

Potential Designated & Potential Priority Metals



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Purpose of agenda item

- ▶ Overview of metals
 - Status under Biomonitoring California
 - Environmental Health Laboratory (EHL) analytical methods
- ▶ Consider chromium as a potential designated chemical
- ▶ Consider currently designated metals as potential priority chemicals
- ▶ Invite input on possible future consideration of additional metals

Designated and *priority* metals

Antimony (Sb)

Arsenic (As)

Barium (Ba)

Beryllium (Be)*

Cadmium (Cd)

Cesium (Cs)

Cobalt (Co)

Lead (Pb)

Manganese (Mn)

Mercury (Hg)

Molybdenum (Mo)

Platinum (Pt)*

Thallium (Tl)

Tungsten (W)

Uranium (U)

**Being dropped from CDC's biomonitoring (will remain designated)*

Additional designated metals as of April 2014*

Copper
Selenium
Strontium
Tin
Zinc

*CDC will report on these in new Updated Tables

Rapid Determination of Ultra-Trace Metals in Blood & Urine by ICP-MS*

*Inductively Coupled Plasma Mass Spectrometry

Analytical methods - Introduction

- ▶ Metals (essential and toxic) can be measured in bodily fluids, including blood and urine
- ▶ EHL's instruments are very sensitive and can analyze multiple metals simultaneously
 - Concerns about interferences

EHL's current capabilities

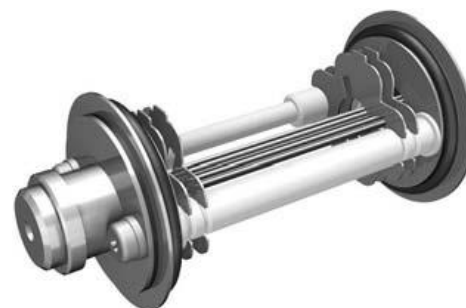
Metal	Essential nutrient	EHL detection limit (µg/L)		CDC detection limit ^a (µg/L)	
		Blood	Urine	Blood	Urine
Arsenic (As)	--	0.037	0.049	--	0.74
Cadmium (Cd)	--	0.011	0.042	0.2	0.042
Chromium (Cr)	--	--	0.161	--	--
Cobalt (Co)	✓	--	0.011	--	0.041
Lead (Pb)	--	0.011 ^b	0.049 ^c	0.25 ^b	0.1
Manganese (Mn)	✓	0.282	0.050	-- ^d	-- ^d
Mercury (Hg)	--	0.029	0.016	0.33	0.08
Molybdenum (Mo)	✓	--	0.074	--	0.92
Selenium (Se)	✓	--	0.343	--	--
Thallium (Tl)	--	--	0.010	--	0.015
Tungsten (W)	--	0.044	0.005	--	0.021
Uranium (U)	--	0.002	0.001	--	0.002

- a. Detection limit in urine as reported for 2009-2010 by CDC (2013).
- b. Blood lead detection limit is in µg/dL.
- c. Can be measured, but is not a recommended biomarker.
- d. CDC has added manganese to the blood and urine metals panel; results will be included in the April 2014 release of the Updated Tables for the National Report on Human Exposure to Environmental Contaminants (Mowbray, pers comm, 2014).

Example: Common polyatomic interferences for ^{52}Cr

Interference	Atomic Mass Unit (amu)
$^{35}\text{Cl}^{16}\text{O}^1\text{H}^+$	52
$^{36}\text{Ar}^{16}\text{O}^+$	52
$^{37}\text{Cl}^{15}\text{N}^+$	52
$^{34}\text{S}^{18}\text{O}^+$	52
$^{36}\text{S}^{16}\text{O}^+$	52
$^{38}\text{Ar}^{14}\text{N}^+$	52
$^{36}\text{Ar}^{15}\text{N}^1\text{H}^+$	52
$^{35}\text{Cl}^{17}\text{O}^+$	52

