Children’s Environmental Health Symposium

*Metals (acute and low level exposures)*

Timur S. Durrani, MD, MPH, MBA
Assistant Clinical Professor
Division of Occupational and Environmental Medicine
Assistant Medical Director, California Poison Control
San Francisco Division
Most important route(s) of exposure to lead for this child is/are:

- Ingestion
- Inhalation
- Dermal contact

Endogenous sources

Start the presentation to activate live content
The toxicity of arsenic is related to:

- Organic or inorganic form
- Valence state
- Solubility
- Rate of absorption

Start the presentation to activate live content.
If you see this message in presentation mode, install the add-in or get help at PollEv.com/app.
accurate test for measuring levels of organic exposure is:

- Urine
- Whole blood
- Serum
- Hair
Acknowledgement and disclaimer

- The findings and conclusions in this presentation have not been formally disseminated by the Agency for Toxic Substances and Disease Registry and should not be construed to represent an agency determination or policy.

- 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.

- No one involved in the planning or presentation of this activity has any relevant financial relationships with a commercial interest to disclose.
Outline

- A case
- Characteristics of metals
- Specific examples: Arsenic, Lead, Mercury
- Common pitfalls
A Case...

- 3 year old male found to have a Blood lead level of 53 ug/dl
- His parents have been remodeling their home.
Request a repeat blood lead level

Obtain a Zinc Protoporphyrin Level (ZPP)

Begin immediate oral and IV chelation

Order a KUB
## Classification of Metals Based on Characteristics of Health Effects

<table>
<thead>
<tr>
<th>Nutritionally Essential Metals</th>
<th>Metals with No Known Beneficial Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobalt</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Chromium III</td>
<td>Antimony</td>
</tr>
<tr>
<td>Copper</td>
<td>Arsenic</td>
</tr>
<tr>
<td>Iron</td>
<td>Barium</td>
</tr>
<tr>
<td>Manganese</td>
<td>Beryllium</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Cadmium</td>
</tr>
<tr>
<td>Selenium</td>
<td>Lead</td>
</tr>
<tr>
<td>Zinc</td>
<td>Mercury</td>
</tr>
<tr>
<td></td>
<td>Silver</td>
</tr>
<tr>
<td></td>
<td>Strontium</td>
</tr>
<tr>
<td></td>
<td>Thallium</td>
</tr>
</tbody>
</table>

Goyer et al, 2004
Dose Response Curve for Metals

- Essential metals
- Non-essential metals

Source: L.L. Brunton, B.A. Chabner, B.C. Knollman: Goodman & Gillman’s: The Pharmacological Basis of Therapeutics, 12ed. www.accesspharmacy.com © McGraw-Hill Education. All rights reserved.
Arsenic, lead and mercury

- Ubiquitous in the environment
- Present in air, water, and soil

Speciation and of metals affects their toxicity

- Elemental eg. Mercury, Hg
- Organic – bound to a carbon eg Dimethyl Mercury, Hg(CH$_3$)$_2$
- Inorganic – bound to non-carbon, eg Mercuric Chloride HgCl
Toxicokinetics

- Absorption
- Distribution
- Metabolism
- Elimination
Elemental Mercury

Dimethyl mercury

Start the presentation to activate live content
If you see this message in presentation mode, install the add-in or get help at PollEv.com/app
Delayed Cerebellar Disease and Death after Accidental Exposure to Dimethylmercury

David W. Nierenberg, M.D., Richard E. Nordgren, M.D., Morris B. Chang, M.D., Richard W. Segler, M.D., Michael B. Bayney, Ph.D., Fred Hothberg, M.D., Tait Y. Toribara, Ph.D., Elsa Gemicharl, M.S., and Thomas Clarkson, Ph.D.


Cerebellar Hemispheric Sections from the Patient (Left) and from a Woman of Approximately the Same Age without Neurologic Disease (Right). Widespread shrinkage of the folia and diminution of the cerebellar cortical thickness are evident in the section from the patient.

Karen Wetterhahn
Arsenic
Is there a health concern?
What is arsenic?

