
Wadsworth Center

NEW YORK STATE DEPARTMENT OF HEALTH

Trace Elements Laboratory

TRACE ELEMENTS IN SERUM

Proficiency Test Report

Event #3, 2013

November 6th, 2013

November 6, 2013

**Trace Elements in Serum
Event #3, 2013**

Dear Laboratory Director:

Results from the third proficiency test (PT) event for 2013 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

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.

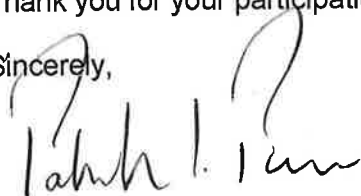
Serum Selenium

Since switching to the serum materials obtained from the Dutch EQA, we have become aware of a potential interference on Se in ICP-MS when sera from bovine sources are used for PT sample pools. Please refer to the Se narrative for further details.

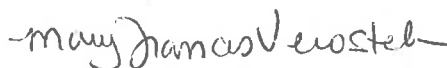
The next PT event for trace elements in serum is scheduled to be mailed Wednesday, January 15th, 2014. Please inform our laboratory staff at (518) 474-7161 if the test materials have not arrived within five days of the scheduled mail out date. **The deadline for reporting results is Wednesday, February 12th, 2014.**

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

New York State Department of Health
Event #3, 2013

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 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 11 $\mu\text{g/L}$ (0.41 $\mu\text{mol/L}$) to 180 $\mu\text{g/L}$ (6.67 $\mu\text{mol/L}$).

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, 87.8% of test results reported were judged as satisfactory, with four out of 23 participant laboratories (17.4%) reporting 2 or more of the 5 results outside the acceptable ranges.

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, 2013 Event #3
ROBUST STATISTICAL SUMMARY

TARGET VALUE ASSIGNMENT AND STATISTICS

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

	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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Robust Mean	9 4	6 1	1 8 0	1 1	1 3 0
Robust Standard Deviation	9	8	7	1.5	11
Standard Uncertainty	2	2	2	0.4	3
RSD (%)	9.6	12.5	4.0	13.6	8.2
Number of Sample Measurements	22	23	22	20	22

Acceptable Range:

Upper Limit	113	73	216	16	156
Lower Limit	75	49	144	6	104

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, 2013 Event #3
PERFORMANCE OF PARTICIPATING LABORATORIES

Lab Code	Method	Results (µg/L serum)					Info Only
		SE13-11	SE13-12	SE13-13	SE13-14	SE13-15	
	Target Values:	94	61	180	11	130	
110	ETAAS-Z	102	68	186	10	136	
114	ICP-MS	96	89 ↑	188	11	137	
147	FAAS	100	65	193	11	137	Info
156	ICP-MS	99	64	180	<11	131	
160	ICP-MS	96	59	186	11	131	
164	ICP-MS	91	58	175	10	128	
179	DRC/CC-ICP-MS	85	54	178	8	116	
197	ICP-MS	106	63	178	<20 ↑	147	
200	DRC/CC-ICP-MS	86	55	179	11	131	Info
206	DRC/CC-ICP-MS	>100	77 ↑	>100	12	>100	
287	ETAAS-Z	89	55	174	9	118	
293	ICP-MS	91	69	174	11	131	Info
305	ICP-MS	106	66	223 ↑	20 ↑	136	
324	ICP-MS	93	56	176	7	123	Info
325	ETAAS-Z	55 ↓	69	189	11	142	Info
355	ICP-MS	87	60	177	10	124	
357	ICP-MS	105	74 ↑	199	13	138	
358	ICP-MS	92	58	174	10	126	
362	ICP-MS	89	56	178	8	115	
363	ICP-MS	92	58	180	12	126	
366	ETAAS-Z	73 ↓	40 ↓	108 ↓	12	110	Info
401	ICP-AES/OES	97	43 ↓	165	<3 ↓	113	Info
458	ETAAS Other	117 ↑	61	183	10	165 ↑	

Percent satisfactory results for all participants: 87.8 %

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, 2013 Event #3
STATISTICAL SUMMARY BY METHOD

