21st Annual Chicago Infection Control Conference

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Health and Policy Challenges in Flint, Michigan

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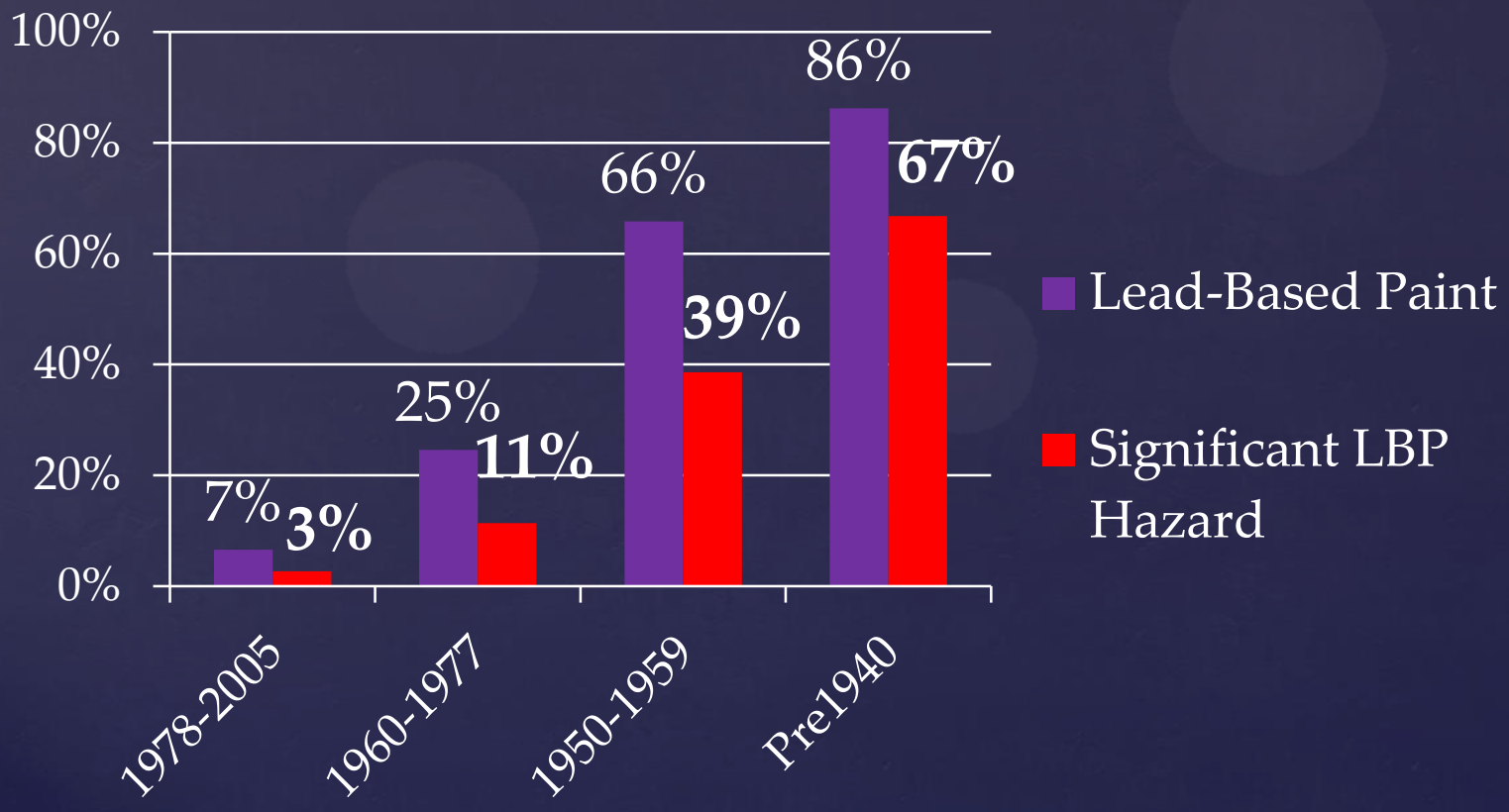
- *Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number* ***DW-75-95877701****. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.*

- *Dr. Helen Binns and Dr. Linda Rae Murray for some slides*

PEHSU
Pediatric Environmental Health Specialty Units

What does lead paint look like?

U.S. Housing-based Lead Paint Risk



American Healthy Homes Survey (AHHS), 2011

How are children exposed?

- Lead flakes/chips and contaminated dust
- Child hand-to-mouth and object-to-mouth activities

- Highest risk spots:
  - Windows
  - Porches

- Soil
  - Near buildings, under porches
  - Track-in

Other Sources

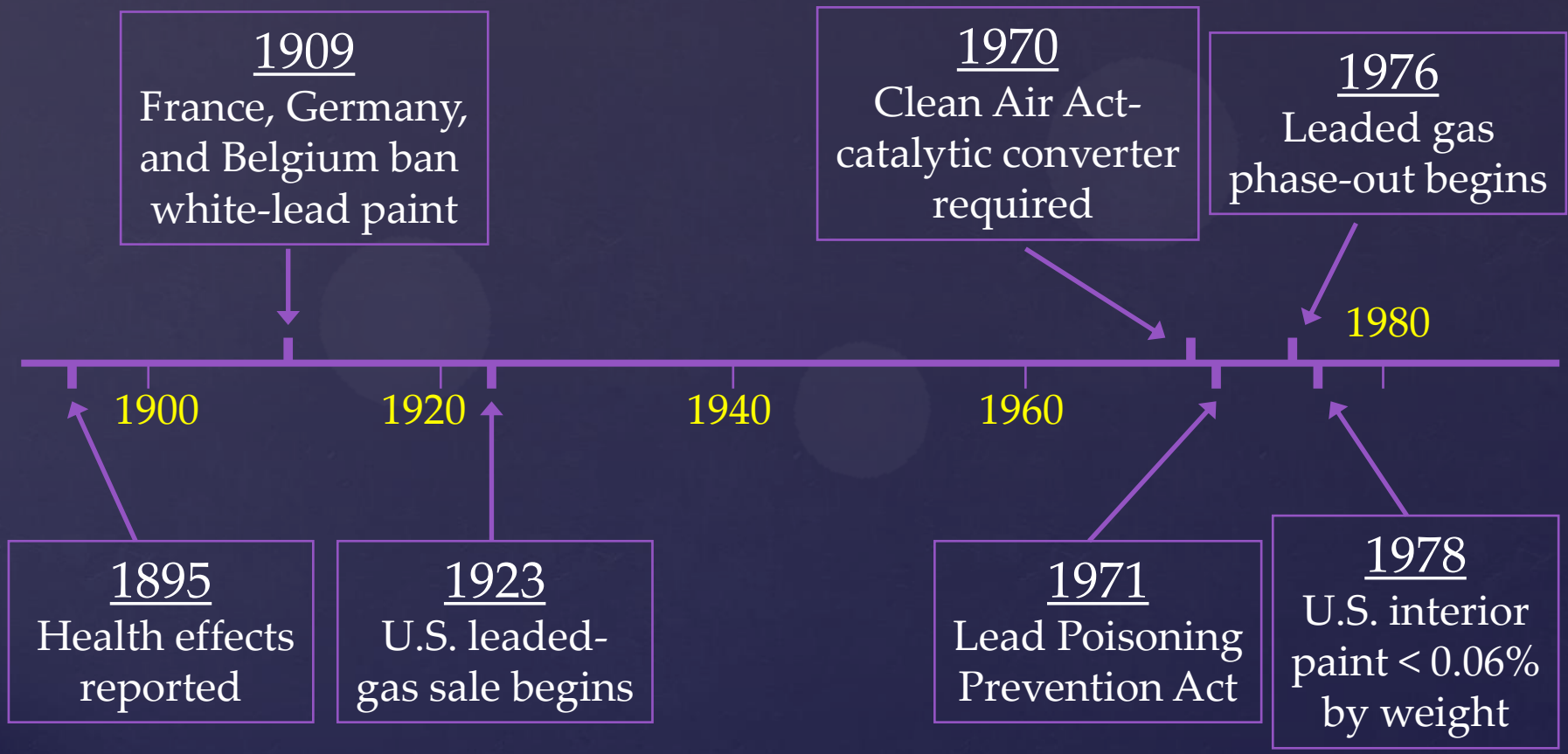
Tumeric Recalled Due To Excessive Levels of Lead

PRAN brand Tumeric spice powder is being RECALLED because it contains high levels of lead.

