Legacy of Lead in Gasoline

Case Study:
60 Years of Adding Lead to Gasoline

Brian S. Schwartz, MD, MS
Summer EH

Brush With Death: A Social History of Lead Poisoning
by Christian Warren
2001

The Nation, March 20, 2000
Legacy of Lead in Gasoline

Overview
• “...a story of corporate greed, hired scientists, complaisant government and flouting of the public interest.”
• “...the tactics used by the corporations profiting from leaded gasoline in suppressing and obfuscating objective scientific investigation and averting government action would become a model for subsequent polluters and sellers of harmful products, such as asbestos, tobacco, pesticides, nuclear power, and genetically modified food.”
• ...and global climate change

Kitman J.,

Tetraethyl Lead
• Lead atom with covalent bonds to a tetrahedral arrangement of ethyl groups.
• The C-Pb bond is weak.
• With combustion, C₂H₅ radicals are released which help propagate the combustion process.
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Metals

- Elemental
  - Zero valence state
  - Metallic
- Inorganic
  - Several cationic valence states
  - Examples – Pb$^{2+}$, Hg$^{2+}$, Hg$^{+}$
  - Variety of anions
- Organic
  - Covalent bond to carbon
  - Examples – TEL, MeHg, organotins, organoarsenicals

Minamata: ataxia, dysarthria, spasticity, constricted visual fields, cognitive dysfunction, emotionality

Putman. National Geographic, 1972
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Lead Use in Early History

• Ancients considered lead “father of all metals”
• Many uses: face powders, rouges, mascaras, paint pigments, spermicide for birth control, abortifacient (killed women even to early 1900s), manufacture of chastity belts, sweet and sour condiment for seasoning, wine preservative, pewter household items, coins, piping
• Latin for lead = plumbum | plumbing | plumbism
• Lead poisoning was common in Roman Empire; some believe crazy behavior of some emperors (e.g., Caligula, Nero, Commodus) due to chronic lead poisoning
• Many early descriptions of lead poisoning
• Extensive use expanded throughout world; by 1900s U.S. leading producer and consumer

Put TEL in the gas tank.

Inorganic lead comes out the tail pipe.

Pb++
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Early TEL History

• Pre-1920s: Highly competitive U.S. automobile industry, dominated by Ford Motor Co. and Model T, small, plain car

• 1922: General Motors, which had interlocking directorship with DuPont Chemical Co., produces larger, powerful cars - require more efficient fuels

• GM workers realize that addition of TEL to gasoline raises the compression and speed by reducing engine "knock"

*now ExxonMobil
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**Kettering (1876-1958)**
- Head of GM’s research division
- Champion of leaded gas
- Contributed to Sloan-Kettering Cancer Center

**Midgley (1889-1944)**
- 1921, learned about TEL
- “Father of Ethyl gas”
- Recognized huge profit potential of TEL
- Defended safety

“By 1929 General Motors had passed the Ford Motor Company to become the leading American passenger-car manufacturer. By 1941 it was making 44% of all the cars in the United States and had become one of the largest industrial corporations in the world. GM Director of Styling David Holls: ‘Before 1927, Cadillac was a good, solid, substantial car. After 1927, the cars had style and elegance.’ ”

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Early 1920s

• Scientists warn of hazards of lead, TEL
  – Pb^{++} will be distributed widely in the environment
• DuPont & GM ask US Bureau of Mines to conduct study of health hazards
  – Worried about skepticism if in-house study
  – Demands publications & press releases be submitted for "comment, criticism, approval"
• Feb 1923: TEL placed on sale

What Did Industry Know?

• March 1922, Pierre du Pont (installed as GM President) wrote his brother - “TEL is a colorless liquid of sweetish odor, very poisonous if absorbed through the skin, resulting in lead poisoning almost immediately.”
• 1923, Midgley suffers lead poisoning while working with TEL.
• However, DuPont, GM, and Ethyl all denied early knowledge of TEL’s toxicity in later settings and hearings.
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Alternative was Available

- Alcohols were long recognized to be very effective antiknock agents.
- Kettering, 1918 - “It is now definitely established that alcohol can be blended with gasoline to produce a suitable motor fuel.”
- Ethanol - renewable, made from surplus crops and crop waste, relatively non-toxic, burned cleanly, could withstand high compression.
- Pressure put on GM Research to find patentable additive to increase profits; ethanol could not be patented.

