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**Wadsworth Center**

**New York State Department of Health**

**TRACE ELEMENTS IN SERUM**

**Interlaboratory Study #1, 2002**

**March 10, 2003**

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**TRACE ELEMENTS**  
**Interlaboratory Study #1, 2002**

Dear Laboratory Director:

Results from our first interlaboratory study of **trace elements in serum** have been tabulated and summarized in the enclosed report. Target values for **Aluminum, Copper, Selenium and Zinc** have been established along with some proposed acceptable ranges. The upper and lower ranges were implemented in the report to provide some feedback to participants on their performance. For those laboratories that operate under a New York State clinical laboratory permit, this should not be construed in terms of a pass or failure since the criteria for successful performance have yet to be developed. Obviously, a laboratory with an apparent significant analytical bias relative to the target value will want to investigate the source of the error.

In this report, we provide a brief narrative on the nature of the test sample including the level of spike, establishment of the target value as well as the specific algorithm for the proposed acceptable ranges. The source of the test materials is caprine serum obtained from a commercial source. Some serum pools were enriched with additional elements as indicated in the analyte specific narrative.

The proposed acceptable ranges for trace elements in serum used in this report are based on those recently recommended by the European Thematic Network of External Quality Assurance Schemes (EQAS) for Trace Elements (M. Patriarca, A. Menditto and A. Taylor, personal communication, 2002) and/or those used by the trace elements Intercomparison Program operated by Institut National de Santé Publique du Québec. Indeed, efforts are currently underway among the various organizers of trace element EQAS/PT programs in Europe and in North America to improve traceability of target values, develop estimates of uncertainty in the target values, and to explore harmonizing grading criteria.

As with any new program, we expect to fine tune various aspects and fix any apparent problems as the program evolves. Our hope is that you will find this exercise both helpful and educational. Any issues or problems should be brought to my attention, either by telephone at 518-474-5475 or by e-mail at [patrick.parsons@wadsworth.org](mailto:patrick.parsons@wadsworth.org).

Thank you for your participation.

Your sincerely,

Patrick J. Parsons, Ph.D.  
Section Head, Trace Elements PT program.

**New York State Department of Health  
Interlaboratory Study #1, 2002**

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**Serum Aluminum**

The test materials for aluminum were prepared using caprine (goat) serum obtained from Bioresource Technology, Inc. (Fort Lauderdale, Florida). This material was certified as 0.2- $\mu$ m filtered, and as having a total protein concentration of 7.0 g/dL. An initial screen of the serum pool by furnace AAS determined that the endogenous aluminum concentration was <2  $\mu$ g/L. The base serum was transferred to five separate acid-washed polypropylene containers, and all five pools were further enriched by spiking with various levels of aluminum. Each serum pool was thoroughly mixed by agitating the container for a 48-h period (at 4°C), prior to dispensing aliquots into acid-washed shipping vials. The test samples were stored at -80 °C prior to shipping.

<b>Sample</b>	<b>Additional Al Spike (approx.)</b>
SE02-01	40 $\mu$ g/L as Al <sup>3+</sup>
SE02-02	90 $\mu$ g/L as Al <sup>3+</sup>
SE02-03	180 $\mu$ g/L as Al <sup>3+</sup>
SE02-04	100 $\mu$ g/L as Al <sup>3+</sup>
SE02-05	20 $\mu$ g/L as Al <sup>3+</sup>

The acceptable range for serum aluminum is based on fixed criteria of  $\pm 20\%$ , or  $\pm 5$   $\mu$ g/L below 25  $\mu$ g/L. As stated in the cover letter, these fixed criteria are based on consensus recommendations from several EQAS organizers (1). Results from this study show relatively poor interlaboratory agreement compared to that for other trace elements in serum. Even though 75.6% of all reported test results was satisfactory, 9 out of 27 laboratories (33%) reported 2 or more unsatisfactory results. Clearly, aluminum is a challenging element to measure in serum and, because of its ubiquitous nature, contamination is a major problem.

