

# Health Impacts of Mercury

*An Environmental Health Concern*

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# In This Presentation

- *What is Mercury?*
- *Uses of Mercury*
- *How it affects health?*
- *What needs to be done?*

# What is Mercury?

- Mercury is naturally occurring chemical extracted from Cinnabar Ore
- Highly toxic
- Three major forms
  - Elemental
    - quicksilver
  - Inorganic
    - Mercury oxide or mercury sulfide
  - Organic
    - Combination of carbon and mercury produce organic compounds (methyl mercury)

**FIGURE 6-4** Cinnabar ore.



*Source:* Author, courtesy of the Almaden Quicksilver Mining Museum, Almaden, California.

# Cont...

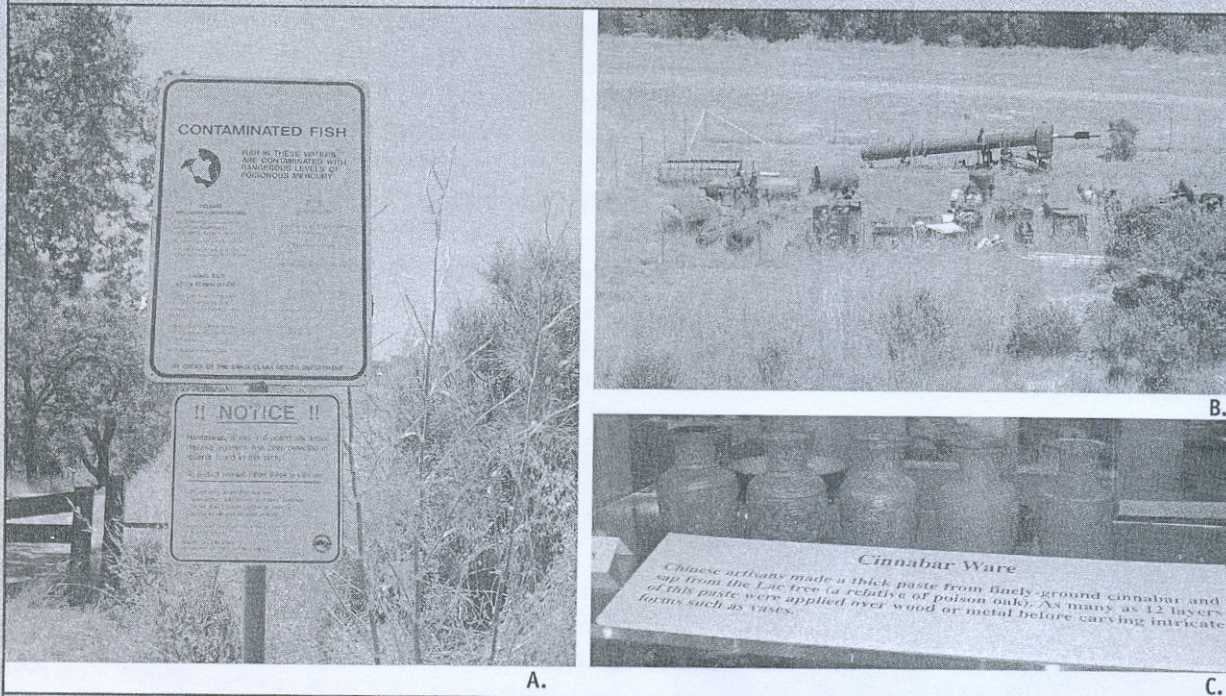
- Used to treat syphilis, be fungicide in agriculture and used in dental amalgams to fill cavities
- Usually releases to environment as a by product of industrial activities
- It accumulates in the beds of lakes, rivers and other bodies of water at even low levels
  - Low levels of mercury can however be magnified to higher levels as the results of methylation and bioaccumulation and pose hazards to human health



## The New Almaden Mine, California

Named after the famous Almaden mines of Spain, the New Almaden Quicksilver Mine is located in the San Francisco Bay area of Northern California. From the late 18th century until 1976 when mining operations terminated, large quantities of mercury were extracted from the mine. However, the legacy of the mining operation lives on: Mercury contamination from this former mining operation poses a continuing hazard to fish and aquatic life in the affected geographic area; signs have been posted to warn persons not to consume fish caught in nearby streams and lakes due to potentially toxic levels of mercury. Figure 6-5 shows different aspects of the mercury mining operations at the New Almaden mine.