	Results ($\mu\text{g/L}$ serum)				
	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
DRC/CC-ICP-MS					
Number of Sample Measurements:	2	3	2	3	2
Mean:	86	62	179	10	124
Standard Deviation:	1	13	1	2	11
RSD (%):	—	—	—	—	—
ETAAS Other					
Number of Sample Measurements:	1	1	1	1	1
Mean:	117	61	183	10	165
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
ETAAS-Z					
Number of Sample Measurements:	4	4	4	4	4
Mean:	80	58	164	11	127
Standard Deviation:	20	14	38	1	15
RSD (%):	25.5	23.4	23.2	12.3	11.9
FAAS					
Number of Sample Measurements:	1	1	1	1	1
Mean:	100	65	193	11	137
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
ICP-AES/OES					
Number of Sample Measurements:	1	1	1	0	1
Mean:	97	43	165		113
Standard Deviation:	?	?	?		?
RSD (%):	—	—	—	—	—
ICP-MS					
Number of Sample Measurements:	13	13	13	11	13
Mean:	96	64	184	11	130
Standard Deviation:	7	9	14	3	8
RSD (%):	6.8	14.5	7.5	30.1	6.2
All Laboratories					
Number of Sample Measurements:	22	23	22	20	22
Mean:	93	62	179	11	130
Standard Deviation:	13	10	20	3	12
RSD (%):	13.5	17.0	11.0	24.2	9.6

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 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 675 $\mu\text{g/L}$ (10.62 $\mu\text{mol/L}$) to 2869 $\mu\text{g/L}$ (45.15 $\mu\text{mol/L}$).

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, 95.0% of test results reported were judged as satisfactory, with two out of 20 participant laboratories (10.0%) 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, 2013 Event #3
ROBUST STATISTICAL SUMMARY**

TARGET VALUE ASSIGNMENT AND STATISTICS

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

	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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Robust Mean	1744	1327	2869	675	2209
Robust Standard Deviation	101	93	162	30	138
Standard Uncertainty	28	26	45	8	39
RSD (%)	5.8	7.0	5.6	4.4	6.2
Number of Sample Measurements	20	20	20	20	20

Acceptable Range:

Upper Limit	2006	1526	3299	776	2540
Lower Limit	1482	1128	2439	574	1878

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, 2013 Event #3
PERFORMANCE OF PARTICIPATING LABORATORIES

Lab Code	Method	Results (µg/L serum)					Info Only
		SE13-11	SE13-12	SE13-13	SE13-14	SE13-15	
Target Values:		1744	1327	2869	675	2209	
107	DRC/CC-ICP-MS	1630	1310	2870	679	2130	Info
110	ICP-MS	1831	1361	2942	697	2281	
114	ICP-MS	1640	1280	2840	670	2050	
147	ICP-MS	1779	1366	2897	693	2205	
156	ICP-AES/OES	1830	1390	2940	695	2270	
160	ICP-MS	1740	1320	2870	690	2230	Info
164	ICP-MS	1748	1225	2771	625	2152	
179	DRC/CC-ICP-MS	1870	1420	3080	700	2300	
197	ICP-MS	1730	1330	2880	670	2230	
200	ICP-MS	1892	1416	3042	724	2356	
206	ICP-MS	1700	1210	2640	660	1980	Info
293	ICP-MS	1697	1278	2753	648	2149	
305	ICP-MS	1490	1150	2460	570 ↓	1850 ↓	
324	ICP-MS	1544	1157	2496	595	1921	
325	ICP-MS	1440 ↓	1500	2720	650	2350	
359	ICP-MS	1793	1261	2835	644	2100	Info
366	ETAAS-Z	1834	1426	3420 ↑	680	2600 ↑	
401	DRC/CC-ICP-MS	1786	1366	2885	693	2281	
457	ICP-AES/OES	1766	1398	3034	707	2383	
481	ICP-MS	1780	1334	2981	699	2209	

Percent satisfactory results for all participants: 95.0 %

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, 2013 Event #3
STATISTICAL SUMMARY BY METHOD

