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# Wadsworth Center

NEW YORK STATE DEPARTMENT OF HEALTH

*Trace Elements Laboratory*

## TRACE ELEMENTS IN SERUM

Event #2, 2012

July 19<sup>th</sup>, 2012

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July 19, 2012

**Trace Elements in Serum  
Event #2, 2012**

Dear Laboratory Director:

Results from the second proficiency test (PT) event for 2012 in the category Trace Elements in Serum have been tabulated and are summarized. Target values for Aluminum, Copper, Selenium and Zinc have been established along with acceptable ranges. Results are graded using element-specific criteria as indicated in each narrative section. A laboratory with an unacceptable significant analytical bias relative to the target value will be expected to investigate the source of the error. A confidential three-digit code number assigned by the PT program identifies participant laboratories.

**PT Materials**

This year, the program has decided to move away from using human serum of U.S. origin, to using bovine serum of Australian origin. The reasons for this change include the high level of endogenous selenium found in North American sera and the opportunity to collaborate with the other PT program for Trace Elements in Serum.

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of aluminum (Al), copper (Cu), selenium (Se) and zinc (Zn) in serum. Additionally, serum pools were spiked with a suite of trace elements: cobalt (Co), chromium (Cr), lithium (Li), magnesium (Mg), manganese (Mn), thallium (Tl), and vanadium (V). The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.


**The next PT event for trace elements in serum is scheduled to be mailed Wednesday, September 19th, 2012.** Please inform our laboratory staff at (518) 474-4484 if the test materials have not arrived within five days of the scheduled mail out date. **The deadline for reporting results is Wednesday, October 17th, 2012.**

Thank you for your participation.

Sincerely,



Patrick J. Parsons, Ph.D.  
Chief, Laboratory of Inorganic and Nuclear Chemistry  
Deputy Director, Division of Environmental Health



Mary Frances Verostek, Ph.D.  
Assistant Section Head  
PT Program for Blood Lead /Trace Elements

### Serum Aluminum

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of Al, Cu, Se and Zn in serum. Additionally, serum pools were spiked with a suite of trace elements (Co, Cr, Li, Mg, Mn, Tl, and V), including aluminum as  $\text{AlCl}_3$  at various concentrations. The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.

**The Target Value** assigned for each PT material is the robust mean of the results reported by all participants in this event. The robust statistics were obtained utilizing algorithms based on those presented in **ISO 13528:2005E** Statistical methods for use in proficiency testing by interlaboratory comparisons. Values for serum aluminum range from 144  $\mu\text{g/L}$  (5.34  $\mu\text{mol/L}$ ) to 247  $\mu\text{g/L}$  (9.15  $\mu\text{mol/L}$ ).

**Acceptable ranges** for serum aluminum are based on fixed criteria of  $\pm 20\%$ , or  $\pm 5 \mu\text{g/L}$  below 25  $\mu\text{g/L}$ . These criteria are based on consensus recommendations from several EQAS organizers (1).

**Discussion.** Based on the above criteria, 93.6% of test results reported were judged as satisfactory, with two out of 25 participant laboratories (8.0%) reporting 2 or more of the 5 results outside the acceptable ranges. Several participants noted that the found concentrations of Al were elevated for all test samples shipped for this event. This was an unintended consequence of transitioning to a different source of material. Future events will be designed to challenge across the relevant clinical range. In addition, participant laboratories are expected to be able to report quantitative results for serum Al up to at least 300  $\mu\text{g/L}$ .

1. Taylor, A., Angerer, J., Claeys, F., Kristiansen, J., Mazarrasa, O., Menditto, A., Patriarca, M., Pineau, A., Schoeters, I., Sykes, C., Valkonen, S. and Weykamp, C. Comparison of procedures for evaluating laboratory performance in external quality assessment schemes for lead in blood and aluminum in serum demonstrates the need for common quality specifications. Clinical Chemistry 2002 **48** 2000-2007.

