A Tale of Two Neurotoxins:

How The Trump Administration's Handling of the Pesticide Chlorpyrifos Contrasts with EPA's Regulation of Lead in the 1970s

August 2017

ACKNOWLEDGEMENTS

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THE ENVIRONMENTAL INTEGRITY PROJECT

The Environmental Integrity Project (http://www.environmentalintegrity.org) is a nonpartisan, nonprofit organization established in March of 2002 by former EPA enforcement attorneys to advocate for effective enforcement of environmental laws. EIP has three goals: 1) to provide objective analyses of how the failure to enforce or implement environmental laws increases pollution and affects public health; 2) to hold federal and state agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws; and 3) to help local communities obtain the protection of environmental laws.

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Executive Summary

This is a tale of two neurotoxins – lead, and a pesticide called chlorpyrifos. Both chemicals damage the developing brains of young children, with permanent impacts on IQ and behavior. Yet the way the Environmental Protection Agency handled lead in the early 1970s and the way the agency is handling chlorpyrifos today are starkly different. With lead, the EPA followed the precautionary mission of America's then-young environmental laws, fought a tough legal battle with regulated industry, and won. As a result, the amount of lead in children's blood dropped dramatically. With chlorpyrifos, the EPA under the Trump Administration is going in the opposite direction. Instead of protecting children's health, EPA administrator Scott Pruitt is protecting Dow Chemical by allowing this dangerous pesticide to continue to be sprayed in farm fields, despite strong evidence that it puts public health at risk. In doing so, Pruitt is ignoring his own agency, the scientific community, the American Aademy of Pediatrics, and countless concerned parents. He is also ignoring EPA's mission.

EPA's scientists say it is time to ban the pesticide chlorpyrifos because it is causing brain damage in children. So does the American Academy of Pediatrics, saying that "[t]he risk to infant and children's health and development is unambiguous." Dow Chemical told EPA Administrator not to worry about it. Pruitt listened to Dow, and the pesticide is still on the market. EPA used to protect children, but Pruitt doesn't care about that. He's there to protect polluters. If Pruitt had been in charge in the early 1970s we would still be burning leaded gasoline.

It helps to look at the current crisis with a historical lens. In the 1970s, the newly created Environmental Protection Agency faced one of its first big challenges: Millions of children across the country were being exposed to lead, mainly from leaded gasoline, and were at risk of permanent neurological damage. At the time, there was still some uncertainty about the degree of risk. The EPA knew that blood lead concentrations greater than 40 micrograms per deciliter were dangerous, and knew that 25 percent of children had blood lead levels at least that high. The Agency also had strong evidence, if not proof, that leaded gasoline was causing elevated levels of airborne lead and blood lead levels. Finally, the Agency suspected, but could not prove, that lower blood levels were also dangerous. It turns out that the EPA was right to be concerned about lower blood lead levels: Today we know that blood lead greater than 5 micrograms per deciliter is dangerous.

Luckily for all of us, the Agency (and the Courts) rose to the challenge and started phasing lead out of gasoline, with truly remarkable results.

- In the 1970s, virtually all children – 99.8 percent – had blood lead levels that would be considered unsafe today. Now these levels occur in fewer than 3 percent of children.

With chlorpyrifos, the health risks are much more certain. In 2016, based on ten epidemiological studies of children, the EPA concluded that "there are neurodevelopmental effects occurring" at chlorpyrifos exposure levels below the old level of concern.[1] An EPA Science Advisory Panel agreed. Yet Scott Pruitt has the gall to state that "significant uncertainty … exists regarding the potential for chlropyrifos to cause adverse neurodevelopmental effects."[2] Pruitt is flagrantly lying to the American people.

The United States has a proud tradition of environmental protection. Over the past fifty years we have made dramatic improvements in air and water quality, and we have reduced numerous threats to human health. All of this occurred during a period of sustained economic growth. The majority of Americans support these policies and think that we could and should do more. Yet our government currently represents a fringe of society that is myopically focused on the profit margins of a few industrial polluters and places little or no value on human health. Since our environmental policies rest on a solid scientific foundation, the radical right has also launched a sustained attack on science. They deny not only the well-established science of climate change, but also any scientific evidence that supports the regulation of industrial pollution. They are even attacking the time-tested, peer-review methods that the Environmental Protection Agency uses to weigh scientific evidence, in order to replace sound science with industry-friendly pseudo-science.

What would the Trump administration have done about leaded gasoline? What would EPA Administrator Scott Pruitt have done? Today's Congress? They would have done nothing. The body of scientific evidence supporting the removal of lead from gasoline in the 1970s was everything that the current government complains about – it contained novel methods, it involved modeling, it was not reproducible, and it was uncertain. Eventually, the evidence of risks from leaded gasoline became unassailable. But that only became possible after lead was phased out, when blood lead levels in children started to decline. In a Trump/Pruitt world, we would likely still be burning leaded gasoline. The whole country would be Flint, Michigan.

This may sound like hyperbole, but the history of leaded gasoline (in which industry fought hard against regulation and nearly won), the positions articulated by the Trump administration, and legislation introduced by the current Congress all point to the same conclusion. And EPA Administrator Pruitt recently showed the American people exactly where his sympathies lie when he rejected his own Agency's scientific conclusions about chlorpyrifos, and reversed an EPA proposal to ban its use on food crops.

- Lead and chlorpyrifos have remarkeably similar health effects after early childhood exposure, including reductions in IQ, behavioral problems, and attention disorders. These are permanent effects, and they happen after low levels of exposure.

Pruitt chose to put children at risk of brain damage in order to save regulated industry a few dollars. This should leave little doubt about how the Trump administration would have handled the leaded gasoline crisis.

This report will review the history of leaded gasoline as an example of how our national environmental policy was born. EPA's decision to phase lead out, and the Court decision that upheld EPA's decision, reflect an approach to science, and basic values about

protecting human health, that have become the backbone of our national environmental policy. This report is also, unfortunately, a story about a competing set of values – reckless disregard of human health and science in pursuit of profit – that currently dominates our government.