(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. *Clin. Chem.* 2002 48 2000-2007

**New York State Department of Health  
Serum Aluminum Test Results, 2002 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05	
Target Values:		48.7	100.1	174.7	111.2	29.1	
110	ETAAS	49	98	146	110	29	
114	ETAAS	35 ↓	69 ↓	140	82 ↓	25	
126	ETAAS	37 ↓	82	204	113	29	
147	ETAAS	50.1	101.4	167.3	110.0	28.4	
156	ICP-MS	47	94	185	102	32	
160	ETAAS	63 ↑	133 ↑	198	142 ↑	32	
164	ICP-MS	47	93	177	104	27	
179	DRC-ICP-MS	55	119	212 ↑	127	32	
197	ICP-MS	48	105	189	113	35 ↑	
200	DRC-ICP-MS	44	99	178	109	25	
206	ICP-MS	36 ↓	76 ↓	151	78 ↓	35 ↑	
208	ICP-MS	50.1	104	170.6	118.9	29.0	
269	ETAAS	41.2	71.9 ↓	98.8 ↓	82.7 ↓	18.9 ↓	
287	ETAAS	45	92	172	103	27	
301	ETAAS	53	114	187	124	36 ↑	
305	ICP-MS	35.9 ↓	84.1	148	85.6 ↓	20.5 ↓	
314	ICP-MS	45	81	129 ↓	84 ↓	32	
355	ETAAS	51	119	202	131	27	
357	ICP-AES	35.0 ↓	83.6	163	95.4	19.7 ↓	
358	ICP-MS	44	97	181	113	30	
360	ETAAS	37 ↓	103	160	109	23 ↓	
361	ETAAS	64 ↑	111	192	129	29	
362	ICP-MS	49	98	185	107	36 ↑	
363	ICP-MS	50	103	187	109	33	
366	ETAAS	31 ↓	70 ↓	125 ↓	80 ↓	26	
367	ETAAS	51	112	194	125	32	
400	ETAAS	51	99	180	111	30	

Percent satisfactory results for all participants: 75.6 %

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

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

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Aluminum Test Results, 2002 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/L serum)				
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
110	ETAAS	49	98	146	110	29
147	ETAAS	50.1	101.4	167.3	110.0	28.4
156	ICP-MS	47	94	185	102	32
164	ICP-MS	47	93	177	104	27
200	DRC-ICP-MS	44	99	178	109	25
208	ICP-MS	50.1	104	170.6	118.9	29.0
367	ETAAS	51	112	194	125	32
400	ETAAS	51	99	180	111	30
Number of Sample Measurements:		8	8	8	8	8
<b>Target value:</b>		<b>48.7</b>	<b>100.1</b>	<b>174.7</b>	<b>111.2</b>	<b>29.1</b>
Standard Deviation:		2.5	6.0	14.2	7.5	2.4
RSD (%):		5.1	6.0	8.1	6.7	8.2
Acceptable Range:						
Upper Limit:		58.4	120.1	209.6	133.4	34.9
Lower Limit:		39.0	80.1	139.8	89.0	23.3

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Aluminum Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>DRC-ICP-MS</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	49.5	109.0	195.0	118.0	28.5
Standard Deviation:	7.8	14.1	24.0	12.7	4.9
RSD (%):	—	—	—	—	—
<b>ETAAS</b>					
Number of Sample Measurements:	14	14	14	14	14
Mean:	47.0	98.2	169.0	110.8	28.0
Standard Deviation:	9.9	19.5	31.7	19.1	4.2
RSD (%):	21.1	19.8	18.8	17.2	14.9
<b>ICP-AES</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	35.0	83.6	163.0	95.4	19.7
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	10	10	10	10	10
Mean:	45.2	93.5	170.3	101.5	31.0
Standard Deviation:	5.3	10.1	20.5	14.0	4.6
RSD (%):	11.6	10.8	12.1	13.8	15.0
<b>All Laboratories</b>					
Number of Sample Measurements:	27	27	27	27	27
Mean:	46.1	96.7	171.2	107.3	28.8
Standard Deviation:	8.2	16.0	26.8	17.0	4.7
RSD (%):	17.8	16.5	15.7	15.9	16.4