**New York State Department of Health**  
**Serum Aluminum Test Results, 2012 Event #2**  
**ROBUST STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Results ( $\mu\text{g/L}$  serum)

	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
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<b>Robust Mean</b>	<b>144</b>	<b>170</b>	<b>196</b>	<b>223</b>	<b>247</b>
Robust Standard Deviation	19	20	26	25	28
Standard Uncertainty	5	5	7	6	7
RSD (%)	12.9	11.9	13.5	11.1	11.3
Acceptable Range:					
Upper Limit	173	204	235	268	297
Lower Limit	115	136	157	178	197

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Aluminum Test Results, 2012 Event #2**  
**PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE12-06	SE12-07	SE12-08	SE12-09	SE12-10	
	Target Values:	144	170	196	223	247	
110	ETAAS-Z	150	182	198	235	259	
114	ETAAS-Z	167	196	231	219	268	
147	ETAAS-Z	141	166	194	216	240	Info
156	ICP-MS	163	187	216	249	268	
159	ETAAS-Z	123	156	178	208	228	
160	ETAAS-Z	143	173	180	214	230	
164	ICP-MS	137	158	188	206	239	
179	DRC/CC-ICP-MS	117	141	165	198	211	
197	ICP-MS	140	168	176	204	228	
200	DRC/CC-ICP-MS	151	175	206	236	257	Info
206	ICP-MS	>100	>100	>100	>100	>100	
287	ETAAS-Z	152	174	222	231	261	
293	ICP-MS	169	204	238 ↑	268	297	Info
305	ICP-MS	134	158	181	222	242	
324	HR-ICP-MS	157	233 ↑	260 ↑	252	277	Info
325	ETAAS-Z	83 ↓	129 ↓	150 ↓	179	150 ↓	Info
355	ICP-MS	150	175	201	233	270	
357	ICP-MS	153	180	213	236	262	
358	ICP-MS	152	175	194	237	>250	
362	ICP-MS	163	178	221	254	277	
363	ICP-MS	134	167	182	210	242	
366	ETAAS-Z	120	154	175	201	225	Info
367	ETAAS-Z	134	148	178	204	225	Info
401	ICP-AES/OES	165	192	216	267	299 ↑	Info
458	ETAAS Other	117	144	165	183	207	

Percent satisfactory results for all participants: 93.6 %

**notes:** ↑ reported outside upper limit  
↓ reported outside lower limit

**Info only:** results included for informational purposes only.

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Aluminum Test Results, 2012 Event #2**  
**STATISTICAL SUMMARY BY METHOD**

	Results (µg/L serum)				
	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	134	158	186	217	234
Standard Deviation:	24	24	29	27	33
RSD (%):	—	—	—	—	—
<b>ETAAS Other</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	117	144	165	183	207
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ETAAS-Z</b>					
Number of Sample Measurements:	9	9	9	9	9
Mean:	135	164	190	212	232
Standard Deviation:	24	20	25	17	35
RSD (%):	18.0	12.1	13.2	7.9	15.1
<b>HR-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	157	233	260	252	277
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-AES/OES</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	165	192	216	267	299
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	10	10	10	10	9
Mean:	150	175	201	232	258
Standard Deviation:	13	14	20	21	22
RSD (%):	8.6	7.9	10.1	9.3	8.6
<b>All Laboratories</b>					
Number of Sample Measurements:	24	24	24	24	23
Mean:	142	171	197	223	246
Standard Deviation:	20	22	26	24	33
RSD (%):	14.1	13.0	13.3	10.8	13.3

**notes:** ? Insufficient data for calculation.

### Serum Copper

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of Al, Cu, Se and Zn in serum. Additionally, serum pools were spiked with a suite of trace elements (Co, Cr, Li, Mg, Mn, Ti, and V), including copper as  $\text{CuCl}_2$  at various concentrations. The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.

**The Target Value** assigned for each PT material is the robust mean of the results reported by all participants in this event. The robust statistics were obtained utilizing algorithms based on those presented in **ISO 13528:2005E** Statistical methods for use in proficiency testing by interlaboratory comparisons. Values for serum copper range from 1505  $\mu\text{g/L}$  (23.68  $\mu\text{mol/L}$ ) to 2177  $\mu\text{g/L}$  (34.26  $\mu\text{mol/L}$ ).

