LEAD Action News vol 10 no 3, June 2010 ISSN 1324-6011
Incorporating Lead Aware Times (ISSN 1440-4966) & Lead Advisory Service News (ISSN 1440-0561)
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Lead in China, pesticides, cancer & vision: plus lead test kit videos - the work of a Summer of interns

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USA Bald Eagles Die from Lead Poisoning

Around 30 bald eagles have died in Iowa as a result of lead poisoning, and the figure may be as high as 200. The highly endangered and heavily protected birds ingest lead when they eat mammals shot with lead ammunition or fish tainted by lead tackle.

New YouTube videos on The LEAD Group's DIY-Sampling lead test kits

Intern Adrian Widjonarko produced and uploaded the following You Tube videos:The LEAD Group - Introduction of Lead Poisoning and DIY Sampling Kit, at www.youtube.com/watch?v=85H0FGV5qCU&feature=channel
Lead Poisoning DIY Lead (Heavy Metal) Test Kit Instruction - Part 1/2, at www.youtube.com/watch?v=s4WzzUcBdCg&feature=channel;
Lead Poisoning DIY Lead (Heavy Metal) Test Kit Instruction - Part 2/2, at www.youtube.com/watch?v=VVbB8wcglV4&feature=channel
Lead Poisoning DIY Lead (Heavy Metal) Test Kit Result, at www.youtube.com/watch?v=L25RTdpKdRo

Lead Poisoning News from China, January 2010

Compiled by Natalie Newman, Intern

China's poor track record of lead poisoning due to factory pollution continues, with news recently of 55 children and 47 adults suffering lead poisoning in **Hekou village, Jiangsu**. The village is situated close to a lead-acid battery factory; there have now been six similar lead poisoning incidents in the past six months across the country.

January 2010 – Hekou, Jiangsu - Dafeng Shengxiang Power Supply Co Ltd

The factory at Hekou village had been operating at 160% capacity, but workers claim that managers were tipped off about visits from environment officers in advance, allowing them time to 'clean up' for the inspection. The government department in charge of organizing environmental checks has so far refused to comment.

Workers have been routinely treated for lead poisoning, and as long as treatment continued were willing to stay silent. They now fear their silence has lead to the hospitalization of village children. There are also concerns that doctors at Dafeng People's Hospital misrepresented the safe levels of blood-lead.

December 2009 – Qingyuan, Guangdong – Aokelai Power Co. Ltd, (Zeliang Battery Factory)

In December, a lead-acid battery factory near **Qingyuan, Guangdong**, was forced to shut down after 44 local children were found to have high blood-lead levels. The children were treated at the government's expense. The factory was situated less than 100 metres from a residential apartment building.

September 2009 – Shanghang, Fujian – Huaqiang Battery Factory

In **Shanghang, Fujian**, 121 children under 14 years of age were found to have excessive blood-lead levels. Local parents say their children have been suffering from symptoms since a battery factory opened in 2006. (Huaqiang Battery Factory). Residents protested for four days, demanding government officials close down the factory, increase testing and pay compensation to affected families.

August 2009 – Wugang, Hunan – Wugang Manganese Smelting Plant

Parents and police violently clashed in August in **Wugang, Hunan** after 1,956 children were found with high blood-lead levels, due to the close proximity of a manganese smelting plant to a school. Fifteen residents were detained for rioting and protesting over the smelter, which had been operating for a year without environmental approval. The owner of the factory turned himself into police, after claims were made that he had abused his position as Deputy to the People's Congress to illegally run the smelter. Two government officials were also investigated.

August 2009 – Fengxiang, Shaanxi – Dongling Lead and Zinc Smelting Co

Following the discovery in August that 615 children were affected by lead poisoning, 11 officials from Fengxiang, Shaanxi, were reprimanded for failing to protect the local environment. The suspected source was a smelting factory, the manager of which has now resigned. Local villagers will be relocated from the area over the next two years.

August 2009 – Kunming, Yunnan – car exhaust emissions (cited cause)

Near Kunming, Yunnan, 200 of 1000 children tested were found to have high blood-lead levels, with three children confirmed as suffering from lead poisoning. Parents blame a nearby industrial park, but the environment bureau claims that other factors, such as exhaust emissions, are the real cause.

In total, 3000 children have been affected across China in the six months prior to January this year.

In all of these cases, final decisive action came only when high numbers of children were found to have excessive blood-lead levels. Yet, local residents had complained for months and even years about sickness, pollutants, sewage, bad smells and dust. China's expansive and swift economic rise has seen local governments, keen to attract businesses and investors to their area, willing to ignore environmental and health concerns. Often, lead-acid battery factories and smelting factories aren't considered "major" polluters, and environmental checks can be less strictly enforced. Manganese smelters illegally use anode slag, which contains lead.

Environmental protection agencies are funded by local governments, which are not keen to ensure the agencies are funded well enough to do their jobs. Lack of staff training and poor resources mean that environmental agencies simply cannot be on top of every environmental disaster waiting to happen.

Even when environmental concerns are considered, the local government's response is usually to find sites suitable for factories, and then relocate villagers to other areas. But this doesn't always solve the problem, as villagers still till fields and raise crops in areas very close to polluting factories. In a country with more than a billion people, the profit margin is placed ahead of people's health. But with a growing environmental consciousness, Chinese people are starting to protest, not just for their health, but for the future of their children.

Northwest and Central China is rich in metals, which require large factories to process.

It is often a requirement for factories to help local families to relocate within a certain timeframe. But in most cases, only a small percentage of families are actually moved by the specified time, and the rest cannot afford to do so on their own.

In August 2009, at the height of the poisonings, the Ministry of Environmental Protection (MEP) called on the country to fight heavy metal pollution, yet the Ministry of Propaganda asked news outlets to play down the poisoning stories in the lead-up to the National Day holidays. But the government is finding it increasingly difficult to ignore the mass protests and riots by ordinary citizens concerned about the health of their children, their farmlands and their future.

More recently, Environment Minister Zhou Shengxian released a paper calling on the need for China to move towards an "ecological civilization":

> Ecological civilization is the summary of physical, spiritual and institutional achievements of human beings when they develop and utilize natural resources while taking initiatives to protect nature and actively improve the relations between man and nature. Traditional industrial civilization leads to the conflicts between man and nature, and imposes a serious threat to the survival and development of mankind itself. Adhering to the idea and requirement for sustainable development, ecological civilization makes overall arrangement of the relations between environmental protection and economic growth in terms of human civilization.

