Wadsworth Center

New York State Department of Health

# TRACE ELEMENTS IN SERUM

## Event #3, 2010

## November 22, 2010

STATE OF NEW YORK
DEPARTMENT OF HEALTH

Wadsworth Center The Governor Nelson A. Rockefeller Empire State Plaza P.O. Box 509 Albany, New York 12201-0509

Richard F. Daines, M.D.
*Commissioner*

James W. Clyne, Jr..
*Executive Deputy Commisioner*

November 22, 2010

# Trace Elements in Serum
# Event #3, 2010

Dear Laboratory Director:

Results from the third proficiency test (PT) event for 2010 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

Test materials were prepared from human serum obtained from Tennessee Blood Services, Inc. Serum units were spiked with a suite of additional trace elements as described in each narrative.

## Assignment of Target Values for Trace Elements

Except for blood lead, we will implement robust statistics for assigning target values for all trace element panels. Method specific and additional trace element data will continue to be calculated utilizing traditional statistics. The use of robust statistics for assigning target values for proficiency testing pools is one approach that is acceptable under ISO 13528. In collaboration with other trace element PT scheme organizers, we have conducted an evaluation of robust statistics. As a result of our evaluation, we have elected to introduce this approach in our program.

**The next PT event for trace elements in serum is scheduled to be mailed Wednesday, January 12th, 2011.** Please inform our laboratory staff at (518) 473-0452 if the test materials have not arrived within five days of the scheduled mail out date. **The deadline for reporting results is Wednesday, February 9th, 2011.**

Thank you for your participation.

Sincerely,

Patrick J. Parsons, Ph.D.
Section Head, Trace Elements Proficiency Testing Program

## Serum Aluminum

The test materials for serum Al were prepared from human serum obtained from Tennessee Blood Services, Inc. The units were tested by FDA approved methods and found to be Non-reactive for Anti-HIV-1/2, Anti-HCV 3.0 and HBsAg. The serum has also been found to STS (RPR) Non-reactive and Negative for HIV-1 and HCV by PCR. Serum units were dispensed into acid-washed 500-mL polypropylene containers to make up five (5) serum pools. Each pool was spiked with a suite of additional trace elements including aluminum as $Al^{3+}$ at various concentrations.

**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 26 µg/L (0.96 µmol/L) to 138 µg/L (5.11 µmol/L).

**Acceptable ranges** for serum aluminum are based on fixed criteria of ±20%, or ±5 µg/L below 25 µg/L. These criteria are based on consensus recommendations from several EQAS organizers (1).

**Discussion.** Based on the above criteria, 90.0% of test results reported were judged as satisfactory, with three out of 26 participant laboratories (11.5%) 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, 2010 Event #3
## ROBUST STATISTICAL SUMMARY

### TARGET VALUE ASSIGNMENT AND STATISTICS

| | Results (µg/L) | | | | |
|---|---|---|---|---|---|
| | **SE10-11** | **SE10-12** | **SE10-13** | **SE10-14** | **SE10-15** |
| **Robust Mean** | **138** | **46** | **99** | **54** | **26** |
| Robust Standard Deviation | 9.1 | 4.9 | 8.5 | 6.6 | 3.7 |
| Standard Uncertainty | 2.2 | 1.2 | 2.1 | 1.6 | 0.9 |
| RSD (%) | 6.6 | 10.6 | 8.6 | 12.2 | 14.5 |
| Acceptable Range: | | | | | |
| Upper Limit: | 166 | 55 | 119 | 65 | 31 |
| Lower Limit: | 110 | 37 | 79 | 43 | 21 |