**Acceptable ranges** for serum copper are based on fixed criteria of  $\pm 15\%$ , or  $\pm 95 \mu\text{g/L}$  below 635  $\mu\text{g/L}$ . These criteria are consistent with those proposed by the OELM Network of EQAS organizers (1, 2) for trace elements in serum, and are slightly less stringent than those previously suggested for NYS ( $\pm 10\%$ ).

**Discussion.** Based on the above criteria, 98.0% of test results reported were judged as satisfactory, with none out of 20 participant laboratories reporting 2 or more of the 5 results outside the acceptable ranges.

1. A. Taylor, J. Angerer, J. Arnaud, F. Claeys, R.L. Jones, O. Mazarrasa, E. Mairiaux, A. Menditto, P.J. Parsons, M. Patriarca, A. Pineau, S. Valkonen, J.-P. Weber and C. Weykamp Accreditation and Quality Assurance 2006 **11** 440-445.

2. J. Arnaud, J.-P. Weber, C.W. Weykamp, P.J. Parsons, J. Angerer, E. Mairiaux, O. Mazarrasa, S. Valkonen, A. Menditto, M. Patriarca, and A. Taylor Clinical Chemistry 2008 **54** 1892-1899.

**New York State Department of Health**  
**Serum Copper Test Results, 2012 Event #2**  
**ROBUST STATISTICAL SUMMARY**

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**TARGET VALUE ASSIGNMENT AND STATISTICS**

Results ( $\mu\text{g/L}$  serum)

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	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
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<b>Robust Mean</b>	<b>1 5 0 5</b>	<b>1 6 5 7</b>	<b>1 8 4 1</b>	<b>2 0 1 6</b>	<b>2 1 7 7</b>
Robust Standard Deviation	68	93	99	114	166
Standard Uncertainty	19	26	28	32	46
RSD (%)	4.6	5.6	5.4	5.6	7.6
Acceptable Range:					
Upper Limit	1731	1906	2117	2318	2504
Lower Limit	1279	1408	1565	1714	1850

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**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.



**New York State Department of Health**  
**Serum Copper Test Results, 2012 Event #2**  
**PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE12-06	SE12-07	SE12-08	SE12-09	SE12-10	
Target Values:		1505	1657	1841	2016	2177	
107	DRC/CC-ICP-MS	1523	1696	1877	2038	2208	Info
110	ICP-MS	1639	1840	2008	2163	2407	
114	ICP-MS	1430	1620	1750	1910	2040	
147	ICP-MS	1512	1773	1893	2103	2249	
156	FAAS	1450	1730	1865	1890	1863	
159	ICP-AES/OES	1580	1750	1920	2090	2270	
160	ETAAS-Z	1480	1690	1820	1990	2180	
164	ICP-MS	1444	1601	1745	1943	2056	
179	DRC/CC-ICP-MS	1540	1690	1880	2080	2240	
197	ICP-MS	1550	1490	2280 ↑	2310	2340	
200	ICP-MS	1422	1613	1772	1949	2070	Info
206	ICP-MS	1370	1500	1660	1810	1920	
293	ICP-MS	1505	1645	1810	1988	2115	Info
305	ICP-MS	1517	1630	1786	2006	2096	
324	HR-ICP-MS	1581	1617	1772	2005	2281	Info
325	FAAS	1530	1800	1980	2160	2400	
362	ICP-MS	1710	1930 ↑	1990	2130	2410	
366	ETAAS-Z	1480	1620	1845	2010	2160	
401	DRC/CC-ICP-MS	1474	1627	1805	1970	2123	Info
457	ICP-AES/OES	1461	1527	1721	1874	2029	Info

