

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:

$$\begin{aligned}\text{Mean} &= \frac{35 + 65}{2} = \frac{100}{2} = 50 \text{ pmol/L} \\ \text{SD} &= \frac{65 - 35}{2 \times 1.96} = \frac{30}{3.92} = 7.65 \text{ pmol/L (to 3 sig figs)}\end{aligned}$$

Next convert the analytical CV to the SD:

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

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

$$\begin{aligned}\text{Total SD}^2 &= \text{Biological SD}^2 + \text{Analytical SD}^2 \\ 7.65^2 &= \text{Biological SD}^2 + 5^2 \\ \text{Biological SD}^2 &= 7.65^2 - 5^2 = 58.52 - 25 = 33.52 \\ \text{Biological SD} &= \sqrt{33.52} = 5.79 \text{ pmol/L (to 3 sig figs)}\end{aligned}$$

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

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

(see question 135 for further information)

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

$$\text{standard error} = \frac{\text{SD}}{\sqrt{2}} = \frac{5}{1.41}$$

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

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

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

$$\begin{aligned}\text{New total SD}^2 &= 5.79^2 + 3.55^2 = 33.52 + 12.60 = 46.12 \\ \text{New total SD} &= \sqrt{46.12} = 6.79 \text{ pmol/L (to 3 sig figs)}\end{aligned}$$

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

$$\begin{aligned}95\% \text{ confidence limits} &= \text{mean} - (1.96 \times 6.79) \text{ to } \text{mean} + (1.96 \times 6.79) \\ &= 50 - 13 \text{ to } 50 + 13 \\ &= \mathbf{37 \text{ to } 63 \text{ pmol/L}}\end{aligned}$$

Question 177

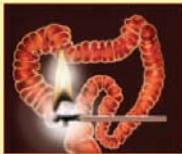
In a random sample of 100 pathology request cards, 36 were found to have an error associated with either the name or date of birth. What is the probability that more than 42% of pathology request cards have such errors?

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	1.75	2.30

FRCPath, Spring 2002


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* ADA: anti-drug antibodies

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