- **Inorganic arsenic (iAs)**
  - Free
  - Known to be highly toxic
  - Human carcinogen
  - Examples: $\text{As}^{\text{III}}, \text{As}^{\text{V}}$
  - Metabolized to:
    - Dimethylarsenic acid, methlyarsonic acid

- **Organic arsenic (oAs)**
  - Bound to carbon
  - Toxicity varies
  - Not always known
  - Examples: Arsenobetaine, Arsenolipids
Health Effects

- Acute
  - Typically starts in the GI tract
  - Multi-organ failure:
    - Heart Failure
    - Brain: Altered Mental Status
    - Blood: Anemia
    - Skin: Soughing

- Chronic
  - Lung, bladder and skin cancer; possibly other cancers
  - Emerging evidence links high exposure early in life to children’s health, with potential lifelong consequences
    - Pulmonary diseases
    - Immunological effects
    - Growth
    - Neurodevelopmental effects
  - Chronic effects of low dose exposure are less studied
Arsenic exposure via water

Is an arsenic level of 10 ppb in our drinking water safe?

3ppb -> 1 excess cancer* in 1,000
5ppb -> 1.5 excess cancer* in 1,000
10ppb -> 3 excess cancer* in 1,000
20ppb -> 7 excess cancer* in 1,000

* cancer refers to bladder and lung cancer
Arsenic exposure via water

PUBLIC WATER:
EPA regulations
< 10 PPB

PRIVATE WATER:
Unregulated
Homeowner is responsible
For testing and treatment

2 million of people in US on wells exceeding U.S. water standard
Arsenic levels in common foods

Arsenic intake occurs through food and drinking water with recent concerns focused on high levels in rice. Elevated levels of arsenic can cause lung, bladder and skin cancers, cardiovascular disease and hypertension and could cause neurological deficits and diabetes.

RICE, RICE PRODUCTS
3.5-6.7 µg per cup

MEAT*
Beef
0.1 µg per half pound

COOKED SPINACH
1.1 µg per cup

Chicken
0.2 µg per half pound

GRAPES
1.1 µg per cup

*FISH
Fish has high amounts of organic arsenic that are not as risky to human health as inorganic arsenic.

RECOMMENDED MAXIMUM ARSENIC INTAKE

220-lb. person
30 µg

50-lb. child
14 µg

Health threat: 50+ µg

Arsenic in water

WELL, SPRING, NATURAL WATER
• Concentration can reach 100-200 ppb (parts per billion) = 200-400 µg per 2 liters of water.

PUBLIC WATER
• Typical concentration: 2-4 ppb = 4-8 µg per 2 liters of water.

NOTE: 10 ppb is the maximum concentration allowed, or 20 µg per 2 liters of water.

Sources: "A Market Basket Survey of Inorganic Arsenic in Food," Food and Chemical Toxicology 37 (1999), by R.A. Schoof, et. al.

James Hilston/
Post-Gazette
Is there a health concern?

- 2008 Baby Rice cereals study
  - Drinking water 10 ppb: 0.17 μg/d/kg
  - Baby rice cereal: 0.21 μg/d/kg
- FDA 2013
  - 1343 samples
  - 30% contained levels > 4.0 ppb per serving (excesses drinking water limit if > 4 servings/day)
  - Arsenic also in Infant and children’s food products
- 2017 Gluten free diet study
  - Higher concentrations of urinary total arsenic,
  - Mean concentration of estimated urinary total arsenic was nearly double among those on a gluten-free diet versus not on a gluten-free diet


What do we know?

- Rice > other grains
  - Anaerobic growing environment
  - Unique physiology
- Brown rice > white rice
  - Arsenic accumulates in the bran
  - Brown rice has more fiber and vitamins
- South Central U.S. > California
- Basmati and sushi rice less than other types of rice
Figure 4. Urinary arsenic and rice intake levels in children by race, NHANES 2003-2008.
Is there a health concern?

Figure 3. Increasing median urine arsenic with increasing rice intake in children. NHANES 2003-2008.
What can you do?