The oil industry waged an anti-ethanol campaign. A 1933 pamphlet opposed a modest tax incentive for ethanol-gasoline blends.

http://www.runet.edu/~wkovarik/envhist/RenHist/1.biofuels1.html
1924

• Aug 1923: DuPont - TEL production at Chambers Works, NJ
  – 8/1923 - 10/1924: 4 deaths due to TEL
  – All original TEL workers had to be removed because of lead poisoning by 10/1923
• 2 workers die at GM research division
• DuPont & GM create Ethyl Corporation
  – Market, produce TEL
  – Ethyl VP called TEL the “gift of God”
• Another 17 refinery deaths (www.runet.edu)
1924

- July: GM writes AMA, prematurely - “research will show that TEL is safe”
- October: Standard Oil's labs in NJ
  - 5 workers die; 35 with severe poisoning
  - company doctor suggests to NY Times "nothing ought to be said about this matter"
  - "men ... went insane because ... worked too hard"
- Bureau of Mines concludes are no public hazards from use of TEL in gasoline

“Loony Gas”
New York Journal-American, 1924

Nine worker deaths were attributed to the "loony gas" at the Bayway plant in Elizabeth, NJ, and the Deepwater (Chambers Works) plant in Salem County NJ. Over 300 were poisoned.

“They died yelling.”
Dr. McCann, attending TEL workers in Ohio, 1924
1925

- TEL sales halted in many municipalities
- Public health outcry increases
- Emery Hayhurst, industrial hygienist at Ohio D of H, *AJPH* editorial board member, writes unsigned editorial for *AJPH* that proclaims TEL safe.
  - Impression that public health profession thought TEL safe
  - Was a paid consultant to Ethyl Corporation
- More deaths at Chambers Works
  - “House of Butterflies” - national scandal
  - Through May 1925, 480 of 1600 men poisoned

May 1925

TEL Conference in Washington

- Industry:
  - Industrial progress; all innovations involve risk; workers at fault for industrial tragedies
  - “… a little thing like industrial poisoning should not ... stand in the way of great industrial advance.”
- In private, industrialists concerned
  - Correspondence suggests those who favored TEL in gasoline were quite worried about their position
May 1925
TEL Conference in Washington

- Opposition:
  - Hazards of lead; burden of proof should be on industry; huge quantities of lead would be spread throughout the nation from automobile exhaust.
  - “… first consideration is the health of the people.”
  - Alice Hamilton vociferous opponent

Alice Hamilton
1869-1970
Died 3mo after passage of OSHAct

*First US woman to win Nobel Peace Prize (1931); prominent progressive, pioneer in settlement movement; leader in women’s suffrage; advocate for women & children, against social ills, for public health
Exploring the Dangerous Trades, Alice Hamilton, 1943

“In 1923-1924, … newspapers carried stories of a number of cases of severe lead poisoning among chemists and workmen who had been exposed to a new poison, tetraethyl lead, which was being produced … for blending with gasoline. This is a very dangerous form of lead, … it … concentrates in the nervous system… The New York World took up the crusade against this dangerous poison; there was widespread panic lest the use of the blended gasoline involve risk to the public …”

1925

• Agree to more studies; sale stops.
• Short-term, limited study of garage filling attendants in Dayton and Cincinnati.
  – Reveals TEL “safe,” but urges long-term government studies
  – Such studies were never carried out
• July: Robert Kehoe, eminent lead researcher & industry consultant, article in JAMA; article downplays hazards
  – Industry’s "hegemony through science"
Leaded gasoline goes on sale in Ohio in Feb., 1923. The octane boosting "Ethyl" additive was never tested for its impact on human health.

National Geographic, September 1927

“Ride with Ethyl in a high compression motor and get the thrill of a lifetime.”

Oddly salacious?
“Our continued development of motor fuels is essential in our civilization … Now, after 10 years research … we have this apparent gift of God which enables us to [conserve oil] … We cannot justify ourselves in our consciences if we abandon the thing.”

Frank Howard, VP Standard Oil, to US Public Health Service, May 20, 1925

“A Niagara of Ethyl Gasoline – over one billion gallons a year – now flows through the pumps bearing the Ethyl emblem.”

“That emblem means two things … [it’ll] ‘knock out that knock’ … [it] must conform to specifications … ”

National Geographic, April 1929

National Geographic, May 1930
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Later years

• 1925-1930: Five workers die at CW
• 1955: Growing awareness of environmental hazards of lead and childhood poisonings from paint
• Feb 1964: Kettering Lab lobbying:
  – “… probably has never been a poisonous product, which, in relation to its toxicity and the total volume produced and used annually, has had a better record, with respect to the rarity of illnesses associated with its handling and distribution.”