Introduction

The Environmental Protection Agency (EPA) has been the subject of increasingly hostile rhetoric from the far right over the past few years, and is now being led by one of its most determined and radical critics. The rhetoric is false and misguided. You might get the impression that the EPA is an out-of-control, bloated agency that drains the federal coffers. In fact, the EPA is a tiny part of the federal budget – just 0.2 percent over the past few years.[3] You will hear that EPA regulations are destroying the economy. In fact, year after year its regulations produce benefits that are worth ten times their costs.[4] Environmental regulations do not kill jobs and they do not hamper economic growth.[5]

There is another line of attack, less audible but equally misguided, that is currently threatening to dissolve the foundation of our environmental protections, and that is the idea that the EPA doesn't use sound science. The idea is pure nonsense. We don't always agree with the EPA's policy determinations. Sometimes we don't even agree with the Agency's interpretation of the scientific literature. But the EPA is required by law to weigh complex scientific evidence, and the procedures that Agency has developed over the years to weigh this evidence, which involve extensive peer review both within and outside of the Agency, are rock-solid.

EPA's detractors know that the agency uses sound science, and they would like to replace that with pseudo-science more favorable to regulated industry. So they employ doublespeak. The "Science Advisory Board Reform Act," which passed the House in March 2017, would change the makeup of EPA's Science Advisory Board (SAB).[6] Specifically, it would waive conflicts of interest for representatives of regulated industries, but prohibit scientists who work on the issue being considered, or scientists who receive EPA grants, from being on the SAB. In short, more industry lobbyists, fewer scientific experts. In a press release, the sponsors of the bill claimed that it would reduce conflicts of interest.[7] Scott Pruitt is promoting a radical deconstruction of our environmental protections, antithetical to EPA's statutory purpose, and calling it "back to basics."[8]

In another well-worn tactic, opponents of regulation claim that the evidence of a risk is uncertain, and that we should wait until we can study the issue more. For example, Scott Pruitt recently rejected the scientific conclusions of his own agency about a neurotoxic pesticide known as chlorpyrifos. The Obama EPA proposed banning the use of chlorpyrifos in 2015. The Pruitt EPA reversed course, stating that the Obama proposal "largely relied on certain epidemiological study outcomes, whose application is novel and uncertain, to reach its conclusions."[9] In rejecting his agency's scientific conclusions, Pruitt had the nerve to say that the agency was "returning to using sound science in decision-making."[10] Citing scientific uncertainty is a classic delay tactic, and its advocates have no genuine interest in sound science. But even if we give them the benefit of the doubt, the argument falls apart for three basic reasons.

First, uncertain science is perfectly valid basis for action. In the real world, we make decisions based on uncertain information all the time. Meteorologists don't know whether it will rain tomorrow, or how much it will rain, but we count on them to give us a probability – an uncertain estimate – so that we can plan. This is the way science works, particularly

regulatory science. Scientists weigh the evidence before them because policymakers have to make decisions. This was eloquently described by Judge J. Skelly Wright in his opinion affirming EPA's 1973 lead regulation, an opinion that we will come back to several times in this report:

> Man's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations. It is only recently that we have begun to appreciate the danger posed by unregulated modification of the world around us, and have created watchdog agencies whose task is to warn us, and protect us, when technological "advances" present dangers unappreciated or unrevealed by their supporters. Such agencies, unequipped with crystal balls and unable to read the future, are nonetheless charged with evaluating the effects of unprecedented environmental modifications, often made on a massive scale. Necessarily, they must deal with predictions and uncertainty, with developing evidence, and, sometimes, with little or no evidence at all.[11]

Second, 'further study' is a form of inaction, and inaction has consequences. As we describe in detail below, the failure to regulate lead would have had massive consequences. Similarly, the failure to regulate chlorpyrifos is currently putting children at risk.

Finally, scientific certainty is not a desirable goal. When we think of pollutants in our environment and risks to human health, we will rarely have true "certainty" until people have been injured or killed. It is better to act before we have that kind of certainty. To quote Judge Wright again, "[a]waiting certainty will often allow for only reactive, not preventive, regulation."[12]

In many cases, the science only improves after a health risk is regulated. As we describe below, in the case of leaded gasoline, it was impossible to reduce uncertainty and identify safer levels of blood lead until after lead was phased out. If we had waited for scientific certainty, we might still be burning leaded gasoline. Many people would have died prematurely, and many more would be suffering from irreversible brain damage.

Science, uncertainty and leaded gasoline

Lead is very bad for you, even at low doses. This is now widely understood to be true. Lead serves no purpose in our bodies. When we inhale lead, or ingest lead that has settled as dust, or drink lead in water, we face an increased risk of neurological damage and other health effects. Children are particularly vulnerable. All of this may seem obvious today, but it took us a long time, at least forty years, to get to this point. It took that long for the scientific community to accumulate a conclusive, irrefutable body of evidence about the sources and effects of low-level exposures, and to fight off attacks from the lead industry.

This is the way science works. Evidence of a causal relationship between a toxic chemical and health effects builds over time. In the beginning, evidence is 'suggestive' and a

relationship is 'possible.' After a while, the evidence may become more compelling. Eventually it becomes 'probable,' and sometimes even 'certain.'[13]

Along the way, as evidence of a health risk begins to accumulate, a debate rages over a pivotal policy question: When should we limit human exposure? When we have any evidence of a risk? Once multiple lines of scientific evidence point to the same conclusion? Or only after we have clear proof of harm? The proponents of each position are predictable. Environmentalists and human health advocates push for a precautionary approach: We should not expose our children to chemicals that might be dangerous. Industries with a financial stake in a chemical tend to favor a less cautious approach, according to which a chemical is 'innocent until proven guilty.'

This is what happened with airborne lead. Two things became increasingly clear between the 1960s and the1980s. First, airborne lead, which came mainly from leaded gasoline, was a significant source of lead in our blood. Second, lead was more dangerous, and toxic at much lower levels, than we once thought. Over the course of the 1970s, Congress and the U.S. Environmental Protection Agency (EPA) stepped in to gradually eliminate lead from gasoline. It took pressure from environmental organizations to get the Agency moving, and EPA then faced intense opposition, and a legal challenge, from the lead industry. The appeals court in Washington D.C. struggled with the decision from 1974 to 1976. First they decided to strike down EPA's new regulations. Then, by a narrow margin, they decided to let EPA proceed, finding that EPA had weighed the scientific evidence fairly and according to law.

