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**Wadsworth Center**

New York State Department of Health

**TRACE ELEMENTS IN WHOLE BLOOD**

**Interlaboratory Study #1, 2004**

**March 17, 2005**

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**Trace Elements in Whole Blood  
Interlaboratory Study #1, 2004**

Dear Laboratory Director:

Results from the third interlaboratory study of trace elements in whole blood have been tabulated and summarized in this report. Target values for Arsenic, Cadmium, Mercury and Lead have been established along with tentative acceptable ranges. For the four non-essential toxic elements (As, Cd, Pb and Hg) highlighted in this study, the upper and lower acceptable ranges are included to provide feedback to participants on their analytical performance. For those laboratories that operate under a New York State clinical laboratory permit, these data should begin to serve as “guidelines” for acceptable performance. 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 as well as the specific algorithm for the tentative acceptable ranges. The source of the test materials is caprine blood obtained from animals dosed with lead acetate and supplemented with additional elements as indicated in analyte specific narrative. At the end of this report, we include a section for “other analytes” that were measured, and voluntarily reported, by some laboratories. These data are provided for informational purposes only.

We expect to continue to fine tune this program as it evolves into a formal proficiency testing program. Our hope is that you will find this exercise both helpful and educational, and that it will ultimately lead to an improvement in laboratory performance. 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 cooperation.

Your sincerely,

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

**New York State Department of Health  
Interlaboratory Study #1, 2004**

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**Whole Blood Arsenic**

The test materials for arsenic were prepared from caprine (goat) whole blood preserved with K<sub>2</sub>EDTA anticoagulant. A total of five blood pools were prepared in acid-washed containers, and supplemented with different amounts of arsenic as As<sup>3+</sup>, dimethylarsenic acid (DMA), monomethylarsonic acid (MMA) and arsenobetaine (AsB).

<b>Sample</b>	<b>As Spike (approx.)</b>
TE04-01	70 µg/L As as As <sup>3+</sup> 7 µg/L As as DMA 7 µg/L As as MMA 13 µg/L As as AsB
TE04-02	None (endogenous level)
TE04-03	5 µg/L As as As <sup>3+</sup>
TE04-04	40 µg/L As as As <sup>3+</sup> 7 µg/L As as DMA 7 µg/L As as MMA 7 µg/L As as AsB
TE04-05	25 µg/L As as As <sup>3+</sup> 7 µg/L As as DMA 7 µg/L As as MMA 7 µg/L As as AsB

**Target values** were established as the mean of 10 referee laboratories using either quadrupole based ICP-MS instrumentation (nine laboratories) or a furnace AAS method (one laboratory). Values range from 2.2 µg/L (0.03 µmol/L) to 86.1 µg/L (1.15 µmol/L). Among the referee group, imprecision (SD) varied from 1.4 - 5.8 µg/L.

**Acceptable ranges** were changed for arsenic during the previous interlaboratory study from ±4 µg/L (≤20 µg/L) to ±6 µg/L (≤30 µg/L) due to poorer than expected interlaboratory agreement, and because there is uncertainty about the clinical significance of total As in whole blood at low concentrations. So the range is fixed at ±6 µg/L for concentrations below 30 µg/L. Above 30 µg/L, it is ±20%.

**Discussion:** Of the four elements tested, arsenic proved the most difficult on which to reach consensus among participants reflecting, no doubt, the polyatomic interference from <sup>40</sup>Ar<sup>35</sup>Cl in ICP-MS. Indeed, the overall consensus was <80%, the threshold used under CLIA '88 to trigger grading. Consequently, no performance grades are implied for this event for whole blood As.

**New York State Department of Health  
Blood Arsenic Test Results, 2004 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L whole blood)					Info Only
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05	
Target Values:		86.1	2.2	7.5	63.6	47.0	
110	DRC/CC-ICP-MS	72.4	3.4	7.6	45.8 ↓	34.8 ↓	
114	ICP-MS	87	8	10	74	58 ↑	
125	ETAAS	84	<10	10	64	44	
147	ICP-MS	82.2	1.4	5.9	55.2	43.6	
156	ETAAS	44 ↓	0	0	32 ↓	21 ↓	
159	ICP-MS	88	<10	10	65	49	
164	ICP-MS	73		3	50 ↓	37 ↓	
179	ICP-MS	84	1	5	62	45	
197	ICP-MS	70	<10	<10	51	39	
200	ICP-MS	86	2.5	7.4	72	50	
206	ICP-MS	84.6	4.2	7.7	57.5	40.2	
208	ICP-MS	86.8	<25.0	<25.0	61.2	45.1	
293	HG-AAS	58 ↓	4	7	40 ↓	26 ↓	Info
305	ICP-MS	95	4.5	8.5	70.8	52.7	
312	ICP-MS	80.55	1.72	6.7	63.04	46.03	
324	DRC/CC-ICP-MS	80.28	1.91	7.96	57.68	47.03	
339	ICP-MS	96.0	0.7	5.9	69.0	52.0	
359	ICP-MS	146 ↑	17 ↑	25 ↑	102 ↑	84 ↑	

Percent satisfactory results for all participants: 82.2 %

**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 method detection limit are excluded from statistical calculations.