	Results ($\mu\text{g/L}$ serum)				
	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
DRC/CC-ICP-MS					
Number of Sample Measurements:	3	3	3	3	3
Mean:	1762	1365	2945	691	2237
Standard Deviation:	122	55	117	11	93
RSD (%):	—	—	—	—	—
ETAAS-Z					
Number of Sample Measurements:	1	1	1	1	1
Mean:	1834	1426	3420	680	2600
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
ICP-AES/OES					
Number of Sample Measurements:	2	2	2	2	2
Mean:	1798	1394	2987	701	2327
Standard Deviation:	45	6	66	8	80
RSD (%):	—	—	—	—	—
ICP-MS					
Number of Sample Measurements:	14	14	14	14	14
Mean:	1700	1299	2795	660	2147
Standard Deviation:	130	97	170	42	153
RSD (%):	7.6	7.5	6.1	6.4	7.1
All Laboratories					
Number of Sample Measurements:	20	20	20	20	20
Mean:	1726	1325	2868	669	2201
Standard Deviation:	123	93	210	39	172
RSD (%):	7.1	7.0	7.3	5.8	7.8

notes: ? Insufficient data for calculation.

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 SeO₂ 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 47 µg/L (0.60 µmol/L) to 268 µg/L (3.39 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. We have become aware of a potential interference on Se in ICP-MS when sera from bovine sources are used for PT sample pools. We are currently investigating this and will report on our findings in due course. Until that time, grading for serum Se is suspended. We ask that participants continue to analyze our serum pools for Se, along with other trace elements, to aid in the investigation. We included human sera for comparison purposes with this PT event (SE13-21 through 25), and we requested participant's cooperation by analyzing these additional materials for Se. We will shortly be circulating a summary of the results, as well as from the questionnaire which asked for more details of the analytical methods used for Se.

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, 2013 Event #3
ROBUST STATISTICAL SUMMARY

TARGET VALUE ASSIGNMENT AND STATISTICS

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

	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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Robust Mean	156	199	47	268	115
Robust Standard Deviation	6	10	4	9	8
Standard Uncertainty	2	3	1	3	2
RSD (%)	4.0	4.9	7.5	3.2	6.7
Number of Sample Measurements	15	15	15	15	15

Acceptable Range:

Upper Limit	187	239	56	322	138
Lower Limit	125	159	38	214	92

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, 2013 Event #3
PERFORMANCE OF PARTICIPATING LABORATORIES

Lab Code	Method	Results (µg/L serum)					Info Only
		SE13-11	SE13-12	SE13-13	SE13-14	SE13-15	
	Target Values:	156	199	47	268	115	
107	DRC/CC-ICP-MS	141	191	46	257	106	Info
110	DRC/CC-ICP-MS	153	193	43	259	108	
114	ICP-MS	235	241	91	268	147	
147	DRC/CC-ICP-MS	159	199	49	270	112	Info
156	ICP-MS	159	193	57	265	117	
164	DRC/CC-ICP-MS	157	181	47	283	125	
179	DRC/CC-ICP-MS	151	202	45	254	112	
200	DRC/CC-ICP-MS	171	213	48	295	127	Info
206	DRC/CC-ICP-MS	158	202	53	286	116	
293	DRC/CC-ICP-MS	152	198	44	269	113	Info
305	ICP-MS	158	204	53	268	118	
324	ICP-MS	153	198	46	265	111	Info
366	ETAAS-Z	140	175	26	263	102	Info
367	DRC/CC-ICP-MS	161	208	46	275	112	Info
401	DRC/CC-ICP-MS	156	206	49	265	123	Info

Percent satisfactory results for all participants: 100.0 %

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 Selenium Test Results, 2013 Event #3
STATISTICAL SUMMARY BY METHOD

	Results ($\mu\text{g/L}$ serum)				
	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
DRC/CC-ICP-MS					
Number of Sample Measurements:	10	10	10	10	10
Mean:	156	199	47	271	115
Standard Deviation:	8	9	3	13	7
RSD (%):	5.0	4.6	6.2	5.0	6.3
ETAAS-Z					
Number of Sample Measurements:	1	1	1	1	1
Mean:	140	175	26	263	102
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
ICP-MS					
Number of Sample Measurements:	4	4	3	4	4
Mean:	176	209	52	267	123
Standard Deviation:	39	22	6	2	16
RSD (%):	22.3	10.4	—	0.6	13.1
All Laboratories					
Number of Sample Measurements:	15	15	14	15	15
Mean:	160	200	47	269	117
Standard Deviation:	22	15	7	11	11
RSD (%):	13.7	7.5	15.2	4.1	9.3

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 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 1289 $\mu\text{g/L}$ (19.71 $\mu\text{mol/L}$) to 2975 $\mu\text{g/L}$ (45.50 $\mu\text{mol/L}$).