- The FDA advises consumers to:
  - Eat a well-balanced diet
  - Vary your grains
  - Consider diversifying infant foods

- The AAP advises parents to:
  - Offer children a wide variety of foods, including other grains such as oats, wheat and barley
  - Parents commonly feed infants rice cereal as a first food, but other foods are equally acceptable as a first food
## Summary: Arsenic

<table>
<thead>
<tr>
<th>Sources of Exposure</th>
<th>Rice, fish, water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary concern (chronic exposure)</strong></td>
<td>Bladder, lung, skin cancer</td>
</tr>
<tr>
<td><strong>T(_{1/2})</strong></td>
<td>Blood 10 hours, urine 48 hours</td>
</tr>
<tr>
<td><strong>Screening:</strong></td>
<td>24 hour urine collection is best</td>
</tr>
<tr>
<td><strong>National average ages 6-11 total arsenic - urine</strong></td>
<td>7.78 μg/L (creatinine corrected)</td>
</tr>
<tr>
<td><strong>National average ages 6-11 inorganic arsenic - urine</strong></td>
<td>7.38 μg/L (creatinine corrected)</td>
</tr>
<tr>
<td><strong>95% Percentile ages 6-11 inorganic arsenic - urine</strong></td>
<td>17.8 μg/L (creatinine corrected)</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>Removal from exposure</td>
</tr>
</tbody>
</table>
Lead
What is lead?

- Inorganic lead is a malleable, blue-gray, heavy metal that occurs naturally in the Earth’s crust. It has a low melting point, high density and corrosion resistant. These properties allow it to be used in a variety of products with minimal technical equipment or expertise.

- Lead was one of the first metals used by humans and consequently, the cause of the first recorded occupational disease (lead colic in a 4th century BC metal worker).

- In 2012, U.S. production of lead was estimated at 1.6 million metric tons; primarily from secondary refining of scrap metal.

- U.S. mines produced 342,000 metric tons, ranking third in the world behind China and Australia.

https://www.osha.gov/SLTC/lead/
Leads movement through the blood brain barrier

- Substitutes for Ca$^{2+}$ and passes through ion channels
- Interferes with astrocyte and endothelial cell communication
- In children <6 (12 – 24 months) have incomplete blood brain barrier that permits the entry

Lead’s multiple toxic mechanisms

- Pb$^{2+}$ enters through Ca$^{2+}$ channel, and binds with calmodulin with a higher affinity than Ca$^{2+}$
- Pb$^{2+}$ may also be stored in the endoplasmic reticulum, in place of Ca$^{2+}$, and released when the G-protein activates phospholipase C, leading to abnormal enzyme activity and gene transcription
- Protein kinase C binds Pb$^{2+}$ more readily than Ca$^{2+}$ resulting in cellular dysfunction


Where is lead?

**Damaged paint in homes built pre-1979**
Cracked or peeling paint creates paint chips and lead dust that can be accessible to children in the home and through contact with bare soil.

**Children's Toys**
Lead has been found in the paint, glaze & metal parts of various toys.

**Children's Clothing**
Coatings, jewelry & decals on some children's clothing.

**Home Remedies**
Some remedies from foreign countries contain lead.

**Lead dust from work and hobbies**
Working in construction, painting, gardening or recycling centers as well as doing activities like fishing or making jewelry, pottery or stained glass can track lead dust back to the house. Shower as soon as getting home.

**Unsafe Work Practices**
Homes can become contaminated with lead due to improper remodeling. Always hire a lead-certified contractor to do home repairs. Requiring lead safe work practices in your home will protect children, pets and the environment.

**Children's Art Items**
Some children's arts and crafts products are recalled due to violation of paint standard. Unless labeled "Meets ASTM D-4236".

**Handmade & Imported Ceramic Ware**
May have lead glaze. Do not purchase if item has Prop. 65 Warning.

**Metallic Jewelry & Keys**
Some necklaces, rings, bracelets, charms and keys contain lead. Swallowing an item can be fatal.

**Imported Candies**
Numerous foreign candies have been found to contain lead. Consider fruit instead of candy.

**Makeup**
Some lipsticks have been found to have lead, as well as eyeliners from the Middle East.

**Soft Cables & Cords**
Lead in the plastic coatings may be swallowed when cables/cords are sucked on or chewed.

Worries About Lead for New York's Garden-Fresh Eggs

A study suggests eggs from neighborhood gardens show elevated levels of lead, but whether the amounts are alarming is not clear.

NYTIMES.COM | BY JULIE SELFO
Blood Lead Concentrations Considered Harmful by the CDC

In 2012, the CDC eliminated the term, "blood lead level of concern" and declared there is no safe level of lead in children's blood.

