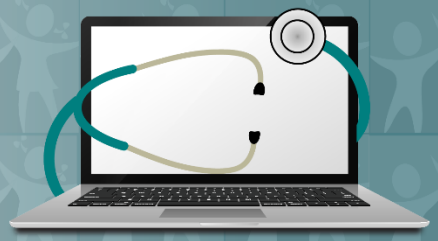
PEHSU NATIONAL CLASSROOM

Pediatric Environmental Health Specialty Units



www.pehsu.net/nationalclassroom

Webinars

- Series of scientific webinars that provide a forum for discourse on scientific issues.
- Live and On-Demand
- Case Conferences
  Journal Clubs
  Grand Rounds
- CE Available

Online Courses

- Evidence-based online courses on a variety of children's environmental health topics.
- Interactive and Self-Paced
- CE Available

Resource Catalog

- Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
- Topics included:
  Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury

Childhood Diet & Arsenic Exposure: Interesting Clinical Cases

Ada Otter, DNP, ARNP
University of Washington
Northwest PEHSU

PEHSU
Pediatric Environmental Health Specialty Units

This material was supported by the American College of Medical Toxicology (ACMT) and funded (in part) by the cooperative agreement FAIN: U61TS000238 from the Agency for Toxic Substances and Disease Registry (ATSDR).

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.

Objectives

At the end of this case presentation, participants will be able to:

- Order and interpret the most appropriate laboratory tests to workup arsenic exposure
- Describe the differences in health risks between inorganic and organic arsenic
- List common dietary sources of both inorganic and organic arsenic
- Identify at least two national or local-level resources to help guide safe seafood consumption

PEHSU Case Conference

Seafood & Arsenic in a 6 y/o boy

Interesting Case in 2015

- MD called NW PEHSU- interpreting urinary arsenic lab results?
- 6 y/o boy with learning and motor delays
- Parents requested heavy metal testing for urine and blood

Preferred lab workup?

Different approach?

Initial Labs

- CBC, ferritin, vitamin D, TSH, electrolytes, BUN/creat and spot urine and blood heavy metal testing
- Basic screening labs = unremarkable
- Serum heavy metal labs = unremarkable

Initial Labs

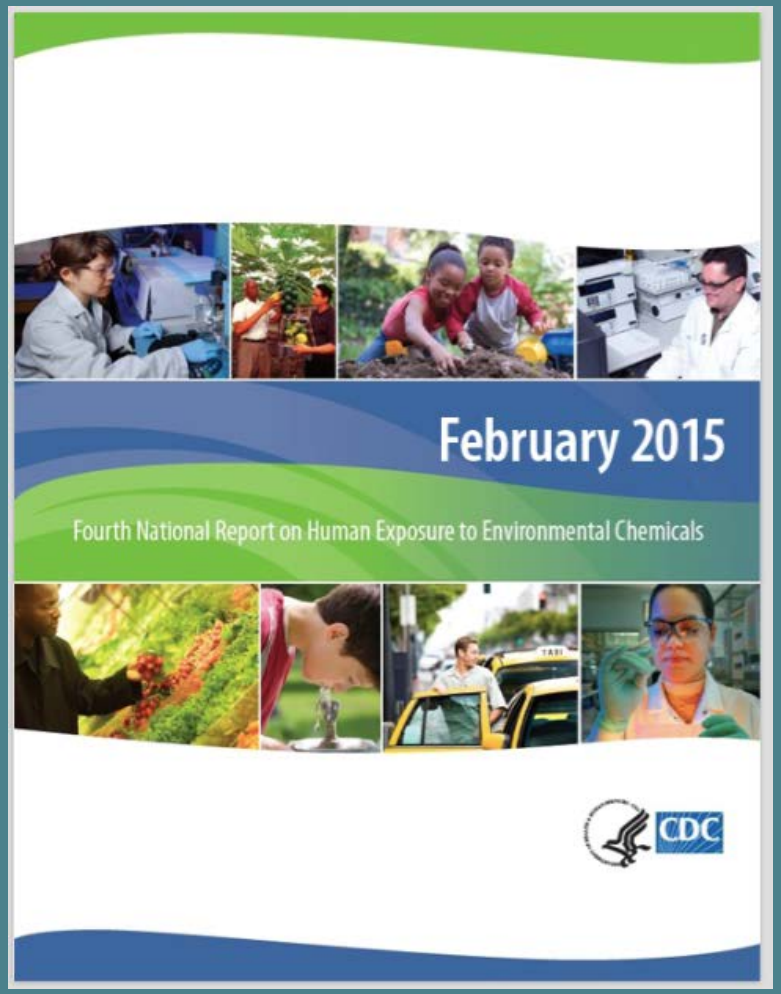
- Random urine sample, Quest Lab

Result Name	**Value**	**Ref Range**
Creatinine, Random Urine	68.7 mg/dL	(2.0-149.0 -)
Arsenic, Random Urine	***93 mcg/gm Cr***	***(< 51 -)***
Mercury, Random Urine	-	(< 5 -)
Lead, Random Urine	-	(< 10 -)

How do we know whether this level of arsenic is high for a child, or not?