Percent satisfactory results for all participants: 98.0 %

**notes:** ↑ reported outside upper limit  
↓ reported outside lower limit

**Info only:** results included for informational purposes only.

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Copper Test Results, 2012 Event #2**  
**STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	3	3	3	3	3
Mean:	1512	1671	1854	2029	2190
Standard Deviation:	34	38	42	56	60
RSD (%):	—	—	—	—	—
<b>ETAAS-Z</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	1480	1655	1833	2000	2170
Standard Deviation:	0	49	18	14	14
RSD (%):	—	—	—	—	—
<b>FAAS</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	1490	1765	1923	2025	2132
Standard Deviation:	57	49	81	191	380
RSD (%):	—	—	—	—	—
<b>HR-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	1581	1617	1772	2005	2281
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-AES/OES</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	1521	1639	1821	1982	2150
Standard Deviation:	84	158	141	153	170
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	10	10	10	10	10
Mean:	1510	1664	1869	2031	2170
Standard Deviation:	104	142	181	146	170
RSD (%):	6.9	8.5	9.7	7.2	7.8
<b>All Laboratories</b>					
Number of Sample Measurements:	20	20	20	20	20
Mean:	1510	1669	1859	2021	2173
Standard Deviation:	78	112	135	117	155
RSD (%):	5.2	6.7	7.3	5.8	7.1

**notes:** ? Insufficient data for calculation.

**New York State Department of Health**  
**Event #2, 2012**

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**Serum Selenium**

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of Al, Cu, Se and Zn in serum. Additionally, serum pools were spiked with a suite of trace elements (Co, Cr, Li, Mg, Mn, Tl, and V), including selenium as SeO<sub>2</sub> at various concentrations. The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.

**The Target Value** assigned for each PT material is the robust mean of the results reported by all participants in this event. The robust statistics were obtained utilizing algorithms based on those presented in **ISO 13528:2005E** Statistical methods for use in proficiency testing by interlaboratory comparisons. Values for serum selenium range from 52 µg/L (0.66 µmol/L) to 109 µg/L (1.38 µmol/L).

**Acceptable ranges** for serum selenium are based on fixed criteria of ±20%, or ±2 µg/L below 10 µg/L. These criteria are a little less stringent than those proposed by the OELM Network of EQAS organizers (±15% or ±8 µg/L below 55 µg/L) (1, 2) for trace elements in serum. As performance for serum Se improves among NYS-permit laboratories, consideration will be given to adopting the OELM criteria.

**Discussion.** Based on the above criteria, 84.7% of test results reported were judged as satisfactory, with three of the 17 participant laboratories (17.6%) reporting 2 or more of the 5 results outside the acceptable ranges. It can be seen that this event included four serum samples with levels of Se below 100 µg/L, which is not typical of serum Se levels in the U.S. population. Such low levels would be close to those considered selenium deficient and of concern for clinical purposes. Future events will be designed to challenge Se at levels across the clinical range, i.e., <50 µg/L to >300 µg/L.

1. A. Taylor, J. Angerer, J. Arnaud, F. Claeys, R.L. Jones, O. Mazarrasa, E. Mairiaux, A. Menditto, P.J. Parsons, M. Patriarca, A. Pineau, S. Valkonen, J.-P. Weber and C. Weykamp Accreditation and Quality Assurance 2006 **11** 440-445.

2. J. Arnaud, J.-P. Weber, C.W. Weykamp, P.J. Parsons, J. Angerer, E. Mairiaux, O. Mazarrasa, S. Valkonen, A. Menditto, M. Patriarca, and A. Taylor Clinical Chemistry 2008 **54** 1892-1899.

**New York State Department of Health**  
**Serum Selenium Test Results, 2012 Event #2**  
**ROBUST STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Results ( $\mu\text{g/L}$  serum)

	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
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<b>Robust Mean</b>	<b>109</b>	<b>97</b>	<b>82</b>	<b>72</b>	<b>52</b>
Robust Standard Deviation	10	11	6	12	5
Standard Uncertainty	3	3	2	4	2
RSD (%)	8.9	11.2	7.9	16.8	9.9
Acceptable Range:					
Upper Limit	131	116	98	86	62
Lower Limit	87	78	66	58	42