Taylor MP, Winder C, Lanphear BP. Australia's leading public health body delays action on the revision of the public health goal for blood lead exposures. Environ Int. 2014 Sep;70:113-7.
Organ System toxicity

- **GI**
  - Lead colic, which includes sporadic vomiting, intermittent abdominal pain, and constipation,

- **Renal**
  - $< 10 \text{ µg/dL} =$ Lead nephropathy/chronic interstitial nephritis, renal tubular dysfunction: aminoaciduria, glycosuria, proteinuria

- **Nervous System**
  - *Any Level* = cognitive deficits.
  - $20 \text{ µg/dL} =$ Peripheral Neuropathy
  - Hearing Loss
  - $100 \text{ µg/dL} =$ encephalopathy
## Target Organs

<table>
<thead>
<tr>
<th>Children</th>
<th>Lead concentration in blood, μg per dl. (μmol per l)</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>150 (7.25)</td>
<td></td>
</tr>
<tr>
<td>Encephalopathy</td>
<td></td>
<td>Encaphalopathy</td>
</tr>
<tr>
<td>Nephropathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frank anemia</td>
<td></td>
<td>Frank anemia</td>
</tr>
<tr>
<td>Colic</td>
<td>100 (4.80)</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin synthesis</td>
<td></td>
<td>Decreased longevity</td>
</tr>
<tr>
<td>Peripheral neuropathies</td>
<td>Frogs (men)</td>
<td>Systolic blood pressure (men)</td>
</tr>
<tr>
<td>Nephropathy</td>
<td></td>
<td>Hearing acuity</td>
</tr>
<tr>
<td>Vitamin D metabolism</td>
<td></td>
<td>Erythrocyte protoporphryin (men)</td>
</tr>
<tr>
<td>Nerve conduction velocity</td>
<td></td>
<td>Erythrocyte protoporphryin (women)</td>
</tr>
<tr>
<td>Iron deficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental toxicity</td>
<td></td>
<td>Hypertension (men)</td>
</tr>
<tr>
<td>IQ</td>
<td>10 (0.5)</td>
<td></td>
</tr>
<tr>
<td>Hearing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transplacental transfer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key:** ▲ Increased function; ▼ decreased function
Lead induced anemia

**Ineffective erythropoiesis**
- <40 µg/dL likely iron deficiency anemia (same risk factors as lead toxicity)
- 40 µg/dL = anemia 2/2 to hemoglobin precursors:
  - Inhibition of delta aminolevulinate dehydratase and ferrochelatase
  - Results in accumulation of heme intermediates such as free protoporphyrin in erythrocytes

**Hemolysis (>70 µg/dL)**
- Acquired deficiency of erythrocyte pyrimidine 5’-nucleotidase
  - or
- Inhibits alpha chain synthesis, mimicking alpha thalassemia
  - or
- Inhibition of RBC membrane ATP-ase


Lead lines

At 30 µg/dL as BLL↑, Vitamin D↓ affecting tooth/bone maturation
Bands of increased density at metaphyses of tubular bones (growing bone)
Metaphyses of growing bones may be dense normally
Lead lines more apt to be seen in proximal fibula and distal ulna
where growth is not as great as other long bones

Frontal radiograph of both knees of a child with lead poisoning

http://www.learningradiology.com/notes/bonenotes/leadpoisonpage.htm#sthash.5lp8J7M4.dpuf
Blood Lead and IQ scores in 1,333 children followed from birth to age 10.
Societal Costs

- The costs of lead hazard control range from $1.2-$11.0 billion/yr.
- The benefits range from $192-$270 billion/yr, this includes the sum of the costs for medical treatment, lost earnings, tax revenue, special education, lead-linked ADHD cases, and criminal activity.


## Levels of Prevention

<table>
<thead>
<tr>
<th></th>
<th>Primary Prevention</th>
<th>Secondary Prevention</th>
<th>Tertiary Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>Intervention implemented before there is evidence of injury</td>
<td>Intervention implemented after a disease has begun, but before it is symptomatic</td>
<td>Intervention implemented after a disease is established</td>
</tr>
<tr>
<td><strong>Intent</strong></td>
<td>Eliminate causative factor</td>
<td>Early identification and treatment</td>
<td>Prevent sequelae</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>Eliminate lead Exposure</td>
<td>Screen for lead exposure</td>
<td>Prevent anemia, encephalopathy, and renal failure</td>
</tr>
</tbody>
</table>
PRIMARY PREVENTION:

• Hygiene Guidance
  – Change out of work clothes and shoes before going inside the home.
  – Take off shoes or wipe them on a doormat before going inside the home.
  – Keep the home clean and dust-free.
  – Keep furniture away from paint that is chipped or peeling.
  – Never sand, dry scrape, power wash or sandblast paint.
  – Always wash hands before eating and sleeping.

