Elevated Arsenic

Important Notice:

*All public health recommendations for routine investigations are based on "Control of Communicable Diseases Manual, 20th edition, 2015" (CCDM) unless otherwise stated. Use the CCDM as the primary resource for case investigations that meet routine follow up. In cases of complicated situations or unique issues not addressed by this manual, please refer to the Administrative Rules of Montana (ARM) Chapter **37.114** or contact the designated subject matter expert in the Office of Epidemiology and Scientific Support at the Montana DPHHS for further clarification.*

PROTOCOL CHECKLIST

- ☐ Confirm diagnosis, see case definition (see section 3.3 and 4.1)
- ☐ Review background information on elevated urine arsenic (see section 2)
- ☐ Contact provider to determine plan to re-test urine arsenic level
- ☐ Notify state health department of case by entering available information into the Montana Infectious Disease Information System (MIDIS), if available, within the time frame for the specific disease per (ARM) **37.114.204** (see section 1.3)
- ☐ Review for use, specific technical assistance guidance documents
- ☐ Interview patient/guardian, cover the following (See the CDEpi Resources Page):
  - ☐ Review health consequences of an elevated urine arsenic facts with patient/guardian (see section 2.2)
  - ☐ Ask about exposures to relevant risk factors to determine the risk of exposure for other household members (see section 4.3)
  - ☐ Educate patient/guardian on arsenic exposure prevention (see section 6)
  - ☐ Implement Control Measures (see section 5.1)
  - ☐ Address patient's/guardian's questions or concerns
  - ☐ Determine answers to "condition specific" questions at the end of each MIDIS investigation and the Follow Up Exposure Questionnaire on Arsenic
- ☐ Fax the Exposure Questionnaire on Arsenic to DPHHS 1-800-616-7460
- ☐ Follow-up on special situations, including possible intentional contamination (see section 5, review references and additional information or contact the Epidemiology and Scientific Support Bureau at 406-202-8866)
- ☐ If exposure is thought to be intentional and criminal, report to local law enforcement immediately
- ☐ Attach any additional lab reports to case investigation in MIDIS
- ☐ When done with MIDIS investigation, close the investigation

1 DISEASE REPORTING

1.1 Provider notification to Public Health Authorities

Any person, including, but not limited to a physician, dentist, nurse, medical examiner, other health care practitioner, administrator of a health care facility or laboratory, public or private school administrator, or laboratory professional who knows or has reason to believe that a case exists of a reportable disease or condition defined in the Administrative Rules of Montana (ARM) **37.114.203** must immediately report to the local health officer.

For more information on analysis and specimen collection, please contact the laboratory conducting the test.

1.2 Local Health Department Follow-up Responsibilities

Immediately after being notified of a case of a reportable condition, a local health officer must investigate per (ARM) **37.114.546**. See section 4.3 below.

Direct the case-patient or physician to Montana Poison Information Center Network (MPICN) (available 24/7) for more information, 1-800-222-1222.

1.3 Local Health Department Reporting to State Public Health Authorities

Methylated plus inorganic arsenic in urine ≥ 35 µg/L or total urine arsenic levels ≥ 70 µg/L must be reported to DPHHS within seven days. Arsenic tests must be reported to DPHHS within seven days regardless of the person's age.

2 THE DISEASE AND ITS EPIDEMIOLOGY

2.1 Public Health Significance in Montana

DPHHS added arsenic poisoning to the reportable diseases list in 2020. Currently, little is known about the public health significance of arsenic exposure in Montana. Arsenic poisoning reporting and surveillance may determine arsenic sources of public health concern; possibly drinking water, workplace exposures, homeopathic medicines, exposures to wood pressure-treated with Chromated Copper-Arsenate (CCA), or wastes containing arsenic. Follow up of identified cases will prevent continued or possibly more widespread exposure to arsenic sources.