(Actively Develop Ecological Civilization--Published in Qiushi Magazine by Minister Zhou Shengxian, 10-12-2009. Source: http://english.mep.gov.cn/)

The Implementation Plan on Controlling Heavy Metal Pollution was passed in principle by the MEP on Aug 28. It demands joint measures by all the relevant departments to avoid further pollution, yet to be approved by State Council.

"On September 29, 2009, MEP announced that it would - along with eight (8) other ministries or bureaus** - commence a three-month nation-wide campaign to investigate enterprises that involve significant amounts of heavy metals (lead, cadmium, mercury, chromium and arsenic) in production, storage or transport processes." - http://switchboard.nrdc.org/blogs/awang/more_heavy_metal_mania_another.html

In a case of double-speak: "When asked by China Daily whether it is safe to build waste incineration plants in residential areas, Zhang said incinerators will not affect people's health or pollute the environment if they are built according to government guidelines." http://websearch.mep.gov.cn/was40/detail?record=11&channelid=24398&searchword=heavy+metals Antidote to Poisoning Polluters, 2009-09-28

"It's quite obvious that just to say the company has not been found by regulatory agencies to violate standards, which I assume are concentration standards, is not enough," said environmental activist Ma Jun, referring to a case in Shaanxi province where a local environmental bureau said smelter owner Dongling Group had met emissions standards.

"It's quite obvious that the environment cannot absorb the volume," Ma said. He recommended restrictions on total volume of emissions, not just the level of emissions.

(China calls for action to stop lead poisoning, www.reuters.com/article/idUSSP56473)

New factories and smelters are subject to stricter environmental controls, but ones that have been operating for years are harder to regulate. However; as massive power shortages across China were forcing smelters to shut down until the end of February, this may have allowed time to address environmental concerns.

http://sg.news.yahoo.com/rtrs/20100118/tbs-henan-power-lead-7318940_1.html

http://news.alibaba.com/article/detail/metalworking/100164940-1-update-1-china-widens-lead-industry.html

In the USA, Website Acton reports that the cost of testing toys for lead in has forced some small manufacturers to move their business offshore, while increased scrutiny of Chinese made products has had some factories opting to swap lead for cadmium. There are calls in the US to strike a balance between the need to ensure products are free from dangerous heavy metals and the needs of small businesses to have transparent cost-effective compliance codes.

Read more: http://catholicexchange.com/2010/01/14/126055/

Editorial: The work of a Summer of Interns

In this newsletter it was decided to draw special attention to the work of interns.

The noun “intern” began by meaning an assistant resident physician or surgeon in a hospital, there to gain experience after graduating in medicine. Now it also has the wider meaning of a person with academic training in a particular technical area, gaining work experience with an appropriate organization – such as The LEAD Group or the Global Lead Advice Service. The group who wrote this newsletter worked over the university summer vacation.

You will notice that only three of the authors have an Anglo-Celtic or European name. The other names indicate a Chinese, Indian or African origin.

This variety of names reflects the large number of overseas students now studying at Australian universities, since Australia set out to compete as a provider of higher education for the Asia/Pacific area.

This newsletter, appropriately enough, focuses on the problem of lead poisoning in mainland China. China is a giant in more ways than one. In relation to lead, three problems stand out: frenetically-fast industrial development, often riding roughshod over local populations and paying insufficient attention to the safety of workers and local residents; a legal system not always able to deal with corruption at the local level, and millennia of agricultural, waste disposal and other practices that have added lead to the soil of agricultural land and to the water supply. India and Africa have some of the same problems. Thanks to the work of interns and volunteers, we are trying to do our bit to help.

At the end of May 2010, Elizabeth O’Brien met a Chinese researcher at the first meeting of the Global Alliance to Eliminate Lead in Paint, held in Geneva under the auspices of the World Health Organisation and the United Nations Environment Program. This researcher is planning a study to further pinpoint the sources and pathways of lead poisoning in China. We hope that some of the articles in this newsletter will make a useful starting point. China does after all, have the world’s largest lead-poisoned population under one government.

Prevalence and pathways and sources of lead poisoning in China

By Kobe He, Tony Yan, Ewan MacAulay McDonnell, and Elizabeth O’Brien, The LEAD Group Inc, Australia

Is Lead a problem in China? What is the evidence?

China is, at 1.32 Billion, the world's most populous nation (CIA World Factbook). However, in a World Health Organization report, only 31,000 deaths are estimated as due to lead poisoning in the region that includes China. Either lead is not a major health issue in China, or the deaths are under-estimated by WHO. The evidence listed below shows that it is probably more likely the second reason (Fewtrell, 2009).

Blood lead levels of people in China - Studies conducted

One study shows that 202 Chinese women tested in 4 different major Chinese cities had, on average, blood lead levels of 5.67 micrograms per decilitre (µg/dL), which is equivalent to 56.7 micrograms per litre (µg/L). By comparison, Japanese women had levels of 3.21 µg/dL (32.1 µg/L). The report concluded that the source of contamination was food and air. (Zhang et al 1997)

In 1996, Shen et al summarised that seventeen publications have reported elevated blood lead levels in children from different areas of China. Lead levels tested in children residing in busy and heavily trafficked areas in the PRC (China), showed blood lead (BPb) levels of a staggering 21.8-67.9 µg/dL. The percentages of BPb values above 10 µg/dL - which is the 1992 World Health Organization's definition of lead poisoning in children - ranged from 64.9% to 99.5%. Even for 'unexposed' children, about 50% of them had BPb values above 10 µg/dL (Shen et al, 1996). Air pollution is out of control in China as a result of rapid industrialisation. When this summary was written in May 1995, lead was still used in petrol. Leaded petrol was officially phased out in 2000. (Xiao, 2008)

Another study shows that for children 1-5 years of age in Wuxi City, the average blood lead level was 8.2 µg/dL (0.40 µmol/L); 27.3% had blood lead levels above10 µg/dL, and 1.0% had blood lead levels above 20 µg/dL. Blood lead levels were particularly high in industrial areas, suggesting an air pollution link again. (Gao, 2008)

A 2008 study shows that Chinese men have higher lead levels for some reason (possibly from a higher prevalence of smoking among men than women); even men who don't have an occupational reason for higher lead exposure. The average in Jinan City, Shandong, in 1991 was 9.23 µg/dL for non-smokers to 12.34 µg/dL for smokers (Qu, 2004). According to The China Post, (7 June 2010), smoking rates in China are 574% for men and 2.6% for women.

Newborn babies can be born with high lead levels, as lead is transferred from their mothers. A study of the blood lead levels of newborn babies was conducted in Shanghai in 1993 (Shen et al, 1993). In 348 cord samples, the geometric mean of cord BPb levels was 9.2 µg/dL, with a 95% confidence interval of the mean 8.86-9.54 µg/dL. 142 babies (40.8%) had cord BPb levels of 10 µg/dL or greater. Among the likely sources, foodstuffs such as Pidan (preserved Duck egg) is reputed to have a high lead content, and is eaten by pregnant women. This is old research, suggesting that the lead content, with China's increasing industrialisation, is probably even greater now, 15 years later.