**New York State Department of Health  
Blood Arsenic Test Results, 2004 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/L whole blood)				
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
125	ETAAS	84	<10	10	64	44
147	ICP-MS	82.2	1.4	5.9	55.2	43.6
159	ICP-MS	88	<10	10	65	49
179	ICP-MS	84	1	5	62	45
200	ICP-MS	86	2.5	7.4	72	50
206	ICP-MS	84.6	4.2	7.7	57.5	40.2
305	ICP-MS	95	4.5	8.5	70.8	52.7
312	ICP-MS	80.55	1.72	6.7	63.04	46.03
324	DRC/CC-ICP-MS	80.28	1.91	7.96	57.68	47.03
339	ICP-MS	96.0	0.7	5.9	69.0	52.0
Number of Sample Measurements:		10	8	10	10	10
<b>Target value:</b>		<b>86.1</b>	<b>2.2</b>	<b>7.5</b>	<b>63.6</b>	<b>47.0</b>
Standard Deviation:		5.5	1.4	1.7	5.8	4.0
RSD (%):		6.4	63.1	22.5	9.1	8.5
Acceptable Range:						
Upper Limit:		103.3	8.2	13.5	76.3	56.4
Lower Limit:		68.9	0.0	1.5	50.9	37.6

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

**New York State Department of Health  
Blood Arsenic Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	2	2	2	2	2
Mean:	76.3	2.7	7.8	51.7	40.9
Standard Deviation:	5.6	1.1	0.3	8.4	8.6
RSD (%):	—	—	—	—	—
<b>ETAAS</b>					
Number of Sample Measurements:	2	0	1	2	2
Mean:	64.0		10.0	48.0	32.5
Standard Deviation:	28.3		?	22.6	16.3
RSD (%):	—	—	—	—	—
<b>HG-AAS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	58.0	4.0	7.0	40.0	26.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ICP-MS</b>					
Number of Sample Measurements:	13	5	10	13	13
Mean:	89.2	1.5	7.0	65.6	49.4
Standard Deviation:	18.6	0.7	2.2	13.4	12.0
RSD (%):	20.8	47.6	31.3	20.4	24.2
<b>All Laboratories</b>					
Number of Sample Measurements:	18	8	14	18	18
Mean:	83.2	2.1	7.3	60.7	45.2
Standard Deviation:	20.1	1.2	2.0	15.2	13.3
RSD (%):	24.2	55.4	27.3	25.1	29.4

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

**New York State Department of Health  
Blood Arsenic Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>Evaluated</b>					
Number of Sample Measurements:	7	1	3	7	7
Mean:	82.7	3.4	6.9	59.4	45.6
Standard Deviation:	31.4	?	3.6	22.8	20.3
RSD (%):	37.9	—	—	38.4	44.5
<b>Info</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	58.0	4.0	7.0	40.0	26.0
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>Reference</b>					
Number of Sample Measurements:	10	6	10	10	10
Mean:	86.1	1.5	7.5	63.6	47.0
Standard Deviation:	5.5	0.6	1.7	5.8	4.0
RSD (%):	6.4	42.2	22.5	9.1	8.5
<b>All Laboratories</b>					
Number of Sample Measurements:	18	8	14	18	18
Mean:	83.2	2.1	7.3	60.7	45.2
Standard Deviation:	20.1	1.2	2.0	15.2	13.3
RSD (%):	24.2	55.4	27.3	25.1	29.4

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

**New York State Department of Health  
Interlaboratory Study #1, 2004**

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**Whole Blood Cadmium**

The test materials for cadmium were prepared from caprine (goat) whole blood preserved with K<sub>2</sub>EDTA anticoagulant. A total of five blood pools were prepared in acid-washed containers, and supplemented with different amounts of cadmium (as Cd<sup>2+</sup>).

<b>Sample</b>	<b>Cd Spike (approx.)</b>
TE04-01	14 µg/L as Cd <sup>2+</sup>
TE04-02	None (endogenous level)
TE04-03	1 µg/L as Cd <sup>2+</sup>
TE04-04	8 µg/L as Cd <sup>2+</sup>
TE04-05	5 µg/L as Cd <sup>2+</sup>

**Target values** were established as the mean of 15 referee laboratories using either quadrupole based ICP-MS instrumentation and/or a furnace AAS method. Values range from 0.8 µg/L (7.12 nmol/L) to 13.0 µg/L (116 nmol/L). Among the referee group, imprecision (SD) varied from 0.4 – 1.1 µg/L increasing with Cd concentration.

