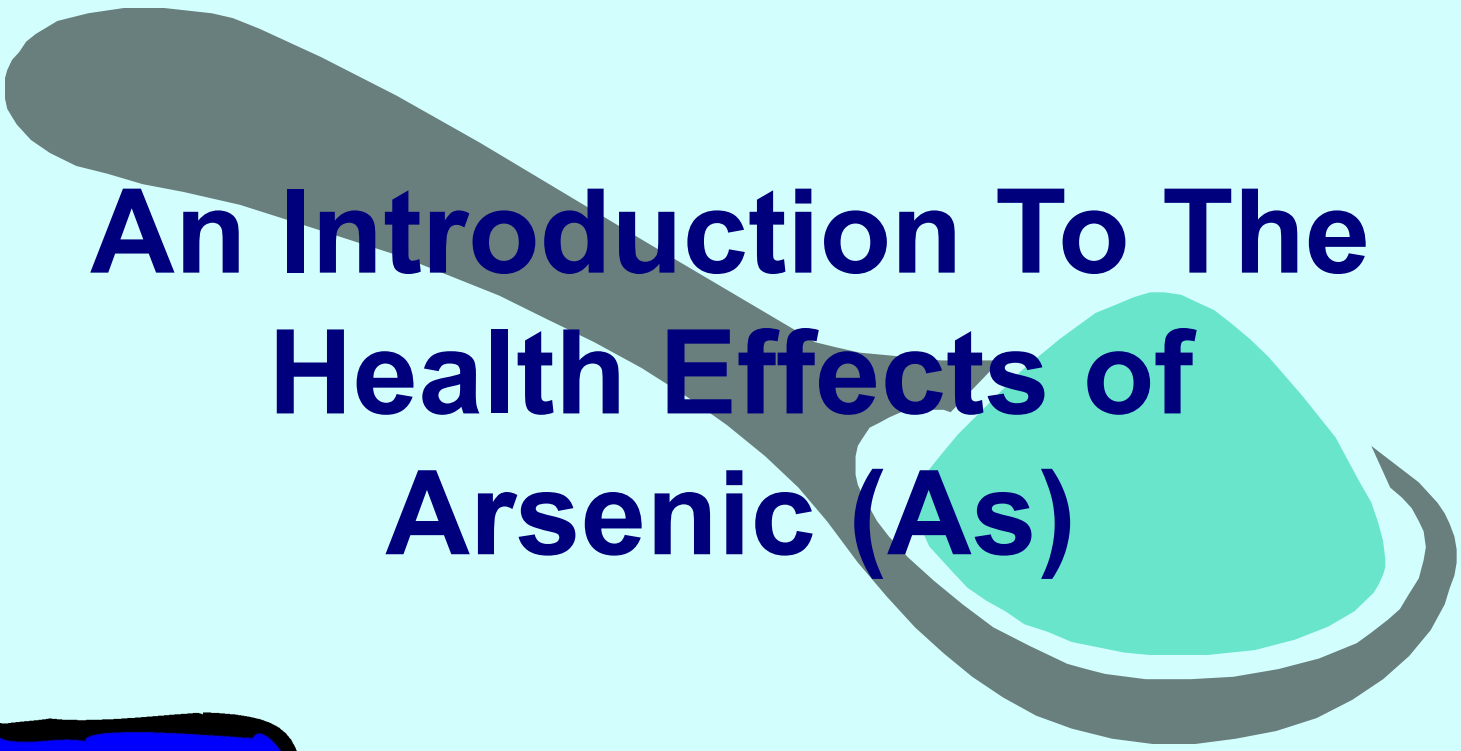


# A Small Dose of™ Arsenic

## 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 ( $\text{As}^{3+}$ )

- arsenic trioxide, sodium arsenite
- arsenic trichloride

## □ Pentavalent ( $\text{As}^{5+}$ )

- 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

**As<sup>5+</sup> (Arsenate)**