Robert Kehoe & Kettering Laboratory

“Kehoe and the Kettering Laboratory forged and defended a body of work that acknowledged some of lead’s dangers while maintaining its essential harmlessness.”

Four principles: lead absorption is natural, every human body contains some; body has mechanisms to cope with “natural” levels; below a “threshold” (80 µg/dL) no ill effects occur; the population’s exposure was much below threshold.
“A crucial lead-using industry [TEL manufacturers], with strong ties to the nation’s largest automotive and chemical concerns, acquired the power to define lead poisoning.”

Warren C. *Brush with Death*, p 132.

“Polluters and manufacturers of dangerous products have waged sophisticated campaigns to manufacture uncertainty about the scientific evidence used to support public health protection and victim compensation.”

“Doubt is our product” – Brown & Williamson tobacco industry executive
Neurobehavioural testing in workers occupationally exposed to lead: systematic review and meta-analysis of publications

M Goodman, N LaVerda, C Clarke, E D Foster, J Iannuzzi, J Mandel

Although the toxic effects of lead on the central nervous system have been well described, the blood concentration at which lead begins to exert adverse effects remains the focus of debate. A meta-analysis of occupational studies was conducted evaluating the association between neurobehavioural testing results and moderate blood lead concentrations.

CONCLUSION – “The data available to date are inconsistent and are unable to provide adequate information on the neurobehavioural effects of exposure to moderate [< 70 µg/dL] blood lead concentrations.”

With regard to funding, the authors note that they are mainly from the Exponent Health Group in Alexandria, Virginia, and Menlo Park, California; however, they fail to describe what motivated the study or sources of funding for the study. We believe this information would be of interest to scientists and policy makers engaged in work on this topic.

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References
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Similar Story: Lead in Paint

• 1897 - toxicity of lead for children first described in medical journal
• 1904 - key source -- paint flaking off a porch railing -- described in medical journal
• 1897 - toxic paint problem sufficiently well-understood; NYC manufacturer advertises "Aspinall's Enamel is NOT made with lead and is non poisonous."
• 1920 - Australia passed law curbing lead in paint (U.S. waited another 50 years).

http://dcworks.net/envhealth/Lead/advertising/adpics/
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Lead helps to guard your health

Paint book cover from Dutch Boy Paints, 1929

Lead paint was marketed to children

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Talisman Terry’s Energy Adventure coloring book

Hello, my name is Talisman Terry, your friendly Fracosaurus. I am here to teach you about a clean energy source called Natural Gas, found right here in the Twin Tiers!

(Twin Tiers are counties on both sides of NY-PA border)

Talisman Energy is Calgary-based natural gas exploration & production company
• Oklahoma Energy Resources Board spent $40M in past 20 years on K-12 education with a “pro-industry bent”
• Hundreds of pages of curricula, a speaker series and an afterschool program, all at no cost to taxpayers
• Similar programs in other states as well as national programs questioning climate change, all industry-funded
• Industry pays advertising and public relations strategists to develop the campaigns and materials
  - Same companies helped tobacco and other industries
• Exploits trusted relationship between student & teacher
• American Petroleum Institute started programs in 1940s; 100s of fossil fuel centric lesson plans are available to educators
  - Teachers incentivized to use materials
  - Students receive free, colorful books!
• No surprise: 1/3 of middle and high school science teachers question climate change; worse in Oklahoma
• Petro Pete! Freddy Fuelless! Oliver Oilpatch! Sammy Shale!

“You wouldn’t live today in a house without an adequate plumbing system. For without modern plumbing, sickness might endanger your life.

Lead concealed in the walls and under the floors of modern buildings helps to give the best sanitation.

Lead, therefore, is contributing to the health, comfort, and convenience of people today as it did when Rome was the center of civilization.

While lead is invaluable in assuring comfort and proper sanitation, its best-known and most widespread use is as white-lead in paint.”