**Acceptable ranges** are based on the OSHA criteria of ±15%, or ±1 µg/L around the target value, whichever is greater. So the range is fixed at ±1 µg/L for concentrations below 6.6 µg/L. Above 6.6 µg/L, it is ±15%. (effective 11/04)

**Discussion:** Based upon the proposed criteria, we had 80.0% satisfactory results from participants.

**New York State Department of Health  
Blood Cadmium Test Results, 2004 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L whole blood)					Info Only
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05	
Target Values:		13.0	0.8	1.7	9.0	5.9	
107	ICP-MS	15	1	2	10	7 ↑	
110	ICP-MS	14.4	1.4	2.3	10.4	6.8	
110	ETAAS	12.6	0.2	1.9	8.6	5.8	
114	ICP-MS	12.0	1.0	1.5	9.3	6.3	
126	ETAAS	10.4 ↓	<0.5	0.6 ↓	6.8 ↓	4.1 ↓	
147	ICP-MS	13.7	0.9	1.8	8.9	6.1	
156	ETAAS	11.6		1.43	7.99	5.23	
159	ICP-MS	13.0	1.0	2.0	9.3	6.0	
164	ICP-MS	11.6	0.7	1.7	8.4	5.3	
179	ICP-MS	13.9	0.7	1.7	9.4	6.0	
197	ICP-MS	13.8	1.2	2.3	9.7	6.2	
200	ETAAS	12.7	0.2	0.8	8.5	5.5	
206	ICP-MS	16.5 ↑	1.3	2.4	10.4	7.9 ↑	
208	ICP-MS	13.0	0.7	1.3	8.1	5.4	
293	ETAAS	0.6 ↓	1.4	7.9 ↑	5.0 ↓	11.3 ↑	Info
305	ICP-MS	11.6	1.4	1.9	8.1	5.1	
312	ICP-MS	14.36	1.98 ↑	3.08 ↑	10.43 ↑	6.90	
324	DRC/CC-ICP-MS	13.68	0.86	1.96	9.26	6.19	
339	ICP-MS	18.0 ↑	3.2 ↑	4.2 ↑	13.1 ↑	9.0 ↑	Info
359	ICP-MS	17 ↑	0.9	2	10	7 ↑	
400	ETAAS	13.1	0.20	1.22	8.79	5.53	

Percent satisfactory results for all participants: 80.0 %

**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 method detection limit are excluded from statistical calculations.

**New York State Department of Health  
Blood Cadmium Test Results, 2004 Event #1  
STATISTICAL SUMMARY**

Lab Code	Method	Results ( $\mu\text{g/L}$ whole blood)				
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
107	ICP-MS	15	1	2	10	7
110	ICP-MS	14.4	1.4	2.3	10.4	6.8
110	ETAAS	12.6	0.2	1.9	8.6	5.8
114	ICP-MS	12.0	1.0	1.5	9.3	6.3
147	ICP-MS	13.7	0.9	1.8	8.9	6.1
156	ETAAS	11.6		1.43	7.99	5.23
159	ICP-MS	13.0	1.0	2.0	9.3	6.0
164	ICP-MS	11.6	0.7	1.7	8.4	5.3
179	ICP-MS	13.9	0.7	1.7	9.4	6.0
197	ICP-MS	13.8	1.2	2.3	9.7	6.2
200	ETAAS	12.7	0.2	0.8	8.5	5.5
208	ICP-MS	13.0	0.7	1.3	8.1	5.4
305	ICP-MS	11.6	1.4	1.9	8.1	5.1
324	DRC/CC-ICP-MS	13.68	0.86	1.96	9.26	6.19
400	ETAAS	13.1	0.20	1.22	8.79	5.53
Number of Sample Measurements:		15	14	15	15	15
<b>Target value:</b>		<b>13.0</b>	<b>0.8</b>	<b>1.7</b>	<b>9.0</b>	<b>5.9</b>
Standard Deviation:		1.1	0.4	0.4	0.7	0.6
RSD (%):		8.1	49.3	23.9	8.0	9.5
Acceptable Range:						
Upper Limit:		15.0	1.8	2.7	10.4	6.9
Lower Limit:		11.1	0.0	0.7	7.7	4.9

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

**New York State Department of Health  
Blood Cadmium Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	13.7	0.9	2.0	9.3	6.2
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ETAAS</b>					
Number of Sample Measurements:	5	4	5	6	6
Mean:	12.1	0.5	1.2	7.6	6.2
Standard Deviation:	1.1	0.6	0.5	1.5	2.5
RSD (%):	9.0	120.0	43.3	19.3	40.8
<b>ICP-MS</b>					
Number of Sample Measurements:	14	14	14	14	14
Mean:	14.1	1.2	2.2	9.7	6.5
Standard Deviation:	2.0	0.7	0.7	1.3	1.1
RSD (%):	13.9	53.5	34.0	13.2	16.2
<b>All Laboratories</b>					
Number of Sample Measurements:	20	19	20	21	21
Mean:	13.6	1.1	1.9	9.1	6.4
Standard Deviation:	1.9	0.7	0.8	1.6	1.5
RSD (%):	14.1	64.7	40.8	17.4	23.9

