MAYO CLINIC LABORATORIES

Test Definition: HMUOE

Heavy Metal Occupational Exposure, with Reflex, Random, Urine

Overview

Useful For

Preferred screening test for detection of arsenic, cadmium, mercury, and lead due to occupational exposure using random urine specimens

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
ASOU	Arsenic Occupational Exposure	Yes, (order ASUOE)	Yes
CDOU	Cadmium Occupational Exposure	Yes, (order CDUOE)	Yes
HGOU	Mercury Occupational Exposure	Yes, (order HGUOE)	Yes
PBOU	Lead Occupational Exposure	Yes, (order PBOUE)	Yes
CRETR	Creatinine, Random, U	No	Yes

Reflex Tests

Test Id	Reporting Name	Available Separately	Always Performed
SPAS	Arsenic Speciation, Random, U	Yes	No

Testing Algorithm

If arsenic concentration is greater than or equal to 10 mcg/L, then speciation will be performed at an additional charge.

Special Instructions

- Metals Analysis Specimen Collection and Transport

Method Name

ASOU, CDOU, HGOU, PBOU: Triple-Quadrupole Inductively Coupled Plasma Mass Spectrometry (ICP-MS/MS)
CRETR: Colorimetric

NY State Available

Yes

Specimen

Specimen Type

Urine

Specimen Required

Patient Preparation:

1. For 48 hours before collection, patient **should not** eat seafood.
2. High concentrations of gadolinium and iodine are known to potentially interfere with most inductively coupled plasma mass spectrometry-based metal tests. If either gadolinium- or iodine-containing contrast media has been administered, **a specimen should not be collected for 96 hours**.

Supplies: Urine Tubes, 10 mL (T068)

Collection Container/Tube: Clean, plastic urine container with no metal cap or glued insert

Submission Container/Tube: Plastic, 10-mL urine tube or clean, plastic aliquot container with no metal cap or glued insert

Specimen Volume: 6 mL

Collection Instructions:

1. Collect a random urine specimen.
2. See Metals Analysis Specimen Collection and Transport for complete instructions.

Specimen Minimum Volume

3 mL

Reject Due To

All specimens will be evaluated at Mayo Clinic Laboratories for test suitability.

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Urine	Refrigerated (preferred)	7 days	
	Frozen	7 days	

Clinical & Interpretive

Clinical Information

Arsenic (As), lead, cadmium, and mercury are well-known toxins, and toxic exposures are characterized by increased urinary excretion of these metals.

Arsenic is a naturally occurring element that is usually found in the environment combined with other elements, such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. The organic forms (eg, arsenobetaine and arsenocholine) are relatively nontoxic, while the inorganic forms are toxic. The toxic inorganic forms are arsenite (As[3+]/As[III]) and arsenate (As[5+]/As[V]). Inorganic As(V) is readily reduced to inorganic As(III), which is then primarily broken down to the less toxic methylated metabolites, monomethylarsonic acid, and subsequently dimethylarsinic acid.

People are exposed to arsenic by eating food, drinking water, or breathing air. Of these, food is usually the largest source of arsenic. The predominant dietary source of arsenic is seafood, followed by rice/rice cereal, mushrooms, and poultry. While seafood contains the greatest amounts of arsenic, from fish and shellfish, this is mostly in an organic form of arsenic called arsenobetaine, which is much less harmful. Some seaweed may contain arsenic in the inorganic form, which is more toxic. In the United States, some areas also contain high natural levels of arsenic in rock, which can lead to elevated levels in the soil and drinking water. Occupational (eg, copper or lead smelting, wood treating, or pesticide application) exposure is another source where people may be introduced to elevated levels of arsenic. Lastly, hazardous waste sites may contain large quantities of arsenic and, if not disposed of properly, may get into the surrounding water, air, or soil.

A wide range of signs and symptoms may be seen in acute arsenic poisoning, including headache, nausea, vomiting, diarrhea, abdominal pain, hypotension, fever, hemolysis, seizures, and mental status changes. Symptoms of chronic poisoning, also called arseniasis, are mostly insidious and nonspecific. The gastrointestinal tract, skin, and central nervous system are usually involved. Nausea, epigastric pain, colic abdominal pain, diarrhea, and paresthesias of the hands and feet can also occur.

Since arsenic is excreted predominantly by glomerular filtration, measurement of arsenic in urine is the most reliable means of detecting arsenic exposures within the last several days.

Lead toxicity primarily affects the gastrointestinal, neurologic, and hematopoietic systems.

Chronic exposure to cadmium causes accumulated kidney damage.

The correlation between the levels of mercury excretion in the urine and the clinical symptoms is considered poor.