One example that has gained national attention is a factory near Xinsi. In an isolated village in the mountains of China's western Gansu province, BPb levels in the children were found to range from 30.4 to 79.8 µg/dL. (Oster and Spencer, 2001).

"The World Health Organisation (WHO) estimates that globally, lead poisoning accounts for 229,000 deaths from cardio-vascular disease (CVD) per year. In China, 38.5% of children and 31.8% of adults are estimated to have more than enough lead exposure for an increased risk of early death by heart attack or stroke." (WHO, 2003).

A more recent study (2006), "Blood lead levels in Children, China" which combines the data from a number of blood lead studies, states that blood lead levels in children on average are now 9.29 µg/dL and 33.8% have blood lead levels above 10 µg/dL. The worst affected province was Shanxi, where levels were recorded as high as 17.25 µg/dL on average. There was a linear relationship found in Shanghai of lead attached to particles in the air and blood lead levels (Wang and Zhang, 2006).

In China, where is the lead contamination coming from?

Food (via Soil contamination)

It is common to use effluent as a fertiliser in China. This results in accumulation over time, within fields, of heavy metals.- cadmium, chromium, copper, nickel, lead and zinc (Cd, Cr, Cu, Ni, Pb and Zn). The longer fields have been subject to effluent irrigation the higher the level of heavy metal accumulation (10/04/08) (Xiong). This could be a possible pathway for

higher than average lead blood levels, for instance in agricultural workers. It may also be plausible, if lead works its way up the food chain, those eating greater quantities of meat would have a higher blood lead level - but this is speculation.

"Heavy metal accumulation in soils at three field sites subject to effluent irrigation." (Xiong, 2003).

RESULTS AND DISCUSSION: In soil, the average contents of Cd, Cu, Pb and Zn are 0.097, 22.6, 26.0 and 74.2 mg/kg, respectively. In the water of the Yangtze River Basin, the concentrations of Cd, Cu, Pb and Zn are 0.080, 7.91, 15.7 and 18.7 microg/L, respectively. In reference to human activities, the heavy metal pollution comes from three sources: industrial emission, wastewater and solid waste. The environment such as soil, water and air were polluted by heavy metals in some cases. The contents of Cd, Cu, Pb and Zn even reach 3.16, 99.3, 84.1 and 147 mg/kg, respectively, in the soils of a wastewater irrigation zone. These contaminants pollute drinking water and food, and threaten human health. Some diseases resulting from pollution of geological and environmental origin, were observed with long-term and non-reversible effects. CONCLUSIONS: In China, the geological background level of heavy metal is low, but with the activity of humans, soil, water, air, and plants are polluted by heavy metals in some cases and even affect human health through the food chain.

Eating lead-contaminated foods

Lead contamination of food is more common in third world countries that do not have strong food standards. It has recently become an issue in countries that have been importing food products from such countries. Food can become contaminated where it is grown, or by cooking vessels or the containers in which it is exported or stored.

There are a number of ways in which lead contamination of food occurs. The most common way has been during the growth and development of plants grown in soil containing an unusually high amount of lead. The plant surfaces become contaminated with dust or soil, or the plants may take up the lead from the soil as they mature. Lead contamination of food can and does occur even in commercial farming. The lead contamination of soil occurs when lead, lead dust, biosolids (sewage sludge), fertilisers made from waste acids from lead smelters or any liquid containing lead is introduced to the soil. [China is a very heavy user of biosolids in agriculture] see: Giblin, A., Lead in

Eating Rice as a source of lead poisoning:

Lead can be emitted during the mining and smelting of mercury ores, because most such ores also contain lead. Lead is also emitted during the burning of coal. Researchers in Guizhou province, where there are 12 large mercury mining and smelting operations and heavy coal-powered industry, found that rice accounted for 94-96% of the uptake of methyl mercury (Raloff, 2010). They were not testing for lead, but it is likely that the rice was also a source of lead in the diet.

Methyl mercury averaged 9.3 micrograms of this especially toxic mercury per kilogram of rice in an area where people down an average of more than a half-kilogram of the grain each day (Raloff 2010).

"Heavy metal pollution in China: origin, pattern and control." (Cheng, 2003)

Water

Evidence within the China Sea shows a huge increase in lead content of sea sediments. "…in the wake of China's rapid economic growth and the lack of management regulations, the

Hangzhou Bay is being contaminated by lead, among other pollutants, at a rate three times faster than the worst case in the western seaboard of U.S. three to seven decades ago. To halt this alarming trend and avert the possibility of serious contamination to the coastal environment, regulatory measures such as sewage treatment and the phasing out of leaded gasoline should be mandated urgently." (Huh and Chen 1999)

The lead contamination is believed to have come from rapid economic growth and a lack of waste control practices. The main source is the Yangtze river, indicating that this catchment is receiving high levels of Pb. It follows that anyone consuming water or food from this area is also receiving high levels of lead. (Huh and Chen, 1999)

Wastewater from rivers near industrial sites near the city of Guiyu have lead levels 400 to 600 times higher than wastewater from uncontaminated river would. Waste management rules are poor or non-existent (Brigden et al, 2005)

A study of a lake in eastern Qinghai province did not display excessive levels of lead content. However, the lake is in the less-industrialised west of China. (Virkutyte and Sillanp, 2006)

An additional study confirms that there are large amounts of lead particulates being deposited into the East China Sea, from where they are being transported (via a Biogeochemical cycle) throughout the world. (Lin et al, 1999).

Exposure to Lead from Leaded Gasoline (Petrol)

Leaded petrol was used in China up until 2000. (But see below: "doubt about the actual phase-out date") Exposure to the lead from leaded petrol is usually through airborne particles, for adults, and via dust ingestion by children, in hand-to-mouth activity, particularly those living in houses and other buildings alongside heavily-trafficked roads.

An EVISA 2006 news article about a meta-analysis of childhood blood lead studies in China found:

Lead petrol phase-out:

> While most industrial nations, including China, have abandoned or at least restricted the use of leaded gasoline, this is not the case for all parts of Asia and Africa.

What is happening?

> Children living in urban or industrial regions (in particular in eastern China) had much higher levels of lead than those living in rural areas. The figures from meta-analysis of AAS and ICP-MS results contrast sharply with those of western counterparts, who have much lower lead levels on average.