The recalled spice powder was distributed in New York and New Jersey through retail stores and direct delivery.

The recalled product is packed in 250 and 400 gram clear plastic jars with yellow lids and "Best Before" dates Oct. 26, 2014 and Jan. 15, 2015. Consumers who have purchased PRAN Tumeric are urged not to consume the product

Lead Timeline

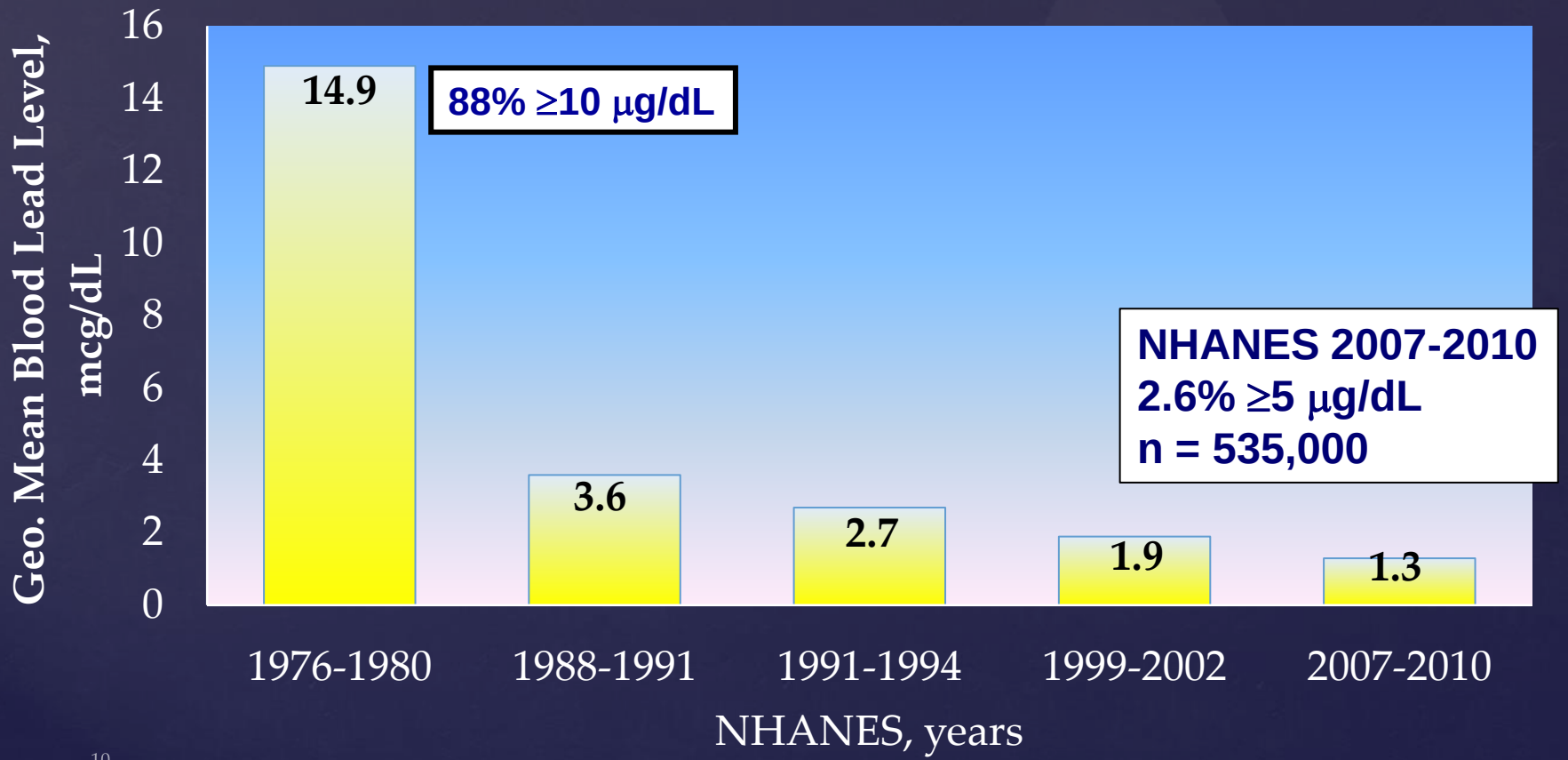


Markowitz, *AJPH* 2000;90:35-46

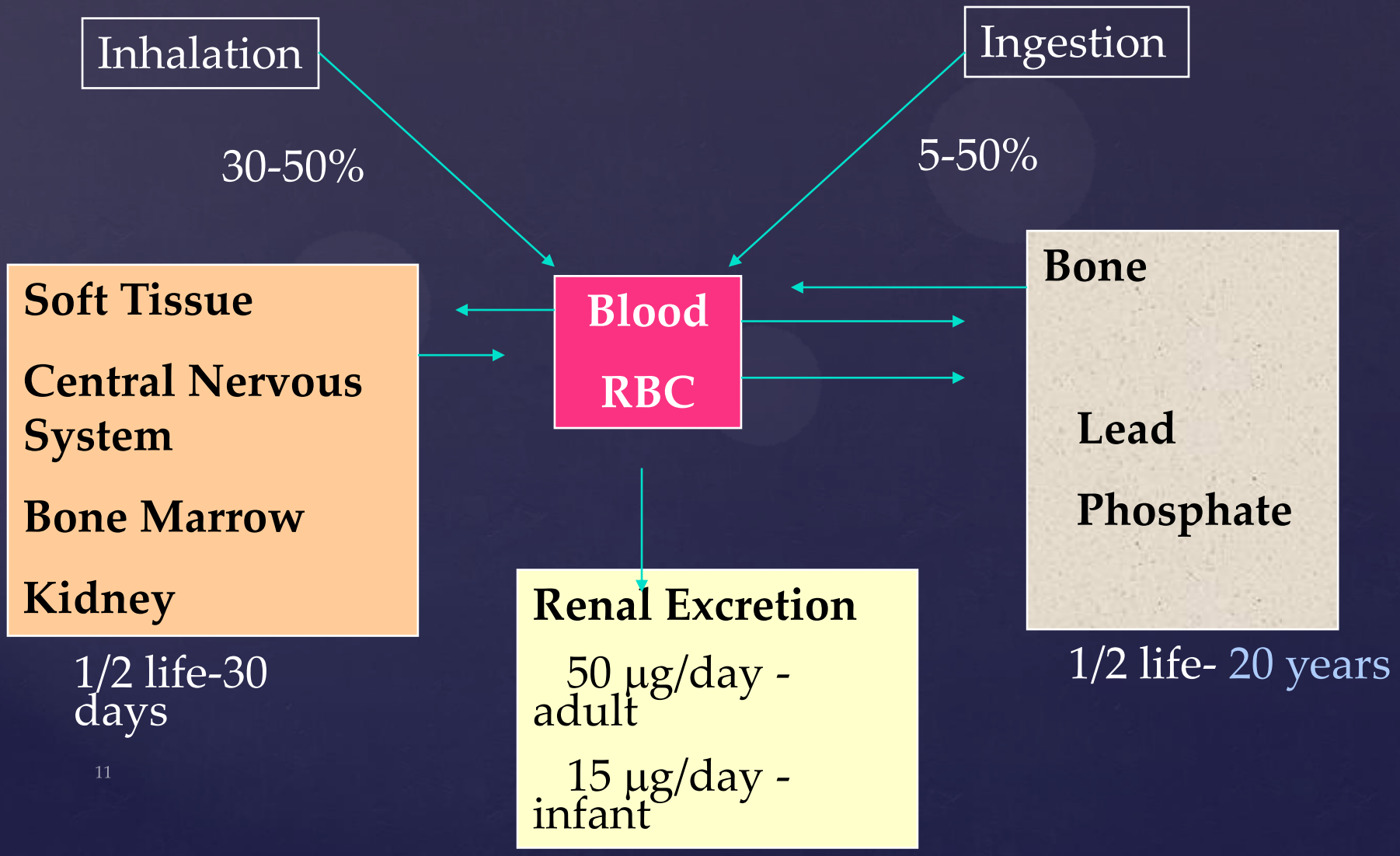
Recent Lead Timeline

- 1986 - limits on lead in plumbing
- 1991 - Safe Drinking Water Act
  - <15 ppb of lead in 1 L of first-draw water taken after the water standing in pipes for ≥6 hours
  - Private well water not regulated
- 1991 – Lead safe housing rule
- 1992 –Disclose known lead at property transfer
- 1995 – Ban on lead solder in cans
- 2001 – Lead dust and soil standards
- 2010 – Lead-safe work practices
  - Contractors and workers
  - Property managers info to tenants

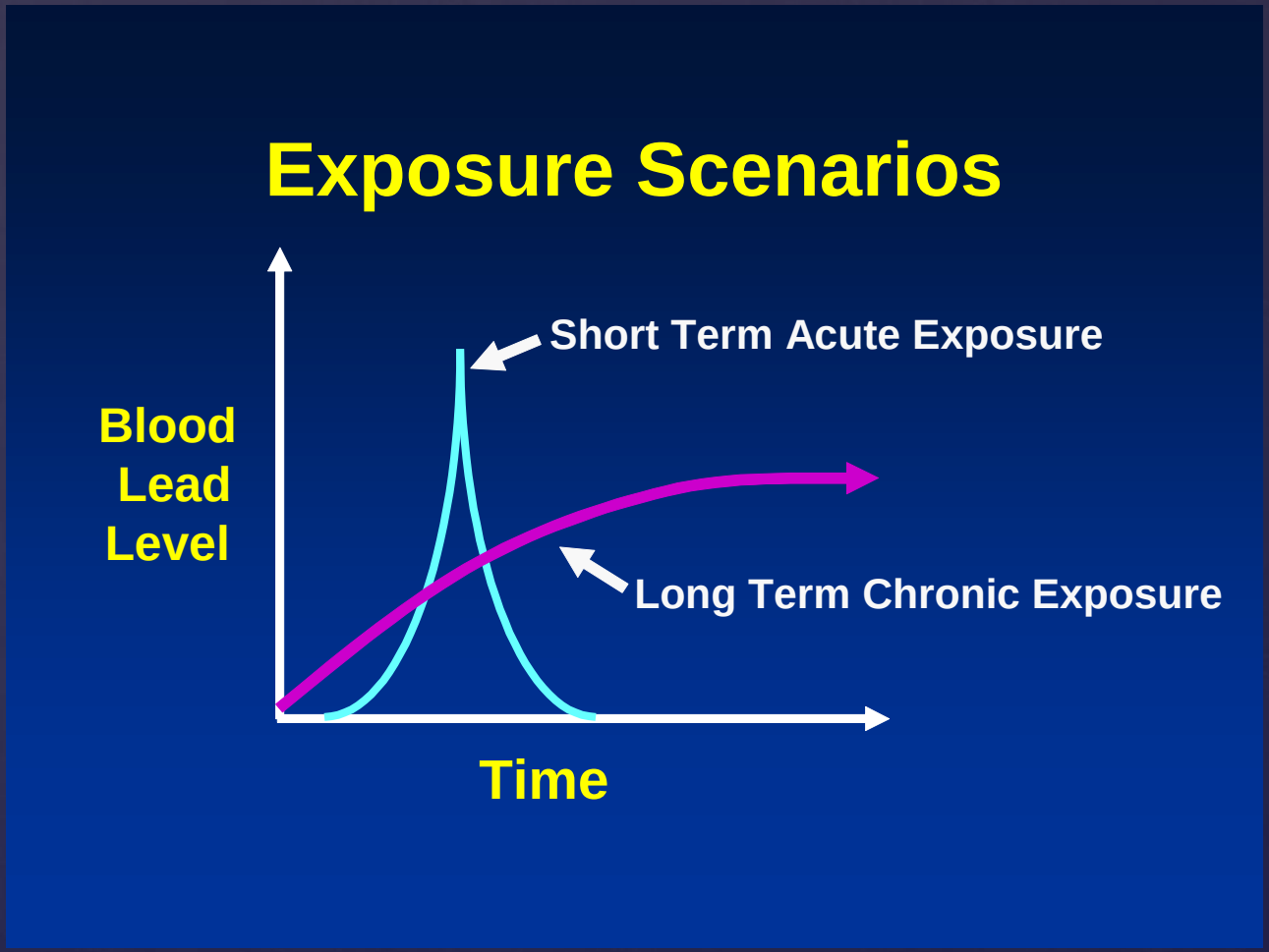
