THE CONTRIBUTION OF ENVIRONMENTAL POLLUTANTS TO THE COSTS OF DISEASES IN CHILDREN

Philip J. Landrigan, MD, MSc
Professor of Pediatrics
Mount Sinai School of Medicine
New York, USA

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Children in Nations around the World Today are Surrounded by an Ever Increasing Number of Chemicals
Children’s Unique Vulnerability to Toxic Chemicals

“Children are not Little Adults”

- Greater exposure pound-for-pound
- Diminished ability to detoxify and excrete many chemical toxins
- Heightened biological vulnerability
- More years of future life

US National Academy of Sciences, 1993
The Epidemiologic Transition

- As nations move toward industrial development, patterns of disease and death change.
- Prior to industrial development, infectious diseases are the major causes of illness and death.
- After development, life expectancy increases and chronic diseases become the major causes of illness and death.
Patterns of Disease are Changing:

The Conquest of Pestilence in New York City

As shown by the death rate as recorded in the official records of the Department of Health.

Deaths per 1000 Population

- 1802: Cholera 5513 deaths
- 1849: Cholera 5071 deaths
- 1870: Yellow Fever 9 deaths
- 1862: Smallpox 304
- 1854: Cholera 2509 deaths
- 1892: Cholera 9 deaths
- 1892: Typhus Fever 200 deaths
- 1854: Smallpox 362
- 1892: Influenza 12,562 deaths
- 1851: Smallpox 362

Key Events:
- 1866: Board of Health and present Health Department established
- 1842: Crucen Water Act opened
- 1872: Chlorination of Water
- 1912: Pasteurization of Milk
- 1907: Control of Typhus Carriers
- 1911: Milk stations for babies inaugurated

Census Population in 1860: 3,128,273

“New Pediatric Morbidity”

The most serious diseases confronting children in the developed nations of the world today are a group of chronic, disabling, and sometimes life-threatening conditions, the “new pediatric morbidity”:

- Asthma
- Cancer
- Birth Defects
- Developmental Disabilities

Environmental toxins are recognized increasingly as contributing to their causation
The Discovery of Disease of Toxic Origin in Children

- Increasingly, toxic chemicals are recognized as causes/contributors to pediatric disease
- Typically begins with recognition of acute cases following high-dose exposure
- Then further research demonstrates a spectrum of toxicity that extends to lower doses
Case Study - Lead Poisoning

• A report from Queensland, Australia in 1904 described an epidemic of lead poisoning in young children.

• Clinical and epidemiologic investigation traced the source of the outbreak to the ingestion of lead-based paint by children playing on verandahs.

• This report led to the banning of lead-based paint in many nations, although not in the United States until 1978.
Clinical Lead Poisoning

- Coma and convulsions
- Peripheral neuropathy
- Kidney failure
- Anemia
Subclinical Lead Poisoning

- Decreased IQ
- Altered behavior
- Slowed nerve conduction
- Elevated uric acid
- Elevated FEP
Subclinical Toxicity

... the concept that relatively low dose exposure to certain chemicals ... may cause harmful effects to health that are not evident with a standard clinical examination. The underlying premise is that there exists a continuum of toxicity, in which clinically apparent effects have their asymptomatic, subclinical counterparts.
Original IQ Distribution

6.0 million "mentally retarded"

6.0 million "gifted"
Effect of a 5 Point Shift in Average IQ

57% increase in "mentally retarded" population

9.4 million "mentally retarded"

2.4 million "gifted"
The Contributions of Environmental Toxins to the New Pediatric Morbidity
Prevalence Rates for Asthma by Age and Year, United States, 1984-1994

Source: Centers for Disease Control & Prevention
ASTHMA

KNOWN ENVIRONMENTAL CAUSES

- Indoor air pollution
- Second-hand tobacco smoke
- Ambient air pollution

--1996 Atlanta Olympics

UPWARD TREND UNEXPLAINED
Childhood Cancer (Age 0-19), Age-Adjusted Incidence and Death Rates, 1975-1996

Source: Pediatric Monograph 1999, Surveillance, Epidemiology, and End Results Program Division of Cancer Control and Population Sciences, National Cancer Institute. American Cancer Society, Surveillance Research
The overall incidence of testicular cancer rose substantially in the United States from 1973 to 1996. Specifically, rates in white males increased 51.2% over that period, while rates for black males rose only 17.3% (the latter increase was not statistically significant). While undescended testes, inguinal hernia, and prenatal factors have been implicated as possible risk factors, the cause of the trend is unknown.