Doubt about the actual phase-out date of leaded petrol for all road vehicles in China

In February 2003, the International Fuel Quality Center (IFQC) reported in *Current Status of Leaded Gasoline Phase Out Worldwide* that "even though leaded gasoline has been switched out in many Asian countries, it is most probably still available in small quantities in some "unleaded countries." For example in China, some small refineries exist in rural areas that produce leaded gasoline. Also, smuggling of leaded gasoline is also present and cannot be completely dismissed. It can be assumed, however, that these quantities are very small. Most of the leaded gasoline is probably used in remote rural areas where it is out of reach of the government statistics."

Other sources and pathways of lead poisoning in China

People in China, of course, are likely to be subject to the other sources and pathways of lead poisoning known to the rest of the world, namely: soil and dust containing lead (a legacy of industrial manufacturing, smelting and mining activities and leaded paint refurbishment), ceramics with a leaded glaze, leaded paint, recycling of lead acid batteries and electronic equipment with parts containing lead, water from tanks with lead solder, water from galvanised iron pipes or lead soldered plumbing, leaded PVC products, leaded jewellery, toys, ammunition, lead contaminated Chinese herbal medicine, cigarettes, etc.

Conclusion

What the evidence from water catchments in the more industrialised parts of the China shows is that there is a clear link between lead contamination of the environment and industrial activity. Coal use in China is rising steadily and it should be noted that coal naturally contains lead. Spectrographic analysis of particulates in Shanghai indicated that up to 45% of such lead may come from coal burning, and may well have exceeded petrol as a source if not for the phasing out of leaded petrol (Zhang et al 2009). In all probability the source of lead contamination is airborne particles, in which form lead is far better absorbed than when orally consumed, but that does not rule out food and drinking water as additional pathways, since, though leaded petrol for road vehicles was officially phased-out in China in 2000, there seems to be an upward trend in blood lead levels.

See also above: "Lead Poisoning News from China **and "**The Global Problem of Lead Arsenate Pesticide**," and below, "**Government action on lead poisoning in China**".**

See also: "Biosolids used as fertilizer in China and other countries**", in LEAD Action News, volume 10, number 1.**

Dangerous polluters are already moving their activities out to rural areas where rules and regulations are weaker. This will mean that while there will be an ongoing unusually high amount of blood lead in subjects in city areas and that rural areas where there are strong sources of lead contamination will also have abnormally high levels.

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Information in Chinese about lead

The US Environmental Protection Agency's Chinese website includes a factsheet on general information regarding lead paint in the United States at:www.epa.gov/lead/pubs/chance_chinese.pdf and www.environment.nsw.gov.au/resources/chinese.pdf

With encouragement from The LEAD Group, the New South Wales Health Department some years ago wrote an article about the dangers of lead in ceiling dust in ceiling voids (the space above the ceiling and below the roof). Are Chinese homes generally built with ceiling voids? If so, then the Chinese version of the article may be of interest: please see www.mhcs.health.nsw.gov.au/mhcs/publication_pdfs/5395/BHC-5395-CHI.pdf

The English version is at www.mhcs.health.nsw.gov.au/mhcs/publication_pdfs/5395/BHC-5395-ENG.pdf

Government action on lead poisoning in China

A factsheet by Kobe He, Intern, The LEAD Group Inc, Australia, February 2010

Attempts of Chinese governments to prevent and manage lead poisoning

Smelters have been shut down for environmental checks

At least three lead smelters in Henan province, and two in Shanxi province, with a combined capacity of more than 6% of China's annual production, were ordered to temporarily halt operations in recent days after hundreds of children tested for high levels of lead in two separate cases in August (Yam, 2009).

Promised testing and medical treatment for lead-poisoned children

Officials announced to concerned residents that all children in Qingyuan would be given access to blood testing and prompt treatment to address the growing problem of lead poisoning. Qingyuan, located next to an industrial park containing a battery factory, shocked health and environmental officials earlier this year when blood testing of about 50 families revealed 44 children with elevated blood lead levels, including one ten-month old with a level as high as 55 μg/dL, several times above the safety limit for blood lead levels (Greenlaw, 2009).

Measurements from announcement of the Central government

In response to the Fengxiang and Wugang incidents, China's Ministry of Environmental Protection (MEP) approved in principle a draft "Implementation Plan for the Comprehensive Handling of Heavy Metal Pollution," on August 28, 2009. One month later, on September 29, 2009, MEP announced that it would – along with eight other ministries or bureaus– commence a three-month nation-wide campaign to investigate enterprises that involve significant amounts of heavy metals (lead and cadmium etc.) in production, storage or transport processes (Greenlaw, 2009).

Guangzhou Maritime Court orders tannery to pay 62,500 RMB in compensation

The Dongtai tannery in Panyu District of Guangzhou was ordered to pay 62,500 RMB in compensation for damages from several incidents of illegal waste water release in 2008, bringing another environmental public interest litigation case to a close. The factory's illegal discharges were uncovered by investigators in July 2008 following complaints from local residents about red-colored water. The Panyu District procuratorate then brought the case before the Guangzhou Maritime Court, arguing that the tannery was responsible for thousands of yuan in damages to local agriculture, ecology, and public health (Greenlaw, 2009).

Chinese minister calls for action to stop lead poisoning

China's environmental protection minister has called for more effective measures to tackle heavy metal poisoning, state media said on Thursday, as anger grows amongst parents with children poisoned by lead. China, which has already set a target of closing 600,000 tons of outdated lead capacity in the next few years, plans to send inspectors to major lead producing provinces for environment checks, industry sources said (Chan, 2009).

Action required by the government in China for children's elevated blood lead levels

The following paragraphs are taken from a document published by MOH (Ministry of Health) China (9th Feb 2006), [with minimal editing, for clarity. Ed].

Diagnosis and classification

Plumbism and lead poisoning in children, high lead blood lead levels of children should be the basis for diagnosis. High lead plumbism: two consecutive blood lead level of 10 ~ 19.9 μg/dL [micrograms per tenth of a litre]; Plumbism: two consecutive blood lead levels equal to or greater than 20 μg/dL; and based on blood lead levels were divided into mild, moderate and severe lead poisoning. Mild lead poisoning: blood lead level of 20 ~ 24.9 μg/dL; Moderate lead poisoning: blood lead level of 25 ~ 44.9 μg/dL; Severe lead poisoning: blood lead levels equal to or greater than 45 μg/dL;

Regulations for Children: Plumbism

Children with high blood lead levels should be managed for lead poisoning at medical and health institutions qualified to conduct such treatment. Medical personnel should assist in the process of complying with environmental interventions, health education and treatment utilizing the basic principles of removing lead from patients' bodies, help identify lead sources of pollution, inform the children's guardians as soon as possible regarding the sources of pollution from lead; give health guidance that is suitable for various situations, explain how nutrition helps to correct lead poisoning. Children should be treated appropriately and in a timely manner.