**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, 2010 Event #3

## PERFORMANCE OF PARTICIPATING LABORATORIES

| Lab Code | Method | Results (µg/L) SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 | Info Only |
|---|---|---|---|---|---|---|---|
| | Target Values: | 138 | 46 | 99 | 54 | 26 | |
| 110 | ETAAS-Z | 134 | 45 | 97 | 52 | 27 | |
| 114 | ETAAS-Z | 210 ↑ | 55 | 120 ↑ | 64 | 33 ↑ | |
| 147 | ETAAS-Z | 136 | 48 | 103 | 56 | 25 | Info |
| 156 | ICP-MS | 155 | 47 | 106 | 55 | 24 | |
| 159 | ETAAS-Z | 136 | 48 | 96 | 57 | 28 | |
| 160 | ETAAS-Z | 131 | 52 | 97 | 62 | 31 | |
| 164 | ICP-MS | 143 | 45 | 98 | 49 | 22 | |
| 179 | DRC/CC-ICP-MS | 134 | 43 | 93 | 49 | 21 | |
| 197 | ICP-MS | 145 | 47 | 101 | 53 | 24 | |
| 200 | DRC/CC-ICP-MS | 133 | 41 | 89 | 45 | 23 | Info |
| 206 | ICP-MS | 147 | 53 | 103 | 67 ↑ | 30 | |
| 287 | ETAAS-Z | 131 | 42 | 96 | 51 | 23 | |
| 293 | ICP-MS | 129 | 41 | 91 | 47 | 24 | Info |
| 301 | ETAAS-Z | 136 | 46 | 100 | 57 | 27 | |
| 305 | ICP-MS | 136 | 44 | 100 | 50 | 24 | |
| 324 | ICP-MS | 122 | 42 | 89 | 49 | 24 | Info |
| 325 | ETAAS-Z | 430 ↑ | 70 ↑ | 150 ↑ | 83 ↑ | 36 ↑ | Info |
| 355 | ICP-MS | 148 | 47 | 106 | 56 | 26 | |
| 357 | ICP-MS | 130 | 41 | 90 | 55 | 23 | |
| 358 | ICP-MS | 143 | 48 | 105 | 54 | 26 | |
| 362 | ICP-MS | 155 | 56 ↑ | 111 | 61 | 31 | |
| 363 | ICP-MS | 133 | 44 | 98 | 51 | 24 | |
| 366 | ETAAS-Z | 143 | 52 | 105 | 63 | 29 | Info |
| 367 | ETAAS-Z | 136 | 40 | 91 | 43 ↓ | 19 ↓ | Info |
| 401 | ICP-AES/OES | 127 | 38 | 89 | 46 | 16 ↓ | Info |
| 458 | ETAAS Other | 132 | 43 | 84 | 50 | 29 | |

Percent satisfactory results for all participants: 90.0 %

**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 Aluminum Test Results, 2010 Event #3
## STATISTICAL SUMMARY BY METHOD

| | Results (µg/L) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **DRC/CC-ICP-MS** | | | | | |
| Number of Sample Measurements: | 2 | 2 | 2 | 2 | 2 |
| Mean: | 134 | 42 | 91 | 47 | 22 |
| Standard Deviation: | 1 | 1 | 3 | 3 | 1 |
| RSD (%): | — | — | — | — | — |
| **ETAAS Other** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 132 | 43 | 84 | 50 | 29 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **ETAAS-Z** | | | | | |
| Number of Sample Measurements: | 9 | 10 | 10 | 10 | 10 |
| Mean: | 144 | 50 | 106 | 59 | 28 |
| Standard Deviation: | 25 | 8 | 18 | 11 | 5 |
| RSD (%): | 17.5 | 17.0 | 16.6 | 18.0 | 17.6 |
| **ICP-AES/OES** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 127 | 38 | 89 | 46 | 16 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **ICP-MS** | | | | | |
| Number of Sample Measurements: | 12 | 12 | 12 | 12 | 12 |
| Mean: | 141 | 46 | 100 | 54 | 25 |
| Standard Deviation: | 11 | 5 | 7 | 6 | 3 |
| RSD (%): | 7.5 | 9.9 | 7.0 | 10.4 | 10.8 |
| **All Laboratories** | | | | | |
| Number of Sample Measurements: | 25 | 26 | 26 | 26 | 26 |
| Mean: | 140 | 47 | 100 | 55 | 26 |
| Standard Deviation: | 17 | 7 | 13 | 8 | 4 |
| RSD (%): | 11.9 | 14.2 | 12.8 | 15.3 | 17.0 |