Geometric Mean Blood Lead Levels in Children Ages 1 to 5 years (National Health & Nutrition Surveys)



Metabolism of Lead



Blood Lead Patterns



Lead Poisoning Usually Has No Symptoms!

Overt Signs and Symptoms of Lead Poisoning

Lower Levels

- <25 µg/dL
- Usually NONE
- Longer term:
  - Developmental delay
  - Learning problems
  - Lower attention

Moderate levels

- 25-69 µg/dL
- Constipation
- Abdominal pain
- Poor appetite
- Anemia (~40 µg/dL)

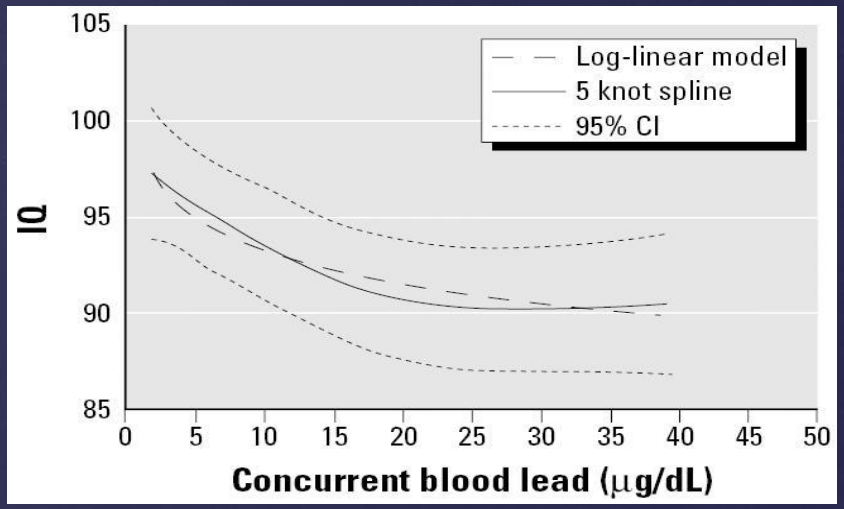
High Levels

- ≥70 µg/dL
- Poor appetite
- Vomiting
- Irritability
- Lethargy
- Seizures

Consequences of Lead Poisoning on Child Development

- Decrease in potential → Learning disability
- Behavior problems → Shortened attention span
- Delinquent behavior
- Decreased language processing
- Deficits of fine motor skills

Low-Level Environmental Lead Exposure and Children's Intellectual Function: An International Pooled Analysis



- Pooled analysis, 7 studies, N= 1,333

Increase in lead:

- from **2.4 to 10** µg/dL →
  - ↓ 3.9 IQ points

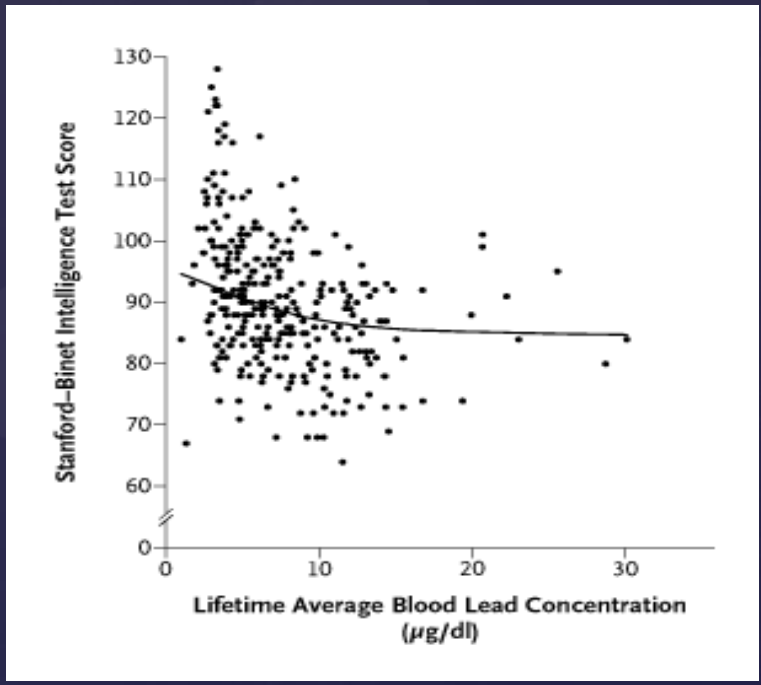
- from **10 to 20** µg/dL →
  - ↓ 1.9 (95% CI, 1.2-2.6)

- from **20 to 30** µg/dL →
  - ↓ 1.1 (95% CI, 0.7-1.5)

Lanphear et al, *Environ Health Perspect*. 2005 July; 113(7): 894–899.

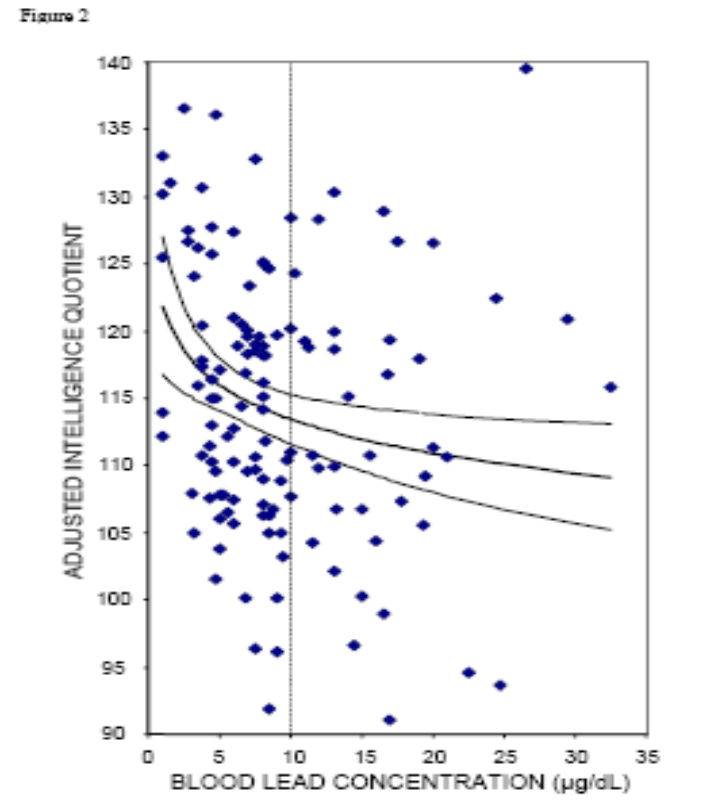
Intellectual Impairment in Children with Blood Lead Concentrations below 10 µg per Deciliter

- 172 inner city children (101 with peak blood lead <10 µg/dL)
- -7.4 points IQ for lifetime avg BLL ↑ from 1 to 10 µg/dL



Canfield, et al. N Engl J Med 2003;348:1517-26

Reduced intellectual development in children with prenatal lead exposure



- Study from Mexico, 150 children
- Geometric mean BLL in pregnancy, 8.0 µg/dL
- Maternal blood lead at 28 wks gestation, significantly assoc with child IQ at age 6-10 yrs

Schnaas; *Env Health Perspect* 2006;114:791-7

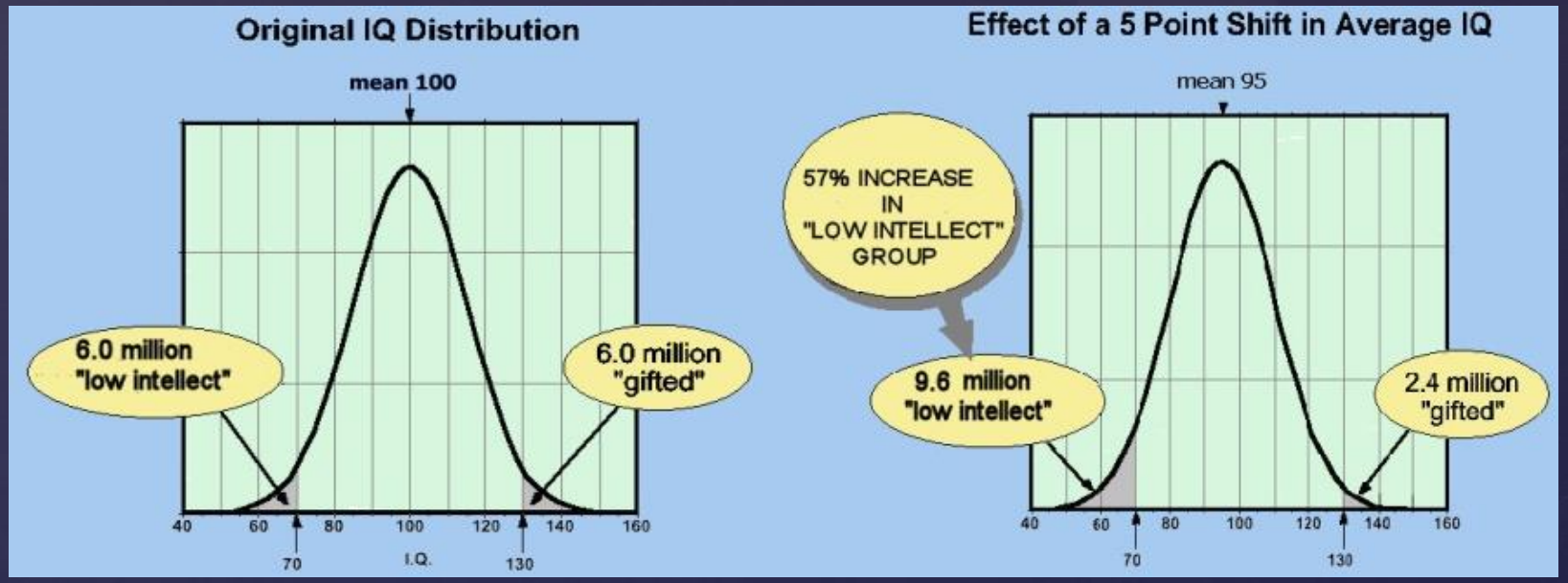
Effects of Blood Lead <5 μg/dL

NHANES III, n=4,853, ages 6-16 years

Current Blood lead	Arithmethic Adjusted mean	Reading Adjusted mean
≤1 μg/dL	95.8	94.5
1.1-1.9 μg/dL	94.0	93.3
2.0-3.0 μg/dL	94.7	93.0
>3.0 μg/dL	91.4	88.2
	p<.0001	p<.0001