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

**New York State Department of Health  
Blood Cadmium Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>Evaluated</b>					
Number of Sample Measurements:	4	3	4	4	4
Mean:	14.6	1.4	2.0	9.4	6.5
Standard Deviation:	3.0	0.5	1.0	1.7	1.6
RSD (%):	20.6	—	51.8	18.6	25.4
<b>Info</b>					
Number of Sample Measurements:	1	2	1	2	2
Mean:	18.0	2.3	4.2	9.1	10.2
Standard Deviation:	?	1.3	?	5.7	1.6
RSD (%):	—	—	—	—	—
<b>Reference</b>					
Number of Sample Measurements:	15	14	15	15	15
Mean:	13.0	0.8	1.7	9.0	5.9
Standard Deviation:	1.1	0.4	0.4	0.7	0.6
RSD (%):	8.1	49.3	23.9	8.0	9.5
<b>All Laboratories</b>					
Number of Sample Measurements:	20	19	20	21	21
Mean:	13.6	1.1	1.9	9.1	6.4
Standard Deviation:	1.9	0.7	0.8	1.6	1.5
RSD (%):	14.1	64.7	40.8	17.4	23.9

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

New York State Department of Health  
Interlaboratory Study #1, 2004

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### Whole Blood Mercury

The test materials for mercury were prepared from caprine (goat) whole blood preserved with K<sub>2</sub>EDTA anticoagulant. A total of five blood pools were prepared in acid-washed containers, and supplemented with different amounts of amounts of mercury as both inorganic (Hg<sup>2+</sup>) and/or organometallic (as methylmercury, CH<sub>3</sub>Hg<sup>+</sup>) species.

Sample	Hg Spike (approx.)
TE04-01	6 µg/L as Hg <sup>2+</sup> 9 µg/L Hg as CH <sub>3</sub> Hg <sup>+</sup>
TE04-02	None (endogenous level)
TE04-03	2 µg/L Hg as CH <sub>3</sub> Hg <sup>+</sup>
TE04-04	6 µg/L as Hg <sup>2+</sup> 6 µg/L Hg as CH <sub>3</sub> Hg <sup>+</sup>
TE04-05	7 µg/L Hg as CH <sub>3</sub> Hg <sup>+</sup>

**Target values** were established as the mean of 10 referee laboratories using either quadrupole based ICP-MS instrumentation and/or a cold-vapor AAS method. Values range from 0.4 µg/L (2 nmol/L) to 12.5 µg/L (62 nmol/L). Among the referee group, imprecision (SD) varied from 0.4 – 1.0 µg/L.

**Acceptable ranges** were fixed at ±20%, or ±3 µg/L around the target value, whichever is greater. So the range is fixed at ±3 µg/L for concentrations below 15 µg/L. Above 15 µg/L, it is ±20%.

**Discussion:** Based on the proposed criteria, 87.4% satisfactory results were reported by all participants.

**New York State Department of Health  
Blood Mercury Test Results, 2004 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/L whole blood)					Info Only
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05	
Target Values:		12.5	0.4	2.4	12.0	6.7	
107	ICP-MS	14	0	2	12	7	
109	CV-AAS	17 ↑	2	3	13	7	Info
110	ICP-MS	12.3	0.4	1.9	11.0	6.6	
114	ICP-MS	11.9	<1.0	1.4	12.1	6.4	
147	CV-AAS	13.0	<0.4	2.2	12.1	6.8	
156	CV-AAS	13.0	0	4.27	12.6	8.43	
159	ICP-MS	14	<4	<4	13	8	
164	ICP-MS	12			11	5	
179	ICP-MS	11	1	2	11	6	
197	ICP-MS	7 ↓	<5	<5	9	7	
200	ICP-MS	11.5	0.3	2.1	11.0	6.6	
206	ICP-MS	12	1	4	14	6	
208	ICP-MS	12.4	<5.0	<5.0	11.8	5.5	
293	CV-AAS	30.0 ↑	3.0	12.5 ↑	40 ↑	23 ↑	Info
305	ICP-MS	8.1 ↓	0.2	1.2	8.0 ↓	3.8	
312	ICP-MS	12.47	0.065	1.66	11.1	6.08	
339	ICP-MS	14.0	<0.1	2.0	12.7	7.1	
359	ICP-MS	16 ↑	2	4	15	9	
401	CV-AAS	5.9 ↓	0.1	0.3	6.8 ↓	1.5 ↓	Info

Percent satisfactory results for all participants: 87.4 %

**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 method detection limit are excluded from statistical calculations.