**As<sup>3+</sup> (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



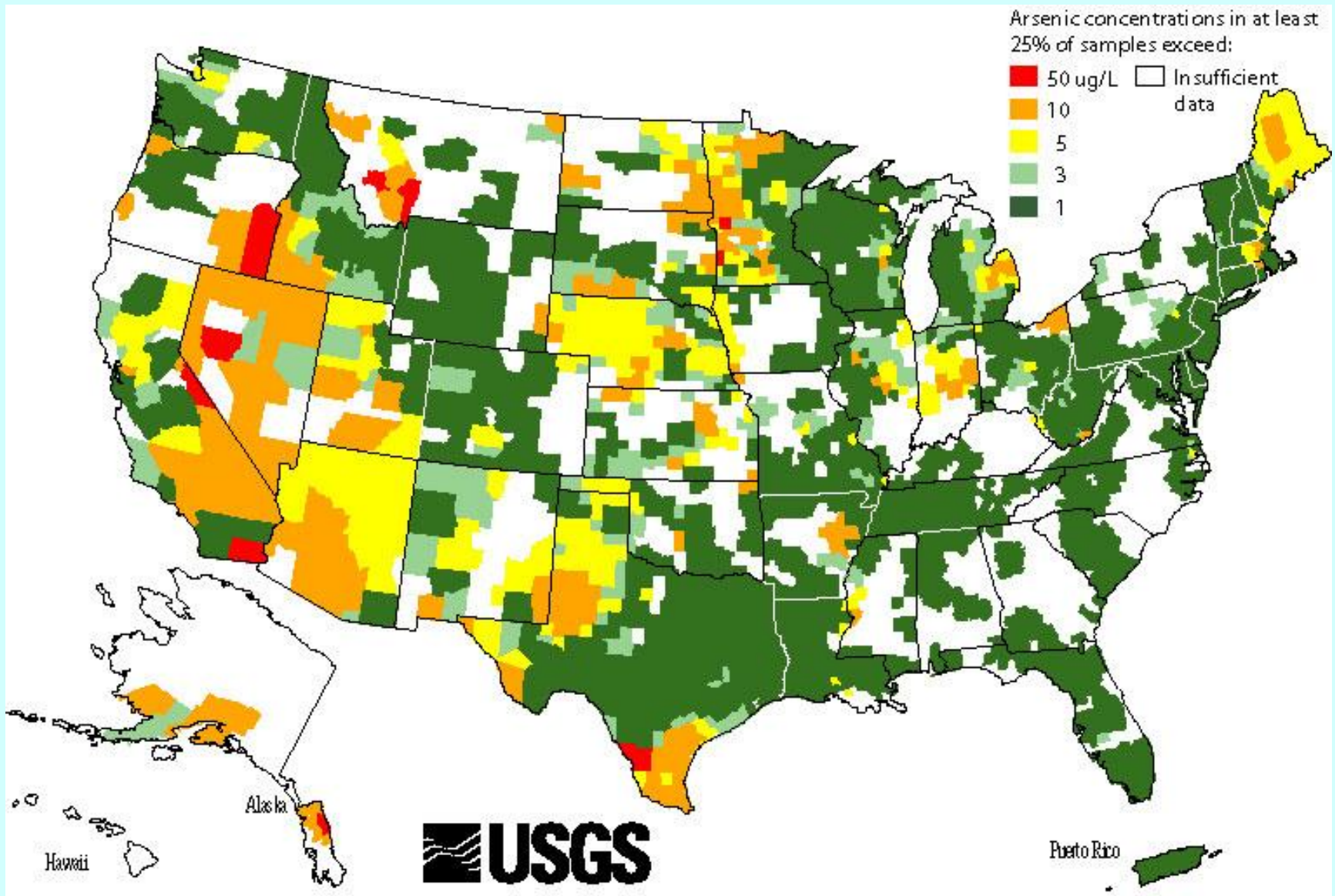


# Exposure

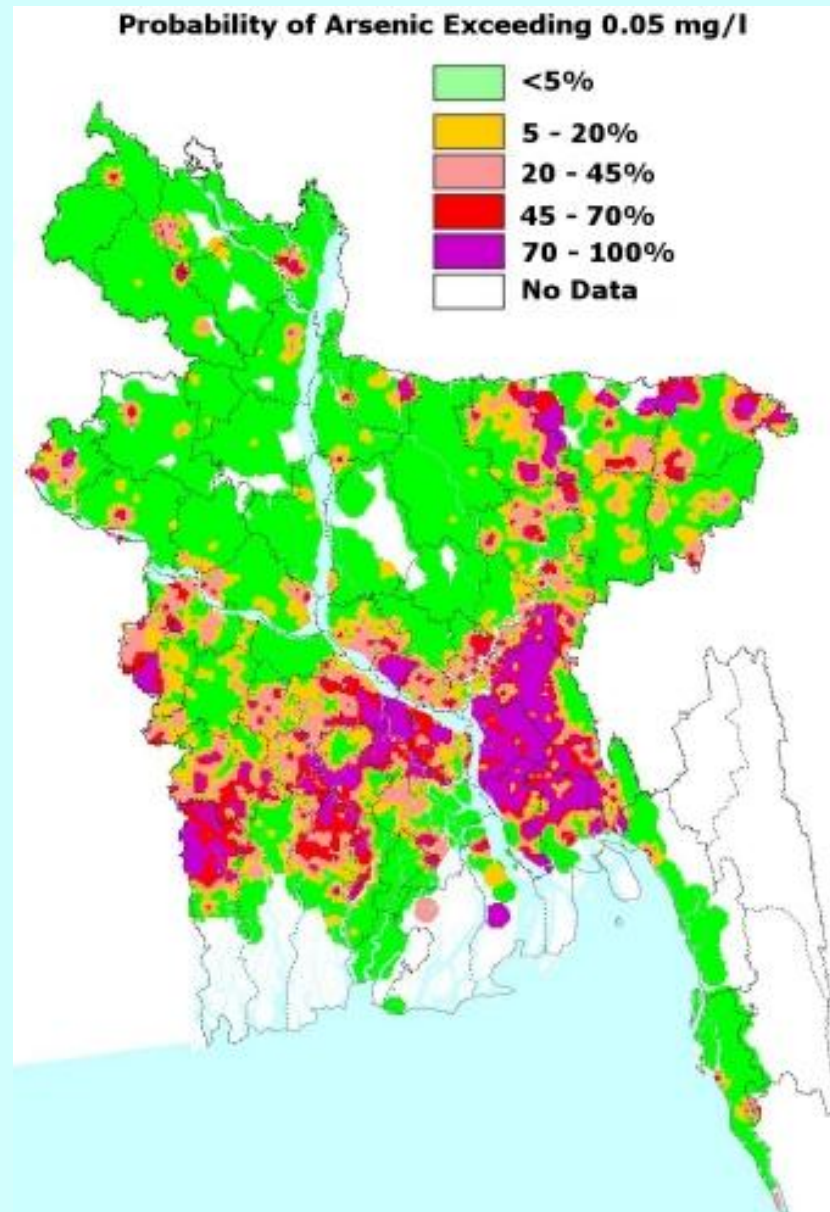
- **Drinking water**
- **Burning arsenic treated wood**
- **Handling treated wood**



# 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  $\text{mg}/\text{m}^3$



# A Small Dose of™ Arsenic





# Additional Information

## □ Web Sites

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



# Authorship Information

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

**For Additional Information Contact  
Steven G. Gilbert, PhD, DABT  
E-mail: [smdose@asmalldoseof.org](mailto:smdose@asmalldoseof.org)  
Web: [www.asmalldoseof.org](http://www.asmalldoseof.org)**

