



Arsenic Exposure and Health Effects

Arsenic and Private Well Training

May 28, 2015

by Stuart C. Schmitz, M.S., P.E.

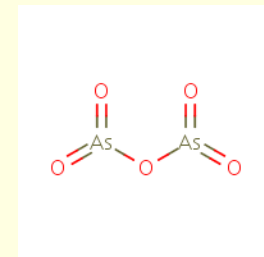
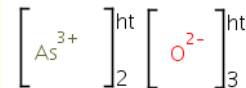
Overview

- Forms of arsenic found within environment
- Arsenic exposures in Iowa
- Health effects from acute exposures to large amounts of arsenic
 - Use of arsenic as a poison
 - Potential for other large exposures
- Health effects from chronic exposure to smaller amounts of arsenic
 - Exposure within food
 - Drinking water
 - Cancer potential
- EPA Maximum Contaminant Level for arsenic
- Arsenic poisoning cases in Iowa

Forms of Arsenic

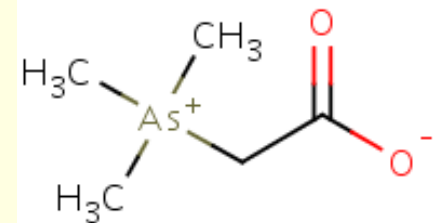
■ Inorganic Arsenic

- Naturally occurring. The IDNR considers a background level of arsenic within shallow surface soil (< 1 ft. deep) to be 17 mg/kg or 17 ppm.
- The concentration of arsenic varies within soil and rock layers
- Arsenic trioxide (As_2O_3), Arsenic pentoxide (As_2O_5)



Forms of Arsenic

- Organic Arsenic
 - Found within seafood – arsenobetaine
 - Much less toxic than inorganic arsenic



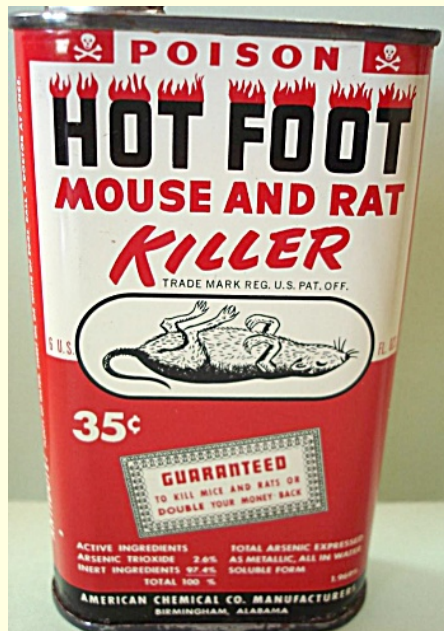
Arsenic in the Environment

- Arsenic is found in the food that we eat
 - Diet is the largest source of both inorganic and organic arsenic for typical individuals
- Arsenic was used in pressure-treated wood - copper chromated arsenic (CCA)
 - In 2003, U.S. manufacturers of wood preservatives containing arsenic began voluntary transition from CCA to other wood preservatives without arsenic



Arsenic in the Environment

- Arsenic has been used in some pesticides
 - Formerly used in rat poison
 - Insecticides, and defoliant agents



Arsenic Exposures in Iowa

- Everyone is exposed to low levels of arsenic
 - Diet is the largest source: Seafood is the likely source of largest source – mostly organic forms of arsenic, non-toxic.
 - Estimated dietary intake ranges from 1 to 20 μg
- Presence of arsenic in soil – impacts to groundwater
 - Elevated arsenic (above EPA MCL of 10 ppb) is found in groundwater throughout Iowa – natural occurring
- Industrial or commercial exposure to arsenic
 - Pesticide manufacture and application
 - Semi-conductor and glass manufacturing – dusts and aerosols

Health Effects – Large Acute Exposures

- Use of arsenic as a poison
 - In the middle ages arsenic became known as the “king of poisons” and the “poison of kings”
 - Undetectable in food and beverages and high toxicity
 - Minimal fatal dose of 150 mg (about 1/10 of a teaspoon)
 - Immediate symptoms of stomachache, nausea, vomiting, and diarrhea; followed by gastrointestinal hemorrhage and death from fluid loss and circulatory collapse
 - Fatal concentration in water at 60,000 ppb
 - Extreme gastrointestinal impacts from 300 to 30,000 ppb