CHILDHOOD CANCER

KNOWN ENVIRONMENTAL CAUSES

- Ionizing Radiation
- Benzene
- Asbestos
- Certain Pesticides

UPWARD TRENDS UNEXPLAINED
HYPOSPADIAS/EPISPADIAS

TRENDS IN REPORTED INCIDENCE, BY QUARTER OF BIRTH,
BIRTH DEFECTS MONITORING PROGRAM / CPHA

JAN 1970 - DEC 1993
(RATES PER 10,000 TOTAL BIRTHS)

- QUARTERLY RATES
- 2-YEAR MOVING AVERAGE

YEAR OF BIRTH
MALE REPRODUCTIVE PROBLEMS

Causes of:
• Falling sperm counts - not known
• Rising testicular cancer - not known
• Increasing hypospadias - not known

Are Endocrine Disrupting Chemicals Responsible?
DEVELOPMENTAL DISABILITIES

• Affect 3 – 8% of all American children
• Include:
  – Dyslexia
  – Attention Deficit/Hyperactivity Disorder (ADHD)
  – Mental Retardation
  – Autism
• The causation of only 10 – 20% can be explained on familial or genetic grounds
COSTS OF ENVIRONMENTAL DISEASE IN CHILDREN

Why should we study costs?

- To help focus prevention
- To balance arguments about the high costs of pollution prevention
- To permit comparison with other disease costs and societal expenditures
- To set priorities and allocate resources
Methodology for Estimating Costs of Disease in Children Attributable to Environment

- Determine total cases of the disease (“disease burden”)
- Determine costs – direct and indirect – *be comprehensive, but careful*
- Determine environmentally attributable fraction (EAF)
- Do the math, including discount factor
# Estimated Costs of Pediatric Lead Poisoning, U.S. 1997

<table>
<thead>
<tr>
<th>EAF</th>
<th>= 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Consequence</td>
<td>= Loss of IQ over lifetime</td>
</tr>
<tr>
<td>Mean blood lead level</td>
<td>= 2.7μg/dL</td>
</tr>
<tr>
<td>A blood level of 1μg/dL</td>
<td>= Mean loss of 0.25 IQ points per child</td>
</tr>
<tr>
<td>Therefore, 2.7μg/dL</td>
<td>= Mean loss of 0.675 IQ points per child</td>
</tr>
<tr>
<td>Loss of 1 IQ point</td>
<td>= Loss of lifetime earnings of 2.39%</td>
</tr>
<tr>
<td>Therefore, loss of 0.675 IQ points</td>
<td>= Loss of lifetime earnings of 1.61%</td>
</tr>
<tr>
<td>Economic Consequences</td>
<td></td>
</tr>
<tr>
<td>For boys: loss of 1.61% X $881,027 (lifetime earnings) X 1,960,200</td>
<td>= $27.8 billion</td>
</tr>
<tr>
<td>For girls: loss of 1.61% X $519,631 (lifetime earnings) X 1,869,6310</td>
<td>= $15.6 billion</td>
</tr>
<tr>
<td><strong>Total costs of pediatric lead poisoning</strong></td>
<td>= $43.4 billion</td>
</tr>
</tbody>
</table>
## Estimated Costs of Pediatric Asthma of Environmental Origin, U.S., 1997