Arsenic is a naturally occurring element widely distributed in the earth's crust. Smelting metal ore can concentrate arsenic in tailings and create arsine gas.

In the environment, arsenic combines with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. CCA is used to preserve wood and is no longer used for residential wood uses in the U.S.; however, it is still permitted in wood preserved for industrial use. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

2.2 Clinical Description of Illness

- **Illness from acute exposure:** Acute arsenic poisoning generally occurs from the ingestion of arsenic regardless of intent and rarely occurs in the workplace today; it usually results from unintentional ingestion, suicide, or homicide. The fatal dose of

ingested arsenic in humans is difficult to determine from case reports and depends upon many factors (e.g., solubility, valence state).

Acute exposure to toxic amounts of arsenic may include signs and symptoms such as vomiting, abdominal pain, diarrhea, light-headedness, headache, weakness, and lethargy. These signs and symptoms may rapidly lead to dehydration, hypotension, pulmonary edema, congestive heart failure, and shock. Different clinical manifestations might follow, including heart dysrhythmias (e.g., prolonged QT, T-wave changes), altered mental status, and multisystem organ failure which may ultimately lead to death.

- **Illness from chronic exposure:** Chronic exposure occurs from the continued ingestion of arsenic over time. Manifestations of chronic arsenic ingestion depend on both the intensity and duration of exposure. Skin lesions and peripheral neuropathy (loss of feeling in the fingers and toes) are the hallmarks of arsenic ingestion, and their presence should result in an aggressive search for this etiology. Neuropathy can occur insidiously in chronic toxicity without other apparent symptoms. However, careful evaluation usually reveals signs of multiorgan and multi-system involvement such as anemia (too few red blood cells), leukopenia (too few white blood cells), skin changes (e.g., bronzing of the skin, raised lesions on the palms or soles), hepatomegaly (enlarged liver), or elevated liver function tests.

- **Especially Susceptible Populations.** Young children have very small bodies and eat more food per pound of body weight than adults as they grow. As a result, they get a higher percentage of arsenic from food or drinks compared to adults. For babies and young children, studies have shown that having arsenic in their bodies over time can lead to:
    - Lower IQ
    - Impaired brain development
    - Growth problems
    - Breathing problems
    - An unhealthy immune system
    - Cancer as an adult

  Arsenic can cross the placenta, which means that a pregnant woman's arsenic exposure through food and water may affect her baby's growth and development or lead to health problems later in their life.

3 CASE DEFINITION

3.1 Clinical Description

See Section 2.2.

3.2 Laboratory Criteria for Diagnosis

Confirmed

Methylated plus inorganic arsenic in urine $\geq$ 35 µg/L or total arsenic levels in urine ≥ 70 µg/L as determined by laboratory test. If laboratory results for urine are reported in µg As/g creatinine (mcg/g creat) and are >15 µg/g creatinine, then results must be converted to µg As/Liter of urine using the following formula and conversion factor.

_____ (µg As/g creat) x _____ (mg creat/dL) x 0.01 = _____ (µg As/Liter urine)
given given calculated

3.3 Case Classification

Confirmed

• A case with confirmatory laboratory test results for methylated plus inorganic arsenic in urine ≥ 35 µg/L, total urine arsenic levels ≥ 70 µg/L, or converted arsenic urine levels (section 3.2) from µg As/g creatinine (mcg/g creat).

Probable

• A clinically compatible case in which a high index of suspicion, (patient's exposure history regarding location and time) exists or an epidemiologic link exists between this case and a confirmed case.

Suspected

• A case in which a potentially exposed person is being evaluated by health-care workers or public health officials for poisoning by a particular chemical agent, but no specific credible threat exists.