How do we know whether this level of arsenic is high for a child, or not?

A: Compare to NHANES percentiles


February 2015
Fourth National Report on Human Exposure to Environmental Chemicals
CDC

Urinary Total Arsenic (creatinine corrected) (2011 - 2012)

Geometric mean and selected percentiles of urine concentrations (in µg As/g of creatinine) for the U.S. population from the National Health and Nutrition Examination Survey.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval) 50th	75th	90th	95th	Sample size
Total	11-12	**7.77** (6.85-8.81)	**6.39** (5.57-7.24)	**13.7** (11.5-16.5)	**30.8** (24.6-38.6)	**50.4** (38.2-70.1)	2502
Age group							
6-11 years	11-12	**8.63** (7.26-10.3)	**6.87** (5.84-8.00)	**12.3** (9.58-15.5)	**27.7** (17.7-57.7)	**91.2** (26.2-129)	398
12-19 years	11-12	**5.75** (4.49-7.36)	**4.69** (3.70-5.73)	**8.73** (6.26-13.3)	**22.1** (11.5-52.6)	**34.9** (21.1-159)	390
20 years and older	11-12	**8.04** (7.07-9.14)	**6.52** (5.88-7.69)	**14.8** (12.1-18.8)	**32.4** (25.2-39.8)	**49.7** (38.2-70.1)	1714
Gender							
Males	11-12	**7.20** (6.15-8.43)	**6.13** (5.18-7.23)	**12.5** (10.5-15.2)	**28.3** (20.2-34.9)	**50.4** (33.3-69.6)	1261
Females	11-12	**8.35** (7.40-9.42)	**6.64** (6.12-7.37)	**15.0** (12.2-19.1)	**33.1** (26.1-41.4)	**50.7** (39.8-79.0)	1241
Race/ethnicity							
Mexican Americans	11-12	**8.00** (6.85-9.36)	**6.91** (6.07-7.98)	**11.9** (9.05-14.6)	**26.1** (16.7-39.4)	**40.8** (24.0-70.1)	317
Non-Hispanic blacks	11-12	**7.24** (5.51-9.51)	**5.83** (4.65-7.96)	**13.5** (9.02-19.0)	**28.8** (21.5-46.3)	**55.4** (31.6-87.1)	669
Non-Hispanic whites	11-12	**7.13** (6.05-8.39)	**5.72** (5.05-6.70)	**12.4** (10.3-15.4)	**28.4** (21.7-37.5)	**46.5** (33.1-75.8)	818
All Hispanics	11-12	**8.53** (7.74-9.40)	**7.60** (6.84-8.42)	**12.8** (11.2-14.1)	**25.3** (20.8-30.8)	**37.5** (28.2-50.6)	573
Asians	11-12	**22.3** (19.1-26.1)	**20.1** (16.3-25.2)	**39.4** (32.2-61.0)	**100** (73.2-129)	**162** (114-202)	353

Biomonitoring Summary: http://www.cdc.gov/biomonitoring/Arsenic_BiomonitoringSummary.html
Factsheet: http://www.cdc.gov/biomonitoring/Arsenic_FactSheet.html

Interpretation

Random urinary arsenic high compared to NHANES data, putting him over the **95th percentile.**

This total urinary arsenic will reflect recent arsenic exposure from the past 1-2 days.

In the setting of a potential chronic exposure (i.e. not an acute poisoning), is it most useful to order a urinary arsenic, serum arsenic, or hair/nail sample arsenic?

In the setting of a potential chronic exposure (i.e. not an acute poisoning), is it most useful to order a urinary arsenic, serum arsenic, or hair/nail sample arsenic?

A: Urinary. Explain why.