Lanphear et al. *Public Health Reports* 2000;115:521-9

Result of a 5 point reduction in average IQ



Expected

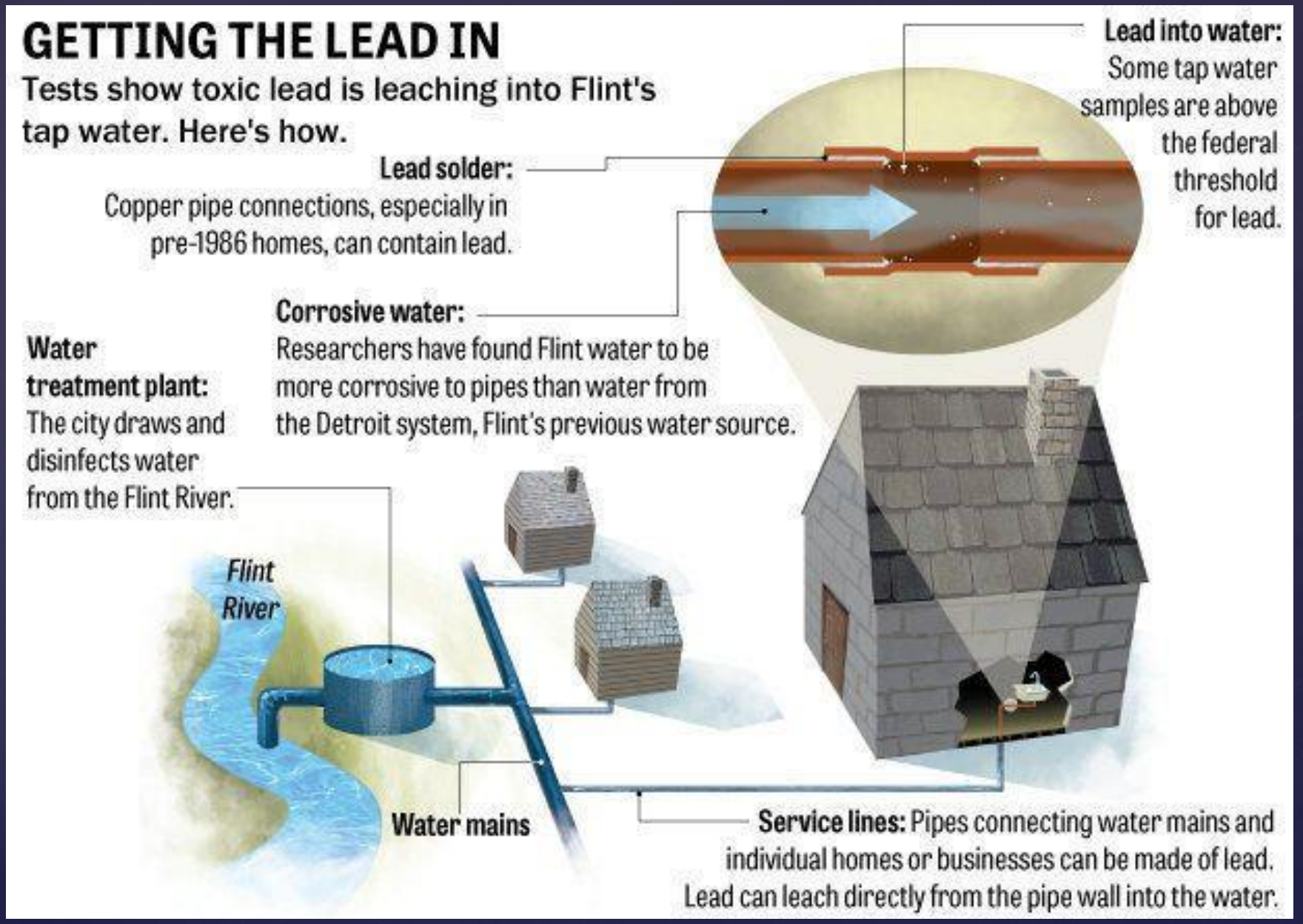
Shifted by 5 IQ points

At mean blood lead levels
< 5ug/dl

- Sufficient evidence for:
  - *Attention-related problems*
  - *Greater incidence of problem behaviors*
  - *Decreased cognitive performance*

National Toxicology Program

National Toxicology Program Monograph on Health Effects of Low-Level Lead 2012



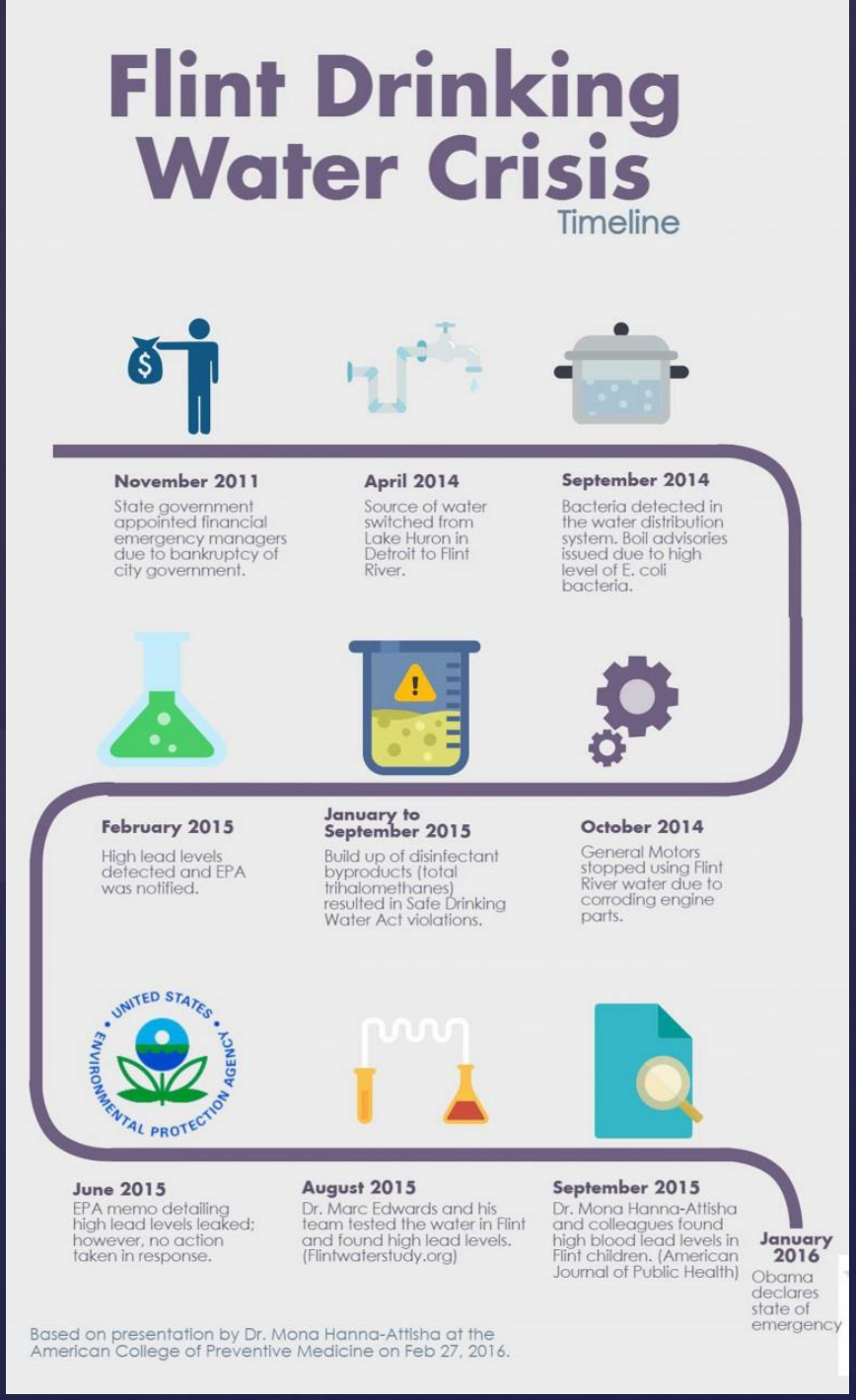
https://ethicsalarms.com/2016/01/19/ethics-questions-and-answers-regarding-the-flint-michigan-water-crisis/