✓ Helium Collision Cell



7900 ICP-MS



QC reference materials statistics

Sample ID	52 Cr (µg/L)	55 Mn (µg/L)	59 Co (µg/L)	75 As (µg/L)	78 Se (µg/L)	95 Mo (µg/L)	114 Cd (µg/L)	182 W (µg/L)	202 Hg (µg/L)	205 Tl (µg/L)	208*Pb (µg/L)	238 U (µg/L)	
MDL	0.161	0.0499	0.0113	0.0493	0.343	0.0736	0.0420	0.00493	0.0163	0.00982	0.0490	0.00134	
Low QC	Target	2.22	2.23	1.18	1.42	8.35	12.7	2.16	1.04	0.802	2.17	2.27	1.03
	Acceptable range(± 3SD)	2.01 - 2.44	1.98 - 2.47	1.11 - 1.24	1.25 - 1.60	7.64 - 9.06	12.0 - 13.3	2.00 - 2.32	0.989 - 1.10	0.691 - 0.912	2.06 - 2.29	2.11 - 2.44	1.00 - 1.07
	Std Dev	0.072	0.081	0.020	0.059	0.236	0.223	0.054	0.018	0.037	0.039	0.055	0.011
	**CV (%)	3.24	3.64	1.71	4.12	2.83	1.76	2.52	1.70	4.59	1.79	2.42	1.04
Medium QC	Target	10.5	7.04	5.27	6.94	19.4	25.3	10.4	5.17	4.25	10.6	10.7	4.98
	Acceptable range(± 3SD)	9.80 - 11.2	6.33 - 7.75	4.98 - 5.56	6.44 - 7.45	17.9 - 21.0	24.2 - 26.4	9.95 - 10.9	4.97 - 5.38	3.83 - 4.68	10.2 - 10.9	10.3 - 11.1	4.84 - 5.12
	Std Dev	0.239	0.237	0.097	0.168	0.521	0.369	0.162	0.068	0.142	0.117	0.144	0.046
	CV (%)	2.27	3.37	1.84	2.41	2.68	1.46	1.56	1.32	3.34	1.11	1.35	0.92
High QC	Target	20.3	16.8	10.2	16.0	33.5	34.6	19.6	9.74	8.27	19.9	20.5	9.56
	Acceptable range(± 3SD)	19.3 - 21.3	15.9 - 17.6	9.70 - 10.7	15.1 - 16.9	29.5 - 37.5	32.9 - 36.3	19.0 - 20.3	9.28 - 10.2	7.01 - 9.53	19.0 - 20.9	19.5 - 21.6	9.08 - 10.0
	Std Dev	0.335	0.283	0.164	0.304	1.33	0.561	0.222	0.155	0.421	0.320	0.347	0.159
	CV (%)	1.65	1.69	1.60	1.90	3.98	1.62	1.13	1.60	5.09	1.61	1.69	1.66

208*Pb = 206 + 207 + 208 Pb isotopes

**CV (%) is the coefficient of variation

Analytical methods - Key points

- ▶ EHL developed accurate and precise methods to measure multiple metals simultaneously
- ▶ Analysis takes ~2 minutes per sample and is relatively inexpensive
- ▶ Can easily customize metal panels for blood, urine and plasma/serum analysis

Potential Designated Chemical: Chromium

Chemical identity

- ▶ “Chromium” would be the entry on the list of designated chemicals
 - This would include all forms of chromium and chromium compounds
- ▶ Cr(III) is considered an essential nutrient
- ▶ Cr(VI) is the toxic form
 - Listed under Proposition 65 as known to the state to cause cancer and reproductive toxicity (endpoints: developmental, male reproductive, and female reproductive)

Reason for consideration

- ▶ Chromium suggested in 2008 chemical selection surveys of state scientists and the public
- ▶ Hexavalent chromium compounds listed under Proposition 65
- ▶ Current EHL lab capability
- ▶ No data from CDC's National Biomonitoring Program

Criteria for designated chemical

- ▶ **Exposure or potential exposure** to the public or specific subgroups
- ▶ **Known or suspected health effects** resulting from some level of exposure based on peer-reviewed scientific studies
- ▶ **Need to assess efficacy of public health actions** to reduce exposure to a chemical
- ▶ **Availability of a biomonitoring analytical method** with adequate accuracy, precision, sensitivity, specificity, and speed
- ▶ **Availability of adequate biospecimen** samples
- ▶ **Incremental analytical cost** to perform the biomonitoring analysis for the chemical

Use of chromium in U.S.

