lead exposure. A recent U.S. Government Accountability Office report found that nearly half of schools surveyed across the country had not tested for lead in their drinking water within the past 12 months, but of those schools that did test, more than one-third found elevated levels.[20] A 2018 Reuters investigation found that children of military families living on bases have suffered from high exposure to lead from paint within military-supplied housing.[21]

Challenges in addressing exposure to lead

There are many challenges inherent in lead remediation efforts, including the large costs that come with replacing lead pipes, replacing contaminated soil, and mitigating the lead paint present in millions of homes and buildings.

This brief highlights an underlying, foundational challenge to addressing the issue of lead: Right now, accurate, reliable, low-level detection requires sophisticated, expensive equipment that is typically found only in formal laboratories and college and university settings. The costs of simply detecting and tracking the presence of lead in schools, homes, and playgrounds is a barrier that needs to be addressed before real management of lead exposure can occur.

For instance, top-performing EPA water testing standards—specifically EPA Method 200.8—require Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analysis.[22] These machines cost over $100,000 and require significant training to learn how to operate and understand the results.[23] This is true in other areas as well. Lead in paint testing requires handheld lead analyzers that can cost over $20,000.[24] These costs add up quickly: The city of New York recently estimated that testing its 130,000 public housing units for lead would cost about $80 million.[25]

Meanwhile, there are some inexpensive do-it-yourself (DIY) lead-screening solutions available. Many stores, including home construction and improvement stores as well as online retailers and marketplaces such as Amazon, have lead-screening kits for sale. These tests—which can come in the form of a dipstick for water testing or pens and swabs to test paint and dust—use chemicals that react to lead and change colors to indicate the presence of the metal.[26] However, these products do not produce results reliable enough to be fully recognized by the EPA, despite being sold in many stores.[27] Indeed, no commercial DIY lead-testing kit has met the EPA's criteria for both positive and negative findings.[28] And, importantly, these analogue methods do not allow for quantitative analysis, which makes low-level detection near impossible.

The lack of low-cost, high-quality lead-testing tools is a problem for a number of reasons. First, it makes individual sample testing slow and inefficient. Samples often have to be sent to a lab and analyzed, and this takes time.

Second, the high cost of quality testing equipment makes testing prohibitive, meaning that institutions will test less often. This is a problem. The presence of lead in a water sample varies greatly depending on the volume of water collected, upstream disturbances, and time of day.[29] This means that one-time tests are not always accurate indicators of the problem, and expensive testing methods and technologies hinder the ability of public health officials to do another round of testing.

Third, the high cost of testing puts the power of testing in the hands of institutions and companies that are able to afford the equipment and the professionals required. This leaves concerned parents and active citizen scientists with little power to understand the health of their home environment. They are subject to the timelines, process, and reliability of their local public health departments, which are chronically underfunded.[30]

The good news is that researchers have been exploring ways to move beyond this paradigm, and they have been making major gains. As one paper in the typically dry and understated *European Journal of Inorganic Chemistry* puts it, "The new developments in reusable, disposable, and affordable electrochemical [lead] sensors has been exciting."[31]

Developments and recommendations

There are a number of promising technology and research innovations worth highlighting. For example, some researchers are manipulating bacteria into biosensors.[32] Others are digitizing and integrating smartphone technology to create next-generation approaches to colorimetry.[33] Still, others are advancing lower-cost approaches to using electricity to measurably excite lead ions.[34]

The development of these approaches goes beyond that found in formal research institutions. Two years ago, for example, an 11-year-old won a national competition with her low-cost device for testing lead in water.[35] More recently, a group of young women won second place in a NASA-led competition for their approach to removing lead in water.[36] Finally, aiming to accelerate the "smart cities" movement, multiple separate research efforts have aimed to develop cheap, continuous lead-monitoring devices that can stay within water pipes and report data via Wi-Fi or satellite.[37]

These are exciting developments; however, these technologies remain in the early stages of research, often with no clear path for commercialization. To accelerate these efforts and spur needed research in other areas, the Center for American Progress proposes a Lead Exposure Activity Detection (LEAD) Innovation Fund, detailed below.

