Deacon's Challenge

No 176 - Answer

Blood specimens from 100 healthy volunteers were analysed for a hormone and the data showed a good Gaussian distribution with 95% confidence limits of 35 to 65 pmol/L. The analytical imprecision (CV_a) of the assay is 10%. Calculate the expected 95% confidence limits if the assays had been performed in duplicate (on a single sample from each individual with results expressed as the mean of the duplicate determinations) instead of singlicate.

First calculate the mean and total *SD* for the population results using the fact that the confidence limits span the mean ±1.96 *SD*:

$$\text{Mean} = \frac{35 + 65}{2} = \frac{100}{2} = 50 \text{ pmol/L}$$

$$SD = \frac{65 - 35}{2 \times 1.96} = \frac{30}{3.92} = 7.65 \text{ pmol/L (to 3 sig figs)}$$

Next convert the analytical *CV* to the *SD*:

$$CV = \frac{SD \times 100}{\text{Mean}}$$

$$\text{SD} = \frac{CV \times \text{Mean}}{100} = \frac{10 \times 50}{100} = 5 \text{ pmol/L}$$

Next calculate the inter-individual biological *SD* from the total and analytical *SDs*:

$$\text{Total } SD^2 = \text{Biological } SD^2 + \text{Analytical } SD^2$$

$$7.65^2 = \text{Biological } SD^2 + 5^2$$

$$\text{Biological } SD^2 = 7.65^2 - 5^2 = 58.52 - 25 = 33.52$$

$$\text{Biological } SD = \sqrt{33.52} = 5.79 \text{ pmol/L (to 3 sig figs)}$$

The standard deviation of the mean of replicates (the standard error) is given by the expression:

$$\text{Standard error} = \frac{SD}{\sqrt{n}}$$

(see question 135 for further information)

Where *n* is the number of replicates. Therefore for duplicates *n* = 2:

$$\text{standard error} = \frac{SD}{\sqrt{2}} = \frac{SD}{1.41}$$

Therefore if the assay had been performed in duplicate the analytical *SD* would be:

$$\text{New analytical } SD = \frac{SD}{1.41} = \frac{5}{1.41} = 3.55 \text{ pmol/L}$$

The new total *SD* is next calculated from this analytical *SD* of duplicates and the biological *SD*:

$$\text{New total } SD^2 = 5.79^2 + 3.55^2 = 33.52 + 12.60 = 46.12$$

$$\text{New total } SD = \sqrt{46.12} = 6.79 \text{ pmol/L (to 3 sig figs)}$$

Finally, the new confidence limits are calculated from the original mean (which is unchanged) and the new total *SD*:

$$95\% \text{ confidence limits} = \text{mean} - (1.96 \times 6.79) \text{ to mean} + (1.96 \times 6.79)$$

$$= 50 - 13 \text{ to } 50 + 13$$

$$= \mathbf{37 \text{ to } 63 \text{ pmol/L}}$$

Question 177

In a random sample of 100 pathology request cards, 36 were found to have an error associated with either the name or date of birth. What is the probability that more than 42% of pathology request cards have such errors?

The probabilities (P) for the z-scores of the upper tail of a normal distribution are:

P	0.31	0.23	0.16	0.11	0.067	0.040	0.023
z	0.5	0.75	1.0	1.25	1.5	175	2.30

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