• Nutrition Guidance
  – Balanced diet two daily servings of dairy or other calcium-rich foods and two servings of fruit or fruit juice provide sufficient calcium and vitamin C in the diet.
Secondary Prevention

- **AAP**
  - A risk assessment and anticipatory guidance to parents of children particularly 6 months to 6 years
  - BLL’s ideally at 1 and 2 years of age, unless lead exposure can be confidently excluded.

- **USPSTF (2006)**
  - There is INSUFFICIENT evidence to recommend for or against routine screening for elevated blood lead levels in asymptomatic children aged 1 to 5 who are at increased risk.
  - Recommends AGAINST routine screening for elevated blood lead levels in asymptomatic children aged 1 to 5 years who are at average risk.

- **CA DPH Screen:**
  - Children in publicly supported programs at both 12 months and 24 months.
  - Children age 24 months to 6 years in publicly supported programs who were not tested at 24 months or later.
  - Lives in a place built before 1978 that has peeling or chipped paint or that has been recently remodeled.

* Bright Futures
Tertiary Prevention

- Any level = **REMOVAL FROM EXPOSURE**!
- >45 µg/dL
  - Gut Decontamination
  - Hospitalization or other Lead free environment
  - Oral Chelation (Succimer/DMSA)
- >70 µg/dL
  - Oral + IV (Succimer + Ca EDTA)
- >100 µg/dL
  - IV + IM (Ca EDTA + Dimercaprol/BAL)
Wholesale Prices for Calcium Disodium Edetate (Calcium EDTA) – 5 ml ampules (200mg/ml)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Package Size (# of ampules)</th>
<th>Effective Date</th>
<th>Wholesale Acquisition Cost - Package</th>
<th>Average Wholesale Price – Package</th>
<th>Average Wholesale Price per ml</th>
<th>Percent Increase per ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graceway Pharmaceuticals</td>
<td>6</td>
<td>10/02/2008</td>
<td>$464.24</td>
<td>$557.09</td>
<td>$18.57</td>
<td></td>
</tr>
<tr>
<td>Valeant Pharmaceuticals North America</td>
<td>5</td>
<td>12/22/2014</td>
<td>$26,927.33</td>
<td>$33,659.16</td>
<td>$1346.37</td>
<td>7,150 %</td>
</tr>
</tbody>
</table>

[Source: Red Book Online Database – Micromedex Solutions® accessed 1/23/2016]
Valeant Ex-CEO, Ex-CFO Are a Focus of U.S. Criminal Probe

by Christian Berthelsen @CBerthelsen1 Greg Farrell @gregfarrel Neil Weinberg @NeilAWeinberg Cynthia Koons @CynthiaLKoons

October 31, 2016 – 12:24 PM PDT Updated on October 31, 2016 – 1:49 PM PDT

Pharmaceuticals.

CaEDTA entered the US pharmacopoeia in the 1950s as a chelating agent that accelerates the removal of lead from the body. When prescribed by medical toxicologists, it is administered by parenteral (i.e. intravenous or intramuscular) injection in a hospital setting to patients with extremely high blood lead concentrations, usually in excess of 100 μg/dl, who are suffering from severe or life-threatening complications of lead poisoning.
Over a 2-month period until in May 2010, nearly 300 children aged <5 years old presented with intractable seizures of unknown etiology, with a mortality of 48%.
Timeline of lead poisoning prevention policies and blood lead levels in children aged 1–5 years, by year—NHANES, United States, 1971–2008.
# Summary: Lead

