EXECUTIVE SUMMARY

The Social Costs of Lead[1]

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Individual people make up a society, and seemingly small influences on who those people are and how they behave can have a large influence on the society as a whole. Lead is a toxin with far-reaching effects. A vast literature in neurotoxicology, epidemiology, and psychology shows that exposure to lead can adversely affect health, impair neurobehavioral and cognitive functioning, and lead to antisocial behavior. What do these effects add up to at the societal, even global, level? Granted, one could argue that we are "done with lead" – that governments have finally listened to public health advocates, and lead has been removed from paint, gasoline, and water pipes. But this is not the whole story. Yes, we have made great progress, and yes, lead is out of most paint and fuel in the United States. But much of the lead that was used before these policies were in place is still around in houses, soil, and water. And there are still new sources of lead in the United States, and more substantial sources of lead globally in countries that have not yet successfully pursued aggressive public health policies. So

[1] Author's note: This work is preliminary and in progress. Please pardon any omissions. Comments are welcome.

lead is not gone. Moreover, as we learn more about lead, the full picture of lead's wide-ranging negative effects – even at low and moderate levels – is taking shape.

This presentation discusses the societal costs of lead. The question addressed is:

> *What would we save as a society if, instead of the current blood lead distribution in the United States, every child's blood level were less than 1 μg/dl?*

This analysis builds on a robust literature. In this presentation, I summarize the existing literature and then attempt to bring it together into a coherent framework – using a consistent approach, filling in gaps, and trying to capture everything. This effort is not without challenges. First, lead's effects are wide-ranging. It is difficult to articulate all of them. Second, the scientific or other empirical evidence on some of these effects is thin or mixed. It can be difficult to choose or estimate the appropriate dose-response relationship. Third, lead's effects may interact or overlap. Our understanding of mechanisms is limited, and one must be careful to assess the full effects without committing errors of double-counting on one hand or omission on the other. Fourth, there are numerous choices to be made. Beyond just what to include and how, there are choices of lead ranges, distributions, data sets, discount rates, and valuation. All in all, these challenges are substantial. They are also par for the course for an ambitious "what if?" analysis of this sort. Scholars have responded to these challenges in diverse ways. I hope to learn from their efforts and work towards a thoughtful and reasonable assessment of lead's societal burden.

In order to compare apples to apples, I transform social cost of lead estimates into a uniform basis. As stated above, I compare two scenarios: A) The status quo lead distribution circa 2005-2010 vs. B) A hypothetical lead distribution in which all children have lead close to zero, or below 1 μg/dl. I do this for a single hypothetical birth-year cohort of U.S. children, born circa 2010. I gradually widen the net for the set of effects to be considered. Existing papers have made careful choices about whether to include particular effects; by putting effects in step by step I hope to clarify the significance of those choices to the final estimates. Thus, the set of lead effects included is gradually expanded from those for which there is a broad consensus to those with more tentative results.

The first set of effects is on cognitive performance and earnings potential. These effects have been included in almost all analyses of the costs of lead, including the earliest ones known

to this author (see Schwartz (1994), Landrigan et al (2002), Grosse et al (2002)). The methodology is now relatively standard: applying the state-of-the-art estimates of lead's effect on IQ to the existing lead distribution, and then multiplying the lost IQ points by a well-regarded estimate of the earnings value of an IQ point. Missing IQ points are responsible for the lion's share of costs in most analyses. Note that some studies also include direct costs for educational interventions such as special education, while others choose to capture the effect with the single endpoint of lifetime earnings.

The second set of effects is those on social behavior – encompassing juvenile delinquency and crime – but also including teen pregnancy and substance abuse. Crime and delinquency effects have been included in some more recent analyses (see Gould (2009), Muennig (2009), Korfmacher (2003)) but not in most earlier analyses; even in the cases in which they were included they have generally been included only partially. The methodology here is more varied, but usually draws on some estimate of a lead-delinquency or lead-crime slope, and then applies standard costs of crime (including direct and possibly indirect costs). I will extend this methodology to include other behavioral outcomes (e.g. teen pregnancy, smoking, and substance abuse) using results from my ongoing analysis of the National Longitudinal Surveys of Youth. Including a wider range of behavioral effects substantially increases the importance of these costs.

The third set of effects is those on health – both child health and adult health. While direct effects on child health such as the direct costs for treatment of lead poisoning have been included in some analyses (see, e.g., Gould (2009) and Korfmacher (2003)), for the most part existing work has respectfully declined to quantify both the broader health effects for children as well as the longterm health effects for adults. I endeavor to include costs for adverse effects on infant health as well as adverse effects on cardiovascular, renal, and respiratory health. The methodology I will employ is to draw on the literature to assess the effect of lead on a particular morbidity or mortality outcome, then convert this effect into quality adjusted life years (QALYs) and in turn into a monetary equivalent. Whenever QALYs are at stake and are worth $100,000 to $150,000 each, values can get quite large, making it important to be clear about all assumptions in this calculation.

A fourth set of effects is not included: what an economist would call the *general equilibrium effects* on society as a whole. That is, all of these effects on cognition and behavior

may interact in ways that make them add up to more on a societal scale than they do individually. This could happen, for example, if societal-level effects created social unrest or adversely affected the performance of the government, the economy, or society as a whole.

I conclude that the social costs of lead, the costs of inaction, are substantial, amounting to approximately $50,000 per person, or $200 billion for a single birth-year cohort. But what are the costs of action? Such estimate is not the focus of the current presentation, but it should suffice to say that those costs are much smaller, by a factor of 10 or more. This analysis echoes the conclusion of previous assessments: however the calculation is done, the social costs of lead are very large. By the usual standards of policy effectiveness, lead policy should be a no-brainer.

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