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, 86.7% of test results reported were judged as satisfactory, with four out of 27 participant laboratories (14.8 %) 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, 2013 Event #3
ROBUST STATISTICAL SUMMARY

TARGET VALUE ASSIGNMENT AND STATISTICS

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

	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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Robust Mean	2132	2497	1289	2975	1813
Robust Standard Deviation	170	226	100	221	161
Standard Uncertainty	41	54	24	53	39
RSD (%)	8.0	9.1	7.8	7.4	8.9
Number of Sample Measurements	27	27	27	27	27

Acceptable Range:					
Upper Limit	2452	2872	1482	3421	2085
Lower Limit	1812	2122	1096	2529	1541

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, 2013 Event #3
PERFORMANCE OF PARTICIPATING LABORATORIES

Lab Code	Method	Results (µg/L serum)					Info Only
		SE13-11	SE13-12	SE13-13	SE13-14	SE13-15	
	Target Values:	2132	2497	1289	2975	1813	
107	DRC/CC-ICP-MS	2010	2400	1280	2790	1660	Info
110	ICP-MS	2286	2660	1364	3190	1912	
114	ICP-MS	1980	2210	1210	2680	1650	
147	ICP-MS	2307	2712	1438	3268	1967	Info
156	ICP-AES/OES	2100	2480	1260	3020	1780	
160	ICP-MS	1980	2320	1210	2870	1710	
164	ICP-MS	2130	2488	1263	3020	1793	
179	DRC/CC-ICP-MS	2250	2630	1370	3140	1880	
197	ICP-MS	2050	2440	1170	3010	1740	
200	ICP-MS	2367	2714	1393	3277	1969	Info
206	ICP-MS	2080	2300	1180	2950	1680	
287	FAAS	2230	2590	1290	3100	1920	
293	ICP-MS	2065	2405	1248	2915	1765	Info
305	ICP-MS	1730 ↓	2030 ↓	1070 ↓	2470 ↓	1480 ↓	
324	ICP-MS	1676 ↓	1934 ↓	1018 ↓	2346 ↓	1417 ↓	Info
325	ICP-MS	1930	2860	1350	2690	2100 ↑	Info
355	ICP-MS	2112	2479	1339	2992	1846	
357	ICP-MS	2050	2440	1230	2830	1740	
358	ICP-MS	2190	2560	1290	3090	1880	
359	ICP-MS	2080	2273	1219	2745	1650	
362	ICP-MS	2080	2420	1340	2890	1740	
363	ICP-MS	2480 ↑	2950 ↑	1390	3040	2070	
366	ETAAS-Z	2024	2290	1204	2735	1700	Info
401	DRC/CC-ICP-MS	2177	2570	1314	3067	1877	Info
457	ICP-AES/OES	2989 ↑	3586 ↑	1546 ↑	4626 ↑	2593 ↑	Info
458	FAAS	2368	2641	1394	3258	1971	
481	ICP-MS	2227	2576	1333	3034	1833	

Percent satisfactory results for all participants: 86.7 %

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 Zinc Test Results, 2013 Event #3
STATISTICAL SUMMARY BY METHOD

Results ($\mu\text{g/L}$ serum)					
	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
DRC/CC-ICP-MS					
Number of Sample Measurements:	3	3	3	3	3
Mean:	2146	2533	1321	2999	1806
Standard Deviation:	123	119	45	185	126
RSD (%):	—	—	—	—	—
ETAAS-Z					
Number of Sample Measurements:	1	1	1	1	1
Mean:	2024	2290	1204	2735	1700
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
FAAS					
Number of Sample Measurements:	2	2	2	2	2
Mean:	2299	2616	1342	3179	1946
Standard Deviation:	98	36	74	112	36
RSD (%):	—	—	—	—	—
ICP-AES/OES					
Number of Sample Measurements:	2	2	2	2	2
Mean:	2545	3033	1403	3823	2187
Standard Deviation:	629	782	202	1136	575
RSD (%):	—	—	—	—	—
ICP-MS					
Number of Sample Measurements:	19	19	19	19	19
Mean:	2095	2462	1266	2911	1786
Standard Deviation:	197	258	111	246	177
RSD (%):	9.4	10.5	8.7	8.4	9.9
All Laboratories					
Number of Sample Measurements:	27	27	27	27	27
Mean:	2146	2517	1286	3002	1827
Standard Deviation:	245	310	111	397	221
RSD (%):	11.4	12.3	8.7	13.2	12.1

notes: ? Insufficient data for calculation.