<table>
<thead>
<tr>
<th>Medical and Indirect Costs</th>
<th>U.S. Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital Care</strong></td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>$634 Million</td>
</tr>
<tr>
<td>Emergency Room</td>
<td>$323 million</td>
</tr>
<tr>
<td>Outpatient</td>
<td>$154 million</td>
</tr>
<tr>
<td><strong>Physician Services</strong></td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>$54 million</td>
</tr>
<tr>
<td>Outpatient</td>
<td>$625 million</td>
</tr>
<tr>
<td>Medications</td>
<td>$2.81 billion</td>
</tr>
<tr>
<td><strong>Total Costs of Pediatric Asthma</strong></td>
<td>$6.6 billion</td>
</tr>
<tr>
<td>Environmentally Attributable Costs of Pediatric Asthma (EAF = 30%; Range 10-35%)</td>
<td>$2.0 billion</td>
</tr>
</tbody>
</table>
## Estimated Costs of Pediatric Cancer of Environmental Origin, U.S., 1997

<table>
<thead>
<tr>
<th>Costs</th>
<th>U.S. Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Costs (per primary case)</td>
<td>$509,000</td>
</tr>
<tr>
<td>Indirect Morbidity Costs (per primary case)</td>
<td>$74,000</td>
</tr>
<tr>
<td>Morbidity Costs of Secondary Cases</td>
<td>$40,000</td>
</tr>
<tr>
<td><strong>Total Annual Morbidity Costs of Childhood Cancer</strong></td>
<td></td>
</tr>
<tr>
<td>Medical and Indirect Morbidity Costs</td>
<td>$4.8 billion</td>
</tr>
<tr>
<td>Costs of Premature Deaths</td>
<td>$1.8 billion</td>
</tr>
<tr>
<td><strong>Total Morbidity Costs</strong></td>
<td>$6.6 billion</td>
</tr>
<tr>
<td><strong>Costs of Environmentally Attributable Pediatric Cancer</strong></td>
<td>$332 million</td>
</tr>
<tr>
<td>(EAF = 5%; Range 2-10%)</td>
<td></td>
</tr>
</tbody>
</table>
## Estimated Total Costs of Pediatric Disease of Environmental Origin, U.S., 1997

<table>
<thead>
<tr>
<th>Disease</th>
<th>Best Estimate</th>
<th>Low Estimate</th>
<th>High Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead Poisoning</td>
<td>$43.4 billion</td>
<td>$43.4 billion</td>
<td>$43.4 billion</td>
</tr>
<tr>
<td>Asthma</td>
<td>$2.0 billion</td>
<td>$0.7 billion</td>
<td>$2.3 billion</td>
</tr>
<tr>
<td>Cancer</td>
<td>$0.3 billion</td>
<td>$0.2 billion</td>
<td>$0.7 billion</td>
</tr>
<tr>
<td>Neurobehavioral Disorders</td>
<td>$9.2 billion</td>
<td>$4.6 billion</td>
<td>$18.4 billion</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$54.9 billion</strong></td>
<td><strong>$48.8 billion</strong></td>
<td><strong>$64.8 billion</strong></td>
</tr>
</tbody>
</table>
Costs of Pediatric Environmental Disease ($54.9B) in Perspective

- 2.8% of total US health care costs
- Annual costs of motor vehicle injury - $80.6B
- Annual costs of stroke - $51.5B
- Annual costs of military weapons research - $35B
- Annual costs of veterans’ benefits - $39B
- Annual costs of all research related to children - $2B
Implications of our Findings

**What is Needed?**

- More comprehensive toxicologic testing of chemicals – old and new
- More research – laboratory and epidemiology
- Better disease tracking
- Pollution prevention
- Right-to-Know
Building Research in Environmental Pediatrics
The National Children’s Study

- “Children’s Framingham Study”
- Goal: To examine the influence on children’s health and development of early exposures to environmental toxins
- Method: Enroll prenatally and follow as many as 100,000 children to at least 18 years of age
- Explore simultaneous impacts of many risk factors
- Create new fellowship training programs

Stimulated in part by data on costs
Critical Questions to be Addressed in the National Children’s Study:

- Contributions of indoor and ambient air pollution to the origins of asthma
- Environmental causes of developmental disabilities
- Effects of exposures to endocrine disruptors
- Causes of the rising incidence of certain pediatric cancers
Center for Children’s Health and the Environment

Mount Sinai School of Medicine