Risk Management for Lead

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"Environmental lead exposure reduction has been shown to be a cost-effective public health measure …Therefore, there is a need for continued efforts to reduce [all] environmental lead exposures in Canada."- Health Canada (March 2012) Blood Lead Action Levels

How does lead exposure affect us?

Lead is a neurotoxin

- Nervous system development
- IQ deficits
- Antisocial Behaviour
- Cardiovascular
- Auditory and visual function
- Renal effects
- Reproductive effects
- Age-related cognitive decline

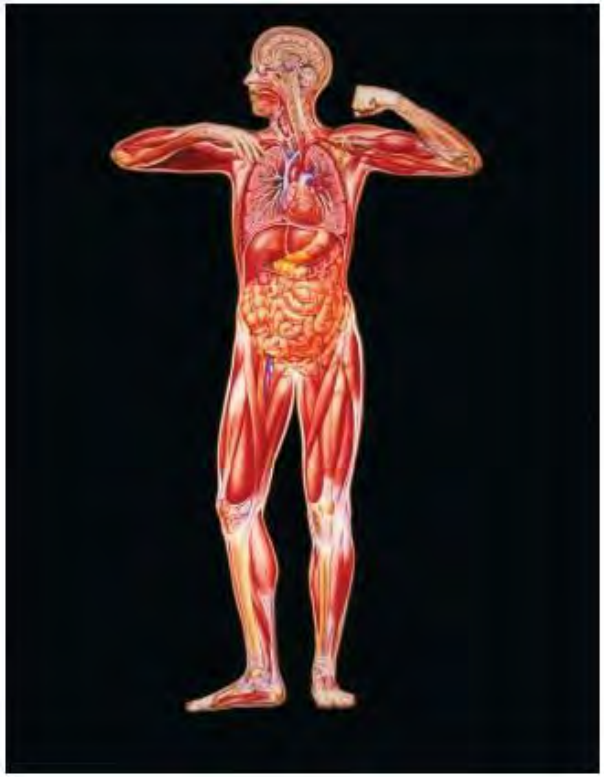


Image: http://www.scienceclarified.com/Al-As/Anatomy.html

What are the main sources of lead?

- Natural sources include bedrock, sediments, surface and ground water
- Anthropogenic sources include smelter operations, smoking, firing ranges, lead pipes delivering water
  - NPRI (2009 est.) air: 260 tons, land: 160 tons, water: 16 tons

What is the estimated intake from different sources?

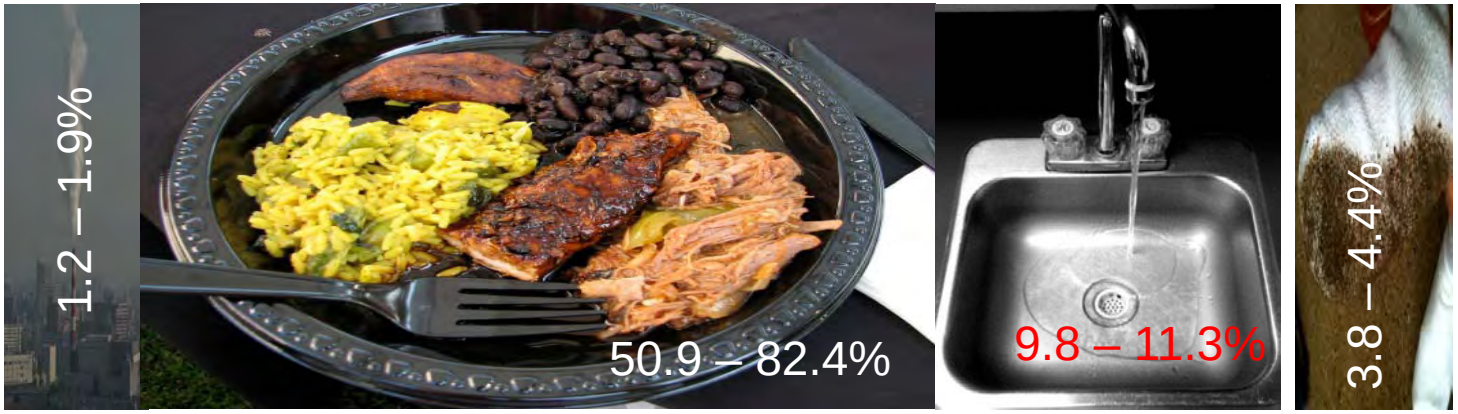


Photo credit flickr images

WHO tolerable weekly allowance: 25 µg/kg/bw

- (Acceptable daily intake of 3.5 µg/kg/bw) NOAEL, (withdrawn)

*Ref. HC 1992, using 0.06 µg/m^3, various, 4.8 µg/L and 140 µ/g for air, food, water and dust, respectively for child 13.6 kg and adult 70 kg.