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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 CoCl_2 , chromium as CrCl_3 , lithium as LiCl , magnesium as MgCl_2 , manganese as MnCl_2 , thallium as TlNO_3 , and vanadium as 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

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Serum Antimony (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	15.3	15.2	15.3	15.3	15.2
147	ICP-MS	15.7	14.7	15.1	15.3	16.2

Serum Arsenic (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
197	DRC/CC-ICP-MS	<10.0	<10.0	<10.0	<10.0	<10.0

Serum Barium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	38.7	39.7	40.5	39.7	40
110	ICP-MS	43.2	43.2	43.1	45.1	44.4
197	ICP-MS	41.9	41.4	41.0	42.3	40.8
	Arithmetic mean	41.3	41.4	41.5	42.4	41.7
	SD	2.3	1.8	1.4	2.7	2.3
	n	3	3	3	3	3

Serum Beryllium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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

Serum Bismuth (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
197	ICP-MS	<1.0	<1.0	<1.0	<1.0	<1.0

Serum Cadmium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	0.2	0.2	0.2	0.1	0.2
147	ICP-MS	0.221	0.185	0.193	0.175	0.212
197	DRC/CC-ICP-MS	<0.5	<0.5	<0.5	<0.5	<0.5
324	ICP-MS	0.13	0.13	0.13	0.13	0.13
	Arithmetic mean	0.18	0.17	0.17	0.14	0.18
	SD	0.05	0.04	0.04	0.04	0.04
	n	3	3	3	3	3

Serum Chromium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	DRC/CC-ICP-MS	4.46	2.97	8.97	0.421	6.11
156	DRC/CC-ICP-MS	4.5	2.8	8.5	<1.0	5.6
164	DRC/CC-ICP-MS	5.1	3.0	8.4	0.4	6.1
179	DRC/CC-ICP-MS	5.0	2.9	9.1	0.3	6.4
197	DRC/CC-ICP-MS	5.8	2.5	8.2	<1.0	5.6
206	DRC/CC-ICP-MS	4.6	3.2	9.4	<1.0	6
305	ICP-MS	5.7	3.5	*11.6	0.3	7.6
324	ETAAS-Z	5.1	3.2	9.9	0.5	7.0
<i>*Omitted</i>	Arithmetic mean	5.0	3.0	8.9	0.4	6.3
	SD	0.5	0.3	0.6	0.1	0.7
	n	8	8	7	5	8

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Serum Cobalt (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	5.3	3.8	9.5	1.1	7.1
114	ICP-MS	5.3	3.8	9.7	1.2	7.2
147	ICP-MS	5.39	3.62	9.78	0.972	7.07
156	DRC/CC-ICP-MS	4.9	3.4	9.1	<1.0	6.4
164	ICP-MS	5.3	3.7	9.9	1.1	6.9
179	DRC/CC-ICP-MS	5.4	3.7	10.0	1.0	7.1
197	ICP-MS	5.7	3.9	9.9	1.2	7.5
206	ICP-MS	5.6	3.5	8.9	1.3	6.7
324	ICP-MS	5.08	3.48	9.05	1.06	6.74
	Arithmetic mean	5.3	3.7	9.5	1.1	7.0
	SD	0.2	0.2	0.4	0.1	0.3
	n	9	9	9	8	9

Serum Iodine (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
114	ICP-MS	133.4	142.7	133.2	136.9	141.4
147	ICP-MS	154	147	151	151	153
164	DRC/CC-ICP-MS	195.0	159.0	186.0	176.0	180.0
179	ICP-MS	150.0	154.0	155.0	154.0	153.0
197	ICP-MS	126.5	125.8	125.5	127.4	127.8
206	ICP-MS	138.3	149.6	144.1	149.5	140.0
	Arithmetic mean	150	146	149	149	149
	SD	25	12	21	17	18
	n	6	6	6	6	6