**New York State Department of Health  
Blood Mercury Test Results, 2004 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results ( $\mu\text{g/L}$ whole blood)				
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
107	ICP-MS	14	0	2	12	7
110	ICP-MS	12.3	0.4	1.9	11.0	6.6
114	ICP-MS	11.9	<1.0	1.4	12.1	6.4
147	CV-AAS	13.0	<0.4	2.2	12.1	6.8
156	CV-AAS	13.0	0	4.27	12.6	8.43
179	ICP-MS	11	1	2	11	6
200	ICP-MS	11.5	0.3	2.1	11.0	6.6
206	ICP-MS	12	1	4	14	6
312	ICP-MS	12.47	0.065	1.66	11.1	6.08
339	ICP-MS	14.0	<0.1	2.0	12.7	7.1
Number of Sample Measurements:		10	7	10	10	10
<b>Target value:</b>		<b>12.5</b>	<b>0.4</b>	<b>2.4</b>	<b>12.0</b>	<b>6.7</b>
Standard Deviation:		1.0	0.4	1.0	1.0	0.7
RSD (%):		7.9	111.4	41.2	8.2	10.8
Acceptable Range:						
Upper Limit:		15.5	3.4	5.4	15.0	9.7
Lower Limit:		9.5	0.0	0.0	9.0	3.7

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

**New York State Department of Health  
Blood Mercury Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>CV-AAS</b>					
Number of Sample Measurements:	4	1	4	4	4
Mean:	12.2	0.1	2.4	11.1	5.9
Standard Deviation:	4.6	?	1.7	2.9	3.0
RSD (%):	37.8	—	68.1	26.1	51.3
<b>ICP-MS</b>					
Number of Sample Measurements:	14	4	10	14	14
Mean:	12.0	0.2	2.2	11.6	6.4
Standard Deviation:	2.3	0.1	1.0	1.8	1.3
RSD (%):	19.2	59.3	44.0	15.5	19.5
<b>All Laboratories</b>					
Number of Sample Measurements:	18	5	14	18	18
Mean:	12.1	0.2	2.3	11.5	6.3
Standard Deviation:	2.8	0.1	1.1	2.0	1.7
RSD (%):	23.2	65.3	50.1	17.4	26.9

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

**New York State Department of Health  
Blood Mercury Test Results, 2004 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/L}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>Evaluated</b>					
Number of Sample Measurements:	6	1	2	6	6
Mean:	11.6	0.2	2.6	11.3	6.4
Standard Deviation:	3.4	?	2.0	2.6	2.0
RSD (%):	29.7	—	—	22.8	30.7
<b>Info</b>					
Number of Sample Measurements:	2	1	2	2	2
Mean:	11.5	0.1	1.7	9.9	4.3
Standard Deviation:	7.8	?	1.9	4.4	3.9
RSD (%):	—	—	—	—	—
<b>Reference</b>					
Number of Sample Measurements:	10	3	10	10	10
Mean:	12.5	0.3	2.4	12.0	6.7
Standard Deviation:	1.0	0.2	1.0	1.0	0.7
RSD (%):	7.9	—	41.2	8.2	10.8
<b>All Laboratories</b>					
Number of Sample Measurements:	18	5	14	18	18
Mean:	12.1	0.2	2.3	11.5	6.3
Standard Deviation:	2.8	0.1	1.1	2.0	1.7
RSD (%):	23.2	65.3	50.1	17.4	26.9

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

**New York State Department of Health  
Interlaboratory Study #1, 2004**

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**Whole Blood Lead**

The test materials for lead were prepared from caprine (goat, undosed) preserved with K<sub>2</sub>EDTA anticoagulant. A total of five blood pools were prepared in acid-washed containers, and supplemented with different amounts of lead (as Pb<sup>2+</sup>).

<b>Sample</b>	<b>Pb Spike (approx.)</b>
TE04-01	65 µg/dL as Pb <sup>2+</sup>
TE04-02	None (endogenous level)
TE04-03	1.5 µg/dL as Pb <sup>2+</sup>
TE04-04	43 µg/dL as Pb <sup>2+</sup>
TE04-05	18.6 µg/dL as Pb <sup>2+</sup>

**Target values** were established as the mean of 14 referee laboratories using either quadrupole based ICP-MS instrumentation and/or a furnace AAS method. Values range from 1.7 µg/dL (0.08 µmol/L) to 57.4 µg/dL (2.77 µmol/L). Among the referee group, imprecision (SD) varied from 0.5 - 2.4 µg/dL increasing with Pb concentration.

**Acceptable Ranges** are based on CLIA '88 criteria of ±10%, or ±4 µg/dL around the target value, whichever is greater. So the range is fixed at ±4 µg/dL for concentrations below 40 µg/dL and ±10% for concentrations above 40 µg/dL.

**Discussion:** The inclusion of blood lead results for these pools is for informational purposes only. We operate a separate well-established PT program for blood lead that is used to certify clinical laboratories in the United States under CLIA '88 for this test. However, it makes sense to include Pb as an analyte in the Whole Blood Trace Elements profile here for completeness and because some ICP-MS laboratories would routinely report this parameter as part of a multielement analysis. Since these materials can be archived as validation materials for trace elements, including Pb is appropriate.

Currently, we are exploring the feasibility of merging our existing PT program for blood lead with our new program for trace elements in whole blood. If the pilot studies are successful, we would expect to provide three whole blood test events per year beginning 2006.