Comment(s)

Most cases of arsenic-induced toxicity in humans are due to exposure to inorganic arsenic. Humans may be exposed to organic arsenicals used in agriculture or those found in fish and shellfish. Organic arsenic found in fish is not believed to be toxic. Total arsenic tests do not distinguish between organic and inorganic arsenic (the more toxic form). For this reason, positive total arsenic laboratory test results for specimens taken within 72 hours of consumption of seafood do not meet the laboratory criteria for diagnosis. If this patient is symptomatic, please recommend the health care provider to retest them, after 3-5 days of no fish consumption.

4 ROUTINE CASE INVESTIGATION

In accordance with (ARM) **37.114.314** conduct an epidemiologic investigation to determine the source and possible arsenic exposure risks. Refer to the CDC / ATSDR for additional resources related to arsenic investigation. Determine the information necessary to complete the investigation in MIDIS (See CD Epi Arsenic Exposure Questionnaire).

4.1 Confirm the Diagnosis

Review the laboratory results to confirm the diagnosis. Clinical signs and symptoms are not necessary to confirm elevated urine arsenic levels. See sections 3.2 and 3.3.

4.2 Laboratory Requirements

See Sections 1.1 and 1.2.

4.3 Case Investigation

The public health recommendations for this investigation guideline are based on the ARMs and CDC rather than the CCDM.

Specific Control Measures

Per ARM **37.114.546**, "The health officer must gather information about the circumstances and nature of the exposure using forms developed by the department (See CD Epi Arsenic Exposure

Questionnaire).The local health officer must ensure that the following actions are performed when a methylated plus inorganic arsenic in urine ≥ 35 µg/L or total urine arsenic levels ≥ 70 µg/L is reported. The health officer or health-care provider must provide:
(a) Counseling about health consequences of arsenic poisoning;
(b) Information about ways to eliminate arsenic exposure; and
(c) Referral of the case and household members potentially at risk of exposure to a health-care provider for additional follow-up and urine-arsenic testing as appropriate.

4.4 Contact Investigation

Because environmental and occupational arsenic exposures may affect entire families, investigation of an individual should note whether there are additional family members (or workers) at risk of exposure to arsenic. If so, those family members or workers should be evaluated for elevated urine arsenic levels. This applies particularly to pregnant women (to protect fetuses), babies, and young children.

4.5 Environmental and Occupational Evaluation

See Sections 1.2 and 4.3(b). Conduct an environmental and occupational evaluation if an ongoing source of exposure is suspected (See CD Epi Arsenic Exposure Questionnaire).

5 CONTROL MEASURES

In accordance with (ARM) **37.114.501**, utilize the control measures (prevention tips) indicated in Section 6.2 for this disease. Contact the Epidemiology and Scientific Support Bureau for consultation and questions at 406-202-8866.

5.1 Case Management

See Section 1.2.

5.2 Contact Management

See Section 4.4.

5.3 Environmental and Occupational Measures

An environmental evaluation is appropriate if an ongoing source of exposure is not identified or if more than one case is associated with a venue, such as an occupational setting.

Depending on the situation, Department of Labor and Industry (DLI) may assist with environmental investigations of public entities and the Occupational Safety and Health Administration (OSHA) may assist with private and federal entities. The Billings MT OSHA contact is Art Hazen at 406-247-7494. A public entity is defined as any state or local government or any department, agency, special purpose district, or other instrumentality of one or more state or local governments. Contact Department of Labor and Industry (DLI) with any questions about public entities at 406-444-6543.

The employee should work with their employer to complete a First Report of Injury. The employer is then required to submit the form to the company's worker's compensation insurer. The insurer will determine whether the injury or occupational disease is work-related and compensable. However, if the employee has issues working with their employer to receive compensation, they can contact the DLI at 406-444-6543 or visit their website for more information and resources http://erd.dli.mt.gov/work-comp-claims.

The incorporation of engineering controls to contain sources of exposure to arsenic compounds is the preferred approach to reducing exposure in smelting, metallurgy, and pesticide manufacturing operations. Personal protective equipment should be worn during periods of potential exposure. The employer should consult OSHA standard 1910.1018 - Inorganic Arsenic, for detailed information on occupational arsenic exposure, including medical surveillance.