Serum Iron (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
457	ICP-AES/OES	1658	1665	1645	1685	1684

Serum Lead (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	0.698	0.723	0.702	0.715	0.719
197	DRC/CC-ICP-MS	0.6	0.7	0.6	0.6	0.6

Serum Lithium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	11520	14851	3185	20958	8189

Serum Manganese (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	104.0	104.0	103.0	102.0	101.0
114	ICP-MS	101.9	113.6	94.8	100.2	104.8
147	ICP-MS	97.3	100	104	100	103
179	DRC/CC-ICP-MS	98.0	101.7	102.4	100.2	103.0
197	DRC/CC-ICP-MS	*115.2	109.3	109.2	103.9	107.1
206	ICP-MS	94.6	95.6	97.2	94.1	95.6
305	ICP-MS	96.9	94.1	94.9	96.1	91.8
324	ICP-MS	99.0	98.3	99.0	98.7	99.6
<i>*Omitted</i>	Arithmetic mean	99	102	101	99	101
	SD	3	7	5	3	5
	n	7	8	8	8	8

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Serum Mercury (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	<0.1	<0.1	<0.1	<0.1	<0.1
197	ICP-MS	<5.0	<5.0	<5.0	<5.0	<5.0

Serum Molybdenum (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	8.8	8.6	8.4	8.6	9.0
147	ICP-MS	9.23	8.85	9.04	9.22	9.28
179	ICP-MS	9.3	9.8	9.6	9.3	9.8
197	ICP-MS	11.8	11.6	11.4	11.5	11.3
	Arithmetic mean	9.8	9.7	9.6	9.7	9.8
	SD	1.4	1.4	1.3	1.3	1.0
	n	4	4	4	4	4

Serum Nickel (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
114	ICP-MS	3.4	3.3	*3.2	3.6	*3.3
147	ICP-MS	0.864	0.87	0.716	1.07	0.635
179	DRC/CC-ICP-MS	0.7	0.7	0.7	0.8	0.7
197	ICP-MS	<2.0	<2.0	<2.0	<2.0	<2.0
206	ICP-MS	<10.0	<10.0	<10.0	<10.0	<10.0
<i>*Omitted</i>	Arithmetic mean	1.7	1.6	-	1.8	-
	SD	1.5	1.5	-	1.5	-
	n	3	3	-	3	-

Serum Platinum (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	0.4	0.5	0.8	0.1	0.2
179	ICP-MS	<10.0	<10.0	<10.0	<10.0	<10.0

Serum Silver (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	0.211	0.323	0.208	0.193	0.214
179	ICP-MS	<0.2	<0.2	<0.2	<0.2	<0.2
197	ICP-MS	<1.0	<1.0	<1.0	<1.0	<1.0

Serum Tellurium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
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	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	5.9	7.8	1.0	10.5	4.0
147	ICP-MS	4.74	6.11	0.697	8.89	3.03
197	ICP-MS	5.3	7.0	<1.0	9.3	3.6
	Arithmetic mean	5.3	7.0	-	9.6	3.5
	SD	0.6	0.8	-	0.8	0.5
	n	3	3	-	3	3

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Serum Thorium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	<0.03	<0.03	<0.03	<0.03	<0.03

Serum Tin (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
110	ICP-MS	0.7	0.7	0.7	0.7	0.7
147	ICP-MS	0.724	0.686	0.677	0.716	0.723
197	ICP-MS	<5.0	<5.0	<5.0	<5.0	<5.0

Serum Tungsten (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	<0.368	<0.368	<0.368	<0.368	-

Serum Uranium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	ICP-MS	0.13	0.157	0.163	0.16	0.138

Serum Vanadium (µg/L)						
Lab Code	Method	SE13-11	SE13-12	SE13-13	SE13-14	SE13-15
147	DRC/CC-ICP-MS	5.88	7.66	1.69	10.1	4.27
179	DRC/CC-ICP-MS	5.0	7.0	1.5	9.1	3.9

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Trace Elements in Serum
METHOD NOTES

ATOMIC SPECTROMETRY METHODS

- A-1 ETAAS-Z (Electrothermal atomic absorption spectrometry with Zeeman background correction)
- A-2 ETAAS other (i.e., D₂, 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.