**New York State Department of Health  
Blood Lead (Trace Elements), 2004 Event #1  
PERFORMANCE OF PARTICIPATING LABORATORIES**

Lab Code	Method	Results (µg/dL whole blood)					Info Only
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05	
Target Values:		57.4	1.7	3.1	44.8	20.1	
107	ICP-MS	58	2	3	45	20	
109	ETAAS	55	1	2	45	20	
110	ETAAS	62	2	4	48	22	
110	ICP-MS	57.2	1.6	3.0	44.1	19.6	
123	ETAAS	61	2	4	48	21	
125	ETAAS	61		4	42	21	
126	ETAAS	64 ↑	2	3	50 ↑	23	
147	ICP-MS	58.7	1.6	3.0	43.0	20.2	
156	ICP-MS	59.2	1.59	2.96	41.7	18.7	
159	ICP-MS	57		3	44	20	
164	ICP-MS	56		3	44	19	
179	ICP-MS	57.6	1.6	3.1	44.3	19.8	
197	ICP-MS	55	2	3	43	19	
200	ETAAS	56	0.6	2.2	44	19.5	
206	ICP-MS	68.5 ↑	1.8	3.5	49.7 ↑	25.1 ↑	
208	ICP-MS	54.6	1.4	2.7	41.0	18.4	
290	ETAAS	51 ↓	1	3	40 ↓	18	
293	ETAAS	55.3	1.7	3.3	43.9	20.1	
305	ETAAS	52.6	1.7	3.2	40.8	18.5	
312	ICP-MS	61.7	1.68	3.11	47.35	20.42	
324	DRC/CC-ICP-MS	52.88	1.43	2.76	41.01	18.21	
339	ICP-MS	56.0	1.8	3.6	44.0	20.0	
359	ICP-MS	69.8 ↑	1.9	3.7	50.2 ↑	23.3	
367	ETAAS	58.8	2.5	3.2	47.8	21.5	
400	ETAAS	60.9	2.4	3.8	47.5	20.9	
401	ETAAS	58.8	1.7	3.1	45.3	20.3	

Percent satisfactory results for all participants: 93.1 %

**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 method detection limit are excluded from statistical calculations.

**New York State Department of Health  
Blood Lead (Trace Elements), 2004 Event #1  
STATISTICAL SUMMARY**

**TARGET VALUE ASSIGNMENT AND STATISTICS**

Lab Code	Method	Results (µg/dL whole blood)				
		TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
107	ICP-MS	58	2	3	45	20
109	ETAAS	55	1	2	45	20
110	ETAAS	62	2	4	48	22
110	ICP-MS	57.2	1.6	3.0	44.1	19.6
147	ICP-MS	58.7	1.6	3.0	43.0	20.2
164	ICP-MS	56		3	44	19
179	ICP-MS	57.6	1.6	3.1	44.3	19.8
200	ETAAS	56	0.6	2.2	44	19.5
293	ETAAS	55.3	1.7	3.3	43.9	20.1
324	DRC/CC-ICP-MS	52.88	1.43	2.76	41.01	18.21
339	ICP-MS	56.0	1.8	3.6	44.0	20.0
367	ETAAS	58.8	2.5	3.2	47.8	21.5
400	ETAAS	60.9	2.4	3.8	47.5	20.9
401	ETAAS	58.8	1.7	3.1	45.3	20.3
Number of Sample Measurements:		14	13	14	14	14
<b>Target value:</b>		<b>57.4</b>	<b>1.7</b>	<b>3.1</b>	<b>44.8</b>	<b>20.1</b>
Standard Deviation:		2.4	0.5	0.5	1.9	1.0
RSD (%):		4.2	30.2	17.5	4.3	4.7
Acceptable Range:						
Upper Limit:		63.1	5.7	7.1	49.3	24.1
Lower Limit:		51.7	0.0	0.0	40.3	16.1

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

**New York State Department of Health  
Blood Lead (Trace Elements), 2004 Event #1  
STATISTICAL SUMMARY BY METHOD**

	Results ( $\mu\text{g/dL}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>DRC/CC-ICP-MS</b>					
Number of Sample Measurements:	1	1	1	1	1
Mean:	52.9	1.4	2.8	41.0	18.2
Standard Deviation:	?	?	?	?	?
RSD (%):	—	—	—	—	—
<b>ETAAS</b>					
Number of Sample Measurements:	12	11	12	12	12
Mean:	58.0	1.7	3.2	45.2	20.5
Standard Deviation:	4.0	0.6	0.7	3.2	1.4
RSD (%):	6.9	35.4	20.4	7.0	6.9
<b>ICP-MS</b>					
Number of Sample Measurements:	13	11	13	13	13
Mean:	59.2	1.7	3.1	44.7	20.3
Standard Deviation:	4.8	0.2	0.3	2.8	1.9
RSD (%):	8.1	11.1	9.2	6.2	9.3
<b>All Laboratories</b>					
Number of Sample Measurements:	26	23	26	26	26
Mean:	58.4	1.7	3.2	44.8	20.3
Standard Deviation:	4.5	0.4	0.5	3.0	1.7
RSD (%):	7.6	25.3	15.5	6.6	8.2

