scientific or policy activities against the corporate interest. AJPH

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The Lead Battery: A Growing Global Public Health Challenge

We are accustomed to thinking of lead as yesterday's problem, whether it is from the past use of lead in gasoline, paint, or pipes. In most of the world, however, the use of lead is largely unregulated, and most countries still manufacture lead paint and other lead-containing products. Few people realize that both lead mining and the production of recycled lead are growing. Most of the lead produced is now going into making lead batteries.

Lead battery production accounts for 90% of lead consumption, and its use for this application continues to increase despite the overwhelming scientific evidence documenting the effects on human health even at extremely low levels (on.doi.gov/2oNTGAx). The industry, and global mine production, has more than doubled since the 1990s and is expected to continue its rapid growth to meet demand for more vehicles, solar and wind power, and backup power for computer server farms and cell phone towers (http://www.ila-lead.org/news/lead-in-the-news/2012-11-30/significant-growth-in-lead-usage-underlines-its-importance-to-the-global-economy) Even hybrid and many electric vehicles require larger lead batteries than do conventional automobiles.

PUBLIC HEALTH AND ENVIRONMENTAL IMPLICATIONS

Although air quality regulations governing lead emissions in the United States have tightened in recent years, the industry has shifted to countries with weaker regulations and few resources for enforcement. Most countries still rely on antiquated standards or sometimes no standards at all.

A review of the literature published from 1993 through 2010 outlined the disparity in emissions and exposures between plants in the United States and the European Union and those operating in low- and middle-income countries.[1] The review concluded that workers in the lead battery industry outside the United States and the European Union had approximately three times higher blood lead levels than did their US counterparts. In addition, airborne lead levels inside lead battery plants were seven times greater than were the levels permitted by the US Occupational Safety and Health Administration.

Lead poisoning affects both adults and children, but at low levels lead affects the developing brain, resulting in IQ deficits, lower school performance, and behavior problems. Adults with lead exposures experience higher blood pressure—a risk factor for cardiovascular diseases, including stroke and myocardial infarction. Lead is responsible for 674 000 deaths a year, primarily because of the chronic effects of high blood pressure.[2] In response to our growing understanding of the health impacts of low-level exposures, the US Centers for Disease Control and Prevention has lowered the action level for children to five micrograms per deciliter.[3] At least 240 million people around the world are exposed above this level.[4] At the same time, we know that even lower exposures have a direct impact on educational opportunity, and there is no known level without deleterious effects.

The removal of lead from gasoline has often been called the greatest public health success of the past century.[5] In the past, contributions from lead in gasoline and paint were generally all that mattered in assessing and controlling an individual's exposure. Paradoxically as we have become concerned about reducing lead exposures to even lower levels, the number of sources of concern has grown as all exposures contribute to the body burden. Now we recognize that public health efforts must continue vigilance to control these sources while also addressing all remaining exposures from water, air, soil, dust, and paint to make further progress in eliminating lead poisoning. In most countries this work is just starting.

Smelters, lead battery manufacturers, and recycling plants emit airborne lead particulates that contribute to environmental contamination of soil and dust in surrounding areas. Communities as diverse as Los Angeles, California; Philadelphia, Pennsylvania; Mombasa, Kenya; and Dong Mai, Vietnam continue to suffer the consequences of lead contamination from shuttered battery recycling plants, because few resources are available for any kind of cleanup. Soil contamination is perhaps the most significant source of chronic exposure and the single largest contributor to children's blood lead levels.

Further compounding the lack of adequate pollution controls in battery manufacturing and recycling is the life expectancy of the product itself. In the United States the average lead battery lasts for five or six years in a vehicle and even longer when used for backup power supplies. Lead batteries used in 200 million electric bicycles in China and hundreds of millions of cars and other vehicles around the developing world

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last for only one or two years before they are sold to a recycler and replaced.

Informal lead battery recycling is a common practice around the world that is associated with extremely high lead exposures and environmental contamination. To make matters worse, many small recycling plants, and all informal backyard recycling, produce lead that is of insufficient purity to make new lead batteries. Therefore smelters specializing in refining lead have to remelt the metal, and environmental emissions are compounded. Overall environmental loss rates during the life cycle of a lead battery in low- and middle-income countries are estimated to be up to one third by weight.[6]

RECOMMENDATIONS FOR IMPROVEMENTS

Regulatory actions and consumer demand in the United States can have direct implications for lead exposures around the world as the industry shifts to distant communities in other countries. We cannot sit back and watch as demand for telecommunications, cloud computing, and transportation continues to grow without considering the enormous public health and environmental costs. Nor can we wait for new battery storage technologies to emerge and eventually take over.

We must work with industry to reinvent lead battery manufacturing and recycling for the 21st century to improve these extremely hazardous industries, invest in new plants, and develop the capacity for lead poisoning prevention programs around the world. Companies relying on lead batteries can take an active role in bringing improvements to this hazardous enterprise. Vehicle manufacturers, telecommunications companies, Internet server farms, and the photovoltaic solar industry rely on this technology and should come together to develop and support minimum standards for manufacturing and recycling lead batteries. In the United States, three major lead battery users, including IBM, Sprint, and AT&T, have agreed to voluntarily stop exporting used lead batteries to countries with weaker standards.

In 2016, the United Nations Environmental Assembly adopted its first ever resolution addressing the growing public health threat from lead battery recycling. The resolution noted "the lack of adequate infrastructure needed to recycle the rapidly growing number of waste lead-acid batteries" and "the need to further reduce releases, emissions and exposures."[7] With this framework in place it is time for government, industry, and global public health funders to take up this challenge to address the enormous public health and environmental costs of this industry.

First, we must develop capacity in all countries to better assess this public health challenge and develop local strategies to respond. Governments must implement regulations to specifically address lead emissions, take-back programs for used lead batteries, and specific siting and licensing criteria for operating smelters, lead battery manufacturers, and recyclers. These policies must encourage consolidation by mandating minimum size plants, as China has, because only the largest facilities can justify the required capital expenditure for adequate pollution control equipment. At the same time, these plants should be required to set aside funds for their eventual closure and off-site remediation.

We must also build the local capacity to test for blood lead levels in all countries and foster research into identifying exposure sources. Global health funders, including private foundations and government agencies, can take an active role in funding these efforts. AJPH

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