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OREGON DEPARTMENT OF HUMAN SERVICES

ARSENIC, DRINKING WATER, AND ENVIRONMENTAL EXPOSURE

MARTHA: Well, dear...for a gallon of Elderberry wine, I take one teaspoon full of arsenic, and a half teaspoon full of strychnine and just a *pinch* of cyanide.
MORTIMER: It should have quite a kick.
ABBY: Oh, yes, yes. As a matter of fact, one of our gentlemen found time to say, "How delicious."

--From the 1944 film *Arsenic and Old Lace*

While it's unlikely that you'll ever see a case of intentional arsenic poisoning in your practice, there is a real potential for you to see at least low-level arsenic exposure in Oregon.

WHAT IS ARSENIC?[1,2,3]

Arsenic (As) is a naturally occurring element. It is found as inorganic and organic compounds. Both types of compounds are generally odorless and tasteless, so the only way to detect their presence in food, air, or water is through laboratory testing. Inorganic forms are considered to be more toxic than the organic forms.

Inorganic or mineral arsenic (arsenic combined with oxygen, chlorine, or sulfur) occurs naturally in soil, rocks, ores, and minerals. Inorganic arsenic is used as a wood preservative (CCA or copper chromated arsenic, phased out for residential use), in semiconductors, as termiticides, and historically in medical lotions, as agricultural pesticides, and in green paint pigments. It can be released into the air when ores such as copper or lead are heated in smelters.

Organic arsenic compounds are formed when arsenic combines with hydrogen and carbon; organic forms (arseno- betaine and arsenocholine) are generally less toxic than most of the inorganic forms. Some fish and shellfish take in arsenic, which bioaccumulates in their tissues.

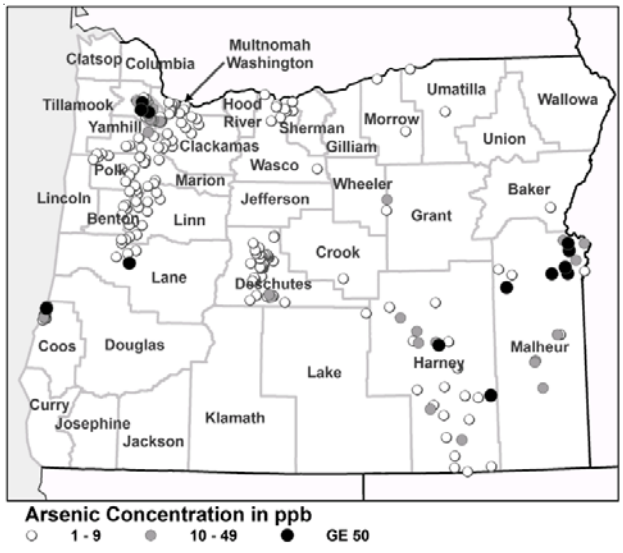
EXPOSURE TO ARSENIC IN OREGON

Over 600,000 Oregonians get their drinking water from private wells.[4] Numerous wells in Oregon contain arsenic concentrations exceeding the EPA drinking water standard of 10 micrograms of arsenic per liter of water (µg/L).[5] This value is equivalent to 10 parts per billion (ppb) and is referred to as a maximum contaminant level, or MCL. Arsenic compounds which get deposited in the earth from volcanic activity can dissolve in water and make their way into drinking water sources.[6] Limited well water data indicate that many private wells in south central and southwestern Oregon contain arsenic at levels well above 50 ppb, in some cases reaching up to 1000 ppb. Public water systems (those that have greater than 4 connections or serve 25 or more people year round) are required to test for and report arsenic levels. However, private wells are exempt from testing.

In 2000, the United States Geologic Survey (USGS) created a map of arsenic levels measured in drinkable water wells throughout the U.S. based on 31,350 groundwater samples. The map shown here has been adapted to show the distribution in Oregon (see Figure). Of the wells tested, five counties were reported to have arsenic levels at or greater than the MCL of 10 ppb in at least 25% of samples per county.[7] Additionally, well testing by Oregon's Department of Environmental Quality between 1986 and 2000 indicated that 24% of 1156 wells sampled for arsenic exceeded 10 ppb.[4] This number likely underestimates the extent of arsenic in groundwater due to the lack of testing in private wells in Oregon.

Other potential sources of arsenic exposure include work (such as in mining or in wood treatment operations), and arsenical pesticides used in agriculture, or from exposure to hazardous waste. Arsenobetaine (organic arsenic) is also commonly found at low levels in seafood, especially shellfish.

Arsenic concentrations in limited well sampling in Oregon.



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HEALTH EFFECTS

Inorganic arsenic has been known as a poison since ancient times. Large oral doses can result in death; acute poisoning can also result in nausea, vomiting, diarrhea, decreased production of red and white blood cells (leading to fatigue, bruising, and arrhythmias). Chronic exposures can result in skin changes (e.g. hyperpigmentation on hands and feet) as well as nerve damage (peripheral neuropathy).[1] There is also limited evidence that links increased arsenic exposure to other conditions such as type II diabetes, cardiomyopathy, and hypertension.[8] Additionally, the U.S. Environmental Protection Agency (EPA) and the Department of Health and Human Services classify inorganic arsenic as a human carcinogen (Class A). Ingestion of inorganic arsenic in drinking water has been linked to skin, lung, bladder, kidney, prostate, and liver cancers.[9]

WHEN AND HOW TO TEST

Arsenic poisoning, like many other environmental and occupational diseases, can manifest as a common medical problem or with nonspecific symptoms. Once suspected as a possibility, an exposure history should be taken that accounts for sources of drinking water, and the potential for exposure from other sources at work or home. A standardized occupational history form, such as one provided by the Agency for Toxic Substances and Disease Registry (ATSDR), can be helpful.*

If there is concern that a patient is experiencing health effects related to arsenic or they are drinking from a private well containing arsenic above the MCL, biological testing can be conducted to determine if their arsenic exposures are elevated. Urinary biomonitoring is the most reliable means of checking recent (within two to three days) or ongoing exposures. Analysis of hair and nail samples can be used to measure past exposures, but reference ranges and testing methods are variable.

Biological samples are usually tested for total arsenic, which can overestimate the inorganic fraction, since the less toxic organic forms such as arsenobetaine (from consuming fish or shellfish) are included in the concentration. Urinary arsenic samples can be speciated by specialized labs into inorganic and organic fractions, which is recommended if initial test results are above the background reference ranges for total arsenic in urine for the general public (50 µg/L or 35 µg/g creatinine adjusted). Shellfish and fish consumption should be avoided 48 hours prior to urinary monitoring for both total arsenic analysis and speciated analysis, and care must be taken with the samples to avoid contamination. Speciated lab results should include background reference ranges to aid in interpretation but toxicologists with the Oregon Public Health Division are available to assist with interpretations as well. Operators are standing by at the Toxicology Unit: 971/673-0440 or Drinking Water Program: 971/673-0405. Additional information can be found at *www.epa.gov/safewater/arsenic/basicinformation.html*.

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