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Which test to order for Arsenic?

Epidemiology

Main route of exposure:

- Arsenic is found in fish, seafood and possibly in smaller amounts in poultry.
- Industrial use of arsenic in the production of pesticides, preservatives, metal alloys, glasses, enamels, semiconductors and other items.
- Exposure from burning of coal, pressure treated wood exposure, smelting, incinerator, and industrial waste from air and or water.
- Arsenic exposure from water sources.

Toxicity

Arsenic exists in inorganic and organic form:

- Inorganic species of arsenic (arsenite As+3 and arsenate As+5), can be found in rock, soil, groundwater and many synthetic products, poisons, pesticides and industrial processes. Arsenite is the most toxic form of arsenic.
- Methylated species (Monomethylarsonic acid, MMA and Dimethylarsonic acid, DMA) are derived from inorganic arsenic. Small amounts can be from food. These forms are less toxic than the arsenite and arsenate and are eliminated from the system more slowly (1-3 weeks).
- Organic species (arsenobetaine and arsenocholine) are found primarily in food such as fish, seafood, seaweed (seaweed can also contain inorganic arsenic). These forms are nontoxic and cleared very rapidly from the system. (1-2 days).

Laboratory Testing

Acute poisoning:

- Due to the short half-life of arsenic in the blood, it is eliminated rapidly. Blood can be used if it is drawn within a couple of hours of acute exposure.
- **Urine** is the preferred sample and should be collected within 48 hours.
- Arsenic will be deposited into the hair tissue after 30 hours of being exposed to arsenic. The arsenic binds to the keratin in the hair and nails. If urine or blood

samples not collected, then hair or nails can be used. However external contamination of the hair cannot be ruled out.

Chronic Exposure:

- **Urine** is the preferred test for chronic exposure. If suspicious of inorganic arsenic exposure order the Inorganic urine arsenic test.
- Due to the short half-life of arsenic in the blood and dependant on the tissue burden of accumulated arsenic, blood might not be a good indicator.
- Hair and nails can be used for assessing arsenic levels.

Testing arsenic:

Total Arsenic in Urine:

- All forms of arsenic are measured in random or 24 hour urine samples, including organic arsenic from seafood consumption.
- Random urine results are corrected for diurnal variation by testing for Creatinine also. All occupational testing is done with random spot samples.

Use First Am Void samples.

Inorganic Arsenic in Urine:

- Inorganic arsenic, monomethylarsonic and dimethylarsonic are measured in random or 24 hour urine samples.
- Random urine results are corrected for diurnal variation by testing for Creatinine also. All occupational testing is done with random spot samples.

Use First Am Void samples.

Whole Blood and Erythrocyte Arsenic:

- All forms of arsenic are measured, including organic arsenic from seafood consumption.

Hair and Nail:

- Arsenic in hair and nail reflects mainly exposure to inorganic arsenic only. Dimethylarsonic has a very low incorporation into hair and nails.
- Segmented hair analysis can be used to find approximate when exposure occurred.
- External exposure of arsenic from groundwater, air and industry will cause falsely elevated results.

References:

1. What is arsenic?
<http://www.sph.emory.edu/PEHSU/html/exposures/arsenic.htm>
2. Subcommittee on Arsenic in Drinking Water, National Research Council. Arsenic in Drinking Water.
3. ATSDR ToxFaq's. Arsenic. <http://www.atsdr.cdc.gov/tfacts2.html>
4. Arsenic exposure – carcinogen.
<http://www.sos-arsenic.net/english/contamin/index.html>

Mercury testing and the alert value for whole blood mercury

Epidemiology

Main route of exposure:

- Mercury (Hg) is used in gold extraction, paper manufacturing, wood preservatives, and pesticides. Mercury is also found in cosmetics, jewelry, household batteries, mercury lamps, electrical switches, and thermometers.
- Mercury amalgam used in dental fillings is composed of 50% metallic mercury with silver. Very small amounts of mercury are slowly released from the surface of the tooth fillings due to chewing or corrosion.
- Large fish such as tuna, shark or swordfish can accumulate high concentrations of organic mercury (methylmercury) and inorganic mercury in their body if living in mercury contaminated water. In the general population, the primary route of exposure to mercury is diet with fish being the dominant source of methylmercury.

Toxicity:

Mercury exists in metallic (Hg^0), inorganic (Hg^{2+}) and organic alkyl and alkyl mercury forms. It is toxic in the metallic mercury vapour form and in the inorganic and organic form of mercury.

- Metallic mercury (also called elemental mercury) is a liquid at room temperature and used in some electrical switches and thermometers. It is poorly absorbed if ingested. However inhalation of mercury vapor enters the CNS and can produce neurological changes.
- Inorganic mercury is also called mercury salt. Following ingestion, less than 10% is absorbed through the GI tract. It is trapped mainly in the kidney and excreted through the urine. The inorganic mercury is distributed in the red cells and plasma, about two thirds is in the plasma and one third is in the red cells.
- Organic mercury is most easily absorbed through the GI tract (about 95% absorbed). Once absorbed, it readily enters the brain, causing neurological problems. Once methyl mercury crosses the brain barrier it will convert to inorganic mercury which has a very long life-time. Thus when blood levels for mercury are decreasing the level of mercury in the brain can still be high or can still be increasing. Organic Mercury is eliminated primarily in the feces. About 90% of the organic mercury is in the red cells and the remainder is in the plasma.

Laboratory Testing

It is important to choose the appropriate test depending on the suspected source of exposure.

Mercury in Whole Blood and Erythrocyte:

- Blood samples are useful for acute and chronic exposure to mercury.
- The red cells contain about 90% of the organic mercury. The inorganic mercury is distributed in the plasma and the red cells. To assess the organic mercury status a urine sample should be analyzed as well, to rule out exposure to inorganic mercury.

- Whole blood mercury will measure the inorganic and organic mercury distributed in the red cells and plasma as total mercury.

Mercury in Urine:

- Urine samples provide the best indicator of body burden from long-term exposure to metallic mercury vapor and inorganic mercury.
- Urine test is not useful for assessing exposure to organic mercury (methylmercury) because this form of mercury is excreted mainly in the feces rather than in the urine.

Hair and Nail:

- Test of mercury in hair is useful only for exposures to methylmercury, since inorganic mercury is not excreted in hair. However external contamination cannot be ruled out, if exposed to high mercury levels in the environment, hair and nail will be falsely elevated for mercury.
- Segmented hair analysis can be used to find approximate when exposure occurred.

Alert value:

The alert value suggests review of work practice for occupational exposure and investigation of the possible source of exposure for non-occupational patients. e.g., the primary source of exposure to mercury is consumption of contaminated fish.

If a result is greater than the alert value, it will be reported with a comment as the following:

Alert Value - Whole blood mercury >50 nmol/L

Whole Blood Mercury concentration is significantly higher than the general population (non-occupational) reference range (0-18 nmol/L).

Follow-up investigation is suggested if clinically indicated.

References:

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3. Elizabeth Brodtkin et al. Lead and mercury exposures: interpretation and action. CMAJ 176:59, 2007.
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http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/mercury/basic_mercury.html
6. Marika Berglund, Inter-individual variations of human exposure biomarkers: a cross sectional assessment. Environmental Health: A global Access Science Source

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