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Selenium Test Results, 2012 Event #2**  
**PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE12-06	SE12-07	SE12-08	SE12-09	SE12-10	
	Target Values:	109	97	82	72	52	
107	DRC/CC-ICP-MS	103	88	75	62	48	Info
110	DRC/CC-ICP-MS	103	89	76	62	48	
114	ICP-MS	128	114	105 ↑	99 ↑	77 ↑	
147	ICP-MS	118	111	96	84	70 ↑	Info
156	ICP-MS	106	94	78	71	54	
159	ETAAS-Z	100	84	70	55 ↓	42	
164	DRC/CC-ICP-MS	103	98	83	66	51	
179	DRC/CC-ICP-MS	109	92	76	65	53	
197	ICP-MS	143 ↑	132 ↑	114 ↑	101 ↑	82 ↑	
200	DRC/CC-ICP-MS	131	111	100 ↑	90 ↑	74 ↑	Info
206	ICP-MS	99	85	78	61	49	
293	DRC/CC-ICP-MS	115	96	83	71	56	Info
305	ICP-MS	111	107	80	79	46	
324	HR-ICP-MS	110	105	90	72	59	Info
366	ETAAS-Z	99	90	85	72	48	Info
367	DRC/CC-ICP-MS	100	87	79	67	51	Info
401	DRC/CC-ICP-MS	107	92	80	66	51	Info

Percent satisfactory results for all participants: 84.7 %

**notes:** ↑ reported outside upper limit  
↓ reported outside lower limit

**Info only:** results included for informational purposes only.

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Selenium Test Results, 2012 Event #2**  
**STATISTICAL SUMMARY BY METHOD**

<b>Results (<math>\mu\text{g/L}</math> serum)</b>					
	<b>SE12-06</b>	<b>SE12-07</b>	<b>SE12-08</b>	<b>SE12-09</b>	<b>SE12-10</b>
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	109	94	82	69	54
Standard Deviation:	10	8	8	9	8
RSD (%):	9.3	8.3	9.9	13.3	15.7
<b>ETAAS-Z</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	100	87	78	64	45
Standard Deviation:	1	4	11	12	4
RSD (%):	—	—	—	—	—
<b>HR-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	110	105	90	72	59
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	6	6	6	6	6
Mean:	118	107	92	83	63
Standard Deviation:	16	16	16	16	15
RSD (%):	13.6	15.3	16.9	19.0	24.3
<b>All Laboratories</b>					
Number of Sample Measurements:	17	17	17	17	17
Mean:	111	99	85	73	56
Standard Deviation:	13	13	12	13	12
RSD (%):	11.4	13.2	14.0	18.2	21.1

**notes:** ? Insufficient data for calculation.

### Serum Zinc

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of Al, Cu, Se and Zn in serum. Additionally, serum pools were spiked with a suite of trace elements (Co, Cr, Li, Mg, Mn, Tl, and V), including zinc as  $\text{ZnCl}_2$  at various concentrations. The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.

**The Target Value** assigned for each PT material is the robust mean of the results reported by all participants in this event. The robust statistics were obtained utilizing algorithms based on those presented in **ISO 13528:2005E** Statistical methods for use in proficiency testing by interlaboratory comparisons. Values for serum zinc range from 1296  $\mu\text{g/L}$  (19.82  $\mu\text{mol/L}$ ) to 1639  $\mu\text{g/L}$  (25.06  $\mu\text{mol/L}$ ).

**Acceptable ranges** for serum zinc are based on fixed criteria of  $\pm 15\%$ , or  $\pm 15 \mu\text{g/L}$  below 100  $\mu\text{g/L}$ . These criteria are consistent with those proposed by the OELM network of EQAS organizers (1) for trace elements in serum.

**Discussion.** Based on the above criteria, 93.1% of test results reported were judged as satisfactory, with two out of 26 participant laboratories (7.7%) reporting 2 or more of the 5 results outside the acceptable ranges.