Doctors are advised to carry out blood lead testing on children diagnosed with learning difficulties and autism

(In the United States, in just one of many strategies to achieve the US national Healthy People target, set in 2000, that no child between the ages of 1 to 6 years in the US should have a blood lead level higher than 10 μg/dL by 2010, all state and local health departments were, on 7th August 2009, recommended to increase the rate of blood lead screening of at-risk children under 6 years of age. In some government agencies in the US, the follow-up (search for sources) blood lead level has been set at 5 μg/dL. For instance, "Understanding Your Child's Lead Test" by the Oregon Department of Human Services (DHS), states: "parents should take steps to identify possible sources of lead in their child's environment in order to prevent any further exposure" [if the blood lead level is 5 μg/dL or higher] (O'Brien and Xu, 2009).)

Give central environmental officials stronger authority and resources to step in when local governments fail to regulate

To break up local protectionism, China's central environmental authorities need sufficient legal authority and resources (human and financial) to intervene in a sustained way in areas where local governments fail to fulfill their legal duties. The MEP's authority should be expanded (even beyond its recent elevation to full ministry status). Such a move would be critical in addressing the types of heavy metal incidents that have been filling the headlines in recent months.

Tie government officials' career prospects more closely to reduction of heavy metal pollution

China has had relatively good success with its total emissions control (TEC) system, which for now sets volume reduction targets for emissions of sulfur dioxide and chemical oxygen demand (COD), a measure of water pollution. Part of its success is the incorporation of pollution reduction targets into government official job evaluations. This has the impact of focusing the minds of officials, even at the lowest levels of the system. This is one of those systems with "unique Chinese characteristics" and its strengths should be harnessed in the name of controlling heavy metal pollution as well.

Disclose emissions to the public

This is perhaps the simplest measure government can take to help reduce pollution. Information disclosure can assist overburdened enforcement officials by driving enterprises to reduce their own pollution, empowering the public to monitor local polluters and providing other stakeholders (like banks and corporate purchasers) with the tools to channel business away from bad environmental actors. China has already moved in this direction, and expanding use of information as a regulatory tool is low-hanging fruit for pollution reduction.

Establish serious penalties for data falsification and illegal operations

When companies provide false data to the government, this weakens the very foundation of the environmental regulatory system. Yet, penalties for lying to the government and obstructing inspections are extremely low (capped at around US$7,000 in China's water pollution law, with no criminal penalties, for example). There should be criminal liability for intentionally lying about environmental data or obstructing government inspection work. Moreover, many enterprises often begin operations without going through basic registration and environmental impact assessment procedures. This makes it more difficult for authorities to regulate these entities and leaves some of the worst polluters out of the scope of environmental regulation. Stronger penalties and enforcement authorities (such as the ability to attach personal liability to company officials) should be put in place for such behaviour.

Ramp-up the monitoring network

There is an urgent need to establish an effective ambient air monitoring network for pollutants with ambient air quality standards. Without a monitoring network continuously measuring air quality in population centers and near priority pollution sources, the air quality standards in place provide little protection to those who most need them. In addition, the monitoring data will provide an important check against fraudulent pollution reports that may be filed by large emitters. China has already invested much in this and is planning to expand its nation-wide monitoring network. The need to ramp-up quickly is more urgent than ever now.

Develop a comprehensive approach to responding to pollution incidents

The response to pollution incidents should be expanded to incorporate the full-range of tools for reducing health risk from heavy metal pollution, including human and environmental sampling, emergency response activities, environmental remediation, exposure reduction, and human health protection measures. These tools should be established on the polluter pays principle, but provide the resources for governmental agencies to act immediately and seek reimbursement later if the polluter is unwilling or unable to react immediately and responsibly. China is using some, but not all, of these tools now and work can be done to make the response system more robust and more standardized around the country.

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The Global Problem of Lead Arsenate Pesticide

By Chido Mpofu, Intern at the Global Lead Advice and Support Service (GLASS), run by The LEAD Group, Sydney Australia, 13 January 2010.

Photo: Courtesy Dr Venkatesh Thuppil

Background

Arsenical insecticides have been used in agriculture for centuries. Records show that arsenic sulfides have been in use since A.D 900 in China. Lead arsenate was first prepared as an insecticide in 1892 for use against gypsy moth (*Lymantria dispar*) in Massachusetts, USA. Initially, lead arsenate was prepared by farmers at home. Over time, it was refined and marketed as basic lead arsenate [$Pb_5OH(AsO_4)_3$] for use in certain areas in California, USA, and acid lead arsenate [$PbHAsO_4$] for all other locations (Peryea, 1998).

The use of lead arsenate insecticide was an internationally accepted practice adopted because of its effective control of insect pests and its low phytotoxicity [phyton: Gr= plant], compared to its contemporaneous alternatives (Peryea, 1998).

Lead arsenate insecticide was used in many countries , including Australia, Canada, New Zealand and the USA. It was used for insect pests on apples and other fruit tree, garden crops and turf grasses, on rubber and coffee trees and for mosquito abatement in cattle dips. (Peryea, 1998).

Termination of the Use of Lead Arsenate in the USA and Australia

The use of lead arsenate was terminated in early 1950s in Massachusetts, USA, in New York and other States in the mid 1960s, and in 1984 in Washington State. All insecticidal uses of lead arsenate in the USA were officially banned on 1 August 1988 (USEPA, 1988), with a comment that all registrations for insecticidal use had lapsed before that date.

In Australia, use of lead arsenate decreased after the introduction of DDT in 1950, and it has not been used on exported crops since 1983 (Peryea, 1998).

How exposure to lead arsenate is possible

Many of the lead arsenate-contaminated sites occur in former rural locations that are undergoing urbanization, particularly residential development. A variety of remediation strategies have been employed or proposed, including removal of contaminated topsoil by excavation, and encapsulation by maintaining a continuous grass turf surface. Keeping lead arsenate-contaminated soils in orchard production effectively limits human exposure to lead arsenate, because the fruit doesn't generally contain significant concentrations of lead or

arsenic. In the days of early settlement of Australia, market gardens existed in what is now a town or city centre, or on the fringes. The implication of this is that people buying land or a house in one of these areas should investigate the history of the area, to see if it once had market gardens.

Exposure to lead arsenate pesticides in former orchard soils involves contact with the bare soils.

Some common activities that may increase exposure are:

- Gardening or digging in the soil,
- Children playing in contaminated soil (particularly if not washing after play),
- Eating without first washing hands and face after digging in soils, and
- Eating unwashed vegetables grown in the soils.