<table>
<thead>
<tr>
<th>Reference value</th>
<th>&lt;5 μg/dL in whole blood</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screening:</strong></td>
<td>12 and 24 Months</td>
</tr>
<tr>
<td><strong>Sources of exposure</strong></td>
<td>Paint chips, demolition, construction</td>
</tr>
<tr>
<td><strong>Treatment (asymptomatic, levels &lt;45 μg/dL)</strong></td>
<td>Removal from exposure, KUB, ZPP, CBC, CMP</td>
</tr>
<tr>
<td><strong>Treatment (symptomatic, &gt;45μg/dL)</strong></td>
<td>Succimer x 19 days x 1</td>
</tr>
<tr>
<td><strong>T&lt;sub&gt;1/2&lt;/sub&gt;</strong></td>
<td>30 Days -blood</td>
</tr>
<tr>
<td><strong>Primary Concern</strong></td>
<td>Neurologic, renal, hematologic</td>
</tr>
</tbody>
</table>
Mercury
Forms of Mercury

Elemental

Inorganic

Organic

Hg

Hg\textsuperscript{0}

HgCl\textsubscript{2}

CH\textsubscript{3}Hg\textsuperscript{+}
The Global Cycle of Mercury.

Elemental

- Absorption: Inhalation
- Source: thermometers, old barometers and electrical switches, fluorescent light bulbs, mercury mining, smelting and artisanal gold mining
- Situation: Generally accidental
- Health Effects:
  - **Neurologic**: tremor, ataxia, polyneuropathy, abnormal reflexes, mercurial erethism (excitability, loss of memory, insomnia, extreme shyness); neurocognitive disorders
  - **Dermatologic**: acrody尼亚 with painful, swelling of extremities, pinkish discoloration, desquamation, erythema
  - **Pulmonary**: cough, dyspnea, **Oral**: gingivitis, stomatitis, **Renal**: proteinuria
- Symptoms may not correlate with levels
Inorganic

- Absorption: Dermal, inhalation, oral
- Source: Skin-lightening creams, soaps, Ayurvedic medicine
- Situation: Exposure/application of products from developing countries

Health Effects:
- Nephritic syndromes
- Acrodyopia
- Tremor
Organic

- **Absorption**: Oral, dermal
- **Source**: Prenatal exposure
- **Situation**: Mother’s diet high in methylmercury
- **Health Effects**:
  - **Chronic low level**: Neurodevelopment: loss of IQ points, decreased performance on tests, including memory, attention, language, and spatial cognition.
  - **Extremely high level**: microcephaly, cerebral palsy, severe mental retardation, seizure disorders, blindness, deafness, a
Advice About Eating Fish

What Pregnant Women & Parents Should Know

Fish and other protein-rich foods have nutrients that can help your child’s growth and development.

For women of childbearing age (about 16-49 years old), especially pregnant and breastfeeding women, and for parents and caregivers of young children.

- Eat 2 to 3 servings of fish a week from the “Best Choices” list OR 1 serving from the “Good Choices” list.
- Eat a variety of fish.
- Serve 1 to 2 servings of fish a week to children, starting at age 2.
- If you eat fish caught by family or friends, check for fish advisories. If there is no advisory, eat only one serving and no other fish that week.*

Use this chart!

You can use this chart to help you choose which fish to eat, and how often to eat them, based on their mercury levels. The “Best Choices” have the lowest levels of mercury.

What is a serving?

To find out, use the palm of your hand!