Flint TIMELINE

- **April 2014**: water switch from Detroit to Flint River
- **Aug 2014**: E. Coli levels high, boil water alert
- **Oct 2014**: high THMs noted, increase in Legionella cases noted

- **Oct 2014**: GM announces will no longer use water due to concerns of corrosion from chloride
- **Dec 2014**: MDEQ notifies Flint re: high levels of TTHMs

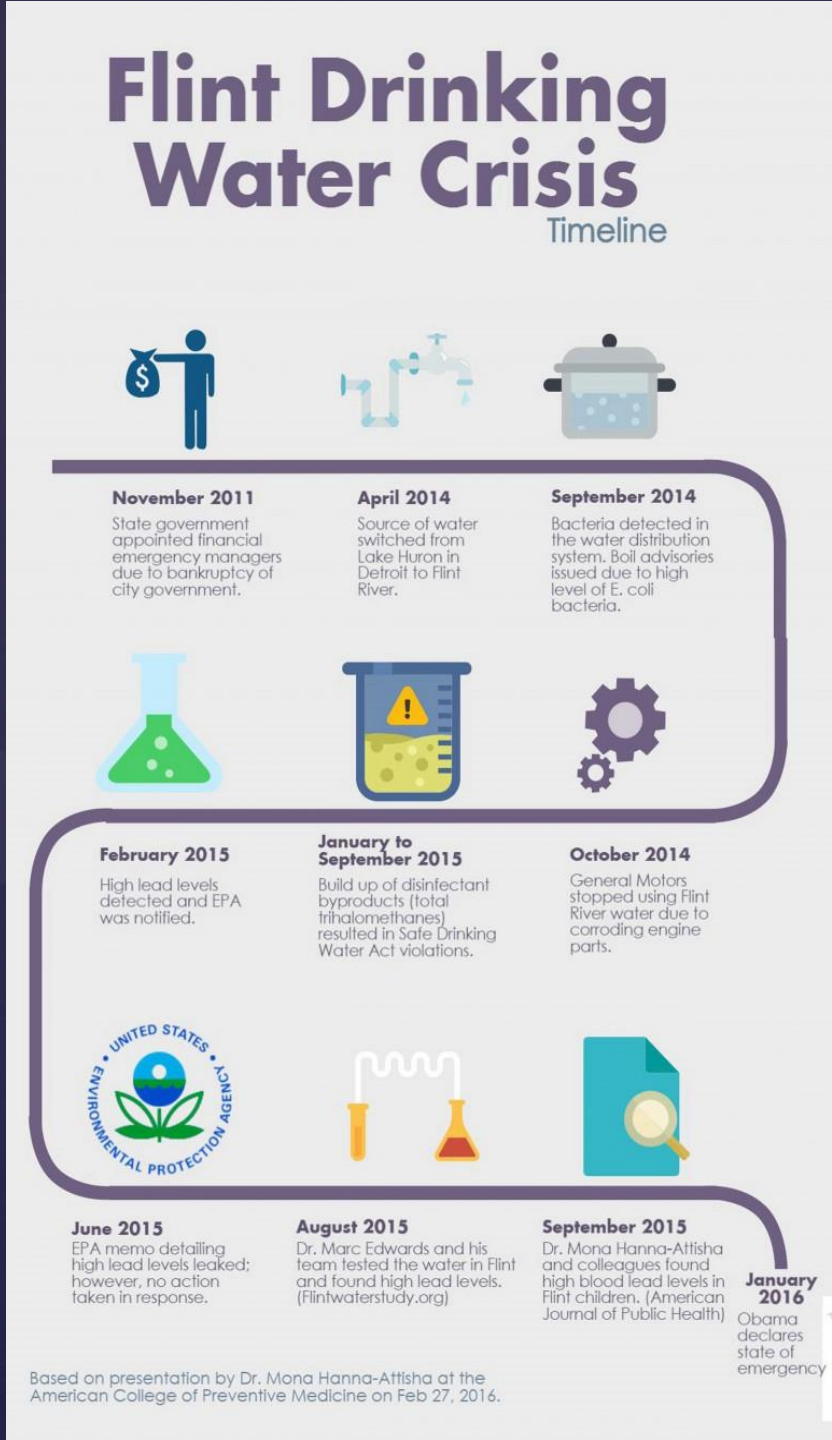
flintwaterstudy.org/wp-content/uploads/2016/03/Flint-task-force-report_2438442_ver1.0.pdf&hl=en_US



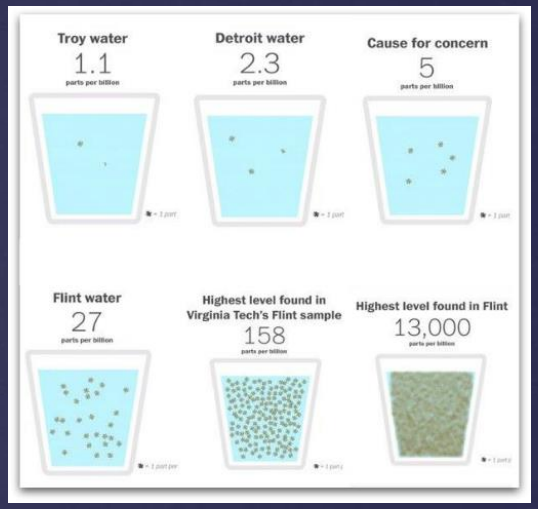
Flint TIMELINE

- **Jan 2014:** State offers bottled water in state offices
- **April – June 2014**: EPA discovers no corrosion control used and homes with elevated lead levels
- **Aug 2015**: Marc Edwards (Virginia Tech) releases first data re: elevated lead levels in homes – 30% over 15ppb
- **Sept 2015**: Dr. Mona Hanna-Attisha presents data from children's BLLs
- **Oct 2015:** Flint water is switched back to Detroit water supply

flintwaterstudy.org/wp-content/uploads/2016/03/Flint-task-force-report_2438442_ver1.0.pdf&hl=en_US



Lead levels in tap water



- Lead and Copper Rule 1991: Action Level 15ppb
- "Systems are required to **perform public education** when there are lead action level exceedances at more than 10% of the taps sampled, **treat source water** if it contributes significantly to lead levels at the tap, and **replace lead service lines** if the lead levels continue to exceed the action level after optimal corrosion control and/ or source water treatment has been installed"
- Flint levels: 40% of the first draw samples > over 5 parts per billion (ppb) Several samples exceeded 100 ppb, and one sample collected after 45 seconds of flushing exceeded 1,000 ppb.

How much does lead in drinking water contribute to blood lead?

"Tap water once contributed to as much as 10-20% of total Pb exposure in the US."

