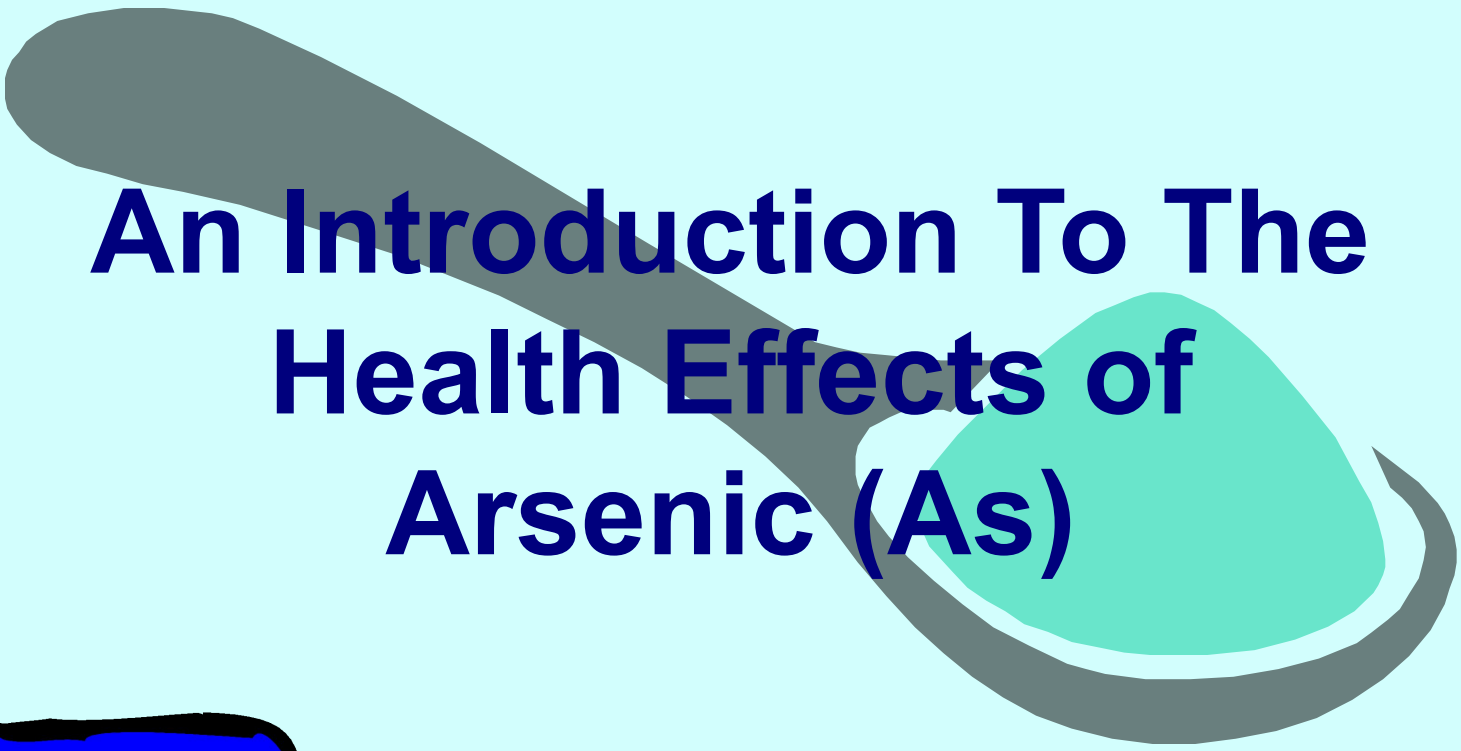


A Small Dose of™ Arsenic

An Introduction To The Health Effects of Arsenic (As)



As Arsenic

Atomic Number: 33

Atomic Mass: 74.92

Ancient Awareness

A Therapeutic Agent and A Poison 2400 Years Ago In Greece and Rome



Quote / History

(Henry Adams)....he found himself invariably taking for granted, as a political instinct, with out waiting further experiment,—as he took for granted that arsenic poisoned,—the rule that a friend in power is a friend lost.