Health Effects – Large Acute Exposures

- Other Health Effects from Large Exposures
 - Decreased production of red and white blood cells
 - Extreme fatigue
 - Abnormal heart rhythm
 - Blood vessel damage resulting in bleeding and bruising
 - Impaired nerve function causing a "pins and needles" sensation in your hands and feet
 - Inhaling a large dose of inorganic arsenic may cause sore throat and irritated lungs

Health Effects – Smaller Chronic Exposures

■ Health Effects from Smaller Chronic Exposures

- Long term impacts from elevated arsenic in drinking water
 - Darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso
 - Also Mees lines: lines of discoloration across the nails of the fingers and toes named after Dutch physician R.A. Mees
 - This impact is seen in India and China – chronic exposure to well water with concentrations as low as 170 ppb.

Pictures of Impacts of Arsenic Exposure



Discoloration of Hands



Mees Lines

Arsenic and Cancer

- A known human carcinogen
- Epidemiological studies and case reports of human exposed to arsenic or arsenic compounds for medical treatment, in drinking water, or occupationally have demonstrated that exposure to arsenic and inorganic arsenic compounds increases the risk of cancer.
(National Toxicology Program)
 - Cancer sites include: skin, lung, digestive tract, liver, urinary bladder, kidney, and lymphatic and blood forming systems

Arsenic and Cancer

- Occupational Exposure to Arsenic
 - Associated with the following industries:
 - Mining and copper smelting
 - Glass workers, hat makers, and pesticide workers
 - Not common in Iowa
 - Cancer from industrial exposure
 - Cancer sites include: Lung, skin, kidney, digestive tract, and lymphatic and blood forming systems

Arsenic and Cancer

- Exposure to Elevated Arsenic in Drinking Water
 - Association with skin cancer and exposure to elevated levels of arsenic in well water
 - Epidemiologic studies in Taiwan
 - In areas where blackfoot disease (darkening and warts on feet and hands) is endemic
 - Drinking water exposure to levels ranging from 350 to 1,140 ppb
 - Increased the risks of urinary-bladder, kidney, skin, lung, liver, and colon cancer

EPA Maximum Contaminant Level (MCL) for Arsenic

- On January 22, 2001 EPA revised the MCL for arsenic from 50 ppb to 10 ppb
- According to the EPA, “The 10 ppb protects public health based on the best available science and ensures that the cost of the standard is achievable.”
- At the time EPA estimated that changing the standard from 50 ppb to 10 ppb would
 - Prevent ~ 19-31 cases of bladder cancer and ~ 5-8 deaths due to bladder cancer per year in US.
 - Prevent ~ 19-25 cases of lung cancer and ~ 16-22 deaths due to lung cancer per year in US.

EPA Maximum Contaminant Level (MCL) for Arsenic

- Application of the arsenic MCL
 - This is enforceable for:
 - Community water systems
 - Non-transient, non-community water systems
 - Recommended for all private water supplies
- How safe is the arsenic MCL of 10 ppb?
 - The lowest level of adverse non-cancerous health impacts seen in human drinking water exposure is a level of 170 ppb. Cancer impacts > 350 ppb
 - The lowest level in human drinking water exposures where no adverse non-cancerous health impacts was observed is at a level ranging from 1 - 17 ppb.
 - Conclusion: MCL is a safe level

Arsenic Poisoning Cases in Iowa

- Arsenic poisoning cases are required to be reported in Iowa
 - Blood levels equal to or greater than the equivalent of 70 micrograms per liter
 - Urine levels equal to or greater than the equivalent of 100 micrograms per gram of creatinine
- IDPH works with health care providers to determine the reason for elevated blood or urine arsenic levels.

Arsenic Poisoning Cases in Iowa

- IDPH has received 5 reported cases of elevated arsenic levels (in urine)
 - 2012: 69-year-old male – intentional ingestion
 - 2012: 62-year-old male – likely food, organic form of arsenic
 - 2014: 74-year-old female – likely food, organic form of arsenic
 - 2014: 63-year-old female – likely food, organic form of arsenic
 - 2014: 74-year-old male – exposure not confirmed, likely food

Thank you!

Stuart C. Schmitz, M.S., P.E.

(515) 281-8707

stuart.schmitz@idph.iowa.gov

Check out Toxicology Manual on IDPH's website – one of the listing is for arsenic.