1. A. Taylor, J. Angerer, J. Arnaud, F. Claeys, R.L. Jones, O. Mazarrasa, E. Mairiaux, A. Menditto, P.J. Parsons, M. Patriarca, A. Pineau, S. Valkonen, J.-P. Weber and C. Weykamp Accreditation and Quality Assurance 2006 **11** 440-445.

2. J. Arnaud, J.-P. Weber, C.W. Weykamp, P.J. Parsons, J. Angerer, E. Mairiaux, O. Mazarrasa, S. Valkonen, A. Menditto, M. Patriarca, and A. Taylor Clinical Chemistry 2008 **54** 1892-1899.

**New York State Department of Health**  
**Serum Zinc Test Results, 2012 Event #2**  
**ROBUST STATISTICAL SUMMARY**

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**TARGET VALUE ASSIGNMENT AND STATISTICS**

Results ( $\mu\text{g/L}$  serum)

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	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
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<b>Robust Mean</b>	<b>1 6 3 9</b>	<b>1 5 5 6</b>	<b>1 4 7 4</b>	<b>1 3 8 8</b>	<b>1 2 9 6</b>
Robust Standard Deviation	99	87	98	65	79
Standard Uncertainty	24	21	24	16	19
RSD (%)	6.0	5.6	6.6	4.7	6.1
Acceptable Range:					
Upper Limit	1885	1789	1695	1596	1490
Lower Limit	1393	1323	1253	1180	1102

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**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.



**New York State Department of Health**  
**Serum Zinc Test Results, 2012 Event #2**  
**PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE12-06	SE12-07	SE12-08	SE12-09	SE12-10	
Target Values:		1639	1556	1474	1388	1296	
107	DRC/CC-ICP-MS	1740	1661	1570	1469	1383	Info
110	ICP-MS	1762	1676	1619	1467	1404	
114	ICP-MS	1440	1400	1300	1220	1170	
147	ICP-MS	1536	1536	1379	1366	1222	
156	ICP-MS	1579	1575	1461	1371	1285	
159	ICP-AES/OES	1680	1600	1500	1420	1330	
160	FAAS	1650	1560	1440	1410	1350	
164	ICP-MS	1607	1500	1417	1353	1261	
179	DRC/CC-ICP-MS	1670	1570	1490	1390	1310	
197	ICP-MS	1720	1390	1790 ↑	1590	1390	
200	ICP-MS	1517	1485	1406	1315	1230	Info
206	ICP-MS	1480	1420	1340	1270	1190	
287	FAAS	1660	1580	1520	1410	1330	
293	ICP-MS	1733	1589	1517	1439	1315	
305	ICP-MS	1564	1462	1333	1291	1182	
324	HR-ICP-MS	1674	1628	1512	1401	1324	Info
325	FAAS	2250 ↑	1995 ↑	1890 ↑	1770 ↑	1650 ↑	
355	ICP-MS	1607	1571	1489	1374	1334	
357	ICP-MS	1670	1580	1520	1430	1340	
358	ICP-MS	1582	1494	1388	1309	1200	
362	ICP-MS	1620	1510	1470	1380	1260	
363	ICP-MS	1190 ↓	1560	1500	1390	1330	
366	FAAS	1614	1453	1299	1149 ↓	1065 ↓	Info
401	DRC/CC-ICP-MS	1681	1596	1504	1412	1314	
457	ICP-AES/OES	1673	1582	1433	1363	1253	Info
458	FAAS	1787	1686	1572	1456	1339	