5.4 Special Circumstances

See Section 4.3

6 ROUTINE PREVENTION

6.1 Immunization Recommendations

N/A

6.2 Prevention Recommendations

Prevention of arsenic exposure:

If the patient's drinking water source is a private well, and an elevated arsenic concentration in the water is suspected, the patient can test their well water for arsenic. Figure 1 shows areas known to the Department of Environmental Quality with arsenic in groundwater aquifers above the drinking water standard, 10 µg/L, as purple triangles. This map was prepared to exclude known hazardous waste sites with arsenic, so the conclusion is that the arsenic occurs naturally. The patient can contact the Montana Public Health Laboratory at 1-800-821-7284 for test bottles for water. The cost of the test varies by private and public water systems. Montana State Environmental Laboratory . Other labs can also be used. See a list of Certified Montana Drinking Water Labs here. The patient should choose a lab capable of running metals.

The patient should use bottled water for drinking until the well is shown to be safe or until appropriate water filtration systems are put in place to remove the arsenic.

- Cigarettes contain small amounts of arsenic. Advise a smoking patient to stop smoking.
- When using CCA-treated lumber in nonresidential applications, follow the warnings regarding the wearing of personal protective equipment such as gloves, eye, and respiratory protection.
  - Most schools and playgrounds have removed CCA-treated lumber play equipment. Children's high incidence of hand to mouth behaviors makes playing on CCA treated play equipment ill-advised.
  - Consider annual application of a sealant on any existing CCA-treated lumber surfaces.
- Limit sun exposure and use sunscreen to help decrease the risk of skin cancer. Exposure to arsenic and UVB radiation together may further increase the risk of developing skin cancer.
- Discuss concerns regarding arsenic and prevention of hazardous exposures at the workplace with the patient's employer and/or workplace health and safety representative. Please see Section 5.3 above for additional means of preventing arsenic exposure in the occupational setting.

Common and less common sources of arsenic are described briefly on page 15 and at length on page 313 of the ATSDR Arsenic Toxicological Profile: https://www.atsdr.cdc.gov/toxprofiles/tp2.pdf

7 ESCALATION/ACTIVATION OF EMERGENCY OPERATIONAL PLANNING

These investigation guidelines are designed to assist local health jurisdictions in the steps and actions needed to report, investigate, and control reported cases of Arsenic Poisoning. Suppose investigations or other reported cases of arsenic exposure appear to a cluster by person, time, and place. In that case, local health jurisdictions need to contact DPHHS under the Administrative Rules of Montana 37.114.314 and 37.114.315 so DPHHS can consider emergency operational escalation or activation under the Communicable Disease Annex to the DPHHS Emergency Operation Plan.

8 ACKNOWLEDGEMENTS

DPHHS would like to acknowledge the Louisiana, Oregon, and Florida State Departments of Health and the Centers for Disease Control and Prevention (CDC) for developing the format and select content of this document.