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

## Serum Copper

The test materials for serum Cu were prepared from human serum obtained from Tennessee Blood Services, Inc. The units were tested by FDA approved methods and found to be Non-reactive for Anti-HIV-1/2, Anti-HCV 3.0 and HBsAg. The serum has also been found to STS (RPR) Non-reactive and Negative for HIV-1 and HCV by PCR. Serum units were dispensed into acid-washed 500-mL polypropylene containers to make up five (5) serum pools. Each pool was spiked with a suite of additional trace elements including copper as $Cu^{2+}$ at various concentrations.

**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 1051 µg/L (16.54 µmol/L) to 2836 µg/L (44.63 µmol/L).

**Acceptable ranges** for serum copper are based on fixed criteria of ±15%, or ±95 µg/L below 635 µg/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 (±10%).

**Discussion.** Based on the above criteria, 90.9% of test results reported were judged as satisfactory, with two of the 22 participant laboratories (9.1%) 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, 2010 Event #3
## ROBUST STATISTICAL SUMMARY

### TARGET VALUE ASSIGNMENT AND STATISTICS

| | Results (μg/L serum) | | | | |
|---|---|---|---|---|---|
| | **SE10-11** | **SE10-12** | **SE10-13** | **SE10-14** | **SE10-15** |
| **Robust Mean** | **1051** | **2836** | **1301** | **1648** | **2109** |
| Robust Standard Deviation | 62 | 147 | 63 | 103 | 114 |
| Standard Uncertainty | 16 | 39 | 17 | 28 | 30 |
| RSD (%) | 5.9 | 5.2 | 4.9 | 6.3 | 5.4 |
| Acceptable Range: | | | | | |
| Upper Limit: | 1209 | 3261 | 1496 | 1895 | 2425 |
| Lower Limit: | 893 | 2411 | 1106 | 1401 | 1793 |

**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, 2010 Event #3

## PERFORMANCE OF PARTICIPATING LABORATORIES

| Lab Code | Method | Results (µg/L serum) | | | | | Info Only |
|---|---|---|---|---|---|---|---|
| | | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 | |
| | Target Values: | 1051 | 2836 | 1301 | 1648 | 2109 | |
| 107 | DRC/CC-ICP-MS | 1091 | 2905 | 1327 | 1631 | 2095 | Info |
| 110 | ICP-MS | 1115 | 2959 | 1377 | 1741 | 2178 | |
| 114 | ICP-MS | 1090 | 2960 | 1450 | 1790 | 2320 | |
| 147 | ICP-MS | 1055 | 2891 | 1328 | 1569 | 2166 | Info |
| 156 | FAAS | 1990 ↑ | 3780 ↑ | 2200 ↑ | 2580 ↑ | 2980 ↑ | |
| 159 | ICP-AES/OES | 1060 | 2740 | 1280 | 1640 | 2090 | |
| 160 | ETAAS-Z | 990 | 2710 | 1200 | 1560 | 1950 | |
| 164 | ICP-MS | 1075 | 2922 | 1284 | 1712 | 2110 | |
| 179 | DRC/CC-ICP-MS | 1050 | 2810 | 1290 | 1650 | 2110 | |
| 197 | ICP-MS | 1110 | 2920 | 1350 | 1720 | 2190 | |
| 200 | FAAS | 1048 | 2769 | 1270 | 1600 | 2038 | Info |
| 206 | ICP-MS | 1030 | 2750 | 1280 | 1520 | 1960 | |
| 293 | ICP-MS | 992 | 2817 | 1266 | 1647 | 2054 | Info |
| 305 | ICP-MS | 10 ↓ | 27 ↓ | 13 ↓ | 16 ↓ | 20 ↓ | |
| 324 | ICP-MS | 1053 | 2801 | 1298 | 1645 | 2089 | Info |
| 325 | FAAS | 1110 | 3120 | 1410 | 1770 | 2280 | Info |
| 360 | FAAS | 990 | 2740 | 1280 | 1650 | 2120 | |
| 362 | ICP-MS | 960 | 2700 | 1250 | 1530 | 2070 | |
| 366 | ETAAS other | 1047 | 2733 | 1294 | 1679 | 2094 | Info |
| 401 | DRC/CC-ICP-MS | 1100 | 2976 | 1336 | 1698 | 2232 | Info |
| 404 | HR-ICP-MS | 917 | 2557 | 1188 | 1454 | 1902 | Info |
| 457 | ICP-AES/OES | 1081 | 2965 | 1354 | 1706 | 2180 | Info |