(Reference: Wisconsin Department of Health and Family Services)

Health Problems Caused by Lead Arsenate

The symptoms which follow oral exposure include severe gastrointestinal damage resulting in vomiting and diarrhea, and general vascular collapse leading to shock, coma and death. Muscular cramps, facial edema, and cardio-vascular reactions are also known to occur following oral exposure to arsenic (EPA, 1986)

General recommendations to Avoid Exposure (Prepared by the Wisconsin Department of Health and Family Services)

Sampling orchard soils

- Soil sampling should be conducted when an agricultural property changes to other land use (e.g. farmland changed to a residential development or park).
- For properties already redeveloped, sampling can be focused in areas where contact with the soils is expected (e.g. children's play areas or gardens).

Limit Access to Contaminated Soils

- Cover any exposed or bare soil with grass, vegetation or other surface material (e.g. gravel or pavement).
- Bring in clean sand for sandboxes; and soil from a non-orchard area for gardens.
- When developing new residential areas in former orchards, plan landscaping so the top six inches of original soil is covered beneath cleaner soils.

Minimize Exposure

When contact with soils cannot be avoided, some basic habits will significantly reduce exposures and related health concerns:

- Wash hands and face after touching soil and before meals and snacks.
- Wash fruits and vegetables from your garden before eating. Uptake of arsenic and lead by plants is less of a concern than eating produce with soil stuck to it.
- Keep toys and pacifiers clean when used outside.
- Avoid tracking soil into the home and clean up right away if it happens.

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How does lead exposure affect our eyes?

By Daisy Shu, Optometry student, University of New South Wales, Australia, Jan

Introduction

Lead exposure is known to disrupt a myriad of body processes due to its toxicity to our vital organs, particularly our bones, heart, kidneys and nervous system[1]. However, there has been scarce research into its effects on vision, a fundamentally cognitive process. Due to the direct association between our eyes and the central nervous system (CNS), there is no doubt that the ability of lead to hinder the development of the nervous system will inevitably affect our vision. Studies have shown that lead exposure can result in a reduced sensitivity of rod photoreceptors[2], blurred vision[3] and irritated eyes[4] as well as an increased susceptibility to cataract[5] and optic neuritis[6]. Interestingly, although high concentrations of lead exposure are detrimental, a recent study[7] has elucidated the beneficial effects of small amounts of lead in preventing and treating eye disease. [Photoreceptors: A nerve ending, cell, or group of cells specialized to sense or receive light. www.answer.com Rods are not sensitive to colour, unlike cones, but are many times more numerous than cones, and more sensitive to light.]

Scotopic visual deficits

Human vision is brought about by the photoreceptors of the retina, namely the rods and cones. Cones are responsible for vision under high light levels whilst scotopic vision, which is vision under dim lighting, is mediated by the rods. Fox and Katz[2] conducted an electrophysiological study on rats, revealing long-term changes in the sensitivity of rods following low and moderate lead exposure (peak blood lead of 19 and 59μg/dL, respectively)[2]. Electroretinographic (ERG) observations show that such alterations are present at the level of the retina. They found an increase in rod outer segment (ROS) calcium, a decrease in rhodopsin content (photopigment found in rods) per eye and reduced rod sensitivity in the dark adaptation function suggesting that rods are directly and selectively influenced by lead[2]. Evidently, lead can severely affect the ability of our eyes to function under dim light conditions, particularly in adapting to the dark.

The development of the CNS and retina occur during gestation in humans and hence lead exposure during this period can have a detrimental effect[2]. A study on rhesus monkeys by Bushnell et al[8] revealed that lead exposure of 85 μg/dL during the first year of life impaired visual discrimination under dim lighting compared to their performance under bright light.

Although the study was conducted on animals, the data has consequences for children exposed to high lead levels during development. It has been suggested that temporary blood lead levels in the vicinity of 200 μg/dL early in life and chronic exposure at 85 μg/dL subsequently can cause similar impairments of scotopic vision in humans[8].

Lead intoxication induces a harmful, chronic impairment of the vision needed under dim lighting, a condition known as night blindness[8] and it has been proposed that this may occur via damage originating from the brain. Rods are quite poorly represented at an area of the brain responsible for vision, called the visual cortex, as there is much less neural tissue dedicated to processing its information compared to the cone photoreceptors[8]. Since lead induces brain damage via demyelinisation[8], which is the loss of the myelin sheath around nerve fibres, deficits in the visual system will be likely to appear first in rod-mediated vision.

Susceptibility to cataract

Cataract is a clouding of the crystalline lens of the eye, causing an obstruction in the passage of light to our retina. Schaumberg et al[5] found that cumulative lead exposure can increase the risk of age-related cataract. They measured bone lead levels in the tibia and patella of a selection of men aged 60-93 years old (mean age of 69) from Boston[5]. It was found that men with the highest levels of lead in the tibia (7.78 ± 4.85 μg/dL) had a greater than 2.5-fold increased risk of cataract compared to men with the lowest tibia lead levels (4.49 ± 2.65 μg/dL)[5]. After controlling for age, the approximated attributable fraction of cataract in this population due to lead exposure was 42%[5].

Lead has been found to be present in lenses with cataract in various studies[9]. It is thought that the invasion of lead into the lens may alter its redox status and cause conformational changes in protein, hence reducing lens clarity[9]. Lead is known to disrupt glutathione metabolism in the lens[9] and raise the protein-bound glutathione and cysteine content[5]. Moreover, lead can hinder the biological balance of calcium in our system, that is, the calcium homeostasis, which is vital in maintaining lens transparency[9]. Evidently, many studies reveal that lead may be present at higher concentrations in cataractous lenses compared to transparent lenses[5, 9-11]. [redox: a reversible chemical reaction in which one reaction is an oxidation and the reverse is a reduction. The Free Dictionary]

Other visual symptoms

Since ancient times, lead poisoning has been found to cause damage to the visual system and even blindness in humans and animals[6]. These effects are collectively termed as “optic atrophy” or “blurred vision”, appearing only in cases of lead poisoning severe enough to cause brain damage[5]. The importation of lead in wine-making, cookery, and jewellery into Rome’s aristocracy circa 150 BC may have contributed to its ultimate ruin and decay[6]. Classical authorities on medicine at the time described symptoms of deteriorating eyesight due to optic neuritis, which is an inflammation of the optic nerve[6]. Moreover, lead was also found to potentially result in amaurosis which is the loss of sight due to disease of the optic nerve or brain without pathology of the eye itself[6].