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

**New York State Department of Health  
Serum Aluminum Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>Evaluated</b>					
Number of Sample Measurements:	19	19	19	19	19
Mean:	45.0	95.3	169.7	105.7	28.7
Standard Deviation:	9.5	18.7	30.9	19.7	5.5
RSD (%):	21.2	19.6	18.2	18.6	19.1
<b>Reference</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	48.7	100.1	174.7	111.2	29.1
Standard Deviation:	2.5	6.0	14.2	7.5	2.4
RSD (%):	5.1	6.0	8.1	6.7	8.2
<b>All Laboratories</b>					
Number of Sample Measurements:	27	27	27	27	27
Mean:	46.1	96.7	171.2	107.3	28.8
Standard Deviation:	8.2	16.0	26.8	17.0	4.7
RSD (%):	17.8	16.5	15.7	15.9	16.4

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

**New York State Department of Health  
Interlaboratory Study #1, 2002**

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### **Serum Copper**

The test materials for copper were prepared using caprine (goat) serum obtained from a commercial source. This material was certified as 0.2- $\mu\text{m}$  filtered, and as having a total protein concentration of 7.0 g/dL. An initial, rapid screen of the serum pool by ICP-MS revealed that the endogenous copper concentration was approximately 800  $\mu\text{g/L}$ . The base serum was transferred to five separate acid-washed polypropylene containers, and four pools were further enriched by spiking with various levels of copper. Each serum pool was thoroughly mixed by agitating the container for a 48-h period (at 4°C), prior to dispensing aliquots into acid-washed shipping vials. Test samples were stored at -80 °C prior to shipping.

<b>Sample</b>	<b>Additional Cu Spike (approx.)</b>
SE02-01	Not spiked (~800 $\mu\text{g/L}$ endogenous)
SE02-02	2195 $\mu\text{g/L}$ as $\text{Cu}^{2+}$ (~800 $\mu\text{g/L}$ endogenous)
SE02-03	495 $\mu\text{g/L}$ as $\text{Cu}^{2+}$ (~800 $\mu\text{g/L}$ endogenous)
SE02-04	1195 $\mu\text{g/L}$ as $\text{Cu}^{2+}$ (~800 $\mu\text{g/L}$ endogenous)
SE02-05	1795 $\mu\text{g/L}$ as $\text{Cu}^{2+}$ (~800 $\mu\text{g/L}$ endogenous)

The acceptable range for serum copper is based on fixed criteria of  $\pm 10\%$ , or  $\pm 10$   $\mu\text{g/L}$  below 100  $\mu\text{g/L}$ . These criteria are similar to those proposed by the European Thematic network of EQAS organizers (1) for trace elements in serum. Results of this study show reasonably good interlaboratory agreement. Three labs reported results in units of  $\mu\text{g/dL}$  and these data were converted to  $\mu\text{g/L}$  for the purposes of this report. We understand that many US laboratories typically report clinical results for serum Cu (and serum Zn) in  $\mu\text{g/dL}$  while some overseas labs prefer to use SI units ( $\mu\text{mol/L}$ ). The issue of which reporting units best reflects our participant base is still under review. We invite participants to contact us via e-mail ([lead@wadsworth.org](mailto:lead@wadsworth.org)) with their recommendations.