What if that case had gone the other way? What if we had waited for scientific certainty before eliminating lead from gasoline? This paper will briefly explore that alternative history. We begin by summarizing what we know about lead today. Then we discuss what the EPA knew about lead in the early 1970s when it decided to start phasing lead out of gasoline. We will also look at the court decision that validated EPA's approach, a decision that speaks directly to the ongoing attacks on the Agency from members of Congress and from the Agency's new administrator. Finally, we will discuss the harm that was avoided by EPA's decision.

Health effects of lead

The fact that lead is toxic at high doses has been known for thousands of years.[14] But only over the last 100 years or so have we accumulated evidence of a broad spectrum of health effects at very low doses.

We now know several things with a high degree of certainty. First, childhood lead exposure, even at low levels, causes permanent, irreversible brain damage. This is typically shown as reduced cognitive function (e.g., IQ score), but can also be seen in lower SAT scores and related measures of academic achievement.[15] Second, we know that childhood lead exposure can cause behavioral problems later in life.[16] Third, there appear to be health risks with any level of exposure – there is no "safe" blood lead level, or threshold.[17] It is clear, however, that levels between 5 and 10 µg/dL are unsafe, and levels as low as 2 µg/dL may

cause reduced IQ.[18] Finally, we know that the dose-response curve is steeper at lower levels.[19] In other words, "the effects of lead on IQ are proportionally greater at lower lead concentrations."[20] For example, according to the results of one study, reducing average blood lead levels from 12 to 11 µg/dL would boost average IQ by 0.5 points. But reducing blood lead from 7 to 6 µg/dL – the same absolute reduction in blood lead, but from a lower starting point – would increase IQ by 1.4 points.[21]

We also know that lead can cause increased blood pressure, coronary heart disease, and an increased risk of death from cardiovascular causes among adults. Again, there is no evidence of a threshold, or safe blood lead level, below which increased blood pressure is avoided.[22] Lead is also known to increase the risk of delayed puberty, to reduce the reproductive success of men (and maybe women), and to affect the health of red blood cells.[23]

In addition, we know that lead exposure *likely* causes:

- Adverse outcomes later in life, including increased aggression and criminal behavior in young adulthood, and depression in the pre-teen years;
- Hearing loss in children and maybe adults;
- Neurological impairment in adults, including symptoms like reduced cognitive function, depression and anxiety;
- Immune system effects like asthma, allergies, and decreased immune system effectiveness;
- And cancer. According to the EPA, lead is a "probable human carcinogen."[24]

Finally, the EPA has listed several health effects for which there is "suggestive" evidence of a causal relationship, including peripheral artery disease, reduced kidney function, and birth outcomes (preterm birth and low birth weight).[25]

In short, lead is associated with a wide range of serious health effects at low doses. The U.S. Centers for Disease Control and Prevention (CDC) now recommend that public health professionals take action if blood lead in children exceeds a "reference level" of 5 micrograms per deciliter of blood (µg/dL).[26]

State of the science in the 1970s

In 1973, the EPA knew less than it does today, but it did know several things:

- Obvious lead poisoning, including intestinal cramps, partial paralysis, and severe mental impairment, occurred at blood lead levels of 80-100 µg/dL.[27]

- There were "subclinical" effects – effects that could only be identified with careful testing – at lower blood levels. EPA cited evidence of neurological damage, behavioral disturbances, anemia, and kidney damage at blood lead levels between 25 and 80 μg/dL.[28] The Agency concluded that "subclinical changes may be associated with blood lead levels in the range of 40-60 [μg/dL]. . . Based upon evidence from these studies, it would seem prudent to regard blood lead levels over 40 [μg/dL] as indicators of lead intake that should be prevented."[29] This was not controversial. The National Academy of Sciences and the U.S. Public Health Service had reached essentially the same conclusion.

- EPA also noted that children were especially vulnerable to the effects of lead, citing evidence from human and animal studies. With that in mind, the Agency suggested that 40 μg/dL should be regarded as a "strict upper limit" for young children.[30]

- Roughly 25% of urban children had blood lead levels above 40 μg/dL.[31]

- People were exposed to lead from several sources, including food and water. Lead paint was thought to be the primary cause of most "overt clinical lead toxicity" in children.[32] In this context, the significance of airborne lead was not perfectly clear.[33] Yet several lines of evidence suggested that airborne lead from gasoline was an important part of the problem:

- Over 200,000 tons of lead were consumed in gasoline each year, with roughly 70% of that lead emitted to the air.[34] Emissions from gasoline represented roughly 90% of total airborne lead emissions.

- Reductions in the use of lead additives were known to produce immediate declines in airborne lead concentrations.[35]

- Direct observations and theoretical calculations suggested that airborne lead concentrations of 5 – 6.7 $\mu g/m^3$ – levels found in some cities at that time – could cause blood lead levels to exceed 40 μg/dL.[36]

- Children living near major roadways had higher blood levels than other children.[37]

- Humans were exposed to airborne lead not only by inhaling it, but also by ingesting it after it had settled as dust. This increased the vulnerability of children, who are both lower to the ground and more likely to ingest dust. EPA provided the vivid example of a "moistened lollipop dropped to the ground," which, in many urban locations, would be expected to pick up more than ten times the amount of lead ingested in food each day.[38]

In short, there were multiple lines of evidence suggesting that the emissions of lead from cars and trucks were harming human health, but there was little "hard proof."[39] EPA also had instructions from Congress. The 1970 Clean Air Act stated that the Agency could

> control or prohibit the manufacture, introduction into commerce, offering for sale, or sale of any fuel or fuel additive for use in a motor vehicle or motor vehicle engine if any emission products of such fuel or fuel additive will endanger the public health or welfare . . . .[40]

EPA's ability to act therefore depended on whether the evidence supported a finding that lead in gasoline endangered public health or welfare, in much the same way that the Agency's ability to regulate greenhouse gases today rests on its endangerment finding for these pollutants.[41]

