QUALITY CONTROL PROBLEMS

1. To investigate the reproducibility of a method for the determination of selenium in foods, nine measurements were made on a single batch of brown rice, with the following results:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Selenium, ( \mu g/g )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>2</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>0.08</td>
</tr>
<tr>
<td>4</td>
<td>0.07</td>
</tr>
<tr>
<td>5</td>
<td>0.07</td>
</tr>
<tr>
<td>6</td>
<td>0.08</td>
</tr>
<tr>
<td>7</td>
<td>0.08</td>
</tr>
<tr>
<td>8</td>
<td>0.09</td>
</tr>
<tr>
<td>9</td>
<td>0.08</td>
</tr>
</tbody>
</table>


Calculate the mean, standard deviation and relative standard deviation of these results.

2. Seven measurements of the pH of a buffer solution gave the following results:

\[ 5.12, 5.20, 5.15, 5.17, 5.16, 5.19, 5.15. \]

Calculate (i) the 95% and (ii) the 99% confidence limits for the true pH. (Assume that there are no systemic errors.)

3. Ten analyses of the concentration of albumin gave a mean of 20.9 g/l and a standard deviation of 0.45 g/l. (J. W. Poote and H. T. Delves, Analyst, 1983, 108, 492.)

Calculate the 95% confidence limits of the mean.

4. The concentration of lead in the blood stream was measured for a sample of 50 children from a large school near a busy main road. The sample mean was 10.1 ng/ml and the standard deviation was 0.6 ng/ml. Calculate the 95% confidence interval for the mean lead concentration for all the children in the school.

About how big should the sample have been to reduce the range of the confidence interval to 0.2 ng/ml (i.e. \( \pm 0.1 \) ng/ml)?
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5. In an investigation into the accuracy and precision of a method for determining arprinocid in feed premixes, six replicate determinations were made on a premix formulated to contain 10.2% arprinocid. The results were:

10.4, 10.4, 10.6, 10.3, 10.5, 10.5.

(J. D. Stong and D. W. Fink, Analyst, 1982, 107, 113.)

Calculate the mean, standard deviation and 95% and 99% confidence limits of the mean. Is the formulated value of 10.2% within (i) the 95%, (ii) the 99% confidence limits?

6. Measurement of the haptoglobin concentration in blood serum taken from a random sample of eight healthy adults gave the following values:

1.82, 3.32, 1.07, 1.27, 0.49, 3.79, 0.15, 1.98 g/l.

Calculate the mean and standard deviation of these results.

Assuming the haptoglobin is log-normally distributed in the population as a whole, calculate the 95% confidence interval for the mean haptoglobin concentration for the whole population.

7. Ten measurements of the ratio of two peak areas in liquid chromatography experiments gave the following values:

0.2911, 0.2898, 0.2923, 0.3019, 0.2997, 0.2961, 0.2947, 0.2986, 0.2902, 0.2882.


Calculate the mean, standard deviation and 99% confidence limits of the mean.

8. A 0.1 M solution of acid was used to titrate 10 ml of 0.1 M solution of alkali and the following volumes of acid were recorded:

9.88, 10.18, 10.23, 10.39, 10.25 ml.

Calculate the 95% confidence limits of the mean and use them to decide if there is any evidence of systemic error.
× 10. Your lab is setting up a test for the enzyme aspartate aminotransferase (AST) which has a CV of 7.5% at the mean of the normal (healthy) range. AST has a normal (healthy) range of 12–31 U/L. (Assume a gaussian distribution.) What is the recommended absolute allowable error (AAE) (in units of U/L) for AST? How much of a systematic error in U/L can be tolerated until 95% of the distribution is no longer between AAE. If you are using Westgard Multi-Rules with 2 controls per run for quality control what is the approximate probability of detecting the above mentioned shift in systematic error? Explain how you arrived at this estimate.

× 11. Using Westgard (Shewhart) Multi-Rules determine which run numbers are out-of-control. Explain your answers by stating which rule led you to the conclusion that the run was out of control.

Zinc protoporphyrin is often used as a screening test for lead poisoning in children. At a screening level of 2 meg/dL the test gives false positive results in 17 percent of healthy children and false negative results in 4 percent of those with high blood lead level. A Massachusetts study found that 8 percent of the children tested has lead poisoning. Calculate:

a) specificity
b) sensitivity
c) predictive value of positive test
d) predictive value of negative test

14. If the uric acid values in normal adult males are approximately normally distributed with a mean and standard deviation of 5.7 and 1 mgs percent respectively, find the probability that a sample size 9 will yield a mean:

a) Greater than or equal to 5.6 mgs percent
b) Between 5.0 and 6.0 mgs percent
c) Less than or equal to 5.2 mgs percent
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15. If the total cholesterol values for a certain population are approximately normally distributed with a mean of 200 mg/100 ml and a standard deviation of 20 mg/100 ml, find the probability that an individual picked at random from this population will have a cholesterol value:

   a) Between 180 and 200 mg/100 ml
   b) Greater than or equal to 225 mg/100 ml
   c) Less than or equal to 150 mg/100 ml
   d) Between 190 and 210 mg/100 ml

16. The following figures refer to the concentrations of albumin, in g/l, in the blood sera of 16 healthy adults:

   37, 39, 37, 42, 39, 45, 42, 39, 44, 40, 39, 45, 47, 47, 43, 41


The first 8 figures are for men and the second 8 for women. Test whether the mean concentrations for men and women differ significantly (95% confidence).