No known reports of community mean BLL over "level of concern" due to contaminated drinking water (Pb in plumbing)

National Toxicology Program Monograph on Health Effects of Low-Level Lead 2012

- Up to 20% of BLL may be due to lead in tap water [US EPA 1993]
- For bottle-fed infants may be > 50% [US EPA]
- Association between lead in tap water and BLL (OR 4.7, CI 2.1-10.2) [Levallois 2014] and $p < 0.05$ [Lanphear 1998]
- Correlation coefficient for lead in tap water and BLL: R sq = 0.43 [Fertmann 2004]

The contribution of tap water to BLL

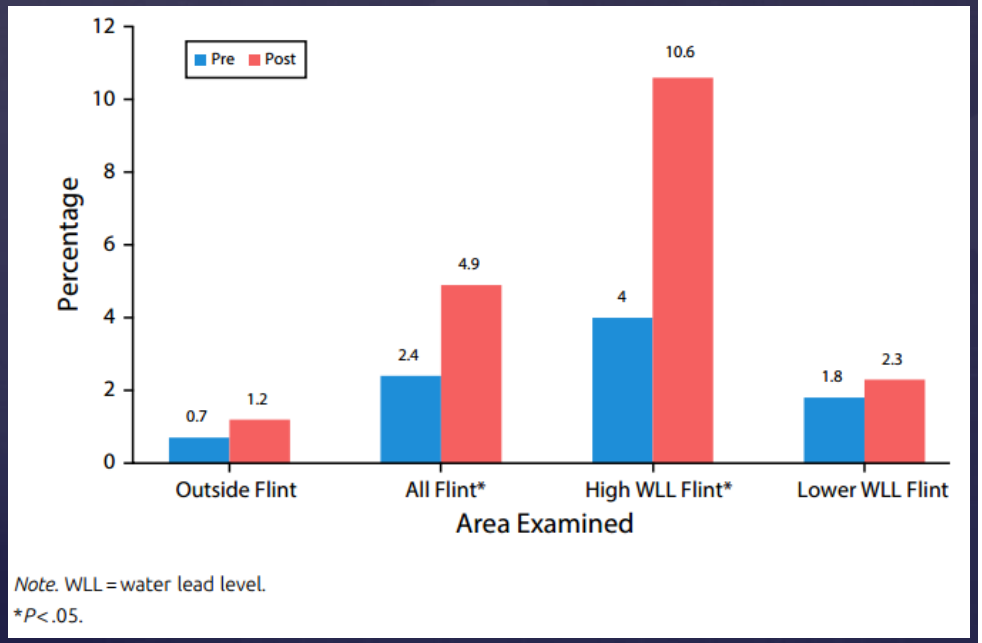
Montreal Study – Impact of Tap Water Lead Concentration on BLL

- Mean blood lead (BLL) = 1.3 μg/dL

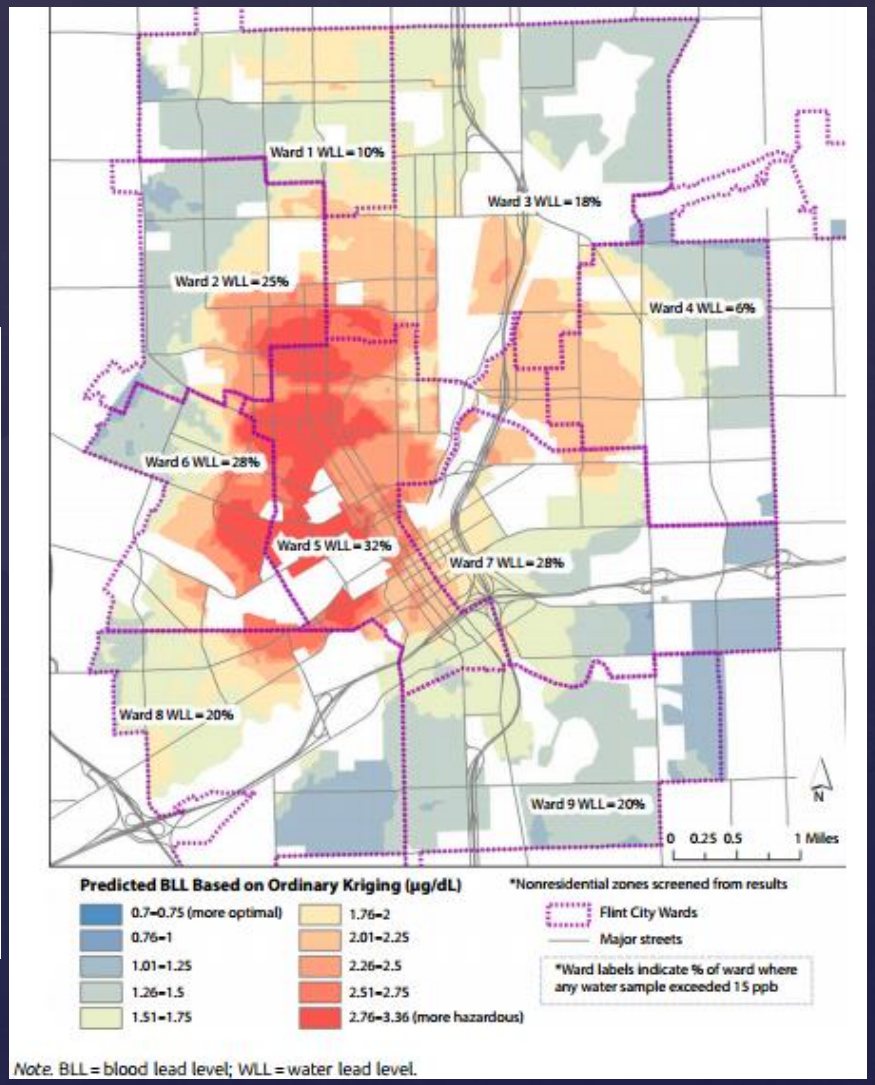
- 1 μg/L (ppm) ↑ in water lead → 1.1 inc in BLL
  - Water intake 21 mg/kg/d
  - After 5 months, BLL ↑ 35%
  - Model explained 13% of variability in BLL