- ▶ Stainless steel and metal alloys
- ▶ Corrosion inhibitors and protective coatings (e.g., chrome-plating)
- ▶ Other applications
 - Pigments
 - Catalysts

U.S. volume : >1 billion pounds per year

Cr(VI) in air

- ▶ Possible sources
 - Chrome-plating
 - Welding, steel dust (subway)
 - Cigarette smoke, e-cigarette emissions
- ▶ Air concentrations
 - CA ambient air level: $0.00004 \mu\text{g}/\text{m}^3$
 - Indoor air: 10–400 times higher with smoking
- ▶ Reference values
 - 1 in 10^6 cancer risk: $0.000007 \mu\text{g}/\text{m}^3$
 - Inhalation reference exposure level: $0.2 \mu\text{g}/\text{m}^3$
 - OSHA Permissible Exposure Limit: $5 \mu\text{g}/\text{m}^3$

Cr(VI) in water

- ▶ Possible sources
 - Industrial releases – such as releases from chrome-plating facilities, past use as wood preservative, use as corrosion inhibitor
 - Natural occurrence
- ▶ CA water concentrations
 - Groundwater – detections $> 50 \mu\text{g/L}$
 - Drinking water – detections $> 1 \mu\text{g/L}$, ~one-third of 7000 sources
- ▶ Reference values
 - Public Health Level: $0.02 \mu\text{g/L}$
 - Proposed Maximum Contaminant Level: $10 \mu\text{g/L}$

Cr(VI) from metal implants

- ▶ Stainless-steel and cobalt-chromium alloys release Cr, with Cr(VI) as predominant species
- ▶ Elevated chromium levels measured in blood, urine and other biological samples from patients with joint replacements

Ability to biomonitor

- ▶ Cr(VI) is largely reduced to Cr(III) in the body
 - Speciation is not useful
- ▶ Measurements in blood and urine considered most reliable to detect elevated exposures
- ▶ To interpret elevated Cr levels, additional information is needed:
 - Known sources of exposure, e.g., workplace
 - Exposure questionnaire
 - Follow-up survey to evaluate possible sources

Location, population	Blood Cr ^a μg/L	Urine Cr ^b μg/L	Comments
U.S., general		0.22	CDC trace element study
	~0.2		

- a. Geometric mean (GM), unless otherwise noted
- b. Arithmetic mean (AM), unless otherwise noted
- c. Reported as “mean”, type not specified
- d. Median

Analytical considerations

- ▶ EHL can measure chromium in urine (detection limit 0.16 $\mu\text{g}/\text{L}$)
- ▶ Can easily be added to blood metals panel

Need to assess efficacy of public health actions

- ▶ Not currently included in National Biomonitoring Program
- ▶ No data located on chromium biomonitoring in California
- ▶ Biomonitoring, with other information, could help map exposures to Cr(VI) across the state

Options for the Panel

- ▶ Recommend chromium as a designated chemical for Biomonitoring California
- ▶ Postpone consideration
- ▶ Recommend against designating chromium

Potential Priority Chemicals: Selected Metals

Criteria for priority chemical

- ▶ The degree of **potential exposure** to the public or specific subgroups
- ▶ The **likelihood of a chemical being a carcinogen or toxicant** based on peer-reviewed health data, the chemical structure, or the toxicology of chemically related compounds
- ▶ The **limits of laboratory detection** for the chemical, including the ability to detect the chemical at low enough levels that could be expected in the general population
- ▶ **Other criteria** that the panel may agree to

Background

- ▶ In 2009, the SGP recommended the following metals as priority chemicals:
 - Arsenic
 - Cadmium
 - Lead
 - Mercury
- ▶ EHL now has capability to measure additional metals
- ▶ Requesting Panel input on which, if any, additional metals should be priority chemicals

Potential priority metals

Under consideration today:

Antimony

Barium

Beryllium

Cesium

Cobalt

Manganese

Molybdenum

Platinum

Thallium

Tungsten

Uranium

Materials provided to SGP

- ▶ Summary table with notes on:
 - EHL capability, CDC status
 - Use
 - Potential exposure (examples)
 - Indications of toxicity (selected)
- ▶ Background materials
 - CDC and USGS excerpts
 - Extensive reference list

Options for Panel

- ▶ Recommend one or more metals as priority chemicals
- ▶ Postpone consideration
- ▶ Recommend no new priority chemicals

Metals for future consideration as potential designated or potential priority chemicals

Input requested

After today's meeting, we invite Panel members* and the public to:

- ▶ Review metals that will be newly designated in April 2014 (via measurement by CDC)
- ▶ Review periodic table
- ▶ Send suggestions to Program (via email to biomonitoring@oehha.ca.gov) on metals or groups of metals for possible future consideration (designated or priority)

*Please send suggestions as an individual (Panel discussions are subject to the Bagley-Keene Open Meeting Act)