— National Geographic, November 1923
Public Health Response

Lead Concentrations in Polar Ice of Northern Greenland

Lead Usage (tons) in Paint and Gasoline, 1920-90

Mean population PbB, 1965
~ 25 µg/dL

NHANES II
15-20 µg/dL
First US population estimates

Falling Consumption of White Lead; Rising Consumption of Leaded Gasoline
Public Health Responds

• 1971: Federal childhood lead screening
  – published in 1973 (NEJM) reveal excessive lead levels in 15-20% of inner city children
• 1970s: CNS effects in children (NEJM, 1979)
• 1977: 40-45% of confirmed childhood Pb cases not linked to paint

TEL Use Resulted in Significant Environmental Contamination

• AJPH, 1983: lead is concentrated and ubiquitous in inner-city soils in Baltimore
  – not explained by lead in paint on buildings
• EPA: 4-5 million metric tons of Pb from gasoline dissipated in environment and remain in dust, soil, and sediment
• ATSDR, 1988: 6M children potentially exposed to lead from gasoline and that 1.6M have BLLs that are too high
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Association Between IQ Scores & Blood Lead Levels in Children

Significance of IQ Deficit

6 pt. shift in mean

IQ Score

Subjects (x100,000)

“Impaired”

“Genius”

Occupational Legacy

• Tens of thousands of U.S. workers involved in production of TEL, 1923-1991
• Many died of acute TEL intoxication
• In 1989, OSHA cited DuPont for violations in Anti-Knocks Area at Chambers Works
  – Recommended several studies, DuPont RFA
  – We then applied for & obtained NIH funding
  – We did some studies over the next 15 years
  – We identified the cohort of workers who were ever employed in the Antiknocks Area
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Cumulative lead dose can be measured
- Tibia lead with $^{109}$Cd K-shell X-ray fluorescence

Selected Results
- *Neurology*, 1999. Cross-sectional study n = 543; tibia lead levels associated with lower cognitive test scores (e.g., executive function, memory, learning)
- *Neurology*, 2000. Longitudinal study; tibia lead associated with declines in cognitive function over time; lead effect almost as large as age effect
- *Environ Health Perspect*, 2001: the influence of cumulative lead dose on cognitive decline was **progressive** (Figure 1)
- *Environ Health Perspect*, 2002: GxE study; apolipoprotein E $\varepsilon$4 allele modified association of tibia lead with cognitive test scores; worse in $\varepsilon$4 carriers
- Suggested some of “normal aging” due to ubiquitous neurotoxicant exposure? (Figure 2)

How could lead do this?
Could a **persistent** structural lesion explain a **progressive** functional effect?

Phase II – structural MRI of brain

- Measure volumes of 3D pixels in the brain
- Add up into regions of interest (ROIs) or analyze pixel-by-pixel
Some Key Findings – Our Work

- **Tibia lead & structural MRI** *(Neurology 2006)*
  - ROI analysis: higher tibia lead → lower volumes (10/20 ROIs), from large to small (e.g., TBV, lobar GM & WM, others)
  - Voxel-wise analysis: confirmed ROI findings
  - WM lesions: higher tibia lead → increased prevalence & severity of WM lesions

- **Structure-function analysis**: ↓ brain volume → ↓ cognitive function *(NeuroImage 2007)*

- **Mediation analysis**: association of tibia lead with cognitive function mediated through brain volumes *(Am J Epidemiol 2008)*

Lead and Health

- Lead is one of the most widely distributed toxicants
- Studies of lead and health impacts: probably one of the largest published literatures of any toxicant
- Virtually every organ system
  - Central nervous system, peripheral nervous system, renal, cardiovascular, reproductive (male, female, fetus), bone
  - Some papers estimated ~18% of all cause mortality in U.S.
- In children, especially developmental, behavioral (including association with crime and incarceration), cognitive, and educational impacts; mild to moderate mental retardation in >0.6M children globally each year
- Many emerging issues: developing countries, lead in toys, crayons, traditional medicines (e.g., ayurvedic), water systems, urban renewal

Fixing the Problem

- 1962, GM & Standard sold Ethyl to the tiny Albermarle Paper Company, Richmond, VA, in first recorded leveraged buyout, with $200M borrowed money.
- Antitrust sentiment; Ethyl involved in nefarious activities with Nazis during WW II; air pollution concerns increasing; increasing concerns about lead burdens; protection from liability?
- In 1970, GM announced that catalytic converters would be in cars its by 1974; knew TEL business would not survive.

Phase Out

- 1969: TEL production peaks
- 1973: EPA issues first regulations on Pb in gasoline
  - Ethyl & DuPont sue EPA, vigorously fight phase-out
  - “Actual harm,” not “significant risk” must be shown
- TEL use declines, mean BLLs decline 75%
- ATSDR: 68M children over-exposed, 1927-1987
- 1985 EPA study: 5,000 annual deaths due to lead-related heart disease
- 1986: Primary phase-out completed
- CDC repeatedly lowers guidelines for child BLLs
As Countries Phased-out the Use of Lead in Gasoline, Blood Lead Levels in Children Declined

**United States**

**Sweden**

![Graph showing the decline in lead used in gasoline and average blood lead levels in the United States from 1976 to 1980.]