For an adult

4 ounces

For children, ages 4 to 7

2 ounces

---

<table>
<thead>
<tr>
<th>Best Choices</th>
<th>EAT 2 TO 3 SERVINGS A WEEK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchovy</td>
<td>Herring</td>
</tr>
<tr>
<td>Atlantic croaker</td>
<td>Lobster, American and spiny</td>
</tr>
<tr>
<td>Atlantic mackerel</td>
<td>Mullet</td>
</tr>
<tr>
<td>Black sea bass</td>
<td>Oyster</td>
</tr>
<tr>
<td>Butterfish</td>
<td>Pacific chub mackerel</td>
</tr>
<tr>
<td>Catfish</td>
<td>Perch, freshwater and ocean</td>
</tr>
<tr>
<td>Clam</td>
<td>Pickerel</td>
</tr>
<tr>
<td>Cod</td>
<td>Plaice</td>
</tr>
<tr>
<td>Crab</td>
<td>Pollock</td>
</tr>
<tr>
<td>Crawfish</td>
<td>Salmon</td>
</tr>
<tr>
<td>Flounder</td>
<td>Sardine</td>
</tr>
<tr>
<td>Haddock</td>
<td>Scallop</td>
</tr>
<tr>
<td>Hake</td>
<td>Shad</td>
</tr>
<tr>
<td></td>
<td>Shrimp</td>
</tr>
<tr>
<td></td>
<td>Skate</td>
</tr>
<tr>
<td></td>
<td>Smelt</td>
</tr>
<tr>
<td></td>
<td>Sole</td>
</tr>
<tr>
<td></td>
<td>Squid</td>
</tr>
<tr>
<td></td>
<td>Tilapia</td>
</tr>
<tr>
<td></td>
<td>Trout, freshwater</td>
</tr>
<tr>
<td></td>
<td>Tuna, canned light</td>
</tr>
<tr>
<td></td>
<td>(includes skipjack)</td>
</tr>
<tr>
<td></td>
<td>Whitefish</td>
</tr>
<tr>
<td></td>
<td>Whiting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Good Choices</th>
<th>EAT 1 SERVING A WEEK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluefish</td>
<td>Monkfish</td>
</tr>
<tr>
<td>Buffalofish</td>
<td>Rockfish</td>
</tr>
<tr>
<td>Carp</td>
<td>Tilefish (Atlantic Ocean)</td>
</tr>
<tr>
<td>Chilean sea bass</td>
<td>Patagonian toothfish</td>
</tr>
<tr>
<td>Grouper</td>
<td>Sheephead</td>
</tr>
<tr>
<td>Halibut</td>
<td>Snapper</td>
</tr>
<tr>
<td>Mahi mahi/ dolphinfish</td>
<td>Tuna, albacre/ white tuna, canned and fresh/frozen</td>
</tr>
<tr>
<td></td>
<td>Spanish mackerel</td>
</tr>
<tr>
<td></td>
<td>Striped bass</td>
</tr>
<tr>
<td></td>
<td>(ocean)</td>
</tr>
<tr>
<td></td>
<td>Weakfish/seaturt</td>
</tr>
<tr>
<td></td>
<td>White croaker/Pacific croaker</td>
</tr>
</tbody>
</table>

---

*Some fish caught by family and friends, such as larger carp, catfish, trout and perch, are more likely to have fish advisories due to mercury or other contaminants. State advisories will tell you how often you can safely eat those fish.

Choices to Avoid

HIGHEST MERCURY LEVELS

King mackerel | Shark | Tilefish (Gulf of Mexico) |
Marlin        | Swordfish | Tuna, bigeye |
Orange roughy |           |           |
## Summary: Mercury

<table>
<thead>
<tr>
<th></th>
<th>Elemental</th>
<th>Inorganic</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Route of absorption</strong></td>
<td>Inhalation</td>
<td>Dermal, inhalation (chronic), oral</td>
<td>Transplacental</td>
</tr>
<tr>
<td><strong>Clinical effects</strong></td>
<td>Tremor, Acrodynia</td>
<td>Erethism, tremor, Acrodynia</td>
<td>“Minamata” disease</td>
</tr>
<tr>
<td><strong>Screening</strong></td>
<td>Urine</td>
<td>Whole Blood/Urine</td>
<td>Whole Blood</td>
</tr>
<tr>
<td><strong>Average value</strong></td>
<td>0.241μg/dL</td>
<td>ND (blood)</td>
<td>0.209 μg/dL</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Thermometers</td>
<td>Skin creams</td>
<td>Predator fish diet</td>
</tr>
<tr>
<td><strong>T$_{1/2}$</strong></td>
<td>90 days in urine</td>
<td>4-45 days in urine</td>
<td>50 days in blood</td>
</tr>
</tbody>
</table>

* Ages 6-11, NHANES 2011-2012
ND = Not detectable
Common Pitfalls
Common Pitfalls

Treating

▪ Chelation
  • Nausea, vomiting
  • Electrolyte disturbances
▪ “Detoxification”
  • Colon cleanse
  • Cyanide
  • Hydrogen peroxide

Testing

▪ Personal Testing:
  • Hair
  • Nails
  • Excreta
  • $$$
▪ Environmental testing
Most important route(s) of exposure to lead for children is/are:

- Ingestion
- Inhalation
- Dermal contact
- Endogenous sources

Start the presentation to activate live content.
If you see this message in presentation mode, install the add-in or get help at PollEv.com/app.
The toxicity of arsenic is related to:

- Organic or inorganic form
- Valence state
- Solubility
- Rate of absorption

Start the presentation to activate live content

If you see this message in presentation mode, install the add-in or get help at PollEv.com/app
accurate test for measuring levels of organic exposure is:

- Urine
- Whole blood
- Serum
- Hair
Early life exposure: greater lung and bladder cancer risk

![Graphs showing odds ratio over age of exposure for lung and bladder cancer.](https://example.com/graphs)

Lung cancer

Bladder cancer

Courtesy Craig Steinmaus
- Arsenic Backup slides
Why Rice?

Rice more As than other grains

- Anaerobic environment, plant characteristics

<table>
<thead>
<tr>
<th>Product</th>
<th>Inorganic arsenic (mcg/serving)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakery mixes and pudding</td>
<td>4.1</td>
</tr>
<tr>
<td>Beverages (incl. beer, protein and rice drinks)</td>
<td>2</td>
</tr>
<tr>
<td>Cereals</td>
<td>2.6</td>
</tr>
<tr>
<td>Grain-based bars</td>
<td>1.8</td>
</tr>
<tr>
<td>Rice cakes</td>
<td>4.3</td>
</tr>
<tr>
<td>White rice</td>
<td>4.2</td>
</tr>
<tr>
<td>Brown rice</td>
<td>7.2</td>
</tr>
<tr>
<td>Basmati rice</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Brief summary of rice grain and rice products sampled by the FDA and the corresponding amount of inorganic arsenic per serving, based on data published in 2013.
US Water Standard
10 µg As/L x 1L/day (adult) = 10 µg/d

- 10 µg/d results in excess cancer risk 1 in 300 *
  - Eating 0.56 cups of cooked rice/d = 10 µg/d**

- Top 1% rice-eating children eat ≥ 1.75 cups
  = >>> 1 in 300 estimated cancer risk

*National Academy of Sciences 2001
**Gilbert-Diamond et al. Rice consumption contributes to arsenic exposure in US women PNAS 2011
Who are at risk?

- Children
- High rice consumers
  - Asian American, ethnic minorities
  - Poor
  - Celiac disease / Gluten Free Diets
  - Food allergies
  - Vegan
  - Macrobiotic Diet
- Lead Backup slides
California Rental Laws

- The landlord must disclose the presence of known lead-based paint and lead-based paint
- The landlord is not required to conduct any evaluation of the lead-based paint, or to remove it.
Flint, Michigan

- April 25, 2014: Michigan state officials changed the water source for the City of Flint from Detroit’s municipal system to the Flint River.

- Anti-corrosives weren’t used, lead began to leach from aging water lines.
Welcome!

We provide services to prevent lead poisoning and to promote health and safety in the home.

Main Phone Line: 510-567-8280
How lead gets into home water

Scenario 1: Only the portion of the service line from the water main to the external shut-off valve or property line is made of lead.
- Lead Service Line
- Non-Lead Service Line

https://www.epa.gov/sites/production/files/2015-10/lead-service-line-scenario1.png
Childhood Lead Exposure

Amid growing evidence that even low levels of lead exposure can cause long-term damage to children’s development, the American Academy of Pediatrics urges stronger federal action to eliminate exposure.

None
Level of lead exposure considered safe for children

$50 billion
Annual cost of childhood lead exposure in the United States

$17 to $221
Money saved for every $1 invested to reduce lead hazards in U.S. housing

535,000
Estimated number of U.S. preschool children with blood lead levels high enough to call for medical management (more than 5 ug/dl)

23 million
Estimated total loss of IQ points among U.S. children today from lead toxicity

1 in 5
Attention Deficit Hyperactivity Disorder cases attributed to lead exposure

Common sources of lead in the home:
- Dust
- Soil
- Water in lead pipes
- Toys
- Nutritional supplements
- Dishware
- Fishing sinkers
- Bullets
- Residue from parent occupations
- Paint/hobby materials

37 million
Estimated number of housing units in United States that contain lead-based paint

U.S. housing built from 1940-1959: 39 percent
U.S. housing built from 1960-1977: 11 percent
U.S. housing built from 1978-1998: 3 percent

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™