More recently, lead exposure has been implicated in ocular neuritis in children which rends them either visually impaired or permanently blind[12]. Gibson found that cases of optic neuritis were often accompanied by an increased intracranial pressure which seemed to directly irritate the optic nerve head[13]. Hence he coined the condition as “ocular plumbism” believing it to be due to swelling rather than inflammation[13]. Lead-induced blindness, albeit a now rare and often transient phenomena, can be quite startling, emphasizing the burden of lead on our well-being.

Other visual symptoms have been documented, including strabismus and double vision noticed in a child with lead poisoning in a public health report on Queensland children[14]. ["Strabismus: a condition in which the eyes do not point in the same direction. It can also be referred to as a tropia or squint." www.answer.com]

It has been suggested that the increased intracranial pressure induced by lead exposure can also cause paralysis of the external recti [straight] muscles involved in eye movement[12]. This may contribute to strabismus, and consequently, double vision, due to the lack of fixation of both eyes on a target.

Tetraethyl lead is a compound more commonly encountered in occupational conditions where it is used as an anti-knock compound in petroleum, including leaded Aviation Gasoline or AvGas[3]. Exposure to tetraethyl lead can cause symptoms of redness and pain in the eyes, as well as blurred vision[3]. Moreover, it can irritate the eyes and result in a potential loss of vision[4].

Vision-related cognitive deficits

Various studies suggest that cumulative lead exposure is related to many chronic disorders of aging, including cognitive decline[5]. A study conducted by Shih et al measured tibia lead levels using ^{109}Cd-induced K shell X-ray fluorescence (XRF)[15]. Subjects were then required to complete a series of tests including those related to hand-eye coordination, visual memory and visuoconstruction[15]. It was found that higher tibia lead levels significantly correlated with poorer vision-related cognitive functioning[15]. ["Visuoconstruction abilities involve the coordination of fine motor skills with visuospatial abilities, usually in the reproduction of geometric figures. This domain looks not only at the individual's aptitude for copying a figure, but how well planned and organized that figure is. Individuals who have difficulties with visuoconstruction and spatial abilities often struggle with daily tasks such as arithmetic, driving, and writing." www.advancedpsy.com/visuoconstruction_abilities-page-25.html]

Prevention of lead-induced damage to the eyes

Lead contamination is widespread in our environment, primarily due to leaded petroleum and lead-based paint, causing practically every adult to have amassed some degree of lead in their system[5]. In industrial settings, avoiding lead exposure of pregnant women, adolescents and children is particularly crucial[3]. Other preventative measures include avoidance of generation of mists[3] [e.g. liquid droplets of an acid in the sulphuric acid works of a lead smelter], adherence to strict hygiene rules and implementation of eye wash fountains in the immediate work area[4]. Eye protection such as splash and impact resistant goggles as well as face shields is also necessary[4]. It is advised that contact lenses should not be worn when working with tetraethyl lead[4].

Prevention of the lead-induced visual disorders remains an important public health goal, and can only be achieved by reducing the distribution of lead in our environment. Through public health campaigns and the enforcement of stringent lead contamination policies, the burden of lead can be significantly reduced.

Treatment

Cataract is commonly treated by surgery which involves removing and replacing the opaque crystalline lens with a plastic intraocular lens (IOL). In Australia, expenditures for cataract surgery cover the largest single line item in the Medicare budget[5], revealing the serious financial burden which lead has contributed to.

Other causes of cataract: "There is some evidence that long-term exposure to sunlight, tobacco, and heavy alcohol consumption may be associated with cataract formation. Some research suggests that people who have a low dietary intake of fruits and vegetables, vitamin

C and E and betacarotene are also at higher risk of the disease. Systemic diseases such as diabetes and vascular disease may increase the risk of cataract development, as may eye injury or the use of

some medications, including corticosteroids."
www.health.gov.au/internet/eyehealth/publishing.nsf/Content/commonprob

Treatment of irritated and red eyes includes the application of lubricant eyedrops.

Beneficial effects of lead

During Egyptian antiquity, lead-based compounds were used in cosmetics, particularly in kohl, used to outline eyelids[7]. Analytical chemistry has revealed that two lead chlorides, laurionite and phosgenite, were manufactured to form fine powders found in eye lotions and makeup[7]. Contrary to modern beliefs of the toxicity of lead, the study suggested that "submicromolar concentrations" of lead ions may play a role in promoting the action of our immunological defences[7].

By studying the consequences of a "submicromolar concentration" of lead on human keratinocytes, lead ions were found to increase the "oxidative stress response[7]." Lead ions stimulated the production of nitric oxide (NO), an essential messenger in our innate immune system which communicates with immune cells such as macrophages and enhances the capillary blood flow for more white blood cells to migrate to the site of infection[7].

It was suggested that such small dosages could prevent diseases such as bacterial conjunctivitis[7]. However, bacterial conjunctivitis is usually self-limiting and current treatment involves antibiotic eye drops and ointments. Although lead does amplify the immune response, it is only effective in small amounts, so careful stoichiometric analysis should be implemented if it is to serve as a potential therapeutic agent.

Conclusions

Although progress has been made in limiting lead exposure in industrialized countries, most individuals have already accrued a considerable body burden of lead[5]. Further research into the effects of lead on vision is particularly beneficial, especially considering the recent finding of accumulated lead exposure as an unrecognised risk factor for cataract[5]. As the leading cause of global blindness and visual impairment[16]. [As proof of this, the national eye health awareness campaign of the Australian Dept of Health and Aging, quoted from above under "other causes of cataract", does not mention lead exposure as a cause of cataract.]

Research suggests that reduction of lead exposure could help decrease the global burden of cataract. Future investigations into the potential of decreasing the risk of cataract may involve prompt treatment of lead poisoning using chelation therapy. Furthermore, the selective rod deficits resulting from lead exposure during gestation and in perinatal development[6] should help raise greater concern for the need to limit foetal and childhood lead poisoning.

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Fact sheet on lead and cancer

By Subothini Srikaran, Volunteer Researcher for the Global Lead Advice and Support Service

What is lead?