1. Menditto, A., Patriarca, M. and Taylor, A. (personal communication, 2002).

**New York State Department of Health  
Serum Copper Test Results, 2002 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05	
Target Values:		751.1	2960.6	1226.1	1606.2	2495.4	
107	ICP-AES	680	2800	1160	1540	2340	
110	ICP-MS	773	3146	1280	1685	2665	
114	ICP-MS	710	2700	1140	1500	2360	
147	ICP-MS	762	3037	1270	1670	2550	
156	Flame AAS	820	2940	1260	1640	2540	
160	ETAAS	700	3150	1220	1590	2540	
164	ICP-MS	700	2680	1150	1520	2300	
174	Other	820	3100	1380 ↑	2640 ↑	1660 ↓	
179	ICP-AES	740	2950	1210	1640	2500	
197	ICP-MS	750	3010	1260	1630	2590	
200	Flame AAS	782	3053	1247	1539	2436	
206	ICP-MS	710	2500 ↓	990 ↓	1350 ↓	2140 ↓	
208	ICP-MS	838 ↑	3173	1343	1789 ↑	2750 ↑	
293	Flame AAS	762	2775	1175	1499	2343	
305	ICP-MS	786	3202	1322	1737	2719	
360	Flame AAS	650 ↓	3040	1150	1500	2440	
366	ETAAS	780	2810	1209	1595	2430	
400	ETAAS	736	3133	1248	1657	2611	

Percent satisfactory results for all participants: 87.8 %

**notes:** ↑ reported value outside upper limit

↓ reported value outside lower limit

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

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Copper Test Results, 2002 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/L serum)				
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
107	ICP-AES	680	2800	1160	1540	2340
110	ICP-MS	773	3146	1280	1685	2665
114	ICP-MS	710	2700	1140	1500	2360
147	ICP-MS	762	3037	1270	1670	2550
179	ICP-AES	740	2950	1210	1640	2500
200	Flame AAS	782	3053	1247	1539	2436
293	Flame AAS	762	2775	1175	1499	2343
305	ICP-MS	786	3202	1322	1737	2719
366	ETAAS	780	2810	1209	1595	2430
400	ETAAS	736	3133	1248	1657	2611
Number of Sample Measurements:		10	10	10	10	10
<b>Target value:</b>		<b>751.1</b>	<b>2960.6</b>	<b>1226.1</b>	<b>1606.2</b>	<b>2495.4</b>
Standard Deviation:		34.7	178.8	57.6	83.6	136.9
RSD (%):		4.6	6.0	4.7	5.2	5.5
Acceptable Range:						
Upper Limit:		826.2	3256.7	1348.7	1766.8	2744.9
Lower Limit:		676.0	2664.5	1103.5	1445.6	2245.9

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Copper Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>ETAAS</b>					
Number of Sample Measurements:	3	3	3	3	3
Mean:	738.7	3031.0	1225.7	1614.0	2527.0
Standard Deviation:	40.1	191.6	20.1	37.3	91.2
RSD (%):	—	—	—	—	—
<b>Flame AAS</b>					
Number of Sample Measurements:	4	4	4	4	4
Mean:	753.5	2952.0	1208.0	1544.5	2439.8
Standard Deviation:	73.1	128.3	53.8	66.3	80.5
RSD (%):	9.7	4.3	4.5	4.3	3.3
<b>ICP-AES</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	710.0	2875.0	1185.0	1590.0	2420.0
Standard Deviation:	42.4	106.1	35.4	70.7	113.1
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	753.6	2931.0	1219.4	1610.1	2509.3
Standard Deviation:	46.8	266.7	118.0	144.2	219.4
RSD (%):	6.2	9.1	9.7	9.0	8.7
<b>Other</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	820.0	3100.0	1380.0	2640.0	1660.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>All Laboratories</b>					
Number of Sample Measurements:	18	18	18	18	18
Mean:	749.9	2955.5	1223.0	1651.2	2439.7
Standard Deviation:	51.4	201.1	89.7	267.3	249.2
RSD (%):	6.9	6.8	7.3	16.2	10.2