Percent satisfactory results for all participants: 93.1 %

**notes:** ↑ reported outside upper limit  
↓ reported outside lower limit

**Info only:** results included for informational purposes only.

**notes:** Results reported as less than the method detection limit are excluded from statistical calculations.

**New York State Department of Health**  
**Serum Zinc Test Results, 2012 Event #2**  
**STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	3	3	3	3	3
Mean:	1697	1609	1521	1424	1336
Standard Deviation:	38	47	43	41	41
RSD (%):	—	—	—	—	—
<b>FAAS</b>					
Number of Sample Measurements:	5	5	5	5	5
Mean:	1792	1655	1544	1439	1347
Standard Deviation:	264	207	219	221	207
RSD (%):	14.7	12.5	14.2	15.4	15.4
<b>HR-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	1674	1628	1512	1401	1324
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-AES/OES</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	1677	1591	1467	1392	1292
Standard Deviation:	5	13	47	40	54
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	15	15	15	15	15
Mean:	1574	1517	1462	1371	1274
Standard Deviation:	140	79	124	90	76
RSD (%):	8.9	5.2	8.5	6.5	5.9
<b>All Laboratories</b>					
Number of Sample Measurements:	26	26	26	26	26
Mean:	1642	1564	1487	1393	1299
Standard Deviation:	173	118	133	116	106
RSD (%):	10.6	7.6	9.0	8.3	8.2

**notes:** ? Insufficient data for calculation.

### **Additional Trace Elements Reported in Serum**

Participant laboratories reported their analytical results for any additional trace elements (other than Al, Cu, Se and Zn) that are routinely reported so that a more complete characterization can be recorded for these PT materials. Results for additional trace elements are reported here, but no target value is implied nor are any acceptable ranges provided. These data are provided solely for educational and informational purposes.

Serum materials were obtained from the Dutch EQA (External Quality Assessment) scheme SKML (Stichting Kwaliteitsbewaking Medische Laboratoria) as part of a global collaborative exercise to harmonize international measurements of Al, Cu, Se and Zn in serum. Additionally, serum pools were spiked with a suite of trace elements at various concentrations including cobalt as  $\text{CoCl}_2$ , chromium as  $\text{CrCl}_3$ , lithium as  $\text{LiCl}$ , magnesium as  $\text{MgCl}_2$ , manganese as  $\text{MnCl}_2$ , thallium as  $\text{TlNO}_3$ , and vanadium as  $\text{VOSO}_4$ . The serum has been tested and found to be negative for BSE (Bovine Spongiform Encephalopathy), and free of pathogens. The Certificate of Analysis provided by SKML is available upon request.

#### **Additional Elements**

Co, Cr, Li, Mg, Mn, Tl, V

**New York State Department of Health  
Serum Additional Elements, 2012 Event #2  
Page 1**

<b>Serum Antimony (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	21.1	20.9	21.2	20.5	21.6

<b>Serum Arsenic (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
197	DRC/CC-ICP-MS	<10	<10	<10	<10	<10

<b>Serum Barium (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	43.1	42.7	42.8	42.8	42.8
197	ICP-MS	52.7	51.5	49.9	50.8	48.9

<b>Serum Beryllium (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	<0.45	<0.45	<0.45	<0.45	<0.45
197	ICP-MS	<0.2	<0.2	<0.2	<0.2	<0.2

<b>Serum Bismuth (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	1.4	1.4	1.4	1.4	1.4

<b>Serum Cadmium (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	0.3	0.2	0.3	0.2	0.2
197	DRC/CC-ICP-MS	<0.5	<0.5	<0.5	<0.5	<0.5

<b>Serum Chromium (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	33.4	28.9	22.3	17.6	11.7
164	DRC/CC-ICP-MS	32	28	22	15	10
179	DRC/CC-ICP-MS	32.3	26.9	21.9	16.3	11.0
197	DRC/CC-ICP-MS	30.2	25.2	20.5	15.1	10.7
293	DRC/CC-ICP-MS	33	32	25	18	13
305	ICP-MS	31.2	27.4	21.8	16.4	10.9
Arithmetic mean (n=6)		32	28	22	16	11
SD		1	2	1	1	1

<b>Serum Cobalt (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	24	28.2	33.2	37.5	42.4
179	ICP-MS	24	29	33	38	40
197	ICP-MS	22.8	27.0	31.9	36.3	40.1
206	ICP-MS	22.7	27.5	32	37.4	41.5
293	DRC/CC-ICP-MS	23	30	34	39	44
Arithmetic mean (n=5)		23	28	33	38	42
SD		1	1	1	1	2

<b>Serum Iodine (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	145.6	146.8	145.6	145.6	146.8