Henry Adams (1838–1918).

The Education of Henry Adams. 1918



Quote / History

**They put arsenic in his meat
And stared aghast to watch him eat;
They poured strychnine in his cup
And shook to see him drink it up**

**A.E. (Alfred Edward) Housman
(1859–1936)**



Historical Awareness

**For many years used to treat
syphilis and amebic dysentery
But caused skin cancer in
patients treated with arsenicals**



Production

- **By product of smelting for cooper, lead, zinc**
- **Last smelter in Tacoma Washington closed in 1985 – still dealing with pollution issues**
- **Annual use 20,000 tons imported**



Current Use

- Use is dropping because of toxicity
- 90% used as wood preservative (although this too is being phased out)
- Silicon based computer chips
- Feed additive (poultry and swine)
- Cotton fields
- Chemotherapeutic



Human Exposure

- Average 20 $\mu\text{g}/\text{day}$ from food and water
- Background air is less than $0.1 \mu\text{g}/\text{m}^3$
- Drinking water usually less than $5 \mu\text{g}/\text{L}$
- Food is usually less than $10 \mu\text{g}/\text{day}$

(assume 2000 mL/day average water consumption at $5 \mu\text{g}/\text{L}$ arsenic)



Inorganic Arsenic

□ Trivalent (As^{3+})

- arsenic trioxide, sodium arsenite
- arsenic trichloride

□ Pentavalent (As^{5+})

- arsenic pentoxide, arsenic acid,
- arsenates (lead arsenate)



Organic Arsenic

- **Less toxic than inorganic As**
- **Produced by Biomethylation**
 - **Organisms in soil and water**
 - **Humans (detoxify organic As)**
 - **High in shrimp**



Absorption

- **Inorganic arsenic (arsenic trioxide) 80-90% absorbed from intestine**
- **Organic arsenic (seafood) poorly absorbed from intestine**
- **Lung**
- **Skin**



Distribution

- **Bound to red blood cells**
- **Distributes to liver**
- **Binds to sulfhydryl containing proteins - concentrates in the hair and fingernails (Mees' Lines)**



Metabolism

As⁵⁺ (Arsenate)



As³⁺ (Arsenite)



Methylarsenite (in liver)



**Dimethylarsenite
(readily eliminated – urine)**



HALF-LIFE

- **3-5 days**
- **Excreted**
 - **Urine (majority)**
 - **Skin cells**
 - **Sweat**



Acute - Toxicity

- Inorganic arsenic (arsenic trioxide)
70 to 180 mg can be fatal
- Constriction of the throat with
difficulty in swallowing
- Severe intestinal pain
- Vomiting, diarrhea
- Muscle cramps
- Severe thirst
- Coma and death



Chronic - Toxicity

Chronic exposure (drinking water)

- **Skin cancer (recognized 100 years ago)**
- **Garlic odor on breath**
- **Excessive perspiration**
- **Muscle tenderness and weakness**
- **Changes in skin pigmentation**
- **Paresthesia in hands and feet**
- **Peripheral vascular disease**
- **Gangrene of feet – Blackfoot disease**