**Figure 6-5** The New Almaden Mine area. **A:** Sign advising against consumption of mercury-contaminated fish. **B:** Defunct equipment used for mercury mining and extraction. **C:** Cinnabar ware crafted by Chinese artisans.



Source: Author, courtesy of the Almaden Quicksilver Mining Museum, Almaden, California.



# Use of Mercury in Industries

- Used as catalyst in manufacturing plastics
- Used as flame-retardant in paper making
- Used as fungicide in paints
- Used as an alloy in dental fillings
- Used in manufacturing of scientific equipment

# The Health Effects

- *Inorganic Mercury:*
  - Attacks liver and kidneys
  - Can diffuse through alveolar membranes of lungs and travel to brain causing neurological problems like lack of coordination
  - Prolonged skin exposure may lead to absorption
    - Mad Hatters' Disease: prevalent among 1th Century's French hatmakers



# The Methyl Mercury

- Among many , methyl mercury is one of the potential hazardous substance for life if it comes in contact with it
- *Methyl mercury* ( $\text{CH}_3\text{Hg}^+$ ) is a neurotoxin, and the form of mercury that is most easily bioaccumulated in organisms
- Minamata disease (1953-1961)
  - Affected Central Nervous System
  - Loss of balance and control

# Cont...

- 1972: 6500 Iraqi villages became seriously ill and 459 died after eating bread made from contaminated wheat
- Hog eating incidence in States which was fed on fungicide treated corn seeds: permanent neurological impairment.

# Cont...

- Mercury biomethylation is the transformation of divalent inorganic mercury ( $\text{Hg(II)}$ ) to  $\text{CH}_3\text{Hg}^+$ , and is primarily carried out by sulfate-reducing bacteria that live in anoxic (low dissolved oxygen) environments
- Methylmercury can also be degraded in the environment, either by photodegradation reactions that take place without the help of bacteria or other organisms, or by bacteria through a variety of pathways.



# How it Affects the Health?

- Mercuric chloride ( $\text{HgCl}_2$ ), which has been used as a preservative for water-quality samples for nutrient analysis, can cause gastrointestinal and kidney problems. Mercury sulfide ( $\text{HgS}$ ) is the mineral cinnabar, which is mined as a source for mercury.
- Methylmercury and ethylmercury compounds were once used as fungicides; however, their use was banned in the 1970s due to their adverse health effects.

# Cont

- Developmental effects become apparent at 1 ppm of Mercury in hair or 5.8 ug/l in cord blood
- Benchmark Dose Level (BMDL) (US EPA) 58ug/l
- USE of EAF (Fash et al. 1989, Leigh et al. 1997): Environmentally Attributable Fraction Model

# Cont..

- Defined by Smith et al. (1999) “The percentage of a particular disease category that would be eliminated if environmental risk factors were reduced to their lower feasible concentrations”
- Used to assess the cost of environmental and occupational disease.
  - $\text{Costs} = \text{Disease Rate} \times \text{EAF} \times \text{population size} \times \text{Cost per case}$



# Cont..

- Developmental affects
  - Studies have found low IQs among the children born to women who consumed contaminated sea food during pregnancy.
- Neurotoxic effects (damages Central Nervous System)
- Nephrotoxic effects (damages kidneys)
- Carcinogenic (produces cancers on long-term exposures)

# Cont...

**Table 2.** Sensitivity analysis: cost of anthropogenic methyl mercury exposure.

| Variable  | Base-case cost estimate (range) <sup>a</sup> |
|---|--|
| Children born to women with Hg > 4.84 µg/L, effect > 3.5 µg/L |  |
| Logarithmic model   | \$8.7 billion (\$4.9–13.9 billion)           |
| Linear model, cord:maternal Hg ratio = 1.7                    | \$32.9 billion (\$20.9–43.8 billion)         |
| Linear model, cord:maternal Hg ratio = 1                      | \$19.3 billion (\$12.3–25.8 billion)         |
| Children born to women with > 5.8 µg/L, effect > 4.84 µg/L    |  |
| Logarithmic model   | \$3.9 billion (\$2.2–6.3 billion)            |
| Linear model, cord:maternal Hg ratio = 1.7                    | \$18.7 billion (\$11.9–24.9 billion)         |
| Linear model, cord:maternal Hg ratio = 1                      | \$11.0 billion (\$7.0–14.6 billion)          |
| Range of estimates  |  |
| Logarithmic model   | \$2.2–13.9 billion                           |
| Linear model  | \$7.0–43.8 billion                           |

Assumptions: EAF = 70%, main consequence = loss of IQ over lifetime.