The Agency began the process of drawing up a rule for phasing lead out of gasoline in 1971. In November 1973, spurred by legal action from the Natural Resources Defense Council, EPA issued a final regulation that would reduce lead in gasoline over a five-year period. On the same day, the Agency also published a final health assessment, which concluded that a significant fraction of urban children had unsafe blood lead levels, that lead in gasoline was "the most important remaining source of controllable lead entering the environment," and that reducing lead in gasoline would reduce human exposure.[42]

Battle over regulations

As evidence of the dangers of lead began to accumulate, and especially after EPA proposed to phase lead out of gasoline, the lead industry presented a laundry list of arguments against taking action. They argued that humans had adapted to lead.[43] They argued that lead was essential to human health.[44] When they had to concede that lead could be dangerous, they argued that there was no relationship between lead in gasoline and lead in the air or lead in blood.[45] They argued that there was no proof that anyone had been hurt by lead from gasoline.[46] They challenged each assumption in EPA's health assessment. For example, they argued that there was no evidence that children ingested dust that fell from automobile exhaust.[47] More generally, and most insidiously, they argued that the Agency should not act when the science was "uncertain"[48] (while simultaneously arguing that EPA should not consider all of the information before it).[49] According to the lead industry, EPA should have waited until it had proof of harm before it acted.[50]

Most of these arguments came up in one form or another when the lead industry challenged EPA's regulations in court. None them were availing, and the Court's responses to several of them bear repeating. To begin with, the industry argued that EPA needed proof of actual harm before it could find that lead in gasoline endangered health. The Court replied that

> a statute allowing for regulation in the face of danger is, necessarily, a precautionary statute. Regulatory action may be taken before the threatened harm occurs; indeed the very existence of such precautionary legislation

> would seem to demand that regulatory action precede, and, optimally, prevent, the perceived threat.[51]

The industry also argued that, even if proof of harm were not necessary to find endangerment, the chance of adverse health effects must be "probable." In response, the Court said:

> Danger, the Administrator recognized, is not set by a fixed probability of harm, but rather is composed of reciprocal elements of risk and harm, or probability and severity . . . . That is to say, the public health may properly be found endangered both by a lesser risk of a greater harm and by a greater risk of a lesser harm.[52]

The case of lead, even in the 1970s was arguably in a third category, with both a relatively high probability and a serious outcome (much like climate change today). The EPA Administrator had found a "significant risk of harm." Given the severity of the risk to be avoided, the Court determined that a "significant risk" was more than sufficient to justify the endangerment finding.[53]

When industry argued that the EPA was required to make a factual determination that lead emissions will endanger human health – in essence, that EPA must wait for certainty in the scientific literature – the Court observed that decisions must be made with evidence at hand, even if it is uncertain:

> [S]peculation, conflicts in evidence, and theoretical extrapolation typify [regulators'] every action. How else can they act, given the mandate to protect the public health but only a slight or nonexistent database upon which to draw? . . . [T]he statutes and common sense demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable.[54]

The Court went on to hold:

> Where a statute is precautionary in nature, the evidence difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge, the regulations designed to protect the public health, and the decision that of an expert administrator, we will not demand rigorous step-by-step proof of cause and effect. Such proof may be impossible to obtain if the precautionary nature of the statute is to be served.[55]

Finally, the Court made clear that mutually consistent evidence from different fields of knowledge (e.g., animal studies, human studies, theoretical considerations) was not only acceptable, but was in fact the ideal:

> Contrary to the apparent suggestion of some of the petitioners, we need not seek a single dispositive study that fully supports the Administrator's determination. Science does not work that was; nor for that matter, does adjudicatory fact-finding. Rather, the Administrator's decision may be fully supportable if it is based, as it is, on the inconclusive but suggestive results of

> numerous studies. By its nature, scientific evidence is cumulative: the more supporting, albeit inconclusive, evidence available, the more likely the accuracy of the conclusion.[56]

The Court hammered the point home with a quote from a pre-Civil War case: "[I]nferences drawn from independent sources, different from each other, but tending to support the same conclusion, not only support each other, but do so with an increased weight."[57]

In the end, the 1973 rule that started to phase lead out of gasoline, together with other regulations promulgated in the 1970s,[58] further gasoline lead reductions in the 1980s,[59] and eventually a ban on lead additives in 1996,[60] eliminated all but a trace amount of lead from gasoline.

Emissions, exposure, and blood lead levels, 1976-today

The history of lead emissions and blood lead levels since 1976 is remarkable. By 1980, it was already clear that declining use of lead in gasoline had caused a decline in ambient air concentrations and a corresponding decline in blood lead. The use of lead in gasoline dropped by 50% between 1976 and 1980. Ambient air concentrations dropped in parallel. Blood lead levels dropped by 37%.[61] All in a span of just four years.

This trend continued to the present day. According to the most recent data, lead emissions have now declined by more than 99%.[62] Ambient air concentrations have also dropped by 99%.[63] Blood lead levels in both children and adults have declined by 93-94%, as shown in Table 1. Most dramatically, the fraction of young children with blood lead levels higher than 5 µg/dL has declined from virtually all children in 1976-1980 (99.8%) to only 2.5% of children in 2013-2014. Although some of the decline in blood lead levels can be attributed to reductions in other exposures (e.g., food and paint), the main cause appears to be the reduction in airborne lead.

TABLE 1: BLOOD LEAD CONCENTRATIONS SINCE 1976.[64]

Date Range	Geometric mean (µg/dL)		95th percentile (µg/dL)		Mean (µg/dL)		Percent of population with blood lead greater than 5 µg/dL[65]	
	All	Ages 1-5	All	Ages 1-5	All	Ages 1-5	All	Ages 1-5
1976-1980	12.80	15.00	25.00	28.00	13.90	16.00	99.2%	99.8%
1988-1991	2.80	3.60	9.40	12.20	3.58	4.62	23.3%	33.2%
2013-2014	0.86	0.97	2.81	2.24	1.09	1.09	n.a.	2.5%[66]
% reduction to date	*93%*	*94%*	*89%*	*92%*	*92%*	*93%*	n.a.	*97%*

Benefits of lead regulations

In 1997, the EPA provided Congress with a comprehensive analysis of the benefits and costs of the Clean Air Act through 1990.[67] The benefits of removing lead from gasoline were substantial.[68] The Agency estimated that, if lead had not been removed from gasoline, in 1990 alone:

- The average IQ in young children would have been 2.8 points lower, and there would have been 10.4 million fewer total IQ points.[69]
- There would have been over 45,000 more children with IQs below 70, requiring remedial education.[70]
- There would have been 22,000 more premature deaths, including 5,000 infant mortalities and 17,000 deaths related to high blood pressure and heart disease in adults.[71]
- There would have been over 10,000 additional cases of coronary heart disease in adults.[72]
- There would have been over 12 million additional cases of hypertension in adult men.[73]

Blood lead levels continued to fall after 1990, and the estimated benefits today should be even greater. For example, using EPA's methods for estimating IQ loss, the average IQ among young children today is roughly 4 points higher than it would be if we still burned leaded gasoline, and we have over 70,000 fewer children that require remedial education.[74]

The estimates are uncertain. On one hand, the use of lead in gasoline may have declined even in the absence of the EPA limits on lead content – limits on other pollutants required the use of catalytic converters, and catalytic converters were, at the time, only compatible with unleaded gasoline.[75] In order to facilitate the adoption of catalytic converters, the EPA required gas stations to start selling unleaded gasoline in 1973 (through separate rulemaking), and effectively required the use of unleaded gasoline in new cars.[76] This was not a guarantee that lead would be phased out, however, because it was always possible that the automotive industry could develop alternatives to lead-sensitive catalytic converters.[77] In any case, waiting for the nation's vehicle fleet to turn over would have produced a much slower phase-out than restricting the amount of lead in gasoline.

On the other hand, the possibility of exposure to gasoline exhaust has gone up. The use of gasoline has increased by roughly 40% since 1980 and by 25% since 1990.[78] The number of people in the United States has increased, and the fraction of the population living in urban areas has also gone up.[79] This means that if we had kept lead in gasoline – if, for example, a lead-compatible catalytic converter had been developed – then more children would now be exposed to greater amounts of lead in the air and in dust.

Moreover, we now know that the dose-response relationship between blood lead and IQ is steeper at low blood lead levels.[80] It its benefits analysis, EPA assumed that the relationship was 0.25 IQ points per µg/dL of blood lead. More recent research suggests that the slope at lower blood lead levels is 1 IQ point per µg/dL or higher.[81] This means that once average blood lead levels dropped below 10 µg/dL or so, the IQ benefits of each successive reduction became increasingly large, and the total IQ benefit is therefore much higher than EPA estimated in 1997.

Finally, the Agency acknowledged that was using an incomplete list of health effects – it did not have enough information to estimate the change in several other likely outcomes including neurological effects after adult exposure, neurological effects in children after exposure to lead in the womb, behavioral effects in children, or reproductive effects in women.[82]

In short, among other unquantified health benefits, the removal of lead from gasoline increased the average IQ of our children by at least 3-4 points, saved tens of thousands of children from serious neurological damage each year, and prevented tens of thousands of premature mortalities each year.

What would the Pruitt EPA have done with leaded gasoline? The case of chlorpyrifos

> *"They used the term 'silent epidemic' with lead, and I think that's really what we're talking about here . . . The longer this goes on, the more accumulated evidence there is."* - Dr. Irva Herz-Picciotto, U.C. Davis[83]

> *"The risk to infant and children's health and development is unambiguous."* – American Academy of Pediatrics[84]

Chlorpyrifos is a pesticide used on food and other crops, on golf courses, to control mosquitos, and in roach and ant traps.[85] Scientists have long known that chlorpyrifos is a cholinesterase inhibitor, which means that it blocks the breakdown of the neurotransmitter acetylcholine, resulting in overstimulation of the nervous system and a range of symptoms from nausea and dizziness to respiratory failure and death.[86] Earlier risk assessments from the Agency have been based on this endpoint.[87]

Now scientists know that chlorpyrifos, like lead, is a also potent neurotoxin in children, causing reduced IQ, delays in mental development, attention disorders, and autism spectrum disorders.[88] EPA, including its pesticide-related Scientific Advisory Panel, have found that risk assessments based on cholinesterase inhibition are not sufficiently protective against childhood neurotoxicity.[89] This is because chlopyrifos can cause neurotoxicity at very low doses. This is hardly a theoretical concern: EPA's risk assessments have found that chlorpyrifos residues on food are roughly 100 times higher than the Agency's target risk level.[90] And food is not the only route of exposure. EPA also found that chlorpyrifos exposures on golf courses, near fields sprayed with the pesticide, near mosquito-control applications, or at work are all unsafe.[91] For agricultural fields, EPA determined that being

anywhere within 300 feet of the field would be unsafe.[92] For workers, who are currently allowed to return to treated fields after 5 days, or in some cases after 24 hours, EPA determined that workers shouldn't be going back to those fields for 18 days.[93] In an example of grim irony, 47 farmworkers in California became ill when they were exposed to drifting chlorpyrifos shortly after EPA decided not to ban the pesticide.[94]

There are clear similarities between chlorpyrifos and lead. Both were (lead) or are (chlorpyrifos) widespread. In both cases, new evidence of a serious risk to young childrens' brains motivated EPA to propose a phase-out or ban.[95] If anything, the evidence for a chlorpyrifos risk – including multiple, mutually consistent epidemiological studies – is much stronger than the evidence for a lead risk was in the 1970s.

Yet today EPA is doing nothing. Scott Pruitt is not interested in protecting children. He is interested in helping Dow Chemical make more money: A few days before deciding not to ban chlorpyrifos, he had a meeting with Dow's CEO.[96] Aside from Dow Chemical, Pruitt has the support of virtually no one. The American Academy of Pediatrics came out against him in June. [97] Most recently, five states and the District of Columbia joined a lawsuit challenging the decision.[98]

Everyone but Scott Pruitt seems to understand that this is a very serious problem. Dr. Irva Herz-Picciotto, one of the foremost scientists studying childhood neurological development and toxicity, put the problem in stark terms: "It's eating away at the development of vulnerable brains."[99] Pruitt's response? Check out EPA's website for the pesticide – it doesn't even mention childhood neurotoxicity.[100]

Discussion

One of the great ironies of the lead debate is that it would have been nearly impossible to identify the effects of lead at low doses before lead was regulated. To begin with, emissions at the then-current level were relatively new, so no one had been exposed to a known amount of lead for a full lifetime.[101] Moreover, there were almost no children at the time with very low blood lead levels. As shown in Table 1 above, 99.8% of children had blood lead levels higher than 5 µg/dL, the current CDC reference level. This means that there was no "control group" against which to compare the health effects of exposed children.[102] This also means that we couldn't have learned that lead was more toxic, per µg/dL, at lower blood lead levels until after lead was removed from the environment. In short, if we had waited for concrete evidence of harm before removing lead from gasoline, we would still be waiting.