![Graph showing the decline in lead levels in Sweden following the phase-out of lead in petrol, 1976–2004.]

**Figure 1.** Geometric mean blood lead levels (BLLs) for persons aged <75 years, by age group — National Health and Nutrition Examination Survey (NHANES) II and III-Phase 1, United States, 1976–1980 and 1988–1991.
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Roberts EM, et al. Pediatrics 2017. Compared prevalence estimates of BLL ≥ 10 µg/dL (EBLL) among children 12mo-5y (from NHANES) with those based on CDC reporting (from 39 states) from 1999-2010 by state. Estimated 1.2M EBLLs during this period but 33% were not reported to CDC, with regional differences.

Tibia Lead Levels are High in Older Members of the General Population

And African-Americans have LIFETIME CUMULATIVE LEAD DOSES that are 30% higher than in whites
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Soil Lead Levels Are Highest in Larger Cities (1980s)

A review of the contamination of soil with lead
II. Spatial distribution and risk assessment of soil lead

Julie Markus*, Alex B. McBratney

Urban gardens: Lead exposure, recontamination mechanisms, and implications for remediation design
Heather F. Clark *, Debra M. Hausladen, Daniel J. Brabander
Department of Geosciences, Wellesley College, Wellesley, MA 02481, USA

“NYC Encourages Urban Gardening and Regional Food” March 4, 2009

Many climate change policy advocates urge urban gardening. How careful must we be?

The New York Times
93 ppm
Urban renaissance in Philadelphia accompanied by unexpected problem: elevated lead levels in children (6-15 µg/dL)
City redeveloping old industrial neighborhoods (Fishtown, Kensington, Port Richmond) for residences
Philadelphia had 36 lead smelters (NYC 21, Boston & Baltimore 9 each, SF 7, other US cities too)
Very high soil lead levels (> 1000 ppm)
Construction is generating lead-containing dust, being inhaled
90% housing stock built before 1970 (1978 paint ban)
Federal guidance: do not grow vegetables > 150 ppm; do not allow children to play > 400 ppm

The New U.S. Lead Poisoning – A Sign of Our Times

- 2017: ~40,000 fatal and 81,000 nonfatal firearm injuries in U.S.
- Many survivors (~75%) have retained bullet fragments (“mass casualty” vs. “urban”)
- Because of ecological concerns (millions of dead ducks & carrion-eaters [condors] from lead poisoning), lead removed from ammunition for hunting waterfowl in 1991
- Intense opposition from National Rifle Association to new regulations (remove lead from all ammunition) to protect people or animals


<table>
<thead>
<tr>
<th>TIME</th>
<th>They Survived Mass Shootings. Years Later, The Bullets Are Still Trying to Kill Them</th>
<th>By Melissa Chan</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 31, 2019</td>
<td>[Image of bullet fragments in a受害者] (BLL = 21 µg/dL)</td>
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<tr>
<td>2019</td>
<td>[Image of bullet fragments in a受害者] (BLL = 37 µg/dL)</td>
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<tr>
<td>2018</td>
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<tr>
<td>2007</td>
<td>[Image of bullet fragments in a受害者] (BLL = 21 µg/dL)</td>
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</tbody>
</table>
Most countries have eliminated use of lead in gasoline.

(MMT = methylcyclopentadienyl manganese tricarbonyl)

“MMT is a fuel additive that economically provides octane enhancement … Ethyl has manufactured and marketed MMT for more than twenty years. Although currently sold primarily in Canada, MMT is gaining support in new markets around the world. MMT provides a number of scientifically proven environmental benefits while posing no harm to automotive emission systems or human health.”

- Lead and manganese are both metals
- Brain is critical target organ of both
- Both meant to increase octane levels
- Brescia Declaration of ICOH 2006: immediate ban of organic manganese in gasoline
- Some use of MMT in EU, but limited
- Use in other countries difficult to discover, but probably happening
- U.S. allows use at 8.3 mg Mn/L
- Companies (Ethyl then Afton) have fought for right to sell
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Low-Level Lead Exposure

• The “epidemiologic transition” for lead
  – From acute and epidemic diseases
  – To chronic health concerns due to low-level exposure

• Persistent disparity by race/ethnicity

• Lead in water and lead pipes
  – How common? This is not just a problem in Flint.
    • Before 1950 Pb used; 3-10M homes with lead service lines
  – Where are they? Not sure.
  – How to tell? Measure Pb and Cu in water