9 REFERENCES AND ADDITIONAL INFORMATION

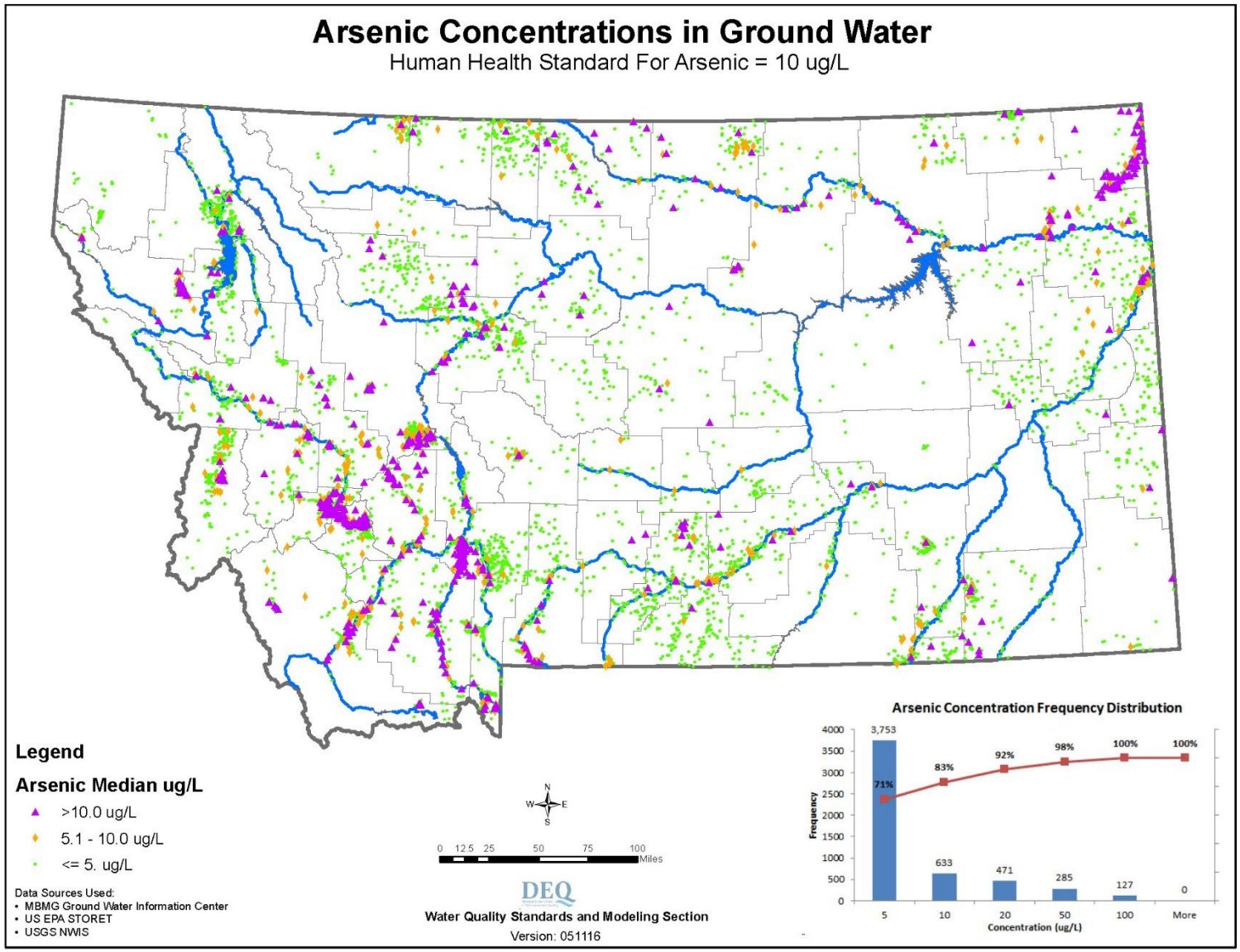
Important references:

A. Information for Health Care Professionals, Arsenic Exposure and Toxicity http://www.ldh.la.gov/assets/oph/Center-EH/envepi/Heavy_Metal/Documents/Arsenic_for_Health_Providers_Final_2017.pdf
B. ATSDR Case Study in Environmental Medicine Arsenic Toxicity https://www.atsdr.cdc.gov/csem/arsenic/docs/arsenic.pdf
C. Arsenic and Children. https://www.dartmouth.edu/~arsenicandyou/health/children.html
D. Arsenic and drinking water Montana Department of Environmental Quality https://deq.mt.gov/water/Programs/dw
E. Consumer Factsheet https://www.oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Monitoring/Documents/health/arsenic.pdf
F. CDC Arsenic Website https://emergency.cdc.gov/agent/arsenic/index.asp
G. Lewis, R. (2007). Occupational Exposures: Metals. In Joseph LaDou (Ed.) *Current Occupational and Environmental Medicine* (pp. 413-438). McGraw Hill Publishing.
H. OSHA 1910.1018 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1018