America's experience with lead has been, and continues to be, a painful learning experience. Unless you are Scott Pruitt. He hasn't learned a thing. During Pruitt's confirmation hearings, Sen. Ben Cardin (D-Md.) asked whether the EPA's decision years ago to remove lead from gasoline was "an important and successful EPA rulemaking." Pruitt's response? "I have not evaluated this issue."[103]

The EPA used to protect our children, and all Americans, from toxic exposures. Not anymore. Scott Pruitt doesn't know anything about science, and he doesn't want to know. He doesn't care about childrens' health. Today the EPA has one mission – to protect the profits of regulated industries. Let's hope that they can return to the proud tradition they started with lead before too much damage is done.

Notes

[1] U.S. EPA, Chlorpyrifos: Revised Human Health Risk Assessment for Registration Review at 13 (Memorandum, Nov. 3, 2016) (hereinafter "Revised HHRA").

[2] U.S. EPA, Order Denying PANNA and NRDC's Petition to Revoke Tolerances, EPA-HQ-OPP-2007-1005, at 36 (Mar. 29, 2017).

[3] U.S. Office of Management and Budget, Fiscal Year 2017 Budget of the U.S. Government, Tables S-1 and S-11 (Feb. 9, 2016). Specifically, the EPA budget represented 0.22% of the actual 2015 budget, 0.21% of the enacted 2016 budget, and 0.20% of the 2017 budget request.

[4] See, e.g., Environmental Integrity Project, Don't Believe the "Job Killer" Hype, 9 (Jan. 16, 2017), http://www.environmentalintegrity.org/reports/dont-believe-the-job-killer-hype/.

[5] *Id.* at 5 – 8.

[6] H.R.1431, EPA Science Advisory Board Reform Act of 2017 (introduced Mar. 8, 2017, referred in Senate Mar. 30, 2017).

[7] House Committee on Science, Space & Technology, SST Committee Members Introduce the Honest and Open New EPA Science Treatment Act of 2017, EPA Science Advisory Board Reform Act of 2017 (Press Release, Mar 6, 2017), https://science.house.gov/news/press-releases/sst-committee-members-introduce-honest-and-open-new-epa-science-treatment-act-0.

[8] U.S. EPA, Back-to-Basics Agenda, https://www.epa.gov/home/back-basics-agenda.

[9] Ariel Wittenberg, E&E News, EPA about-faces on banning chemical it once called a risk (Mar. 30, 2017).

[10] U.S. EPA News Release, EPA Administrator Pruitt Denies Petition to Ban Widely Used Pesticide (Mar. 29, 2017). Pruitt has also bent over backwards to deny the scientific consensus on climate change, arguing that there "should be a vigorous debate about that" and that we should abandon the Paris agreement and climate regulations in the meantime. *See, e.g.*, Andrew Kaczynski, CNN, In interviews, Trump's EPA pick questioned climate change, said Obama EPA rules would be undone (Dec. 13, 2016).

[11] *Ethyl Corporation v. EPA*, 541 F.2d 1, 6 (D.C. Cir. 1976).

[12] *Id.* at 25.

[13] Strictly speaking, certainty is unattainable. As Judge Wright observed, "[e]ven scientific 'facts' are not certain, but only theories with high probabilities of validity. Scientists typically speak not of certainty, but of probability; they are trained to act on probabilities that statistically constitute 'certainties.'" *Id.* at 25, n. 52.

[14] See, e.g., Gilbert and Weiss, A rationale for lowering the blood lead action level from 10 to 2 μg/dL, Neurotoxicology 27(5):693-701 (2006).

[15] See, e.g., K. Chandramouli et al., Effects of Early Childhood Lead Exposure on Academic Performance and Behaviour of School Age Children, Arch Dis Child 94:844-848 (2009); S. Skerfving et al., Late Effects of Low Blood Lead Concentrations in Children on School Performance and Cognitive Functions, Neurotoxicology 49:114-120 (2015).

[16] U.S. EPA, Integrated Science Assessment for Lead, lxxxviii (2013); J. Liu et al., Blood Lead Levels and Children's Behavioral and Emotional Problems: A Cohort Study, JAMA Pediatr 168(8):737-745 (2014).

[17] R.L. Canfield et al., Intellectual Impairment in Children with Blood Lead Concentrations below 10 μg per Deciliter, N Engl J Med 348:1517-26, 1518, 1525 (2003); B.P. Lanphear et al., Low-level Environmental Lead Exposure and Children's Intellectual Function: An International Pooled analysis, Environ Health Perspect 113:894-899 (2005); U.S. EPA, Integrated Science Assessment for Lead, lxxxviii, 1-28 (2013).

[18] T.A. Jusko et al., Blood Lead Concentrations <10 μg/dL and Child Intelligence at 6 Years of Age, Environ Health Perspect 116:243-248, 246 (2008).

[19] R.L. Canfield et al., Intellectual Impairment in Children with Blood Lead Concentrations below 10 μg per Deciliter, N Engl J Med 348:1517-26, 1521-24 (2003); U.S. EPA, Integrated Science Assessment for Lead, xciv (2013).

[20] *Id.* at 1522.

[21] *Id.* at 1523-1524 (2003) (using adjusted overall changes in IQ in relation to lifetime average blood lead levels).

[22] U.S. EPA, Integrated Science Assessment for Lead, lxxxiv-lxxxv, 1-28 (2013)

[23] *Id.* at lxxxvi.

[24] U.S. EPA, Integrated Risk Information System, Lead and compounds (inorganic), https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=277.