International Lead Poisoning

• *EHP* 2007: e-waste recycling, southeast China: 82% of children BLLs > 10 µg/dL

• Aug09: Mn smelter, Wugang, central China: >1,300 children (70% of tested) with ↑ BLLs

• May11: battery factory, near Shanghai, > 100 persons poisoned

• Jun11: tinfoil processing, eastern China, 600 persons (100 children) poisoned

• US CDC 2000: among adopted children, 40% from Cuba & Haiti, 37% Asia, 27% Vietnam & Africa, 25% from Near East: ↑ BLLs
  – 11.3% of adopted foreign-born children: ↑ BLLs 70
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- China: >2,000 lead-acid battery plants and >1,000 battery recycling plants
- Industry growing at 20% per year
- NYT: In the past 2.5 years, thousands of workers, villagers and children in at least 9 of mainland China’s 31 province-level regions have been found to be suffering from toxic levels of lead exposure … from battery factories and metal smelters.
- HRW: Hundreds of thousands of children in China are suffering permanent mental and physical disabilities as a result of lead poisoning.

NYT, June 15, 2011

“My Children Have Been Poisoned”
A Public Health Crisis in Four Chinese Provinces

June 2011

http://www.hrw.org/node/99451

Photos from PeterEssick.com

Burning e-waste, Accra, Ghana

Burning circuit boards, Karachi, Pakistan

Backyard smelter, China

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Global Health Implications

- Like in U.S., there was extensive use of lead in developing countries
  - Data suggest that the poorer the country, the higher the average lead content in gasoline (UNEP data)
- Most such uses being phased out (e.g., Partnership for Clean Fuel & Vehicles 2002; Dakar Declaration 2001)
- Lead & cognitive function in adults: implications for aging population worldwide for decades (65+ yrs: 2000 = 420M; 2050 = 1,440M)

You Are a Public Health Researcher and Used Tax Dollars to do Research. You Learned A Lot. What do You do NOW?
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The Politics of Lead Toxicology and the Devastating Consequences for Children

David Rosner, MPH, PhD, and Gerald Markowitz, PhD

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE (2007)

“At virtually every step in the history of the uncovering of lead’s toxic qualities, resistance was shown by a variety of industrial interests to the association of lead and toxicity.”

Three Primary Means

• Lead industry sought to control research by sponsoring and funding university research
  – GM, DuPont, and Standard Oil established Kettering Labs at University of Cincinnati
  – Funds to Dr. Joseph Aub at Harvard
• Portrayed lead as an indispensable and healthful element essential for modern life, safe for children to be around
• Direct marketing to children
• Directly influenced scientific integrity of clinical observations and research; exerted pressure and intimidated researchers and clinicians
• This forms the playbook now used by all industries
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“Killer chemicals and greased palms – the deadly 'end game' for leaded petrol”
Tetra ethyl lead is banned in UK but Ellesmere Port firm used dirty tactics to ensure export markets kept on buying"

- Octel plant in Manchester last TEL manufacturing site
- Indonesia, Iraq, and other countries continued to use TEL

Octel's former chief executive, Dennis Kerrison, said: "Our strategy was to win the endgame for TEL." He assured investors in 1998: "Developing these markets promises us more than sufficient cash flow for at least the next eight years."

- Octel increased prices as other manufacturers closed; kept access to markets by bribery; paid a few fines
- From 1998-2009, Octel sold $1.8B of TEL, $600M profit

Summary

- Health hazards of lead known to all parties;
- Early warnings by public health were ignored and attacked by industry;
- Safer alternatives were available - covered up, denied, fought, suppressed, maligned;
- U.S. government was fully apprised;
- Benefits of TEL were overstated – bad for car engines too;
- Most research was funded by industry and researchers allowed themselves to be co-opted;
- As phase-out in West was going on, sales in developing countries increased; and
- Companies have avoided liability.
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Key Points from Lecture

• Decisions were made about a commercial product that failed to consider public health consequences or alternatives.

• Estimated 7 million tons of lead burned in gasoline in 20th century now in environment - over 90% of environmental lead.

• Failure of the precautionary principle.

• There was a large environmental and occupational legacy that continues.

• It took 60 years to correct the initial poor decision.
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Selected References

- http://www.chm.bris.ac.uk/motm/leadtet/leadh.htm
- http://www.chemcases.com/tel

Selected References (continued)

Selected References
Childhood Lead Exposure


