

ORAL FLUID TESTING FOR HEAVY METALS

Erica A. Guice
Western Slope Laboratory

WESTERN SLOPE
LABORATORY 



FINANCIAL DISCLOSURES

- ◎ Employee of Western Slope Laboratory
- ◎ Pharmaceutical Sciences Advisory Board at University of Toledo
- ◎ Research Support Thermo Fisher Scientific



OUTLINE

- ◎ Heavy metal definition
- ◎ Instrumentation and methods
- ◎ Advantages and consideration for oral fluid



HEAVY METALS

- ◎ loosely defined subset of elements that exhibit metallic properties
- ◎ includes the transition metals, some metalloids, lanthanides, and actinides
- ◎ There are twenty three metals that are deemed heavy metals



HEAVY METALS

- ◎ antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc



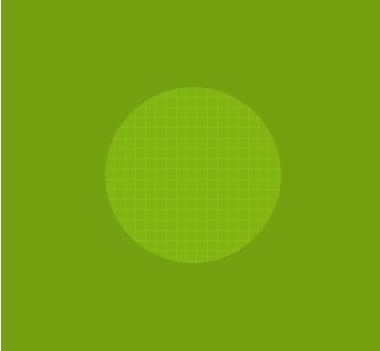
IMPORTANT HEAVY METALS TO CLINICAL CHEMISTRY

- ◎ arsenic, cadmium, copper, lead, mercury, and zinc
- ◎ Aluminum though not a heavy metal can be quite toxic and is very abundant



INSTRUMENTATION AND METHODS

- ◎ There are three methods for testing for metals regardless of matrix:
 - ◎ Atomic Absorption (AA)
 - ◎ Inductively Coupled Plasma
 - Optical Emission Spectrometry (ICP-OES)
 - Mass Spectrometry (ICP-MS)



ALUMINUM

- ◎ Usually tested in blood, plasma, and serum
- ◎ Has a very high LD₅₀ and is not acutely toxic

AA	ICP-OES	ICP-MS
30ng/mL	20ng/mL	0.001ng/mL

- ◎ Why test in oral fluid?
- ◎ Non-invasive and less risk of contamination
- ◎ With ICP-MS, the detection limits are lower



ARSENIC

- ◎ Usually tested in blood or urine (total arsenic)
- ◎ US exposure limit of 35ng/mL

AA	ICP-OES	ICP-MS
300ng/mL	50ng/mL	0.001ng/mL

- ◎ Why test in oral fluid?
- ◎ Non-invasive and less risk of contamination
- ◎ With ICP-MS, the preparation and detection limits are well below the needed limits for exposure in US
- ◎ Provide information on recent exposure



CADMUM

- ◎ Usually test blood and urine

AA	ICP-OES	ICP-MS
1.5ng/mL	5ng/mL	0.0005ng/mL

- ◎ Why test in oral fluid?
 - ◎ The permissible limits are so low and the exposure result so vast that decreasing the detection limits would be beneficial.



COOPER

- ◎ Usually test blood and urine (24 hr collection usually)
- ◎ MCL permissible levels are ~2mg/L

AA	ICP-OES	ICP-MS
3ng/mL (Cu^{+2})	5ng/mL	0.001-0.01ng/mL

- ◎ Why test in oral fluid?
- ◎ Ease of collection and correlation to plasma levels



LEAD

- ◎ Usually a blood test (US) or oral fluid (UK)
- ◎ CDC 5 μ g/dL action level (children; lowered from 10 μ g/dL)

AA	ICP-OES	ICP-MS
10ng/mL	50ng/mL	0.0001-0.001ng/mL

- ◎ Why test in oral fluid?
- ◎ Non-invasive, inexpensive, and correlates to whole blood and plasma levels



MERCURY

- ◎ Usually tested for in blood and urine
 - ◎ Ingestion limits between 0.002-1mg/L
 - ◎ Harmful in all forms (organic, inorganic, elemental)

AA	ICP-OES	ICP-MS
145ng/mL	50ng/mL	0.001-0.01ng/mL

- ◎ Why test in oral fluid?
 - ◎ Ease of collection and correlation to plasma levels
 - ◎ Repeat collection issues solved



ZINC

- ◎ Usually tested orally, in serum, plasma, hair, and urine
- ◎ The US Recommended Daily Allowance is 15 mg

AA	ICP-OES	ICP-MS
1ng/mL	5ng/mL	0.001-0.01ng/mL

- ◎ Why test in oral fluid?
 - ◎ Simple without the subjective taste test
 - ◎ Non invasive

Element	AAS Detection Limit (DL)	ICP-OES D. L.	ICP-MS D. L.
Antimony	40ng/mL	50ng/mL	0.0001-0.001ng/mL
Bismuth	50ng/mL	100ng/mL	0.0001-0.001ng/mL
Cerium	100µg/mL	50ng/mL	0.0001-0.001ng/mL
Chromium	0.5ng/mL	5ng/mL	0.003ng/mL
Cobalt	5ng/mL	5ng/mL	0.001-0.01ng/mL
Gallium	65ng/mL	50ng/mL	0.0001-0.001ng/mL
Gold	2ng/mL	5ng/mL	0.0001-0.001ng/mL
Iron	0.002ng/mL	5ng/mL	0.001-0.01ng/mL
Manganese	2ng/mL	1ng/mL	0.001-0.01ng/mL
Nickel	10ng/mL	5ng/mL	0.001-0.01ng/mL
Platinum	75ng/mL	50ng/mL	0.0001-0.001ng/mL
Silver	8ng/mL	50ng/mL	0.0001-0.001ng/mL
Tellurium	30ng/mL	50ng/mL	0.001-0.01ng/mL
Thallium	20ng/mL	50ng/mL	0.0001-0.001ng/mL
Tin	95ng/mL	50ng/mL	0.001-0.01ng/mL
Uranium	40µg/mL	500ng/mL	0.0001-0.001ng/mL
Vanadium	50ng/mL	5ng/mL	0.001-0.01ng/mL



METHODS FOR ORAL FLUID

- ◎ Currently, there is one method for oral fluid heavy metals testing that has been accepted:
 - ◎ Lead
 - In the UK, this is a routine test though several different methods exist with varying efficiencies
 - In the US, there is one patented method for ICP-MS
 - ◎ There is research into the other areas of heavy metals testing beginning those with the largest public health concern
 - ◎ Mercury and Aluminum



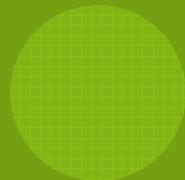
RISK OR PITFALLS OF SALIVA METALS

- ◎ Not all metals partition into the saliva
 - ◎ Rate of transfer into the plasma is the determining effect
 - ◎ Affected by binding to red blood cells and blood proteins
- ◎ Correlation studies need to be completed in order to draw clinical conclusions about the saliva metals result
 - ◎ And correlation needs to be statistically significant



THINGS TO CONSIDER WHEN DOING OF METALS

- ◎ Age of average donor
- ◎ Volume needed for accurate measure
- ◎ Device metal content
- ◎ Internal standards and industry standardization
- ◎ Sample preparation steps and optimization
- ◎ Instrumentation



PROFICIENCY TESTING

- ◎ Programs exist for hair, urine, serum, and whole blood
- ◎ There has been inquiries for saliva heavy metal proficiency testing programs



SUMMARY

- ◎ Oral fluid can be beneficial for metals testing
 - ◎ Same sample size
 - ◎ Non-invasive
 - ◎ Relationship to blood levels
- ◎ Method exist for lead; mercury and aluminum to follow
- ◎ Need for proficiency testing program