[25] U.S. EPA, Integrated Science Assessment for Lead. at lxxxiii – lxxxvii.

[26] U.S. CDC, Lead, https://www.cdc.gov/nceh/lead/.

[27] U.S. EPA, EPA's Position on the Health Implications of Airborne Lead, III-1 – III-2 (Nov. 28, 1973) (hereinafter "1973 Lead Position").

[28] *Id.* at III-2 – III-11.

[29] *Id.* at III-11.

[30] *Id.* at IV-7.

[31] *Id.* at VII-3.

[32] *Id.* at VI-21.

[33] *Id.* at VI-15.

[34] *Id.* at II-4.

[35] *Id.* at II-5.

[36] *Id.* at V-17.

[37] *Id.* at VI-16 – VI-17.

[38] *Id.* at VI-7.

[39] Ethyl Corp. v. EPA, 541 F.2d 1, 4 (1976).

[40] Pub.L. 91-604; Sec. 211(c)(1) (Dec. 31, 1970); this is now codified, with some changes, at 42 U.S.C. § 7545(c)(1).

[41] U.S. EPA, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act; Final Rule, 74 Fed. Reg. 66496 (Dec. 15, 2009).

[42] 1973 Lead Position, *supra* note 27, at VIII-6 – VIII-8 (Nov. 28, 2973)

[43] H.L. Needleman, The Removal of Lead from gasoline: Historical and Personal Reflections, Environ. Res. Section A 84:20-35, 23 (2000).

[44] *Id.* at 33; K. Bridbord and D. Hanson, A Personal Perspective in the Initial Federal Health-Based Regulation to Remove Lead from Gasoline, Environ. Health Perspect. 117:1195-1201, 1196 (2009).

[45] *Id.* at 1197, Ethyl Corp. v. EPA, 541 F.2d 1, 11 n.9 (1976).

[46] Needleman, *supra* note 43, at 29; Bridbord and Hanson, *supra* note 44, at 1199.

[47] Ethyl Corp. v. EPA, 541 F.2d 1, 45 (1976).

[48] Chemical & Engineering News, EPA low lead rules called wasteful, (Dec. 10, 1973); Ethyl Corp. v. EPA, 541 F.2d 1, 25 (1976).

[49] *Id.* at 40-41.

[50] *Id.* at 12.

[51] *Id.* at 12 – 13.

[52] *Id.* at 18.

[53] *Id.* at 19.

[54] *Id.* at 20, 24 – 25.

[55] *Id.* at 28.

[56] *Id.* at 37 – 38, 42.

[57] *Id.* at 38, n.80.

[58] Specifically, another 1973 regulation required that gas stations sell at least some unleaded gasoline in order to accommodate cars with catalytic converters. U.S. EPA, Regulation of Fuels and Fuel Additives, Final Rule, 38 Fed. Reg. 1,254 (Jan. 10, 1973).

[59] The 1973 gasoline regulation required a reduction in the lead content of all gasoline sold by a refinery from 1.7 grams per gallon to 0.5 grams per gallon. U.S. EPA, Regulation of Fuels and Fule additives, Control of Lead Additives in Gasoline, 38 Fed. Reg. 33,734 (Dec. 6, 1973). This lead content applied on a "pooled" basis, meaning that the average lead content of leaded and unleaded gasoline had to be below the applicable limit. In 1982, EPA established a standard specifically for leaded gasoline (1.1 grams per gallon). U.S. EPA, Regulation of Fuels and Fuel Additives, Final Rule, 47 Fed. Reg. 49,322 (Oct. 29, 1982). The leaded gasoline standard was reduced to 0.1 grams per gallon in 1985. U.S. EPA, Regulation of Fuels and Fule Additives; Gasoline Lead Content, Final Rule, 50 Fed. Reg. 9,386 (Mar. 7, 1985).

[60] U.S. EPA, Prohibition on Gasoline Containing Lead or Lead Additives for Highway Use, 61 Fed. Reg. 3,832 (Feb. 2, 1996).

[61] See, e.g., Needleman, *supra* note 43, at 31-32; J.L. Annest et al., Chronological Trends in Blood Lead Levels Between 1976 and 1980, N Engl J Med 308:1373-7 (1983).

[62] Lead emissions were roughly 190,000 tons from all sources in 1975, with roughly 180,000 tons coming from transportation. U.S. EPA, The Benefits and Costs of the Clean Air Act, 1970 to 1990, B-38, Table B-21 (Oct 1997). In 2014, total lead emissions were 730 tons. U.S. EPA, 2014 National Emissions Inventory (NEI) Data, https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data.

[63] U.S. EPA, Lead Trends: National Trends in Lead Levels, https://www.epa.gov/air-trends/lead-trends. The annual maximum 3-month average has declined from 1.84 $\mu g/m^3$ in 1980 to 0.02 $\mu g/m^3$ in 2015.

[64] Data for 1976-1980 and 1988-1991 are from J.L. Pirkle et al., The Decline in Blood Lead Levels in the United States: The National Health and Nutrition Examination Surveys (NHANES), JAMA 272:284-291 (1994); data for 2013-2014 are from U.S. CDC, Fourth National Report on Human Exposure to Environmental Chemicals: Updated Tables, January 2017, Volume One (2017). Mean blood levels were only reported for the 1976-1980 period (National Center for Health Statistics, Blood Lead Levels for Persons 6 Months – 74 Years of Age: United States, 1976-1980, Advance Data from Vital and Health Statistics No. 79 (May 12, 1982)). Mean levels for 1988-1991 and 2013-2014 were calculated from the lognormal distributions described by the sources cited above.

[65] U.S. CDC data for 2013-2014 do not include the fraction of people exceeding 5 µg/dL, but it must be much lower than 5% given the fact that the 95th percentiles for all individuals and for young children are both less than 3 µg/dL.

[66] L.F. McClure et al., Blood Lead Levels in Young Children: US, 2009-2015, J Pediatr 175:173-81 (2016). Data are for all children <6 years old, May 2013-April 2014.

[67] U.S. EPA, The Benefits and Costs of the Clean Air Act, 1970 to 1990 (Oct. 1997).

