HOW TO MANAGE LAB ERROR & PASS PROFICIENCY TESTING

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Disclaimer:

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March 29 – April 1, 2015
Caribe Royale All-Suite Hotel
and Convention Center
Orlando, Florida
GOALS

• Reinforce PT Basics
• Offer troubleshooting guidelines
• “Total QA Package”
• Proactive approach - prevention

OUTLINE

• Reasons for PT
• Basics of PT
• Troubleshooting
• Probability of Failure
• Recommendations – Prevention of Failure
WHY DO PT?

• REGULATORY REQUIREMENTS
  • CLIA’ 88 - the dreaded * and #

• QUALITY ASSURANCE TOOL
  LOOKING BEYOND THE * and #
  • Accuracy
  • Precision
  • Comprehensive PI program— QC, calibration, maintenance, variances, patients

BIG BROTHER

• CLIA ’88, HCFA (now CMS) mandated
• All labs performing PPM, moderate and/or high complexity testing
• Regulated vs. Non-regulated
• CAP requires PT for all analytes
  • Semi-annual split sample testing
SURVEYS

• 2015 CMS Approved listing:
  • CAP, ASCP, AAB, API etc…
  • State Departments of Health
  • American Academies FP-PT, CA Thoracic Society, etc
  • Others – commercially available

THE BASICS

• THE TESTING PROCESS
  • Handling of PT material
  • Performance limits and categories

• THE RESULTS - INTERPRETATION
  • Failures - * and #
  • Looking beyond * and # (QA/QI)
TEST LIKE A PATIENT

• Testing personnel
• Read instructions carefully
• Check for clerical errors
• Duplicate Testing
• Attestation Statement
• Keep all records and samples

LIMITS

• TARGET VALUES
  • PEER GROUP MEANS
  • Size, variability, methodology

• ACCEPTABLE PERFORMANCE
  • CLIA PT LIMITS (more to follow)
    > Percent (Glucose +/- 10%)
    > Quantity (Calcium +/- 1.0 mg/dl)
    > SD (+/- 3 SD) 2.9 vs. 3.1
LIMITS – Converting PT Limits to CV

- Creatinine PT Limits: +/- 0.3 mg/dl or 15%, whichever is greater

- Survey C-01
  - Mean = 1.5
    - 15% x 1.5 = 0.22 (<0.3 mg/dl so use 0.3 mg/dl criteria)
    - 1.5 + 0.3 = 1.8
  - CV = SD/mean
  - CV = 0.3/1.5 = 0.2 or 20% so, 1/3 CV = 6.7%

- Survey C-02
  - Mean = 4.94
    - 15% x 4.94 = 0.74 (>0.3 mg/dl so use 15% criteria)
    - 4.94 + 0.74 = 5.68
  - CV = SD/mean
  - CV = 0.17/4.94 = 0.34 or 34% (>15%), 1/3 CV = 5%

GAUSSIAN DISTRIBUTION

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CATEGORIES

• Current Event Performance
  • Satisfactory 80% or better
  • Unsatisfactory < 80%
  • Except ABO Rh typing & compatibility testing

• Cumulative Performance
  • Successful 80% for analyte or subspecialty
  • Unsuccessful <80% for analyte or subspecialty
  • Exception BB

CATEGORIES (cont.)

• Unsuccessful Performance – Failure in 2 out of 3 challenges
  <1> Means currently successful - At risk for next survey
  <2> Means currently successful - At risk for next two surveys
  <3> Means currently unsuccessful - At risk for the next three surveys

• Failure to return a survey is considered a failure
UNSUCCESSFUL PERFORMANCE

- CMS, formerly HCFA
  - Require a written response, action plan and allow continued testing
  - May implement sanctions such as
    - Financial penalties
    - Mandatory suspension
    - Revocation of the lab’s certification

FAILURES – TROUBLE SHOOTING

* Unsatisfactory – initial investigation
  - Consider suspending testing
  - Clerical check
  - Methodology codes
  - CAP scanning error
  - Improper reconstitution/sample handling
TROUBLE SHOOTING

- QC – in range, shifts or trends, history of CVs (time of testing)
- Maintenance records
- Calibration & Verification – correct and up to date
- Reagents and controls – in date
TROUBLE SHOOTING PATTERNS