Lead is a main-group element (known to occur in nature) with an atomic number eighty two and the symbol Pb. It is one of the "heavy metals" (of high relative atomic mass), is one of the softest and weakest of the commonly used metals, is a poor conductor of electricity, has a low melting point and resists acid corrosion. Its colour is variable. For instance, when it is freshly cut, it has a bluish-white colour; on exposure to air it has a dull, greyish colour, and when it is melted into a liquid has a shiny chrome-silver lustre. *(1)*

Background on Cancer

Cancer, also known as malignant neoplasm, is a group of diseases where a class of cells shows uncontrolled growth, invasion and sometimes metastasis (spread to other sites in the body). In contrast, benign tumours are self-limited which do not invade or metastasize. *(2)*

Association between lead exposure and cancer

According to Lundstrom et al, lead exposure expressed as three different indices was not recognized as a risk factor for lung cancer. The studies of lead-exposed workers referred to in this article illustrate different findings concerning the development of lung cancer. Mainly, the elevated incidences of lung cancer in lead smelter and battery workers are moderate and could be explained by confounding factors not accounted for. Some studies are limited by

small number of participants. Most of the studies are complex because of multifactorial exposure and due to deficiency of detailed information about individual exposure to lead and to other exposures in the working environment. Most of the studies also lack information regarding dietary and smoking habits. Furthermore, five other studies have not demonstrated elevated risks for any malignancies in lead-exposed workers. Authors of this paper conclude that, according to the findings in previous studies and their nested case-referent study, there is insufficient evidence to support occupational exposure to inorganic lead and lead compounds as a possible risk of lung cancer in humans. *(3)*

Wong et al found a significant mortality from *stomach* cancer in the cohort study. However, the elevation of stomach cancer mortality derived from the analyses of the cohort and the nested case control study did not seem to be related to lead exposure. Wong et al also observed a small, statistically significant mortality increase from lung cancer. However, they suggest that the small increase- in the absence of an exposure response relationship - could be because of confounding as a result of smoking, and probably not causally related to lead exposure. Although there was a significant increase in the cancer of the thyroid and other endocrine glands, few deaths, deficiency of data about potential confounding factors, and the deficiency of reporting of a similar elevation in other studies highlight the requirement to perceive this finding carefully. In addition, they did not find an increase in mortality from lung cancer, bladder cancer, cancer of the central nervous system or lymphatic and hematopoietic cancer *(4)*.

Steenland et al suggest that, according to animal studies, lead is not genotoxic invitro. However it is said to promote the mutagenicity of other mutagens, perhaps through inhibition of DNA repair. [A mutagen is also likely to act as a carcinogen: Hutchinson, Dictionary of Science, 1194]. For example, early animal studies have shown that lead causes cancer in animal studies, mainly kidney cancer in two species through various routes of administration. For instance, they found that lead acetate and lead oxide acted synergistically to elevate kidney and lung tumors respectively, after administration of known carcinogens (nitrosamines, benzo(a)pyrene.) *(5 & 6)*. Lead acetate was used in most of these studies because of ease of administration, given orally, subcutaneously, or intraperitoneally, generally at high doses. In contrast, most human exposure to lead is through lead oxides or inhalation of lead fumes. However, the compounds used in the aforementioned animal studies are all inorganic lead compounds, so if the blood lead level (in humans) is comparable to the levels in the studies then we could extrapolate these findings to humans. The authors suggest that in the eight studies with high exposures the evidence is rather indicative of a link with lung cancer and stomach cancer, but remains restricted. Perhaps confounding by arsenic is a concern in the study with the highest lung cancer relative risk. Also, there is weaker evidence of an association with kidney cancer and gliomas *(7)*

"There is some evidence showing that lead may cause cancer, but this evidence is weak. Most of the evidence linking lead exposure and cancer comes from studies of workers with high levels of occupational (work-related) exposure to inorganic lead. People who have worked in heavily lead-exposed industries have been found to have blood lead concentrations of 40 to 100 micrograms per deciliter (mcg/dL). In comparison, in 1991, the average blood lead concentration in US males in the general population was 4 mcg/dL (10 mcg/dL is considered a low lead level)."

"A recent report in the literature suggested a link between occupational exposure to lead and brain cancer."

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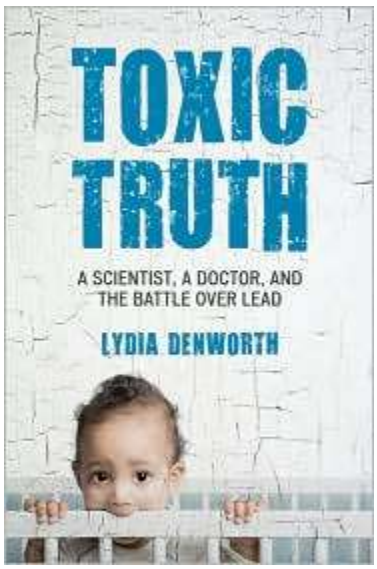

Book: "Toxic Truth: A Scientist, A Doctor, and the Battle over Lead"

by Lydia Denworth, Published by Beacon, 2008

Editor's note: This is not a paid advertisement by the book publishers. A LEAD group researcher has pronounced it "a great read", but has not (yet) written a review.

Text of back cover:

"Toxic Truth is an engrossing and inspiring story of how two courageous men shone the clear light of science on industry's effort to conceal the harm to our children–and to all of us - by lead in the environment."

-**Philip** and **Alice Shabecoff** authors of

Poisoned Profits: The Toxic Assault on Our Children

"Toxic Truth is a Compelling and Forceful portrayal of the lives and pain of these two remarkable scientific pioneers. An impressively researched and well-documented book, it is an astonishing chronicle of one of the most insidious and avoidable health problems of our time."

Dr. Devra Davis, author of

When Smoke Ran Like Water: Tales Of Environmental Deception and the Battle against Pollution

"Before most Americans had given a thought to lead poisoning, a geochemist named Clair Patterson and a passionate doctor, Herb Needleman, were learning just how widespread it was, and how damaging. Their work set the framework for the future examination of man-made toxins, and their scientific and political struggles for the truth set a pattern for future

battles between industry and advocates over the significance of toxics. With plenty of gritty details. Lydia Denworth tells the story of these two giant lead–killers, shedding light on the foundations of a key issue in public policy."

Arthur Allen, author of

Vaccine: The Controversial Story of Medicine's Greatest Lifesaver

"In *Toxic Truth*, Lydia Denworth has pulled off a rare feat: she's written a true page-turner, animated by a fascinating medical mystery, that's also a nuanced and immensely thoughtful look at how good ideas can overthrow orthodoxy – and ultimately make the world a better place."

Steven Johnson, author of

The Ghost Map: The Story of London's Most Terrifying Epidemic - and How It Changed Science, Cities, and the Modern World

"The 'unearthing' of the problem of children's injury from environmental lead, by intrepid researchers such as Needleman and Patterson, makes for an intriguing chronicle. The pitfalls and challenges they encountered at every step, their persistence in the face of extraordinary attacks, are instructive for others who pursue the truth with the courage of their convictions."

Dr. Alan Woolf, Director

Pediatric Environmental Health Center at Children's Hospital, Boston, and Associate Professor of Pediatrics, Harvard Medical School

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