Reference Values

ARSENIC:
Biological Exposure Indices (BEI): <35 mcg/L at end of work week

CADMIUM:
BEI: <5.0 mcg/g creatinine

MERCURY:
BEI: <35 mcg/g creatinine

LEAD:
BEI: <150 mcg/g creatinine

CREATININE:
<18 years: Not established
> or =18 years: 16-326 mg/dL

Interpretation

Arsenic:
Mayo Clinic uses the American Conference of Governmental Industrial Hygienists biological exposure index (BEI) as the reference value. The BEI is the sum of all the toxic species (inorganic arsenic plus methylated arsenic metabolites).

Physiologically, arsenic exists in a number of toxic and nontoxic forms. The total arsenic concentration reflects all the arsenic present in the sample regardless of species (eg, inorganic vs. methylated vs. organic arsenic). The measurement of urinary total arsenic levels is generally accepted as the most reliable indicator of recent arsenic exposure. However, if the total urine arsenic concentration is elevated, arsenic speciation must be performed to identify if it is a toxic form (eg, inorganic and methylated arsenic forms) or a relatively nontoxic organic form (eg, arsenobetaine and arsenocholine).

The inorganic toxic forms of arsenic (eg, As[III] and As[V]) are found in the urine shortly after ingestion, whereas the less toxic methylated forms, monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) are the species that predominate longer than 24 hours after ingestion. In general, urinary As(III) and As(V) concentrations peak in the urine at approximately 10 hours and return to normal 20 to 30 hours after ingestion. Urinary MMA and DMA concentrations normally peak at approximately 40 to 60 hours and return to baseline 6 to 20 days after ingestion.

This test can determine if a patient has been exposed to above-average levels of arsenic. It cannot predict whether the arsenic levels in their body will affect their health.

Cadmium:
In chronic cadmium exposure, the kidneys are the primary target organ effected. Urine concentrations of cadmium can be useful to assess long-term exposure and determine cadmium body burden.

Cadmium excretion above 3.0 mcg/g creatinine indicates significant exposure to cadmium. For occupational testing, the OSHA cadmium standard is below 3.0 mcg/g creatinine, and the BEI is 5 mcg/g creatinine.

Mercury:
The correlation between the levels of mercury excretion in the urine and the clinical symptoms is considered poor.

Previous thought indicated urine as a more appropriate marker of inorganic mercury because organic mercury represented only a small fraction of urinary mercury. Based on possible demethylation of methylmercury within the body, urine may represent a mixture of dietary methylmercury and inorganic mercury. Seafood consumption can contribute to urinary mercury levels (up to 30%),(1) which is consistent with the suggestion that due to demethylation processes in the human body, a certain proportion of urinary mercury can originate from dietary consumption of fish/seafood.(2)

Lead:
Measurements of urinary lead levels have been used to assess lead exposure. However, like blood lead, urinary lead excretion mainly reflects recent exposure and thus, shares many of the same limitations for assessing lead body burden or long-term exposure.(3,4)

Urinary lead concentration increases exponentially with blood lead and can exhibit relatively high intra-individual variability, even at similar blood lead concentrations.(5,6)

Cautions

Consumption of seafood before collection of a urine specimen for arsenic testing is likely to result in a report of an elevated concentration of arsenic found in the urine, which can be clinically misleading.

Clinical Reference

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Performance

Method Description

Arsenic. Cadmium, Mercury, Lead:
The metal analytes of interest are analyzed by triple-quadrupole inductively coupled plasma mass spectrometry.(Unpublished Mayo method)

Creatinine:
This enzymatic method is based on the conversion of creatinine with the aid of creatininase, creatinase, and sarcosine oxidase to form glycine, formaldehyde, and hydrogen peroxide. Catalyzed by peroxidase the liberated hydrogen peroxide reacts with 4-aminophenazone and HTIB (2,4,6-triiodo03-hydroxybenzoic acid) to form a quinone imine chromogen. The color intensity of the quinone imine chromogen formed is directly proportional to the creatinine concentration in the reaction mixture.(Package insert: Creatinine plus ver.2. Roche Diagnostics; 07/2024)

PDF Report
No

Day(s) Performed
Monday through Friday

Report Available
2 to 4 days

Specimen Retention Time
14 days

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Superior Drive

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification
This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. It has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information
82175
82300
83825
83655
82570

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value

HMUOE	Heavy Metal Occ Exp w/Reflex, U	29589-9

Result ID	Test Result Name	Result LOINC® Value
CRETR	Creatinine, Random, U	2161-8
608890	Arsenic Occupational Exposure	13463-5
608891	Total Arsenic Concentration	5586-3
608892	Cadmium Occupational Exposure	13471-8
608893	Mercury Occupational Exposure	13465-0
608894	Lead Occupational Exposure	13466-8