<sup>a</sup>Based on range of possible IQ decrement:increase cord blood mercury.

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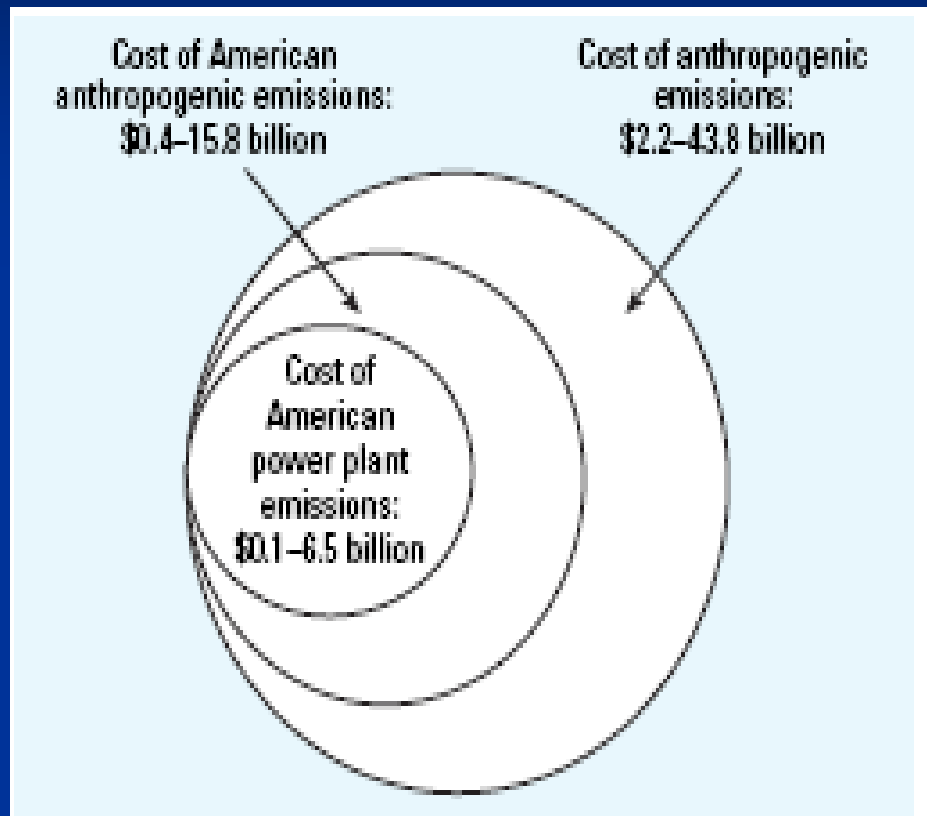


Figure 1. Portions of cost of methyl mercury exposure attributed to sources. Assumptions: 18-36% attributable to American sources; 41% of American emissions attributable to American power plants.



# What Needs to be Done?

- Research , research and research with stakeholders' collaboration
- Costing out the losses due to anthropogenic mercury production in the country
- Public awareness through media
- Political commitment and policy formulation
- Enforcement of laws

# Three Models for Improving the State of Human Health and the Environment



*Clinical Intervention Model*

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*Public Health Intervention Model*



*Environmental Stewardship Model*



# References

- Leonardo Trasande, Philip J. Landrigan, and Clyde Schechter. *Public Health and Economic Consequences of Methyl Mercury Toxicity to the Developing Brain*. Environmental Health Perspective, pages 590-596, Vol.113, Number 5, May 2005.
- Man and Environment, A Health Perspective: *Anne Nadakavukaren* Third edition