Percent satisfactory results for all participants: 90.9 %

**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, 2010 Event #3
## STATISTICAL SUMMARY BY METHOD

| | Results (µg/L serum) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **DRC/CC-ICP-MS** | | | | | |
| Number of Sample Measurements: | 3 | 3 | 3 | 3 | 3 |
| Mean: | 1080 | 2897 | 1318 | 1660 | 2146 |
| Standard Deviation: | 27 | 83 | 24 | 35 | 75 |
| RSD (%): | — | — | — | — | — |
| **ETAAS other** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 1047 | 2733 | 1294 | 1679 | 2094 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **ETAAS-Z** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 990 | 2710 | 1200 | 1560 | 1950 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **FAAS** | | | | | |
| Number of Sample Measurements: | 4 | 4 | 4 | 4 | 4 |
| Mean: | 1285 | 3102 | 1540 | 1900 | 2355 |
| Standard Deviation: | 473 | 484 | 445 | 459 | 429 |
| RSD (%): | 36.8 | 15.6 | 28.9 | 24.2 | 18.2 |
| **HR-ICP-MS** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 917 | 2557 | 1188 | 1454 | 1902 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **ICP-AES/OES** | | | | | |
| Number of Sample Measurements: | 2 | 2 | 2 | 2 | 2 |
| Mean: | 1071 | 2853 | 1317 | 1673 | 2135 |
| Standard Deviation: | 15 | 159 | 52 | 47 | 64 |
| RSD (%): | — | — | — | — | — |
| **ICP-MS** | | | | | |
| Number of Sample Measurements: | 9 | 9 | 9 | 9 | 9 |
| Mean: | 1053 | 2858 | 1320 | 1653 | 2126 |
| Standard Deviation: | 52 | 94 | 64 | 96 | 102 |
| RSD (%): | 5.0 | 3.3 | 4.8 | 5.8 | 4.8 |
| **All Laboratories** | | | | | |
| Number of Sample Measurements: | 21 | 21 | 21 | 21 | 21 |
| Mean: | 1093 | 2882 | 1348 | 1690 | 2153 |
| Standard Deviation: | 212 | 242 | 205 | 221 | 215 |
| RSD (%): | 19.4 | 8.4 | 15.2 | 13.1 | 10.0 |

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

## Serum Selenium

The test materials for serum Se were prepared from human serum obtained from Tennessee Blood Services, Inc. The units were tested by FDA approved methods and found to be Non-reactive for Anti-HIV-1/2, Anti-HCV 3.0 and HBsAg. The serum has also been found to STS (RPR) Non-reactive and Negative for HIV-1 and HCV by PCR. Serum units were dispensed into acid-washed 500-mL polypropylene containers to make up five (5) serum pools. Each pool was spiked with a suite of additional trace elements including selenium as $Se^{4+}$ at various concentrations.

**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 113 µg/L (1.43 µmol/L) to 282 µg/L (3.57 µmol/L).

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

**Discussion.** Based on the above criteria, 97.6% of test results reported were judged as satisfactory, with none of the 17 participant laboratories reporting 2 or more of the 5 results outside the acceptable ranges.

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

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

# New York State Department of Health
## Serum Selenium Test Results, 2010 Event #3
## ROBUST STATISTICAL SUMMARY

### TARGET VALUE ASSIGNMENT AND STATISTICS

| | Results (µg/L serum) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **Robust Mean** | **282** | **154** | **113** | **218** | **137** |
| Robust Standard Deviation | 21.9 | 10.9 | 9.9 | 17.4 | 12.4 |
| Standard Uncertainty | 6.6 | 3.3 | 3.0 | 5.3 | 3.8 |
| RSD (%) | 7.8 | 7.0 | 8.8 | 8.0 | 9.1 |
| Acceptable Range: | | | | | |
| Upper Limit: | 338 | 185 | 136 | 262 | 164 |
| Lower Limit: | 226 | 123 | 90 | 174 | 110 |

**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, 2010 Event #3

## PERFORMANCE OF PARTICIPATING LABORATORIES

| Lab Code | Method | Results (µg/L serum) | | | | | Info Only |
|---|---|---|---|---|---|---|---|
| | | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 | |
| | Target Values: | 282 | 154 | 113 | 218 | 137 | |
| 107 | DRC/CC-ICP-MS | 271 | 147 | 107 | 208 | 127 | Info |
| 110 | DRC/CC-ICP-MS | 267 | 148 | 106 | 206 | 128 | |
| 114 | ICP-MS | 249 | 141 | 101 | 168 ↓ | 121 | |
| 147 | ICP-MS | 250 | 143 | 104 | 203 | 125 | Info |
| 156 | ICP-MS | 288 | 156 | 112 | 222 | 146 | |
| 159 | ETAAS-Z | 288 | 162 | 116 | 227 | 141 | |
| 164 | ICP-MS | 280 | 148 | 109 | 213 | 133 | |
| 179 | DRC/CC-ICP-MS | 255 | 146 | 101 | 199 | 127 | |
| 197 | ICP-MS | 298 | 166 | 125 | 233 | 145 | |
| 200 | DRC/CC-ICP-MS | 269 | 145 | 104 | 205 | 126 | Info |
| 206 | ICP-MS | 310 | 196 ↑ | 122 | 230 | 149 | |
| 293 | DRC/CC-ICP-MS | 301 | 167 | 131 | 246 | 157 | Info |
| 305 | ICP-MS | 278 | 152 | 120 | 227 | 147 | |
| 324 | ID-ICP-MS | 277 | 148 | 107 | 208 | 126 | Info |
| 366 | ETAAS-Z | 306 | 166 | 115 | 220 | 145 | Info |
| 367 | DRC/CC-ICP-MS | 289 | 156 | 112 | 227 | 137 | Info |
| 401 | DRC/CC-ICP-MS | 313 | 167 | 125 | 249 | 150 | Info |

Percent satisfactory results for all participants: 97.6 %

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

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

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

## New York State Department of Health
## Serum Selenium Test Results, 2010 Event #3
## STATISTICAL SUMMARY BY METHOD

| | Results (μg/L serum) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **DRC/CC-ICP-MS** | | | | | |
| Number of Sample Measurements: | 7 | 7 | 7 | 7 | 7 |
| Mean: | 281 | 154 | 112 | 220 | 136 |
| Standard Deviation: | 21 | 10 | 11 | 21 | 13 |
| RSD (%): | 7.4 | 6.3 | 10.1 | 9.4 | 9.3 |
| **ETAAS-Z** | | | | | |
| Number of Sample Measurements: | 2 | 2 | 2 | 2 | 2 |
| Mean: | 297 | 164 | 116 | 224 | 143 |
| Standard Deviation: | 13 | 3 | 1 | 5 | 3 |
| RSD (%): | — | — | — | — | — |
| **ICP-MS** | | | | | |
| Number of Sample Measurements: | 7 | 7 | 7 | 7 | 7 |
| Mean: | 279 | 157 | 113 | 214 | 138 |
| Standard Deviation: | 23 | 19 | 9 | 23 | 12 |
| RSD (%): | 8.2 | 12.1 | 8.2 | 10.6 | 8.4 |
| **ID-ICP-MS** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 277 | 148 | 107 | 208 | 126 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **All Laboratories** | | | | | |
| Number of Sample Measurements: | 17 | 17 | 17 | 17 | 17 |
| Mean: | 282 | 156 | 113 | 217 | 137 |
| Standard Deviation: | 20 | 14 | 9 | 19 | 11 |
| RSD (%): | 7.1 | 8.7 | 8.1 | 8.9 | 8.1 |