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

**New York State Department of Health  
Serum Copper Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>Evaluated</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	748.5	2949.1	1219.1	1707.4	2370.0
Standard Deviation:	69.8	238.9	123.4	397.6	341.7
RSD (%):	9.3	8.1	10.1	23.3	14.4
<b>Reference</b>					
Number of Sample Measurements:	10	10	10	10	10
Mean:	751.1	2960.6	1226.1	1606.2	2495.4
Standard Deviation:	34.7	178.8	57.6	83.6	136.9
RSD (%):	4.6	6.0	4.7	5.2	5.5
<b>All Laboratories</b>					
Number of Sample Measurements:	18	18	18	18	18
Mean:	749.9	2955.5	1223.0	1651.2	2439.7
Standard Deviation:	51.4	201.1	89.7	267.3	249.2
RSD (%):	6.9	6.8	7.3	16.2	10.2

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

**New York State Department of Health  
Interlaboratory Study #1, 2002**

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**Serum Selenium**

The test materials for selenium were prepared using caprine (goat) serum obtained from a commercial source. This material was certified as 0.2- $\mu$ m filtered, and as having a total protein concentration of 7.0 g/dL. An initial, rapid screen of the serum pool by ICP-MS revealed that the endogenous selenium concentration was approximately 170  $\mu$ g/L. The base serum was transferred to five separate acid-washed polypropylene containers, and four pools were further enriched by spiking with various levels of selenium. Each serum pool was thoroughly mixed by agitating the container for a 48-h period (at 4°C), prior to dispensing aliquots into acid-washed shipping vials. Test samples were stored at -80 °C prior to shipping.

<b>Sample</b>	<b>Additional Se Spike (approx.)</b>
SE02-01	Not spiked (~170 $\mu$ g/L endogenous)
SE02-02	132 $\mu$ g/L as Se <sup>4+</sup> (~170 $\mu$ g/L endogenous)
SE02-03	32 $\mu$ g/L as Se <sup>4+</sup> (~170 $\mu$ g/L endogenous)
SE02-04	12 $\mu$ g/L as Se <sup>4+</sup> (~170 $\mu$ g/L endogenous)
SE02-05	82 $\mu$ g/L as Se <sup>4+</sup> (~170 $\mu$ g/L endogenous)

The acceptable range for serum selenium is based on fixed criteria of  $\pm 20\%$ , or  $\pm 2$   $\mu$ g/L below 10  $\mu$ g/L. These criteria are similar to those proposed by the European Thematic network of EQAS organizers (1) and the Institut National de Santé Publique du Québec for their trace elements in serum program. Results of this study show reasonably good interlaboratory agreement with only 4 out of 18 laboratories (22%) reporting more than 2 of the 5 results outside the acceptable range.

1. Menditto, A., Patriarca, M. and Taylor, A. (personal communication, 2002).

**New York State Department of Health  
Serum Selenium Test Results, 2002 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05	
Target Values:		124.1	252.1	153.5	135.7	201.6	
107	DRC-ICP-MS	121	245	150	132	191	
110	DRC-ICP-MS	123	250	150	133	195	
114	ICP-MS	132	261	158	146	213	
147	ICP-MS	122	250	153	133	200	
156	ETAAS	132	267	162	145	214	
160	ETAAS	93 ↓	252	129	108 ↓	185	
164	ETAAS	127	261	153	142	210	
179	DRC-ICP-MS	130	262	160	142	209	
197	ICP-MS	127	252	159	139	208	
200	DRC-ICP-MS	116	238	146	131	198	
206	ICP-MS	104	183 ↓	118 ↓	106 ↓	146 ↓	
208	ICP-MS	159 ↑	287	188 ↑	170 ↑	231	
293	ETAAS	130	348 ↑	131	122	207	Info
305	ICP-MS	138	275	173	158	236	
360	ETAAS	80 ↓	220	120 ↓	100 ↓	170	
366	ETAAS	135	250	160	135	210	
367	ETAAS	122	259	159	136	200	
400	ETAAS	113	245	146	127	190	