Ngueta G, et al. *Environ Health Persp* 2016

BLOOD LEADS OF FLINT CHILDREN

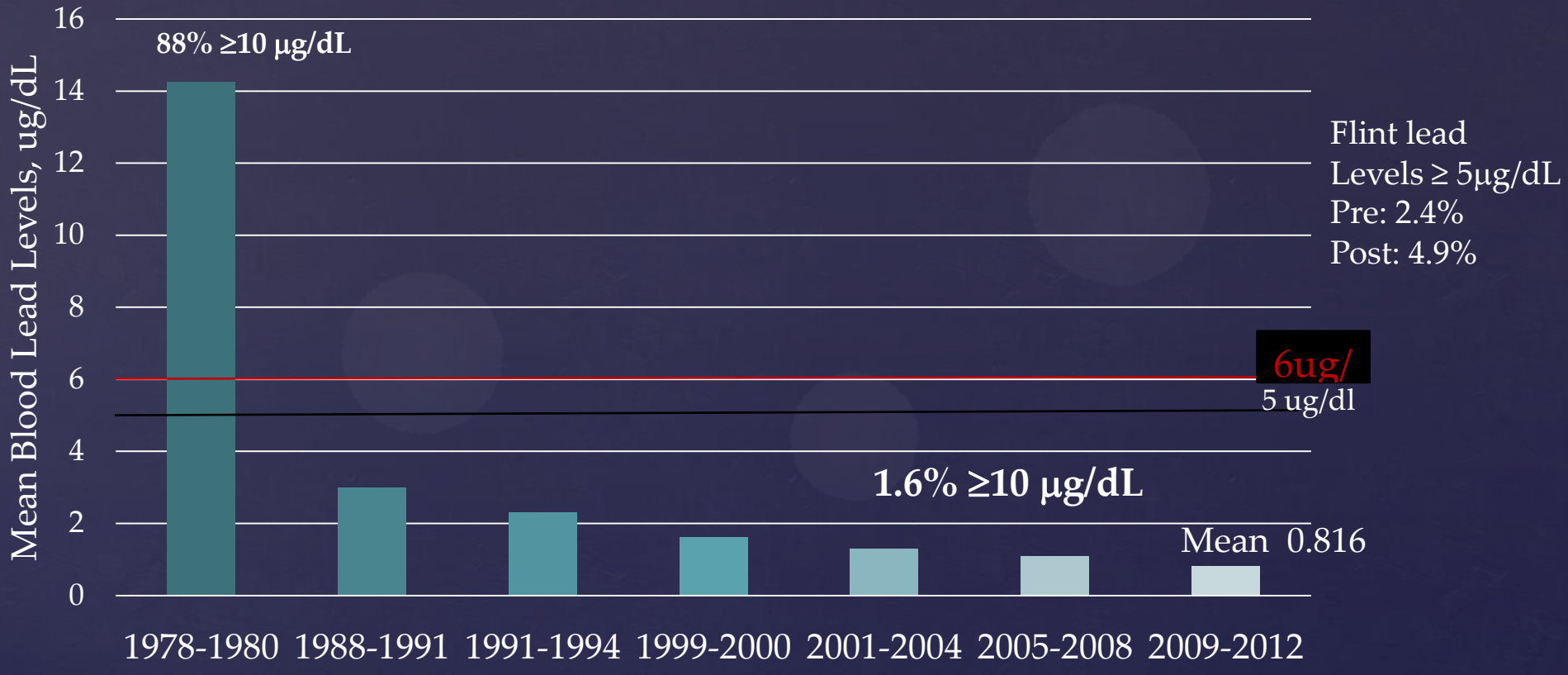


Note. WLL = water lead level.
*$P < .05$.



Note. BLL = blood lead level; WLL = water lead level.

Mean Blood Lead Levels in US Children (1-19 yo)



Flint lead Levels ≥ 5µg/dL
Pre: 2.4%
Post: 4.9%

- Source: The National Health and Nutrition Examination Survey
- 76-80 data: http://www.ncbi.nlm.nih.gov/pubmed/6333758
- 88-91 data: http://www.cdc.gov/mmwr/preview/mmwrhtml/00032080.htm
- 91-94 data: http://www.cdc.gov/mmwr/preview/mmwrhtml/00048339.htm
- 99-12 data: http://www.cdc.gov/biomonitoring/pdf/FourthReport_UpdatedTables_Feb2015.pdf

Health effects:

- Rash
- Hair loss
- Tooth loss

http://mic.com/articles/133019/22-powerful-photos-show-the-devastating-reality-of-flint-s-water-crisis#.b6yPmkrkJ

OSHA Lead Standard

- Workers are removed when blood lead is **50-60**ug/dl
- Return to work when blood lead decreases to **40ug/**dl

Preventing Lead Exposure

- Identify lead hazards
  - Avoid (esp. windows, porches)
  - Clean up
  - Fix up (safely)
- Identify child risks
  - Oral behaviors
  - Low iron (screen with ferritin, not Hgb
- Sensible measures
  - Wash hands before food handling
  - Shoes off at door
  - Cold, flushed water
  - Avoid other sources of lead

Promote Nutritional Health

- Treat iron deficiency
  - Vitamin C ↑ iron absorption
- Ensure Recommended Daily Allowance
  - Calcium
  - Provide daily multivitamin with iron

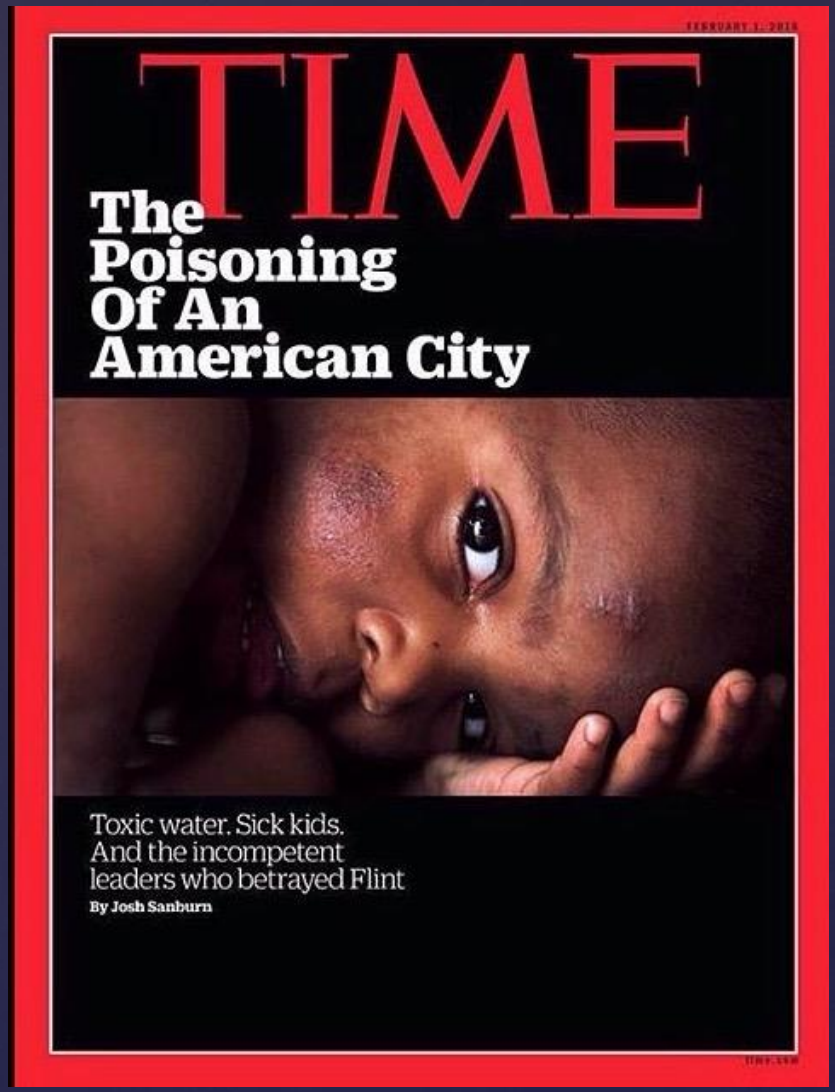
- Enhanced absorption of lead after prolonged fast (so eat breakfast)

*Solon et al. J Pediatr 2008;152:237-43)

Language Enrichment

- Begin in early months of life
- Provide quantity
  - TV is NOT a substitute
- Attend to quality of language
  - Simple (but stretching), use repetition, enunciate
  - Conversation (allow the child to talk to you)
  - Listen
  - Be positive (do not correct a child's speech)
  - Reading (vocabulary, use of book to start conversation); effect of reading evident by age 2


WHITE
COLORED
MICHIGAN 2016


TIME
The Poisoning Of An American City
Toxic water. Sick kids. And the incompetent leaders who betrayed Flint
By Josh Sanburn

Group fears bathing risks in Flint water

Jim Lynch and Jacob Carah, The Detroit News 11:31 p.m. EDT April 8, 2016

(Photo: Daniel Mears / The Detroit News, file)

Federal regulators are re-assessing Flint's water quality amid new questions about the safety of bathing and showering in it.

While no conclusive evidence has emerged indicating widespread dangers, a small sample of water tests conducted by a nonprofit has highlighted gaps, it believes, in the testing and water quality monitoring being used in the beleaguered city.

The organization contends that current testing focusing on water does not take into account possible harm from lead and other contaminants through inhalation of steam and vapor, as well as absorption through skin.

"You can't find what you're not looking for," said Scott Smith, chief technology officer and investigator with the New York-based Water Defense, a nonprofit founded by Academy Award-nominated actor Mark Ruffalo.

Challenges: public health messaging

- Michael Moore – “They are ruined for life and someone needs to tell you the truth about that. They will, forever, suffer from various neurological impediments, their IQs will be lowered by at least 20 points.”
  - Has led to: emotional trauma, anger, hysteria?

- Opportunities:
  - Early interventions can help
  - Good nutrition can help

Policy Challenges

- This is only the tip of the iceberg- other cities
- Test every tap for lead in water?
- Replace all lead service lines?
- Or more funds should go towards early intervention services