The LEAD Innovation Fund

The proposed LEAD Innovation Fund, to be managed by the National Science Foundation, would accelerate the development of next-generation approaches to lead detection and monitoring. Specifically, it would focus on approaches that are smarter and cheaper and that better meet benchmarks set by federal agencies such as the EPA and the U.S. Department of Housing and Urban Development.

The fund aims to address the underlying problems present with the current state of lead-screening and lead-monitoring technologies. Goals of this fund could include:

- The development of improved low-cost, consumer-facing lead-screening tools that are fully recognized by the EPA or other relevant agencies and certification organizations
- The development of technologies to identify the location of lead service lines
- The piloting of the use of continuous monitoring sensors
- The development of digital analyzers to supplant analogue analyzers
- The spurring of research into the future of big data in digital environmental signaling
- Among the mechanisms included in the proposed LEAD Innovation Fund is a multistage competition for the development of inexpensive, hand-held lead-testing

technologies of both water and other substances that would give immediate, reliable results.

Over the past decade, prizes and challenges have proven to be appropriate and useful mechanisms to spur innovation in critical areas, and there are a number of federally managed challenges currently underway from which the LEAD Innovation Fund could take inspiration. For instance, the American-Made Solar Prize Challenge is a $3 million prize competition funded by the U.S. Department of Energy, designed to revitalize U.S. solar manufacturing.[38] The Kidney Innovation Accelerator (KidneyX) is a public-private partnership between the U.S. Department of Health and Human Services and the American Society of Nephrology to accelerate innovation in the prevention, diagnosis, and treatment of kidney diseases.[39] And the EPA, in partnership with four other federal agencies, is running the Nutrient Sensor Action Challenge, a multistage competition to spur the development of sensors to measure excess nitrogen and phosphorus in the nation's waters.[40]

The LEAD Innovation Fund competition would build on these and other efforts. The fund would outline a set of targets, coupled with incentives, that researchers, entrepreneurs, and citizen scientists would need to meet in order to win each stage of the competition, from concept and ideation to prototype and scaling. As appropriate, outside partnerships, organizations, and investors would be incorporated.

Other mechanisms of the fund could spur innovative, classroom-based activities, and cultivate local partnerships to pilot community-driven approaches to lead exposure detection. For instance, the fund might run a competition where high school science students partner with a local college or university to develop ways to test their schools, homes, and playgrounds for lead. This would generate useful data on lead exposure rates while educating the next generation of scientists and cultivating critical local conversations on the impact the lived environment has on one's health. Still, other mechanisms could go toward the data and technology infrastructure of public health, such as advancing the role of big data and predictive analytics to identify exposure risk and prevent lead poisoning.[41]

The cost of the proposed LEAD Innovation Fund is $25 million, which would cover prize money, programmatic administration, and other costs. The administering agency would be required to do due diligence market analysis and conduct research on effective competition design and other modern, open approaches to research and development funding opportunities. The fund would also help ensure that local efforts that expose the presence of lead within communities get connected to existing educational resources for how to limit exposure and to existing funding streams for remediation.

Conclusion

The LEAD Innovation Fund would spark important, transformative change that goes beyond just advancement in analytical methods and greater awareness of lead exposure rates within communities. By nudging the market toward digital solutions, the fund would accelerate modern, data-driven approaches to public health and environmental signaling.

By investing in continuous monitoring devices, the fund would also shift the paradigm beyond the limited capabilities of point-in-time testing and support the growing movement toward smart cities. Most importantly, by emphasizing the democratization of technology, the fund would spur developments in low-cost, handheld devices that would give power to individuals everywhere.

In short, this comparatively small, one-time investment in lead screening and detection technology would be a powerful lever for change with both short- and long-term positive returns for children, cities, and the future of public health.

Ulrich Boser is a senior fellow at the Center for American Progress. Read Holman is a Fellow at Public Lab, a community and non-profit democratizing science to address environmental issues.

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