Lab Options

- A serum (blood) arsenic level reflects arsenic exposure in the past: **1-2 hours**
- A urine arsenic level reflects arsenic exposure in the past: **1-2 days**

Lab Options

- Hair and nail samples
  - **Not recommended**
  - Would reflect exposure in past 6-12 months, poor at detecting low levels

What does the total arsenic level tell us about what types of arsenic are present?

What does the total arsenic level tell us about what types of arsenic are present?

A: Trick question, it doesn’t really. It includes both inorganic and organic forms

Arsenic Forms

- Total arsenic (As_{total}) composed of organic, inorganic, and arsine gas forms
  - Organic (plants, animals)- arsenic combined w/ carbon and hydrogen; generally not toxic
  - Inorganic (soil, water)- arsenic combined w/ oxygen, chlorine, and sulfur; more toxic

Interpretation

Total arsenic measures both inorganic and organic components = can be misleading

Food Sources

Rice, apples, fish/shellfish, seaweed, poultry, mushrooms.

Nonfood Sources (inorganic)

- Water
- Soil
- Pesticides/herbicides
- Lumber (pressure treated w/ copper chromated arsenate- CCA)
- Occupational
- Industrial pollution
- Tobacco/cigarette smoke
- Historical

What questions could a clinician ask to gather more information about potential arsenic sources/exposures?

What questions could a clinician ask to gather more information about potential arsenic sources/exposures?

A: Dietary history. Also nonfood sources.

Dietary Organic vs. Inorganic

In this case, how could you workup whether the dietary arsenic exposure was organic or inorganic?

A: Gather a dietary hx/typical food intake and habits.

1) Seafood = abstain from seafood for 2 days/48 hours, then redraw a total random urine arsenic.
2) No seafood, = order a speciated urinary arsenic to break out organic vs. inorganic.

Case workup

- An exposure history was gathered by the MD.
- There were no nonfood arsenic exposures identified by the parents
- Direct questioning reveals that child is “picky” eater, but regularly eats “a lot of fish in various sources, mostly fried and some in sushi”
- Family ate a fish-abstaining diet for 2 days and then followed up with a repeat urine sample

Subsequent Labs
(After Abstaining from Seafood x48hrs)

Result Name	Value	Ref Range
Creatinine, Random Urine	59.6 mg/dL	(2.0-149.0 -)
Arsenic, Random Urine	***11 mcg/gm Cr***	***(< 51 -)***
Mercury, Random Urine	4 mcg/gm Cr	(< 5 -)
Lead, Random Urine	See Comment	(< 10 -)

Interpretation

- Arsenic levels after abstaining from seafood improved, now **between the 50th and 75th percentiles**

Any different approaches?

Routes of exposure

- Ingestion (food, water, soil)
- Inhalation (sawdust and smoke from CCA-treated wood)
- ~Dermal absorption (handling CCA wood)

Health Effects of Arsenic- Acute High Doses

- Abd pain, n/v/d
- Neuro & cardiovascular effects (ex. bruising (2° blood vessel damage), ↓ production RBCs & WBCs = fatigue, abnormal heart rhythm)
- Hepatic dysfunction
- Shock, encephalopathy, death (adult- single dose 60,000 mcg)

Health Effects of Arsenic- Chronic High Dose

- Months to years for sx to manifest
- Most studies at arsenic levels far above drinking water standard (ex. 100+ ppb daily)
  - Skin lesions
  - Peripheral neuropathy
  - GI, neuro, & cardio affects, anemia/pancytopenia, DM,
  - Possible decreased IQ or neurocognitive impairment in children
  - Cancer (skin, bladder, lung CA = strong; liver, kidney CA = limited)

Health Effects of Arsenic- Chronic Low Dose

- What about health effects from arsenic levels at or below drinking water standard?
  - ???

Health Effects of Arsenic

- Pregnancy/breastfeeding-
  - Crosses placenta, low levels in breastmilk
  - Low birth weight, fetal malformations, fetal death [in animal studies]

Treatment

- Identify and remove arsenic sources
- Good nutrition.
- No chelation (reserved for acute high-dose intoxication).
- If acute poisoning- look up.

Prevention & Counseling

- Food:

Eat a varied diet focusing on a wide variety of whole unprocessed foods (esp. fruits and vegetables, preferably organic) and diversify grains.

A few notes on rice…

- Consider limiting rice consumption (CR max: adults 1-3 servings of rice or rice-based foods per week, children 1.25 servings per week or 1 small serving rice cereal/day).
- Choose lower-arsenic varieties of rice.
- Rinse rice and cook rice in extra water.
- Do not give infants rice cereal as their first solid food.