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

**New York State Department of Health  
Blood Lead (Trace Elements), 2004 Event #1  
STATISTICAL SUMMARY BY CLASS**

	Results ( $\mu\text{g/dL}$ whole blood)				
	TE04-01	TE04-02	TE04-03	TE04-04	TE04-05
<b>Evaluated</b>					
Number of Sample Measurements:	12	10	12	12	12
Mean:	59.6	1.7	3.3	44.8	20.5
Standard Deviation:	5.9	0.3	0.4	4.0	2.3
RSD (%):	9.9	18.6	13.2	8.8	11.0
<b>Reference</b>					
Number of Sample Measurements:	14	13	14	14	14
Mean:	57.4	1.7	3.1	44.8	20.1
Standard Deviation:	2.4	0.5	0.5	1.9	1.0
RSD (%):	4.2	30.2	17.5	4.3	4.7
<b>All Laboratories</b>					
Number of Sample Measurements:	26	23	26	26	26
Mean:	58.4	1.7	3.2	44.8	20.3
Standard Deviation:	4.5	0.4	0.5	3.0	1.7
RSD (%):	7.6	25.3	15.5	6.6	8.2

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

**New York State Department of Health  
Interlaboratory Study #1, 2004**

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**Additional Trace Elements Reported in Whole Blood**

For this interlaboratory study, we requested that participant laboratories report their analytical results for any additional trace elements (other than As, Cd, Pb and Hg) that are routinely reported so that a more complete characterization can be recorded for these 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.

**New York State Department of Health  
Interlaboratory Study, 2004 Event #1  
Whole Blood Additional Elements**

TE04-01

<b>Lab Code</b>	<b>110</b>	<b>179</b>	<b>197</b>	<b>206</b>	<b>290</b>	<b>339</b>	<b>401</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>%R.S.D.</b>
Technique	ICP-MS	ICP-MS	ICPMS	ICP-MS	Flame AAS	ICP-MS	ETAAS				
<b>Ba (µg/L)</b>	22.6							1			
<b>Be (µg/L)</b>	15.4							1			
<b>Co (µg/L)</b>	7.1		6.9	6				3	6.7	0.59	8.8
<b>Cr (µg/L)</b>			30.2					1			
<b>Cu (µg/L)</b>	1415				810			2			
<b>Mn (µg/L)</b>			31.1				22.9	2			
<b>Sb (µg/L)</b>	13							1			
<b>Se (µg/L)</b>			379			243		2			
<b>Sn (µg/L)</b>	32.2							1			
<b>Tl (µg/L)</b>	30.1	30	29.8	34				4	31.0	2.0	6.5
<b>U (µg/L)</b>	1.48							1			
<b>Zn (µg/L)</b>	2914				2650			2			

**New York State Department of Health  
Interlaboratory Study, 2004 Event #1  
Whole Blood Additional Elements**

TE04-02

<b>Lab Code</b>	<b>110</b>	<b>179</b>	<b>197</b>	<b>206</b>	<b>290</b>	<b>339</b>	<b>401</b>	<b>n</b>	<b>Mean</b>	<b>S.D.</b>	<b>% R.S.D.</b>
Technique	ICP-MS	ICP-MS	ICPMS	ICP-MS	Flame AAS	ICP-MS	ETAAS				
<b>Ba (µg/L)</b>	6.6							1			
<b>Be (µg/L)</b>	0.03							1			
<b>Co (µg/L)</b>	0.8		< 1.0	0.2				3	< 1.0		
<b>Cr (µg/L)</b>			< 1.0					1			
<b>Cu (µg/L)</b>	794				420			2			
<b>Mn (µg/L)</b>			15.8				8.2	2			
<b>Sb (µg/L)</b>	0.43							1			
<b>Se (µg/L)</b>			255			149		2			
<b>Sn (µg/L)</b>	1.34							1			
<b>Tl (µg/L)</b>	0.05	0.5	< 1.0	0				4	< 1.0		
<b>U (µg/L)</b>	0.01							1			
<b>Zn (µg/L)</b>	2297				2050			2			