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

## Serum Zinc

The test materials for serum Zn were prepared from human serum obtained from Tennessee Blood Services, Inc. The units were tested by FDA approved methods and found to be Non-reactive for Anti-HIV-1/2, Anti-HCV 3.0 and HBsAg. The serum has also been found to STS (RPR) Non-reactive and Negative for HIV-1 and HCV by PCR. Serum units were dispensed into acid-washed 500-mL polypropylene containers to make up five (5) serum pools. Each pool was spiked with a suite of additional trace elements including zinc as $Zn^{2+}$ at various concentrations.

**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 558 µg/L (8.53 µmol/L) to 1754 µg/L (26.82 µmol/L).

**Acceptable ranges** for serum zinc are based on fixed criteria of ±15%, or ±15 µg/L below 100 µg/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, 86.4% of test results reported were judged as satisfactory, with five out of 28 participant laboratories (17.8%) 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, 2010 Event #3
## ROBUST STATISTICAL SUMMARY

### TARGET VALUE ASSIGNMENT AND STATISTICS

| | Results (µg/L serum) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **Robust Mean** | **1003** | **558** | **797** | **1754** | **1475** |
| Robust Standard Deviation | 69 | 46 | 70 | 126 | 110 |
| Standard Uncertainty | 16 | 11 | 16 | 30 | 26 |
| RSD (%) | 6.9 | 8.3 | 8.7 | 7.2 | 7.5 |
| Acceptable Range: | | | | | |
| Upper Limit: | 1154 | 642 | 917 | 2017 | 1696 |
| Lower Limit: | 853 | 474 | 678 | 1491 | 1254 |

**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, 2010 Event #3

## PERFORMANCE OF PARTICIPATING LABORATORIES

| Lab Code | Method | Results (µg/L serum) | | | | | Info Only |
|---|---|---|---|---|---|---|---|
| | | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 | |
| | Target Values: | 1003 | 558 | 797 | 1754 | 1475 | |
| 107 | DRC/CC-ICP-MS | 1100 | 592 | 851 | 1731 | 1497 | Info |
| 110 | ICP-MS | 1071 | 601 | 872 | 1949 | 1648 | |
| 114 | ICP-MS | 1090 | 690 ↑ | 970 ↑ | 1800 | 1590 | |
| 147 | ICP-MS | 948 | 528 | 752 | 1739 | 1458 | Info |
| 156 | ICP-MS | 971 | 546 | 750 | 1621 | 1225 ↓ | |
| 159 | ICP-AES/OES | 1030 | 610 | 830 | 1760 | 1500 | |
| 160 | FAAS | 940 | 450 ↓ | 700 | 1530 | 1140 ↓ | |
| 164 | ICP-MS | 1026 | 579 | 793 | 1856 | 1508 | |
| 179 | DRC/CC-ICP-MS | 1000 | 540 | 790 | 1810 | 1520 | |
| 197 | ICP-MS | 1030 | 540 | 810 | 1830 | 1540 | |
| 200 | FAAS | 1014 | 569 | 798 | 1753 | 1504 | Info |
| 206 | ICP-MS | 1000 | 570 | 810 | 1730 | 1470 | |
| 287 | FAAS | 990 | 540 | 750 | 1770 | 1460 | |
| 293 | ICP-MS | 850 ↓ | 485 | 706 | 1642 | 1347 | Info |
| 305 | ICP-MS | 9 ↓ | 5 ↓ | 7 ↓ | 16 ↓ | 13 ↓ | |
| 324 | ID-ICP-MS | 1033 | 562 | 840 | 1825 | 1543 | Info |
| 325 | FAAS | 1020 | 570 | 810 | 1650 | 1410 | Info |
| 355 | ICP-MS | 1065 | 598 | 883 | 1887 | 1559 | |
| 357 | ICP-MS | 940 | 520 | 750 | 1660 | 1350 | |
| 358 | ICP-MS | 994 | 575 | 808 | 1796 | 1497 | |
| 360 | FAAS | 1060 | 590 | 820 | 1850 | 1590 | |
| 362 | ICP-MS | 1020 | 610 | 860 | 1850 | 1450 | |
| 363 | ICP-MS | 1170 ↑ | 650 ↑ | 930 ↑ | 2050 ↑ | 1730 ↑ | |
| 366 | FAAS | 938 | 493 | 748 | 1653 | 1403 | Info |
| 401 | DRC/CC-ICP-MS | 1066 | 582 | 850 | 1896 | 1608 | Info |
| 404 | HR-ICP-MS | 801 ↓ | 392 ↓ | 643 ↓ | 1562 | 1285 | Info |
| 457 | ICP-AES/OES | 938 | 512 | 749 | 1665 | 1402 | Info |
| 458 | FAAS | 996 | 544 | 798 | 1747 | 1491 | |