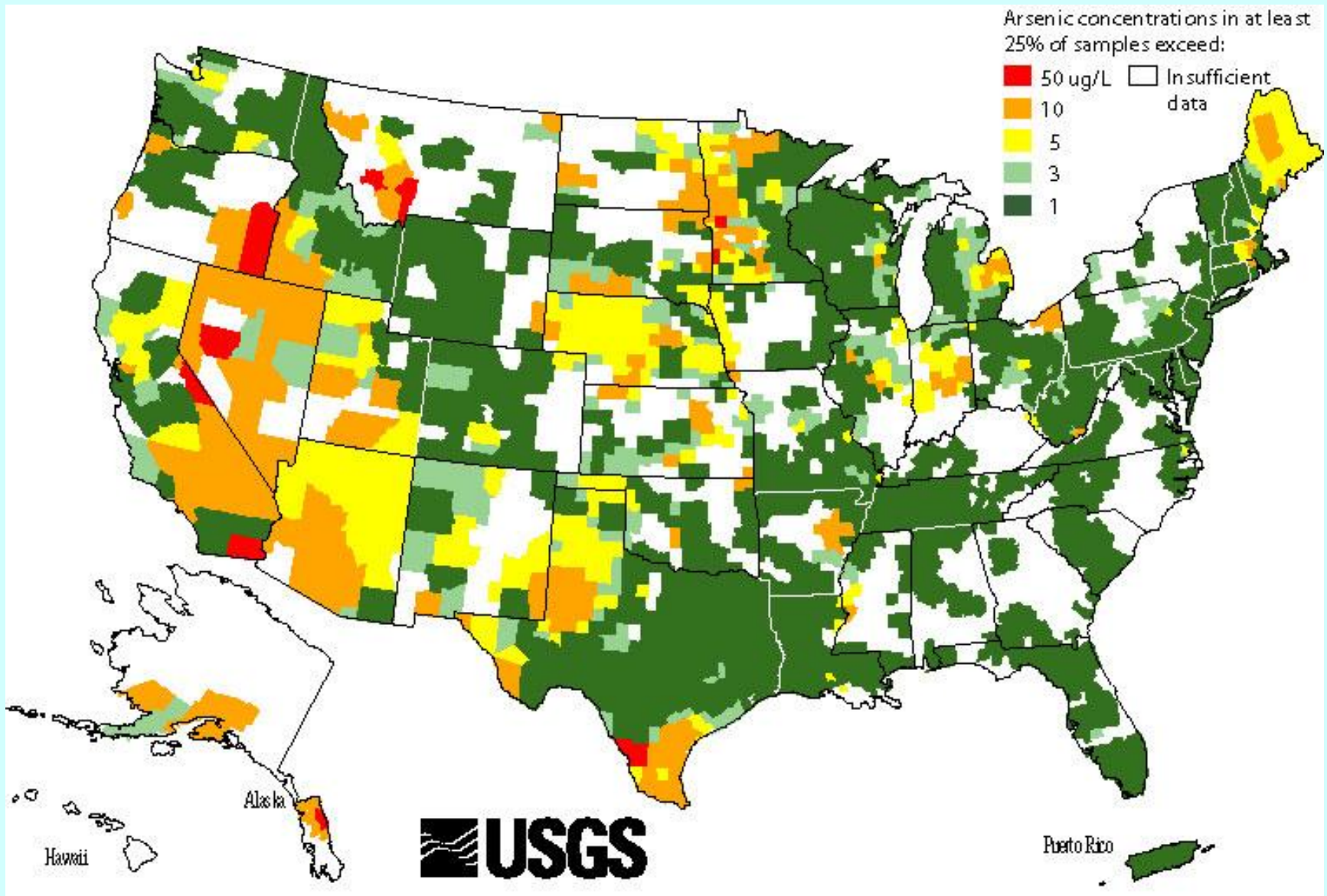


Exposure

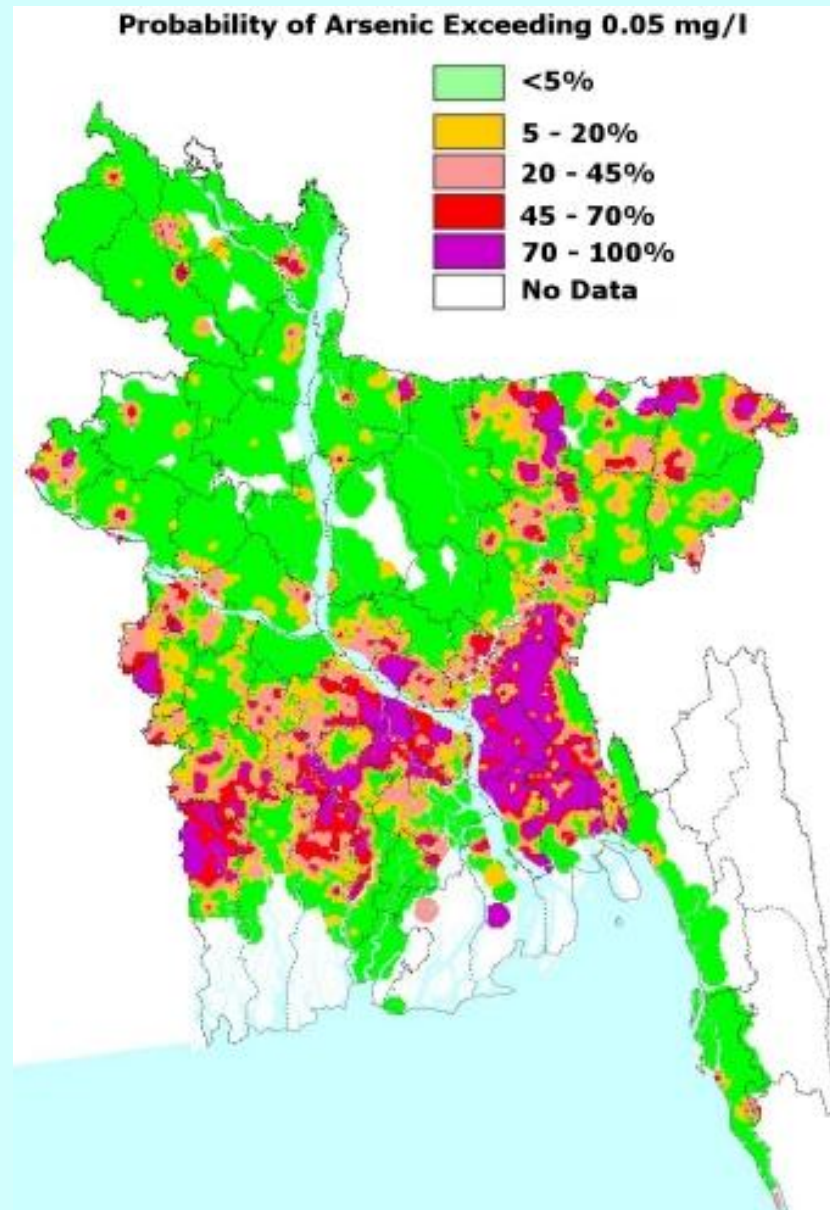
- **Drinking water**
- **Burning arsenic treated wood**
- **Handling treated wood**



US Arsenic Map



Bangladesh Arsenic Map



Susceptibility & Variability

**Children – small size,
higher water consumption
for size**



Reducing Exposure

- **Avoid (do not use treated lumber)**
- **Test drinking water**
- **Stop smoking**
- **Wash hands**



Summary

- **Arsenic in drinking water is a worldwide human health hazard**
- **Avoid the use of arsenic treated wood**
- **Reduce or avoid arsenic exposure**



Regulatory Status

- EPA - Drinking water 50 $\mu\text{g}/\text{L}$ (50 ppb) (under review to 10 $\mu\text{g}/\text{L}$)
- EPA – RfD - .3 $\mu\text{g}/\text{kg}\text{-day}$
- ATSDR – MRL – 0.3 $\mu\text{g}/\text{kg}/\text{day}$ (chronic exposure)
- OSHA - Workplace air - 0.5 mg/m^3



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Additional Information

□ Web Sites

- ATSDR –Toxicology Profile Series Arsenic - <http://www.atsdr.cdc.gov/ToxProfiles/>
- US Environmental Protection Agency (EPA) – www.epa.gov



Authorship Information

**This presentation is supplement to
“A Small Dose of Toxicology”**

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