**New York State Department of Health  
Interlaboratory Study, 2004 Event #1  
Whole Blood Additional Elements**

TE04-03

<b>Lab Code</b>	<b>110</b>	<b>179</b>	<b>197</b>	<b>206</b>	<b>290</b>	<b>339</b>	<b>401</b>	<b>n</b>	<b>Mean</b>	<b>S.D.</b>	<b>% R.S.D.</b>
Technique	ICP-MS	ICP-MS	ICPMS	ICP-MS	Flame AAS	ICP-MS	ETAAS				
<b>Ba (µg/L)</b>	8.5							1			
<b>Be (µg/L)</b>	1.2							1			
<b>Co (µg/L)</b>	1.4		< 1.0	0.6				3			
<b>Cr (µg/L)</b>			2.6					1			
<b>Cu (µg/L)</b>	849				620			2			
<b>Mn (µg/L)</b>			16.9				10	2			
<b>Sb (µg/L)</b>	1.42							1			
<b>Se (µg/L)</b>			264			156		2			
<b>Sn (µg/L)</b>	3.86							1			
<b>Tl (µg/L)</b>	2.18	2	2.3	2.2				4	2.17	0.12	5.8
<b>U (µg/L)</b>	0.13							1			
<b>Zn (µg/L)</b>	2343				2120			2			

**New York State Department of Health  
Interlaboratory Study, 2004 Event #1  
Whole Blood Additional Elements**

TE04-04

<b>Lab Code</b>	<b>110</b>	<b>179</b>	<b>197</b>	<b>206</b>	<b>290</b>	<b>339</b>	<b>401</b>	<b>n</b>	<b>Mean</b>	<b>S.D.</b>	<b>% R.S.D.</b>
Technique	ICP-MS	ICP-MS	ICPMS	ICP-MS	Flame AAS	ICP-MS	ETAAS				
<b>Ba (µg/L)</b>	16.8							1			
<b>Be (µg/L)</b>	10.3							1			
<b>Co (µg/L)</b>	4.8		4.7	3.7				3	4.4	0.61	13.8
<b>Cr (µg/L)</b>								1			
<b>Cu (µg/L)</b>	1209				900			2			
<b>Mn (µg/L)</b>			25.7				19.9	2			
<b>Sb (µg/L)</b>	9.14							1			
<b>Se (µg/L)</b>			365			208		2			
<b>Sn (µg/L)</b>	22.2							1			
<b>Tl (µg/L)</b>	20.8	21	20.1	21.8				4	20.9	0.70	3.3
<b>U (µg/L)</b>	1.04							1			
<b>Zn (µg/L)</b>	2753				2420			2			

**New York State Department of Health  
Interlaboratory Study, 2004 Event #1  
Whole Blood Additional Elements**

TE04-05

<b>Lab Code</b>	<b>110</b>	<b>179</b>	<b>197</b>	<b>206</b>	<b>290</b>	<b>339</b>	<b>401</b>	<b>n</b>	<b>Mean</b>	<b>S.D.</b>	<b>% R.S.D.</b>
Technique	ICP-MS	ICP-MS	ICPMS	ICP-MS	Flame AAS	ICP-MS	ETAAS				
<b>Ba (µg/L)</b>	12.9							1			
<b>Be (µg/L)</b>	6.2							1			
<b>Co (µg/L)</b>	3.2		3	2.6				3	2.9	0.31	10.4
<b>Cr (µg/L)</b>			13					1			
<b>Cu (µg/L)</b>	1037				760			2			
<b>Mn (µg/L)</b>			21.6				13.5	2			
<b>Sb (µg/L)</b>	5.7							1			
<b>Se (µg/L)</b>			304			175		2			
<b>Sn (µg/L)</b>	13.9							1			
<b>Tl (µg/L)</b>	12.6	13	12.1	14.4				4	13.0	1.0	7.6
<b>U (µg/L)</b>	0.61							1			
<b>Zn (µg/L)</b>	2523				2230			2			

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

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**ETAAS-ZL:**

Electrothermal atomic absorption spectrometry with longitudinal Zeeman background correction, e.g., Perkin-Elmer (4100ZL, 4110ZL, 5100ZL, AAnalyst 600 or 800, SIMMA 6000 or 6100), etc.

**ETAAS-Z:**

Electrothermal atomic absorption spectrometry with transverse Zeeman background correction, e.g., Perkin-Elmer (Z5100), Varian (220Z, 300Z, 400Z, 880Z), Hitachi Z9000, etc.

**ETAAS-D<sub>2</sub>:**

Electrothermal atomic absorption spectrometry with continuum (deuterium) background correction, e.g., Perkin-Elmer (3110, AAnalyst 700), Varian (200P, 300P, 400P), Thermo-Electron (PU 239), Hitachi 8200, etc.

**ETAAS-Other:**

Electrothermal atomic absorption spectrometry with S-H background correction, or unknown, e.g., TJA AtomSpec, etc.

**ICP-MS:**

Inductively-coupled plasma mass spectrometry.

**FLAME AAS:**

Flame atomic absorption spectroscopy.

**ICP-MS:**

Inductively-coupled plasma mass spectrometry (standard mode).

**DRC-ICP-MS:**

Inductively-coupled plasma mass spectrometry with Dynamic Reaction Cell.

**CV-AAS:**

Cold vapor atomic absorption spectrometry (eg, FIAS, FIMS or batch mode).

**HG-AAS:**

Hydride generation - heated tube atomic absorption.

**HG-AFS:**

Hydride generation - atomic fluorescence spectroscopy.

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