Percent satisfactory results for all participants: 86.4 %

**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, 2010 Event #3
## STATISTICAL SUMMARY BY METHOD

| | Results (µg/L serum) | | | | |
|---|---|---|---|---|---|
| | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
| **DRC/CC-ICP-MS** | | | | | |
| Number of Sample Measurements: | 3 | 3 | 3 | 3 | 3 |
| Mean: | 1055 | 571 | 830 | 1812 | 1542 |
| Standard Deviation: | 51 | 28 | 35 | 83 | 59 |
| RSD (%): | — | — | — | — | — |
| **FAAS** | | | | | |
| Number of Sample Measurements: | 7 | 7 | 7 | 7 | 7 |
| Mean: | 994 | 537 | 775 | 1708 | 1428 |
| Standard Deviation: | 44 | 49 | 43 | 105 | 142 |
| RSD (%): | 4.4 | 9.2 | 5.6 | 6.1 | 9.9 |
| **HR-ICP-MS** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 801 | 392 | 643 | 1562 | 1285 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **ICP-AES/OES** | | | | | |
| Number of Sample Measurements: | 2 | 2 | 2 | 2 | 2 |
| Mean: | 984 | 561 | 790 | 1713 | 1451 |
| Standard Deviation: | 65 | 69 | 57 | 67 | 69 |
| RSD (%): | — | — | — | — | — |
| **ICP-MS** | | | | | |
| Number of Sample Measurements: | 13 | 13 | 13 | 13 | 13 |
| Mean: | 1013 | 576 | 823 | 1801 | 1490 |
| Standard Deviation: | 79 | 55 | 77 | 124 | 133 |
| RSD (%): | 7.8 | 9.6 | 9.4 | 6.9 | 9.0 |
| **ID-ICP-MS** | | | | | |
| Number of Sample Measurements: | 1 | 1 | 1 | 1 | 1 |
| Mean: | 1033 | 562 | 840 | 1825 | 1543 |
| Standard Deviation: | ? | ? | ? | ? | ? |
| RSD (%): | — | — | — | — | — |
| **All Laboratories** | | | | | |
| Number of Sample Measurements: | 27 | 27 | 27 | 27 | 27 |
| Mean: | 1004 | 557 | 803 | 1763 | 1471 |
| Standard Deviation: | 76 | 60 | 70 | 118 | 127 |
| RSD (%): | 7.5 | 10.7 | 8.8 | 6.7 | 8.6 |

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

# Additional Trace Elements Reported in Serum

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

In addition to Al, Cu, Se and Zn, the serum pools were supplemented with additional trace elements as indicated below.