[68] *Id.* Although the EPA monetized the benefits of reduced lead exposure – almost $2 trillion dollars over the 1970-1990 time period in 1990 dollars – we focus here on health endpoints rather than the economic value of those endpoints.

[69] *Id.* at Appendix G. EPA did not provide an estimate of average IQ loss directly, but this value can be calculated in two ways. First, EPA did provide the underlying relationship between mean blood lead levels and IQ loss – 0.25 points per µg/dL. This can be used to calculate the mean IQ difference between 1976-1980, when mean childhood blood lead levels were 16 µg/dL, and 1990, when mean levels were 4.62 µg/dL (see Table 1). A blood lead decline of 11.38 µg/dL corresponds to an average IQ gain of 2.8 points. Alternatively, the number of children aged 0-6 in 1990 (25.6 million) can be divided by seven (to account for the seven age-years in the 0-6 age range) and then divided into the total number of IQ points saved (10.4 million) to arrive at a mean IQ gain of 2.8 points.

[70] *Id.* at ES-4 and G-34 – G-35.

[71] *Id.*

[72] *Id.* at G-34 – G-35. Table ES-1 on page ES-4 appears to include an error; the average of the two methods used to calculate coronary heart disease in Table G-9 and G-10 on pages G-34 – G-35 is 10,555 cases.

[73] *Id.* at ES-4 and G-34 – G-35.

[74] *Id.* at G-2 – G-8 (EPA methods); U.S. Census Bureau, American FactFinder, Single Years of Age and Sex: 2010, 2010 Census Summary File 1 (population statistics for 2010); blood levels as shown in Table 1 of this report.

[75] Needleman, *supra* note 43, at 28 (2000).

[76] Specifically, the 1973 regulation required gasoline retailers to sell some unleaded gasoline, required motor vehicle manufacturers to attach "unleaded gasoline only" labels to new motor vehicles, and established nozzle size requirements that made it impossible to fill new cars with leaded gasoline. U.S. EPA, Regulation of Fuels and Fuel Additives, Final Rule, 38 Fed. Reg. 1,254 (Jan. 10, 1973).

[77] Bridbord and Hanson, *supra* note 44, at 1196 (2009).

[78] U.S. Energy Information Administration, February 2017 Monthly Energy Review, Table 3.7c Petroleum Consumption: Transportation and Electric Power Sectors, Motor Gasoline Consumed by the Transportation Sector (Feb. 24, 2017), http://www.eia.gov/totalenergy/data/monthly/index.php#petroleum. The average 2016 daily use of gasoline was compared to the averages for 1980 and 1990.

[79] U.S. Census Bureau, 2010 Census Urban and Rural Classification and Urban Area Criteria, https://www.census.gov/geo/reference/ua/urban-rural-2010.html (showing that the U.S. population was 80.7% urban in 2010); U.S. Census Bureau, 1990 census of population and housing: Population and unit counts, Table 4 (1993), http://www.census.gov/prod/cen1990/cph2/cph-2-1-1.pdf (showing that the U.S. population was 73.6% urban in 1970).

[80] See discussion in Section 4 of this report.

[81] R.L. Canfield et al., Intellectual Impairment in Children with Blood Lead Concentrations below 10 μg per Deciliter, N Engl J Med 348:1517-26, 1518, 1523-1524 (2003) (using adjusted overall changes in IQ in relation to lifetime average blood lead levels).

[82] U.S. EPA, The Benefits and Costs of the Clean Air Act, 1970 to 1990, at ES-5 and G-1 (Oct. 1997).

[83] S. Levin, Environmentalists sue EPA for reversing Obama-era move to ban pesticide, the Guardian (Apr. 4, 2017).

[84] Letter from the American Academy of Pediatrics to EPA Administrator Scott Pruitt regarding "the agency's recent reversal on its proposal to revoke tolerances for chlorpyrifos" (June 27, 2017).

[85] Revised HHRA, *supra* note 1, at 5.

[86] *Id.* at 3; U.S. EPA, Chlorpyrifos, https://www.epa.gov/ingredients-used-pesticide-products/chlorpyrifos.

[87] Revised HHRA, *supra* note 1, at 8 – 10.

[88] *Id.* at 12.

[89] *Id.* at 3, 8 – 10.

[90] *Id.* at 6; *see also* J. Sass, Experts Support EPA Proposed Ban on Chlorpyrifos (NRDC, Jan. 17, 2017), https://www.nrdc.org/experts/jennifer-sass/experts-support-epa-proposed-ban-chlorpyrifos.

[91] Revised HHRA, *supra* note 1, at 6 – 7.

[92] *Id.* at 6.

[93] *Id.* at 7.

[94] O. Milman, Pesticide that Trump's EPA refused to ban blamed for sickening farm workers, the Guardian (May 17, 2017).

[95] The EPA proposed a rule that would ban ("revoke all tolerances" for) the use of chlorpyrifos in November, 2016. U.S. EPA, Chlorpyrifos; Tolerance Revocations; Notice of Data Availability and Request for Comment, 81 Fed. Reg. 81,049 (Nov. 17, 2016).

[96] Associated Press, EPA chief met with Dow Chemical CEO before deciding not to ban toxic pesticide (June 27, 2017).

[97] Letter from the American Academy of Pediatrics to EPA Administrator Scott Pruitt regarding "the agency's recent reversal on its proposal to revoke tolerances for chlorpyrifos" (June 27, 2017).

[98] D. Henry, States join lawsuit over EPA pesticide decision, The Hill (July 6, 2017), http://thehill.com/policy/energy-environment/340899-states-join-suit-over-epa-pesticide-decision.

[99] S. Levin, Environmentalists sue EPA for reversing Obama-era move to ban pesticide, the Guardian (Apr. 4, 2017).

[100] https://www.epa.gov/ingredients-used-pesticide-products/chlorpyrifos

[101] Ethyl Corp. v. EPA, 541 F.2d 1, at 25 – 26 (1976).

[102] *Id.*

[103] T. Cama, Dem: Trump's EPA pick gave answers 'shockingly devoid of substance,' The Hill (Jan. 26, 2017), http://thehill.com/policy/energy-environment/316246-dem-epa-pick-gave-answers-shockingly-devoid-of-substance