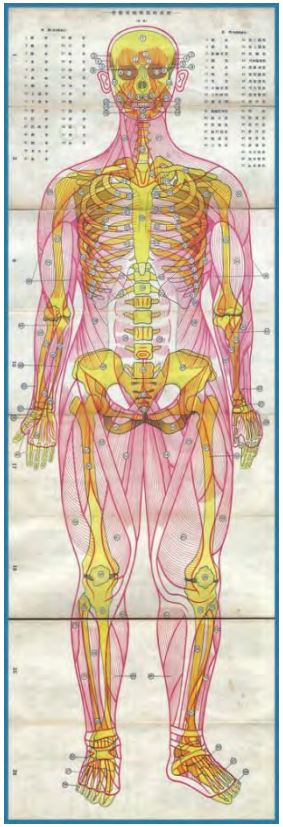
Where does lead accumulate in the human body?

- Uptake (similar to Ca)
- Release during periods of bone turnover—pregnancy, menopause, osteoporosis
- Biological half-life

  Blood ~25 days

  Tissue ~40 days

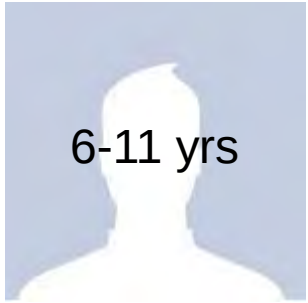
  Bones ~20 years



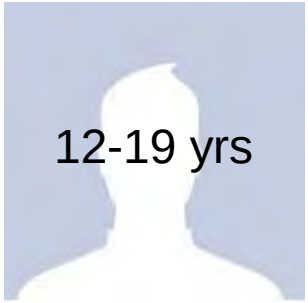
Lead levels in the Canadian Population are decreasing

- Canadian lead levels based on CHMS, 6-79 yrs is 1.34 µg/dL (Geometic Mean)
- Highest in oldest Canadians (60-79 yrs)

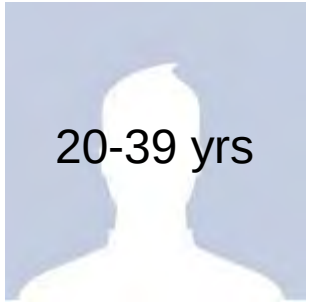
CHMS 07-09, 95th percentile



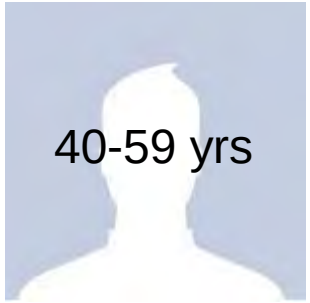
1.95 (1.65, 2.25)



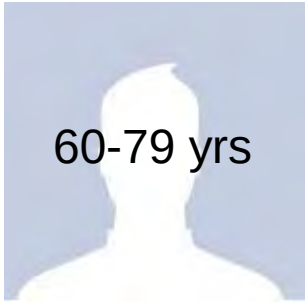
1.64 (1.47, 1.82)



3.12 (2.75, 3.49)



3.87 (3.16, 4.57)



5.19 (4.20, 6.18)

What are the guidelines for Lead?

- Current Canadian (Whole) Blood Lead Intervention Level of 10 µg/dL
- Other guidelines—CDC, WHO 10 µg/dL, are under downward revision
- CDC - **Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention,** January 4, 2012

Impacts of lead shown at low levels

Blood Lead Level (µg/dL)	IQ
2.4 – 10	3.9 ↓
10 – 20	1.9 ↓
20 – 30	1.1 ↓

Lanphear et al., 2005

Findings: lead-associated IQ deficit greater *per µg/dL* for BLL <7.5 than ≥7.5 µg/dL

No "safe" level of lead exposure has been identified

- Evidence suggests a dose-related continuum of effects
- No apparent threshold
- Underscores importance of <u>primary prevention</u>

What are the proposed Risk Management Strategies for Lead?

