MAYO CLINIC LABORATORIES

Test Definition: HMU24

Heavy Metals Screen, with Reflex, 24 Hour, Urine

Overview

Useful For

Detecting arsenic, cadmium, mercury, and lead exposure and toxicity using 24-hour urine specimens

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
ASHU	Arsenic, 24 Hr, U	Yes, (order ASU24)	Yes
CDHMU	Cadmium, 24 Hr, U	Yes, (order CDU)	Yes
HGHU	Mercury, 24 Hr, U	Yes, (order HGU)	Yes
PBHU	Lead, 24 Hr, U	Yes, (order PBU)	Yes

Reflex Tests

Test Id	Reporting Name	Available Separately	Always Performed
SPASU	Arsenic Speciation, 24 Hr, 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

- Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens
- Metals Analysis Specimen Collection and Transport

Method Name

Triple-Quadrupole Inductively Coupled Plasma Mass Spectrometry (ICP-MS/MS)

NY State Available

Yes

Specimen

Specimen Type

Urine

Specimen Required

1. For the 48-hour period prior to the start of collection, as well as during the 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 aliquot container with no metal cap or glued insert

Submission Container/Tube: Plastic, 10-mL urine tube

Specimen Volume: 6 mL

Collection Instructions:

1. Collect urine for 24 hours.
2. Refrigerate specimen within 4 hours of completion of 24-hour collection.
3. See Metals Analysis Specimen Collection and Transport for complete instructions.

Additional Information: See Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens for multiple collections.

Urine Preservative Collection Options

Note: The addition of preservative or application of temperature controls **must occur within 4 hours of completion** of the collection.

Ambient (no additive)	No
Refrigerate (no additive)	Preferred
Frozen (no additive)	OK
50% Acetic Acid	OK
Boric Acid	No
Diazolidinyl Urea	No
6M Hydrochloric Acid	OK
6M Nitric Acid	OK
Sodium Carbonate	No
Thymol	No
Toluene	No

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:
Arsenic (As) 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 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, for 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.

Cadmium:
The toxicity of cadmium (Cd) resembles the other heavy metals (arsenic, mercury, and lead) in that it attacks the kidney; kidney dysfunction with proteinuria and a slow onset (over a period of years) is the typical presentation. Measurable changes in proximal tubule function, such as decreased clearance of para-aminohippuric acid also occur over a period of years and precede overt kidney failure.

Breathing the fumes of cadmium vapors leads to nasal epithelial deterioration and pulmonary congestion resembling chronic emphysema.

For nonsmokers, the primary source of cadmium exposure is from the food supply. In general, leafy vegetables such as lettuce and spinach, potatoes and grains, peanuts, soybeans, and sunflower seeds contain high levels of cadmium. For smokers, the most common source of cadmium exposure is tobacco smoke, which has been implicated as the primary

sources of the metal leading to reproductive toxicity in both men and women.

The concentration of cadmium in the kidneys and urine is elevated in some patients exposed to cadmium.

Mercury:
The correlation between the levels of mercury (Hg) 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)

For additional information, see HG / Mercury, Blood

Lead:
Increased urine lead (Pb) excretion rate indicates significant lead exposure. Measurement of urine lead excretion rate before and after chelation therapy has been used as an indicator of lead exposure.

However, the American College of Medical Toxicology (ACMT 2010) position statement on post-chelator challenge urinary metal testing states that "post-challenge urinary metal testing has not been scientifically validated, has no demonstrated benefit, and may be harmful when applied in the assessment and treatment of patients in whom there is concern for metal poisoning."(3)

Blood lead measurement is the best test for clinical correlation of toxicity.

For additional information, see PBDV / Lead, Venous, with Demographics, Blood.

Reference Values

ARSENIC:
0-17 years: Not established
> or =18 years: <35 mcg/24 h

CADMIUM:
0-17 years: Not established
> or =18 years: <0.7mcg/24 h

MERCURY:
0-17 years: Not established
> or =18 years: <2 mcg/24 h
Toxic concentration: >50 mcg/24 h

The concentration at which toxicity is expressed is widely variable between patients. The lowest concentration at which

toxicity is usually apparent Is 50 mcg/24 h.

LEAD:
0-17 years: Not established
> or =18 years: <2 mcg/24 h

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.

After a seafood meal (seafood generally contains the nontoxic, organic form of arsenic, eg, arsenobetaine), the urine output of arsenic may increase to over 300 mcg/24 h, after which it will decline.

This test can determine if the 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. Urine concentrations of cadmium can be useful to assess long-term exposure and determine cadmium body burden. Collection of urine over 24 hours minimizes fluctuations of observed cadmium concentrations in random urine samples.

Cadmium excretion above 3.0 mcg/g creatinine indicates significant exposure to cadmium. For occupational testing, OSHA cadmium standard is less than 3.0 mcg/g creatinine, and the BEI is 5.0 mcg/g creatinine.

Mercury:
Daily urine excretion of mercury above 50 mcg/day indicates significant exposure (per World Health Organization standard).

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

or long-term exposure.(4,5)

Urinary lead concentration increases exponentially with blood lead and can exhibit relatively high intra-individual variability, even at similar blood lead concentrations.(6,7)

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.

Collection of urine specimens through a catheter frequently results in elevated values because rubber contains trace amounts of cadmium that are extracted as urine passes through the catheter.

To avoid contamination by dust, specimen should be collected away from the site of suspected exposure.

Clinical Reference

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Performance

Method Description
The metal analytes of interest are analyzed by triple-quadrupole inductively coupled plasma mass spectrometry.(Unpublished Mayo method)

PDF Report
No

Day(s) Performed
Monday through Friday

Report Available
1 to 3 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

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
HMU24	Heavy Metal Scrn w/Reflex, 24 Hr, U	94575-8

Result ID	Test Result Name	Result LOINC® Value
8678	Cadmium, 24 Hr, U	5612-7
TIME4	Collection Duration (h)	13362-9
VL16	Volume (mL)	3167-4
92215	Total Arsenic Concentration	21074-0
48539	Arsenic, 24 Hr, U	5587-1
92408	Mercury, 24 Hr, U	6693-6
92409	Lead, 24 Hr, U	5677-0