Percent satisfactory results for all participants: 85.6 %

**notes:** ↑ reported value outside upper limit

↓ reported value outside lower limit

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

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Selenium Test Results, 2002 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/L serum)				
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
107	DRC-ICP-MS	121	245	150	132	191
110	DRC-ICP-MS	123	250	150	133	195
114	ICP-MS	132	261	158	146	213
147	ICP-MS	122	250	153	133	200
164	ETAAS	127	261	153	142	210
179	DRC-ICP-MS	130	262	160	142	209
200	DRC-ICP-MS	116	238	146	131	198
366	ETAAS	135	250	160	135	210
367	ETAAS	122	259	159	136	200
400	ETAAS	113	245	146	127	190
Number of Sample Measurements:		10	10	10	10	10
<b>Target value:</b>		<b>124.1</b>	<b>252.1</b>	<b>153.5</b>	<b>135.7</b>	<b>201.6</b>
Standard Deviation:		6.9	8.3	5.5	5.9	8.4
RSD (%):		5.6	3.3	3.6	4.3	4.2
Acceptable Range:						
Upper Limit:		148.9	302.5	184.2	162.8	241.9
Lower Limit:		99.3	201.7	122.8	108.6	161.3

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Selenium Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>DRC-ICP-MS</b>					
Number of Sample Measurements:	4	4	4	4	4
Mean:	122.5	248.8	151.5	134.5	198.3
Standard Deviation:	5.8	10.1	6.0	5.1	7.7
RSD (%):	4.7	4.1	3.9	3.8	3.9
<b>ETAAS</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	116.5	262.8	145.0	126.9	198.3
Standard Deviation:	20.0	37.3	16.3	16.1	15.3
RSD (%):	17.2	14.2	11.2	12.7	7.7
<b>ICP-MS</b>					
Number of Sample Measurements:	6	6	6	6	6
Mean:	130.3	251.3	158.2	142.0	205.7
Standard Deviation:	18.2	36.3	23.5	22.1	32.3
RSD (%):	14.0	14.5	14.8	15.6	15.7
<b>All Laboratories</b>					
Number of Sample Measurements:	18	18	18	18	18
Mean:	122.4	255.8	150.8	133.6	200.7
Standard Deviation:	17.5	31.9	17.7	17.3	20.7
RSD (%):	14.3	12.5	11.7	13.0	10.3

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

**New York State Department of Health  
Serum Selenium Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>Evaluated</b>					
Number of Sample Measurements:	7	7	7	7	7
Mean:	119.0	248.0	149.9	132.3	198.6
Standard Deviation:	27.7	35.7	27.6	27.7	33.0
RSD (%):	23.3	14.4	18.4	21.0	16.6
<b>Info</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	130.0	348.0	131.0	122.0	207.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>Reference</b>					
Number of Sample Measurements:	10	10	10	10	10
Mean:	124.1	252.1	153.5	135.7	201.6
Standard Deviation:	6.9	8.3	5.5	5.9	8.4
RSD (%):	5.6	3.3	3.6	4.3	4.2
<b>All Laboratories</b>					
Number of Sample Measurements:	18	18	18	18	18
Mean:	122.4	255.8	150.8	133.6	200.7
Standard Deviation:	17.5	31.9	17.7	17.3	20.7
RSD (%):	14.3	12.5	11.7	13.0	10.3

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

**New York State Department of Health  
Interlaboratory Study #1, 2002**

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**Serum Zinc**

The test materials for zinc were prepared using caprine (goat) serum obtained from a commercial source. This material was certified as 0.2- $\mu$ m filtered, and as having a total protein concentration of 7.0 g/dL. An initial, rapid screen of the serum pool by ICP-MS revealed that the endogenous zinc concentration was approximately 690  $\mu$ g/L. The base serum was transferred to five separate acid-washed polypropylene containers, and four pools were further enriched by spiking with various levels of zinc. Each serum pool was thoroughly mixed by agitating the container for a 48-h period (at 4°C), prior to dispensing aliquots into acid-washed shipping vials. Test samples were stored at -80 °C prior to shipping.

<b>Sample</b>	<b>Additional Zn Spike (approx.)</b>
SE02-01	Not spiked (~690 $\mu$ g/L endogenous)
SE02-02	1811 $\mu$ g/L as Zn <sup>2+</sup> (~690 $\mu$ g/L endogenous)
SE02-03	311 $\mu$ g/L as Zn <sup>2+</sup> (~690 $\mu$ g/L endogenous)
SE02-04	511 $\mu$ g/L as Zn <sup>2+</sup> (~690 $\mu$ g/L endogenous)
SE02-05	1511 $\mu$ g/L as Zn <sup>2+</sup> (~690 $\mu$ g/L endogenous)

The acceptable range for serum zinc is based on fixed criteria of  $\pm 15\%$ , or  $\pm 15$   $\mu$ g/L below 100  $\mu$ g/L. These criteria are similar to those proposed by the European Thematic network of EQAS organizers (1) for trace elements in serum. Results of this study show reasonably good interlaboratory agreement. Three labs reported results in units of  $\mu$ g/dL and these data were converted to  $\mu$ g/L for the purposes of this report. We understand that many US laboratories typically report clinical results for serum Zn (and serum Cu) in  $\mu$ g/dL while some overseas labs prefer to use SI units ( $\mu$ mol/L). The issue of which reporting units best reflects our participant base is still under review. We invite participants to contact us via e-mail ([lead@wadsworth.org](mailto:lead@wadsworth.org)) with their recommendations.

1. Menditto, A., Patriarca, M. and Taylor, A. (personal communication, 2002).

**New York State Department of Health  
Serum Zinc Test Results, 2002 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L serum)					Info Only
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05	
Target Values:		632.6	2384.1	936.5	1132.6	2037.4	
107	ICP-AES	590	2270	900	1100	1930	
110	ICP-MS	656	2567	986	1197	2226	
114	ICP-MS	610	2170	870	1070	1850	
125	Flame AAS	570	2270	850	1030	1930	
147	ICP-MS	654	2495	980	1185	2110	
156	ICP-MS	604	2049	1167 ↑	1128	1996	
160	Flame AAS	740 ↑	2280	840	1180	2140	
164	ICP-MS	540	2060	810	980	1770	
174	Other	750 ↑	2570	1040	1090	2180	
179	ICP-AES	640	2520	950	1190	2180	
197	ICP-MS	600	2310	910	1090	1990	
200	Flame AAS	687	2446	1001	1177	2039	
206	ICP-MS	540	2120	780 ↓	970	1750	
208	ICP-MS	653	2532	963	1215	2202	
287	Flame AAS	600	2300	850	1050	1910	
293	Flame AAS	654	2335	955	1112	2034	
305	ICP-MS	657	2596	999	1226	2226	
357	ICP-AES	549	2100	812	984	1860	
358	ICP-MS	554	2015 ↓	845	1025	1769	
360	Flame AAS	670	2480	940	1110	2080	
361	Flame AAS	670	2550	990	1380 ↑	2350 ↑	
362	ICP-MS	650	2300	950	1120	2050	
363	ICP-MS	670	2380	970	1160	2100	
366	Flame AAS	775 ↑	2650	1050	1350 ↑	2250	Info