- For all sources: existing risk management guidelines and regulations
- For water in particular:
  - Guidelines for Canadian Drinking Water Quality (10 µg/L)
  - Guidance for controlling corrosion in drinking water distribution systems

Leaching from lead-containing plumbing is the most common route

- The degree of leaching depends on 3 key factors:
  - Distribution system & building plumbing, type and age of system
  - Water usage patterns
  - Water chemistry

Type of distribution system

- Lead-containing plumbing
  - Lead pipes, tin-lead solder, brass fittings
- Age of buildings
  - May have more lead plumbing = higher leaching
  - Pipes may have more buildup = less leaching
- Other factors
  - Pipe length
  - Pipe diameter

Usage Patterns can influence lead content

- Longer contact times → more leaching
- Intermittent use

  "First draw" typically highest lead levels

Water Chemistry

FACTOR	EFFECT ON LEACHING
Low pH	↑
Low alkalinity	↑
Soft Water	↑
Corrosion inhibitors	↓
Cold water	↓

adapted from Barn and Kosatsky, (2011)

Corrosion Control Measures

- Guidelines for residential and non-residential (Health Canada)
  - Sampling
  - Action levels
  - Public education
- Raising pH to > 7.5 and 9.5 (8-9 WHO)
- Optimal alkalinity ranges 30 to 75 mg/L as Calcium Carbonate

Lead can be a problem in Schools

- Aging infrastructure, costly to replace
- Types of outlets
  - Drinking fountains: narrower pipes, more soldered joints
  - Water coolers: require long contact times for cooling purposes
- Intermittent use
- Impact to vulnerable group

Lead exposure in school drinking water

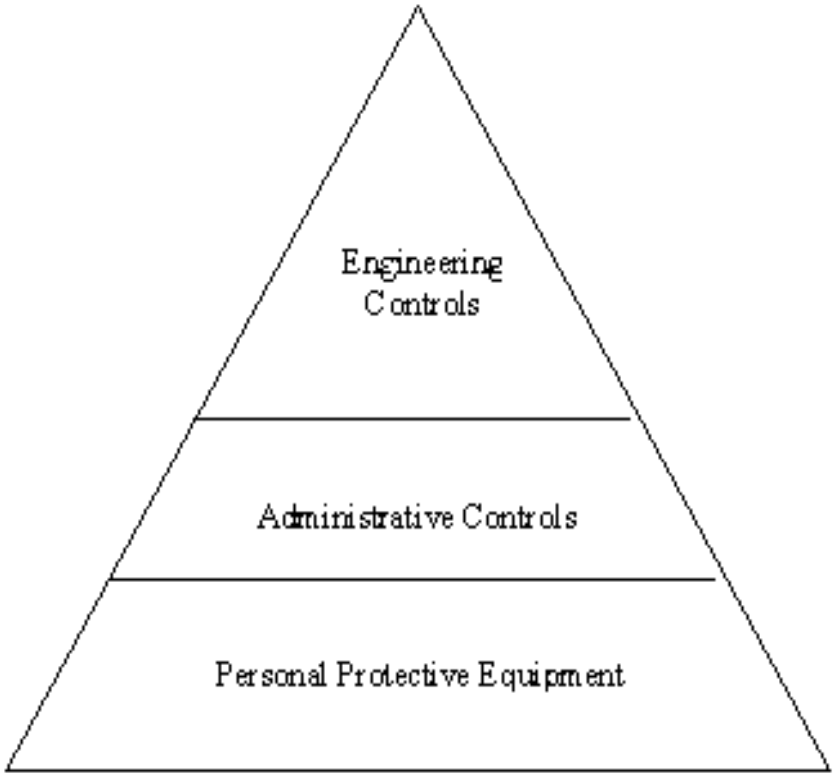
- School in BC
  - Trigger was salmon eggs dying in classroom tank
- Initiated testing for lead and copper
  - Fountains and taps tested
  - ✓ High levels of lead (and copper) found

The Hierarchy of Controls

Engineering: Isolate or remove the contaminant

Administrative: Change procedures to reduce exposure to contaminant

PPE: Final barrier between contaminant and individual



Mitigation strategies

Level	Approach
Engineering	-Replacing lead-containing plumbing -Altering water chemistry (at water treatment level)
Administrative	-Regular flushing of plumbing system in building -Use of only cold-water taps -Use of alternative drinking water source -Public education
Personal Protective Equipment	-Water filtration, Point of Use

Summary

- No threshold level identified with respect to health effects
- Lead accumulated in the body, intergenerational impacts
- Low levels of lead have shown health impacts including IQ deficit
- Blood Lead Intervention level being revisited

Summary

- Risk management includes water-characterization, corrosion control, infrastructure replacement, administrative controls, public education
- Difficult to identify source in individual cases, exposure to lead from all sources should be reduced

Thank you

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