## Additional Elements

Mn, Cr, V

## Serum Arsenic (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.802 | 0.987 | 0.673 | 0.778 | 0.883 |
| 197 | DRC/CC-ICP-MS | <10 | <10 | <10 | <10 | <10 |

## Serum Barium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 1.634 | 0.891 | 1.483 | 2.307 | 1.14 |
| 197 | ICP-MS | <2.0 | <2.0 | <2.0 | 2.6 | <2.0 |

## Serum Beryllium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 197 | ICP-MS | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |

## Serum Cadmium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.038 | 0.049 | 0.023 | 0.043 | 0.006 |
| 197 | DRC/CC-ICP-MS | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |

## Serum Chromium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.262 | 5.065 | 2.361 | 1.04 | 7.176 |
| 164 | ICP-MS | 0.3 | 4.6 | 2.1 | 1 | 6.5 |
| 179 | DRC/CC-ICP-MS | 0.3 | 5.2 | 2.3 | 1.2 | 7.1 |
| 197 | DRC/CC-ICP-MS | <1.0 | 5.1 | 2.5 | 1.2 | 7.3 |
| **Arithmetic Mean (n=4)** | | **0.3** | **5.0** | **2.3** | **1.1** | **7.0** |
| SD | | 0.02 | 0.3 | 0.2 | 0.1 | 0.4 |

## Serum Cobalt (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.4 | 0.695 | 0.444 | 0.286 | 0.267 |
| 179 | ICP-MS | 0.4 | 0.6 | 0.4 | 0.3 | 0.2 |
| 197 | ICP-MS | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| **Arithmetic Mean (n=3)** | | **0.4** | **0.6** | **0.4** | **0.3** | **0.2** |
| SD | | 0.0 | 0.07 | 0.03 | 0.01 | 0.05 |

## Serum Iodine (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 51.772 | 44.557 | 70.633 | 52.658 | 52.278 |

## Serum Iron (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 457 | ICP-AES/OES | 1176 | 1878 | 1379 | 966 | 783 |

## Serum Lead (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 197 | DRC/CC-ICP-MS | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |

## Serum Magnesium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 457 | ICP-AES/OES | 16465 | 16200 | 16493 | 17580 | 17227 |

## Serum Manganese (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 5.258 | 1.852 | 9.176 | 18.956 | 2.769 |
| 179 | DRC/CC-ICP-MS | 5.4 | 2 | 9 | 19.4 | 2.7 |
| 197 | DRC/CC-ICP-MS | 5.4 | 2.3 | 9.4 | 19.1 | 2.7 |
| 305 | ICP-MS | 6 | 1.9 | 9.3 | 19.1 | 2.9 |
| 457 | ICP-AES/OES | 5 | 1 | 8 | 18 | 2 |
| **Arithmetic Mean (n=5)** | | **5.4** | **1.8** | **9.0** | **18.9** | **2.6** |
| SD | | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 |

## Serum Mercury (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.178 | 0.231 | 0.211 | 0.279 | 0.194 |

## Serum Molybdenum (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.806 | 1.036 | 0.947 | 1.027 | 0.689 |

## Serum Nickel (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 1.245 | 1.08 | 1.151 | 1.145 | 1.075 |

## Serum Silver (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.138 | 0.143 | 0.109 | 0.091 | 0.087 |

## Serum Tellurium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 197 | ICP-MS | <1.0 | <1.0 | <1.0 | NA | <1.0 |

## Serum Thallium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 2.453 | 0.235 | 0.564 | 1.619 | 1.006 |
| 197 | ICP-MS | 2.2 | <1.0 | <1.0 | 1.5 | 1 |

## Serum Tin (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 147 | ICP-MS | 0.336 | 0.281 | 0.166 | 0.227 | 1.176 |
| 197 | ICP-MS | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |

## Serum Vanadium (µg/L)

| Lab Code | Method | SE10-11 | SE10-12 | SE10-13 | SE10-14 | SE10-15 |
|---|---|---|---|---|---|---|
| 179 | DRC/CC-ICP-MS | 4.5 | 1.3 | 2.3 | 0.6 | 1.0 |

# New York State Department of Health
# 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., $D_2$, 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 $\mu$mol ZPP/mol heme)

F-4 Other

***OTHER METHODS***

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