<b>Serum Iron (µg/L)</b>						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
457	ICP-AES/OES	1737	1684	1688	1690	1644

New York State Department of Health  
Serum Additional Elements, 2012 Event #2  
Page 2

Serum Lead (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	0.67	0.66	0.64	0.59	0.64
197	DRC/CC-ICP-MS	0.6	0.7	0.6	0.6	0.5

Serum Lithium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	11312	9438	7495	5635	3796

Serum Manganese (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
107	DRC/CC-ICP-MS	147	146	146	144	146
147	ICP-MS	143	141.8	145.6	142.3	145.6
179	DRC/CC-ICP-MS	>100	>100	>100	>100	>100
197	DRC/CC-ICP-MS	139.5	137.7	138.1	140.7	140.5
305	ICP-MS	135.1	137.4	160.9	138.4	139.7
Arithmetic mean (n=4)		139	139	148	140	142
SD		4	2	12	2	3

Serum Mercury (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	<0.1	<0.1	<0.1	<0.1	<0.1

Serum Molybdenum (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	9.8	9.6	9.7	9.4	9.6

Serum Tellurium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	<0.09	<0.09	<0.09	<0.09	<0.09
197	ICP-MS	<1.0	<1.0	<1.0	<1.0	<1.0

Serum Thallium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	4.3	5.4	6.4	7.3	8
197	ICP-MS	5.0	5.6	6.8	7.6	8.7

Serum Thorium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	<0.03	<0.03	<0.03	<0.03	<0.03

Serum Tin (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	0.7	0.7	0.7	0.7	0.7
197	ICP-MS	<5.0	<5.0	<5.0	<5.0	<5.0

Serum Uranium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	0.2	0.2	0.2	0.2	0.2

Serum Vanadium (µg/L)						
Lab Code	Method	SE12-06	SE12-07	SE12-08	SE12-09	SE12-10
147	ICP-MS	6.3	5.4	4.5	3.6	2.6
179	DRC/CC-ICP-MS	6.3	5.0	4.4	3.5	2.4

**New York State Department of Health**  
**Trace Elements in Serum**  
**METHOD NOTES**

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***ATOMIC SPECTROMETRY METHODS***

- A-1     ETAAS-Z (Electrothermal atomic absorption spectrometry with Zeeman background correction)
- A-2     ETAAS other (i.e., D<sub>2</sub>, S-H background correction)
- A-3     FAAS (Flame atomic absorption spectrometry)
- A-4     CV-AAS (Cold vapor atomic absorption spectrometry)
- A-5     HG-AAS (Hydride generation atomic absorption spectrometry)
- A-6     AFS (Atomic fluorescence spectrometry)
- A-7     Other

***INDUCTIVELY COUPLED PLASMA***

- P-1     ICP-MS (Inductively coupled plasma - mass spectrometry)
- P-2     DRC/CC-ICP-MS (ICP-MS used in the Dynamic Reaction Cell or Collision Cell mode)
- P-3     ICP-AES/OES (ICP atomic/optical emission spectrometry)
- P-4     HR-ICP-MS (High resolution ICP-MS)
- P-5     ETV-ICP-MS (Electrothermal vaporization ICP-MS)
- P-6     ID-ICP-MS (Isotope dilution ICP-MS)
- P-7     Other

***ELECTROCHEMICAL METHODS***

- E-1     ASV (Anodic stripping voltammetry without digestion)
- E-2     ASV-LeadCare® (Anodic stripping voltammetry using the ESA LeadCare® system)
- E-3     Fluoride specific electrode
- E-4     Other

***MOLECULAR FLUORIMETRY***

- F-1     EtOAc (Ethyl acetate-acetic acid extraction method for determination of erythrocyte protoporphyrin)
- F-2     Aviv hematofluorometry (for determination of EP at hematocrit 35)
- F-3     Helena ZPP (for determination of zinc protoporphyrin in  $\mu\text{mol ZPP/mol heme}$ )
- F-4     Other

***OTHER METHODS***

If your method is not listed in the above list, please describe it briefly.

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