• High/Low values – suspect

• Only one out of many tests on same instrument – suspect

TROUBLE SHOOTING PATTERNS

• Multiple tests/PT samples on same instrument - suspect

• Several tests on same PT sample -suspect
TROUBLESHOOTING

- Retest PT sample
- Split sample testing
  - Prove degradation
  - Peer group is optimal
- Educational challenges
  - CMS (HCFA) vs. patients

CODE [26]

[26] = Educational Challenge

<table>
<thead>
<tr>
<th>METHOD</th>
<th>SPECIMEN</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-PROTHROMBIN T</td>
<td>CR-06</td>
<td>NEGATIVE (26)</td>
</tr>
<tr>
<td>ROCKE CARDIAC T</td>
<td>CR-07</td>
<td>POSITIVE (26)</td>
</tr>
</tbody>
</table>
THE ASTERISK

There’s more to it

*

than meets the eye

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CODE [26]

[26] = Educational Challenge

Hey, don’t sweat it. It’s only a challenge…

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TROUBLE SHOOTING

• Understand the problem
• Understand Clinical Significance
• Consider assistance
  • Manufacturer or Consultant
• Discontinue testing, if necessary
• Patients, patients, patients
• Document, document, document

“Doctor, your patient has a Glucose of 225 mg/dL.”
ACCURACY

- BIAS or SYSTEMATIC ERROR
- INTER-LABORATORY - EXTERNAL QC
- PEER GROUP COMPARISON

- EVALUATE (even if no *)
  - Consistently over or under target
  - How much is too much?
  - Examine QC and Calibration history
  - Verify calibration or recalibrate

BIAS LIMITS

- CAP
  - SDI +/- 1.5
- Westgard
  - SDI 1.0
- Poor Man’s (Person’s) Guide
  - < 20 % of HCFA (CMS) limits
PRECISION

- VARIABILITY or RANDOM ERROR
- INTRA-LABORATORY – INTERNAL QC
- COEFFICIENT OF VARIATION (CV)
- EVALUATE (even if no *)
- GOAL
  - MAXIMUM CLIA LIMITS?
  - RULE OF ONE THIRD

PROBABILITY OF FAILURE

- CV = CLIA LIMIT (Glucose +/- 10%)
  - Lab would fail (2 out of 5 misses) 50% of time
- CV = 50% CLIA LIMIT (Glucose +/- 5%)
  - Lab would fail 2% of time
- CV = 33% CLIA LIMIT (Glucose +/- 3%)
  - Lab would not be expected to fail

Assumes 0% bias
- CLIA limit represents TE (Glucose +/- 6 mg/dL or 10%, whichever is greater

Laessign-Ehrmeyer, et al. 1990
PROBABILITY OF FAILURE

% chance of some PT failures, related to CV
one 2 of 5 event, bias=20% of PT limit

<20% bias + 30% CV = ~0%; L&E’s “1-2 Punch”

BE HERE!

BE HERE!

Laessign-Ehrmeyer, et al. 1990

SIGNIFICANCE

- What error is acceptable for your lab?
- Random vs. systematic
- Instrumentation performance characteristics
- Clinical significance
- It’s ultimately all about patient care
- Medical decision limits
RECOMMENDATIONS

• Reduce CV to 1/3 CMS PT limit
• Eliminate Bias or ≤ 20% of CMS PT limit
• Thoroughly investigate PT Survey information, not only failures
• Educational challenges
• Multiple instrument comparisons - intralab
• Other methodologies and caveats
• READ THE BOOKS (websites)!
• Time

RECOMMENDATIONS

• Incorporate PT into a Comprehensive Quality Plan (PI)
  • Quality Control
  • Incidents/variances
  • MFR recommendations
  • Maintenance
  • Calibration
  • and most importantly Patients
Even with a perfect proficiency survey, there is much to be learned.

Are You Sure? (10 minute break)
### Evaluate PT Surveys

![Image](www.cap.org)

### CAP Troubleshooting Guide

**Table 1.** Guidelines for monitoring PT performance using diagnostic information from the SDI values reported on the PT evaluations

<table>
<thead>
<tr>
<th>SDI Rule</th>
<th>Comments</th>
<th>Suggested Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least one result exceeds ± 2 SDIs</td>
<td>Review results to rule out possible problems; identify possible errors from non-analytical sources for results with very large SDIs</td>
<td>See listing of suggested actions for evidence of systematic or random error</td>
</tr>
<tr>
<td>The average of your SDIs is &gt; 1.5 or, if negative, &lt; -1.5</td>
<td>Participant needs to calculate the average SDI; published studies confirm large average deviations can reveal potential problems</td>
<td>See listing of suggested actions for evidence of systematic error</td>
</tr>
<tr>
<td>The difference between the largest and smallest SDI is &gt; 4</td>
<td>Published studies confirm large differences can reveal potential problems</td>
<td>See listing of suggested actions for evidence of random error</td>
</tr>
</tbody>
</table>

[www.cap.org](http://www.cap.org)
### CAP Troubleshooting Guide – Table 2

**Table 2. Guidelines for monitoring PT performance using the evaluation graphs**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Comments</th>
<th>Suggested Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>One result in a mailing exceeds ±75% of the allowed deviation</td>
<td>Review results to rule out possible problems; identify possible errors from non-analytical sources such as clerical errors for results that exceed ±100% of the allowed deviation</td>
<td>If the data fail either of the rules below, follow the suggested actions for systematic or random error, as appropriate</td>
</tr>
<tr>
<td>All results are on one side of the target values with at least 1 difference exceeding ±50% of the allowed deviation</td>
<td>Shows bias indicating a possible calibration drift; there would be less concern if the relative differences were all close to 0</td>
<td>See listing of suggested actions for evidence of systematic error</td>
</tr>
<tr>
<td>Large positive and negative differences; combined lengths of longest positive and negative bars is &gt; 140 out of total range of 200</td>
<td>Shows possible random error</td>
<td>See listing of suggested actions for evidence of random error</td>
</tr>
</tbody>
</table>

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### CAP TS Guide – cont. Table 2

**Table 2. Guidelines for monitoring PT performance using the evaluation graphs**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Comments</th>
<th>Suggested Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent results on one side of the target values</td>
<td>Shows persistent bias, even if small; recalibration should have occurred within this time frame</td>
<td>See listing of suggested actions for evidence of systematic error</td>
</tr>
<tr>
<td>Results flip from one side of the target to the other</td>
<td>Shows impact of system and/or process changes; longer bars are of more concern</td>
<td>See listing of suggested actions for evidence of systematic error</td>
</tr>
<tr>
<td>Over time, length of bars increase</td>
<td>A sudden shift may show impact of systematic or random error, as appropriate</td>
<td>Follow the suggested actions for systematic or random error, as appropriate</td>
</tr>
<tr>
<td>Over time, length of bars decrease</td>
<td>Shows impact of system and/or process changes, particularly as a result of corrective action</td>
<td>Retain as documentation that corrective action has been successful</td>
</tr>
</tbody>
</table>

**www.cap.org**

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### CAP Troubleshooting Guide – Table 3

**Table 3.** Examples illustrating various patterns in cumulative PT results

<table>
<thead>
<tr>
<th>Pattern Description</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of persistent bias spanning recalibration. Review process of setting QC target values; evaluate performance with assayed control material.</td>
<td><img src="image1" alt="Graph" /></td>
</tr>
<tr>
<td>Results flip from positive to negative bias. Review records to confirm system and/or process change. Follow suggested actions for systematic error.</td>
<td><img src="image2" alt="Graph" /></td>
</tr>
<tr>
<td>Over time, lengths of the bars increase on both sides of 0. For this pattern, follow suggested actions for random error.</td>
<td><img src="image3" alt="Graph" /></td>
</tr>
</tbody>
</table>

### CAP TS Guide – cont. Table 3

**Table 3.** Examples illustrating various patterns in cumulative PT results

<table>
<thead>
<tr>
<th>Pattern Description</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over time, lengths of the bars increase primarily on one side. For this pattern, follow suggested actions for large systematic error.</td>
<td><img src="image4" alt="Graph" /></td>
</tr>
<tr>
<td>Lengths of the bars decrease. Corrective action following a previous failure can be easily demonstrated.</td>
<td><img src="image5" alt="Graph" /></td>
</tr>
<tr>
<td>Plot shows a result exceeding ±75% of the allowed deviation. This problem was due to a transcription error where results for high and hematocrit were switched.</td>
<td><img src="image6" alt="Graph" /></td>
</tr>
<tr>
<td>Many PT challenges are for non-regulated analytes that can be identified as having only two samples. The same general patterns appear for non-regulated analytes, though with fewer data points on each plot. Here the C metting samples were switched.</td>
<td><img src="image7" alt="Graph" /></td>
</tr>
</tbody>
</table>
Examples – Cases

Case 1a - Transcription // Clerical Error

<table>
<thead>
<tr>
<th>Case</th>
<th>Unit of Measure</th>
<th>Best Group</th>
<th>Evaluation and Comparative Method Statistics</th>
<th>Plot of the Relative Distance of Your Results from Target Percentages of Clinical Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALT (SGPT)</td>
<td>U/L</td>
<td>Case 1 - Transcription 1a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VITAMIN B12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALK PHOSPHATASE</td>
<td>U/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLOMERULAR FILTERING CAPACITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SODIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SODIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTASSIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTASSIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUN</td>
<td>mg/dL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUN</td>
<td>mg/dL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CREATININE</td>
<td>mg/dL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CREATININE</td>
<td>mg/dL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UREA</td>
<td>mg/dL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case 1b/c – Transcription // Clerical Error

[20] = No appropriate target/response could not be graded
[28] = Response qualified with a “>” or “<” sign; or unable to quantitate

<table>
<thead>
<tr>
<th>Test</th>
<th>Unit of Measure</th>
<th>Specimen</th>
<th>Year Result</th>
<th>Mean S.D.</th>
<th>No. of Labs S.D.I</th>
<th>Lower</th>
<th>Upper</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCG</td>
<td>screen, quant</td>
<td>HCG-46</td>
<td>&lt;2.0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td>nM/L (0.05)L</td>
<td>HCG-47</td>
<td>90.3</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HCG-48</td>
<td>110.9</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HCG-49</td>
<td>&lt;2.0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HCG-50</td>
<td>1111.6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>[20]</td>
</tr>
</tbody>
</table>

Case 2 – Bias

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Case 2 Cont - Bias

<table>
<thead>
<tr>
<th>Sample</th>
<th>Assay 1</th>
<th>Assay 2</th>
<th>Mean</th>
<th>SD</th>
<th>CV</th>
<th>Bias</th>
<th>Bias %</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN-01</td>
<td>80</td>
<td>89</td>
<td>84.5</td>
<td>6.9</td>
<td>8.3</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-02</td>
<td>112</td>
<td>112</td>
<td>112</td>
<td>6.9</td>
<td>6.3</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-03</td>
<td>137</td>
<td>136</td>
<td>136.5</td>
<td>7.2</td>
<td>5.3</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-04</td>
<td>161</td>
<td>161</td>
<td>161</td>
<td>7.3</td>
<td>4.5</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-05</td>
<td>167</td>
<td>167</td>
<td>167</td>
<td>7.4</td>
<td>4.5</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-06</td>
<td>210</td>
<td>213</td>
<td>211.5</td>
<td>7.5</td>
<td>3.6</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
<tr>
<td>LN-07</td>
<td>242</td>
<td>241</td>
<td>241</td>
<td>7.5</td>
<td>3.6</td>
<td>2.5</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Precision – Method Decision Data

<table>
<thead>
<tr>
<th>FIB LOW</th>
<th>ABNORMAL A</th>
<th>NORMAL C</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>MLA 1400 ACL 9000</td>
<td>MLA 1400 ACL 9000</td>
</tr>
<tr>
<td>1</td>
<td>73</td>
<td>67.4</td>
</tr>
<tr>
<td>2</td>
<td>71.5</td>
<td>66.9</td>
</tr>
<tr>
<td>3</td>
<td>73</td>
<td>67.1</td>
</tr>
<tr>
<td>4</td>
<td>72.5</td>
<td>67.5</td>
</tr>
<tr>
<td>5</td>
<td>71.5</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>72.7</td>
<td>67</td>
</tr>
<tr>
<td>7</td>
<td>70.8</td>
<td>67.3</td>
</tr>
<tr>
<td>8</td>
<td>72</td>
<td>72.3</td>
</tr>
<tr>
<td>9</td>
<td>71.5</td>
<td>67.9</td>
</tr>
<tr>
<td>10</td>
<td>70.7</td>
<td>70.3</td>
</tr>
<tr>
<td>11</td>
<td>73.5</td>
<td>68.5</td>
</tr>
<tr>
<td>12</td>
<td>71.5</td>
<td>70.6</td>
</tr>
<tr>
<td>13</td>
<td>72</td>
<td>68</td>
</tr>
<tr>
<td>14</td>
<td>70.8</td>
<td>71.3</td>
</tr>
<tr>
<td>15</td>
<td>69.6</td>
<td>67.8</td>
</tr>
<tr>
<td>16</td>
<td>71.2</td>
<td>72</td>
</tr>
<tr>
<td>17</td>
<td>69.5</td>
<td>68.5</td>
</tr>
<tr>
<td>18</td>
<td>70.2</td>
<td>71</td>
</tr>
<tr>
<td>19</td>
<td>68.7</td>
<td>66.6</td>
</tr>
<tr>
<td>20</td>
<td>69.2</td>
<td>67.8</td>
</tr>
</tbody>
</table>

| n       | 20       | 20       | 20       | 20       | 20       |
| Mean    | 71       | 69       | 169     | 169     | 300     | 302 |
| SD      | 1.5      | 1.8      | 5.4     | 6.4     | 4.3     | 11.3 |
| CV      | 2.1%     | 2.7%     | 3.2%    | 3.8%    | 1.4%    | 3.8% |
| Bias    | 2.6      | 0        | 1       | -0.1%   | -0.8%   |
| Bias %  | 3.7%     | 0.1%     | -0.4%   |
Method Decision Chart

<table>
<thead>
<tr>
<th>Test Method</th>
<th>FIB-C @ 71 mg/dL</th>
<th>CLIA: +/- 20% @150 mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable Total Error (%)</td>
<td>20.0</td>
<td>Operating point: +</td>
</tr>
<tr>
<td>Imprecision (CV):</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>Inaccuracy (bias%):</td>
<td>3.70</td>
<td>Method Performance: Excellent</td>
</tr>
</tbody>
</table>

Developed by: Jose Carlos Basques, Marcelo Basques, and Marcus Basques.

1/3 CLIA = 6.7% / 1/4 CLIA = 5% / 1/5 CLIA = 4% / 6 Sigma = 3.3%
www.westgard.com

Reportable Range - Linearity

- Analyte pCO2, mmHg
- 1. Is the line straight?
- 2. Is it visually linear?
- 3. What makes it linear?
- 4. Why?
- 5. It looks straight, passes through zero, slope doesn’t change, TE < TEa
- 6. AMR, CRR, Reportable Range? (CAP requires definition of each)
Method – Is the method the problem?

1. **ACCURACY** (Rhoads EP Evaluator): A Comparison of Methods Experiment for the new I-Stats compared: pH, pCO₂, PO₂, Na, K, and Ca with the old I-Stats. 42 specimens were analyzed in a uniformed “bin-box” manner. All six analytes demonstrated a correlation coefficient (r) greater than 0.975, non-significant Student’s T-test result, and acceptable regression analysis. Bias was judged to be acceptable at the medical decision levels.

2. **PRECISION** (Westgard) A replication experiment was accomplished to estimate the imprecision of the new I-stats versus the old I-Stat. Three levels of quality control materials that covered the medical decision points were analyzed 21 times over a period of 10 days. CVs at all levels (x,y, and z) were less than 1/3 CLIA Limits and judged to be acceptable by using a method decision chart.

3. **REPORTABLE RANGE** (Rhoads EP Evaluator): A linearity experiment was performed to estimate the new I-Stat’s accuracy, linearity, and reportable range using an I-Stat linearity kit. Testing was performed in duplicate and the average value was plotted. At least 5 samples were tested for each analyte that encompassed low, mid and high values – see attachment.

4. **REFERENCE RANGE:** Normally, we would analyze specimens collected for physical exams or volunteers to verify the reference range. In lieu of obtaining 21-41 arterial blood gasses from normal healthy individuals, the medical director has approved the use of manufacturer’s ranges.

Codina, Taillon, Harms_SAFMLS 2005

**REFERENCES**

- Publications by Laessig RH, Ehrmeyer SS, et al.:
  - Clinical Chemistry 1990;36;1736-40
  - Archives Pathology and Lab Med. 1992;116(7):770-76
- Laboratory Accreditation Program. College of American Pathologists. Northfield, IL.
Questions