Resources for Adult Cases

A. Information for Health Care Professionals, Arsenic Exposure and Toxicity in workers https://acoem.org/acoem/media/News-Library/Arsenic_Exposure_Assessment_Toxicity_Diagnosis.pdf
B. United States Department of Labor https://www.osha.gov/SLTC/semiconductors/solutions/arsenic.html

Figure 1. Median Arsenic Values for Montana Aquifers



Arsenic Concentrations in Ground Water – Statewide Mapping Project, Metadata for Previous Map, Arsenic Concentrations in Groundwater, May 12, 2016

A DEQ Standards and Modeling Section Project.
Data acquisition

- Datasets:
    - EPA STORET – From previous DEQ project (2,849 Records, water, dissolved arsenic)
    - USGS-NWIS – From previous DEQ project (1,446 Records, GW & Springs, dissolved arsenic)
    - MBMG GWIC – Special retrieval from MBMG (20,641 GW, dissolved arsenic)

General data processing:

- Converted arsenic numeric values to ug/L.
- Removed field blanks, field duplicates, and other "QA/QC" samples.
- Attempted to remove all contamination sites or "non-ambient/non-background" samples
    - Eliminated mines, sewage treatment ponds etc. where field designations existed.
    - Set an arbitrary upper "presumed ambient" arsenic concentration to less than 100 ug/L.
- Flagged and removed duplicates identified between datasets.
- Removed any duplicate records within datasets.
- Processed records with inequality codes, marked as below MDL or MRL. Used the rules below:
- Data for all sites was reduced to a single median value and mapped using ESRI ArcGIS software. The median dataset consists of 7,678 values.

QC Indicator		Definition	Action	Source
	No Code	Detected value shown	Use value shown	MBMG/Others
	* or Dup	Dup. analysis not within control limits	Discard	MBMG/Others
	<Value	Less than Value Shown In Cell, no other code given	Discard values > MDL, Keep those < MDL and use 50% of MDL	MBMG
	E	Estimated	Discard	
	J	Detected above MDL but less than MRL	Discard values > MDL, Keep those < MDL and use 50% of MDL	MBMG
	U	Analyzed for but not detected above MDL	Use 50% of detection limit	MBMG
	<U**	Less than Analyzed for but not detected above MDL	Discard values > MDL, Keep those < MDL and use 50% of MDL	MBMG
	UE**	Estimated Value	Discard	MBMG
	UJ**	An oxymoron?	Discard	MBMG
	UR	R code is undefined	Discard	MBMG
	B	Can't find MBMG Reference	Discard	MBMG
	D	Can't find MBMG Reference	Discard	MBMG
	R	Can't find MBMG Reference	Discard	MBMG
	RS	Can't find MBMG Reference	Discard	MBMG
	S	Method of standard additions	Discard	MBMG
	H	Exceeded holding time	Discard	MBMG
	<MRL	Less than reporting limit	Use 50% of reporting limit	MBMG
	<MDL	Less than Detection limit	Use 50% of detection limit	MBMG
	Not Detected	Not Detected	Use 50% of detection limit	MBMG
** = Combination of codes shown for value				
Storet Codes				
QC Indicator		Definition	Action	Source
	No Code	Detected value shown	Use value shown	STORET
	Not Detected	Not Detected	Use 50% of detection limit	STORET

Note on MBMG Data: Used a detection limit of 0.06 ug/L from EPA Method 200.8 quoted from recent MBMG sampling study. Reduced record set from 19,770 to 16,003 Coded values of <U, <J that were greater than 0.06 were deleted. Values less than 0.06 were set to 0.03 ug/L.