Percent satisfactory results for all participants: 92.5 %

**notes:** ↑ reported value outside upper limit

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

↓ reported value outside lower limit

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Zinc Test Results, 2002 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/L serum)				
		SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
107	ICP-AES	590	2270	900	1100	1930
110	ICP-MS	656	2567	986	1197	2226
114	ICP-MS	610	2170	870	1070	1850
125	Flame AAS	570	2270	850	1030	1930
147	ICP-MS	654	2495	980	1185	2110
179	ICP-AES	640	2520	950	1190	2180
200	Flame AAS	687	2446	1001	1177	2039
293	Flame AAS	654	2335	955	1112	2034
Number of Sample Measurements:		8	8	8	8	8
<b>Target value:</b>		<b>632.6</b>	<b>2384.1</b>	<b>936.5</b>	<b>1132.6</b>	<b>2037.4</b>
Standard Deviation:		39.1	142.6	56.4	63.3	130.6
RSD (%):		6.2	6.0	6.0	5.6	6.4
Acceptable Range:						
Upper Limit:		727.5	2741.7	1077.0	1302.5	2343.0
Lower Limit:		537.7	2026.5	796.0	962.7	1731.8

**notes:** Results reported as less than the detection limits are multiplied by 0.75 for statistical and grading purposes.

**New York State Department of Health  
Serum Zinc Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>Flame AAS</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	670.8	2413.9	934.5	1173.6	2091.6
Standard Deviation:	66.9	140.2	79.7	129.6	151.0
RSD (%):	10.0	5.8	8.5	11.0	7.2
<b>ICP-AES</b>					
Number of Sample Measurements:	3	3	3	3	3
Mean:	593.0	2296.7	887.3	1091.3	1990.0
Standard Deviation:	45.6	211.3	69.9	103.3	168.2
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	12	12	12	12	12
Mean:	615.7	2299.5	935.8	1113.8	2003.3
Standard Deviation:	48.6	215.0	103.3	88.5	180.6
RSD (%):	7.9	9.3	11.0	7.9	9.0
<b>Other</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	750.0	2570.0	1040.0	1090.0	2180.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>All Laboratories</b>					
Number of Sample Measurements:	24	24	24	24	24
Mean:	636.8	2348.5	933.7	1130.0	2038.4
Standard Deviation:	64.2	192.8	90.8	104.1	166.7
RSD (%):	10.1	8.2	9.7	9.2	8.2

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

**New York State Department of Health  
Serum Zinc Test Results, 2002 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ serum)				
	SE02-01	SE02-02	SE02-03	SE02-04	SE02-05
<b>Evaluated</b>					
Number of Sample Measurements:	15	15	15	15	15
Mean:	629.8	2309.5	924.4	1113.9	2024.9
Standard Deviation:	67.6	205.1	104.3	109.9	183.7
RSD (%):	10.7	8.9	11.3	9.9	9.1
<b>Info</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	775.0	2650.0	1050.0	1350.0	2250.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>Reference</b>					
Number of Sample Measurements:	8	8	8	8	8
Mean:	632.6	2384.1	936.5	1132.6	2037.4
Standard Deviation:	39.1	142.6	56.4	63.3	130.6
RSD (%):	6.2	6.0	6.0	5.6	6.4
<b>All Laboratories</b>					
Number of Sample Measurements:	24	24	24	24	24
Mean:	636.8	2348.5	933.7	1130.0	2038.4
Standard Deviation:	64.2	192.8	90.8	104.1	166.7
RSD (%):	10.1	8.2	9.7	9.2	8.2

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

**New York State Department of Health  
TRACE ELEMENTS  
METHOD NOTES**

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**FAAS:**

Flame atomic absorption spectrometry.

**ETAAS:**

Electrothermal (i.e., graphite furnace) atomic absorption spectrometry.

**ICP-AES:**

Inductively-coupled plasma atomic emission spectrometry.

**ICP-MS:**

Inductively-coupled plasma mass spectrometry (standard mode)

**DRC-ICP-MS (or CC-ICP-MS):**

Inductively-coupled plasma mass spectrometry equipped with dynamic reaction cell (DRC) or collision cell (CC) technology .

**HGAAS:**

Hydride generation - atomic absorption spectrometry.

**HGAFS:**

Hydride generation - atomic fluorescence spectrometry.

**CVAAS:**

Cold-vapor atomic absorption spectrometry

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