A few notes on rice…

- Avoid processed foods.
  - If needed, buy processed foods that don’t contain rice (low-arsenic grains include barley, faro, couscous, bulgur wheat; to avoid gluten, amaranth, buckwheat, millet, quinoa, oats*, cornmeal, grits, polenta).
  - Watch for rice syrup as a ‘natural’ sweetener.
- Do not use rice milk as a dairy substitute for cow's milk.

A few notes on rice…

- American Academy of Pediatrics (AAP) now suggests considering:

1. “Cereals from other grains, finely chopped meats, and vegetable purees are equally acceptable as rice cereal for introduction as first food”

2. Alternative thickeners like oats and cornstarch to thicken first foods (if needed, ex. reflux)

Prevention & Counseling

- Nonfood:
  - Test well water
  - Avoid cigarette and tobacco smoke
  - Wash hands and toys, and wet mop/dust your home often.
  - Don’t use or burn CCA-treated wood

Prevention & Counseling

- Seal arsenic treated lumber with an oil-based sealant (annually)
- Do not allow your children to play on or around CCA-treated wood structures
- Do not garden in or around wood structures containing CCA
- Do not allow children to play in soil if it contains high levels of arsenic
- Avoid UV exposure/use sunscreen (b/c combined skin CA role w/ arsenic)

Regulation

- Drinking & bottled water = 10 ppb (EPA)
- Air = no regulation (EPA)
- Food = no enforceable regulation (FDA)
  - Non-binding “action level” of 10 ppb for apple juice
  - No maximum levels of arsenic for other foods (ex. rice, processed foods)

Case Wrap Up

- What else was going on?
  - Being worked up for autism spectrum disorders…
  - Close ongoing management and support for parents and children
  - Worthwhile to repeat a urine arsenic (again, after 48 hr seafood abstaining diet; or ideally, even 1-2 weeks) in a few months to make sure levels were staying down

Case Teaching Moment

- Since dietary patterns/fish consumption were brought up in relationship to arsenic, good teaching moment with the family to talk about healthy fish consumption (maximize benefits, minimize risks)- this would touch on the issue of mercury as well

Readings

- ATSDR Public Health Statement for Arsenic: http://www.atsdr.cdc.gov/phs/phs.asp?id=18&tid=3
- EPA-FDA Advisory on Mercury in Fish and Shellfish: http://www.epa.gov/fish-tech/epa-fda-advisory-mercury-fish-and-shellfish

Readings

- Seafood Health Facts: Making Smart Choices (Balancing the Benefits and Risks of Seafood Consumption): Resources for Healthcare Providers and Consumers
  - http://seafoodhealthfacts.org/seafood_safety/practitioners/index.php
- http://www.ewg.org/research/ewgs-good-seafood-guide

Readings

- Healthy Fish Consumption:
  - http://www.fda.gov/food/foodborneillnesscontaminants/metals/ucm393070.htm
  - http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/HealthyFishGuide
  - http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/WomenandChildren
  - http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/MercuryAdvisories

Readings

- FDA Arsenic in Rice and Rice Products: http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm319870.htm

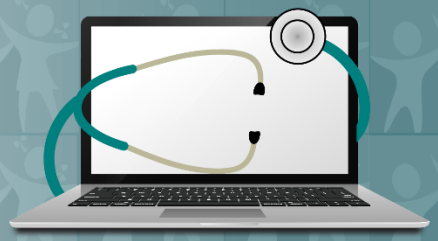
- FDA Arsenic in Apple Juice: http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm280209.htm

Readings

- *Arsenic and Rice: Translating Research to Address Health Care Providers' Needs*. Lai, Pui Y. et al. The Journal of Pediatrics , Volume 167 , Issue 4 , 797 80. http://dx.doi.org/10.1016/j.jpeds.2015.07.003
- American Academy of Pediatrics: https://www.aap.org/en-us/about-the-aap/aap-press-room/pages/aap-offers-advice-for-parents-concerned-about-arsenic-in-food.aspx

PEHSU NATIONAL CLASSROOM

Pediatric Environmental Health Specialty Units



www.pehsu.net/nationalclassroom

Webinars

- Series of scientific webinars that provide a forum for discourse on scientific issues.
- Live and On-Demand
- Case Conferences
  Journal Clubs
  Grand Rounds
- CE Available

Online Courses

- Evidence-based online courses on a variety of children's environmental health topics.
- Interactive and Self-Paced
- CE Available

Resource Catalog

- Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
- Topics included:
  Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury