Deacon's Challenge No. 37 Answer

The analytical imprecision (CVa) of serum iron in your laboratory is 10%. Iron was measured on several occasions in healthy volunteers, and the within-subject coefficient of variation of the measured iron results was found to be 15% (calculated using nested ANOVA).

Estimate the true biological coefficient of variation in serum iron.

Calculate the expected coefficient of variation of the results in these volunteers if the analytical procedure is performed in duplicate (on a single sample per patient with results expressed as the mean of the duplicate determinations) instead of singlicate.

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The square of the total CV is equal to the sum of the squares of the component CVs:

$$CV_t^2 = CV_b^2 + CV_a^2$$

where

CV_t is the total coefficient of variation = 15%
CV_b is the biological coefficient of variation = ?
CV_a is the analytical coefficient of variation = 10%

Substitute values for CV_t and CV_a and solve for CV_b:

$$15^2 = CV_b^2 + 10^2$$

$$CV_b^2 = 15^2 - 10^2 = 225 - 100 = 125$$

$$CV_b = \sqrt{125} = \textbf{11.2\%}$$

If replicate measurements are made on the same sample, then the standard deviation (SD) of the mean (called the standard error, SE) depends on the number of replicates (n):

$$SE = \frac{SD}{\sqrt{n}}$$

Since for single measurements, $CV(\%) = \frac{SD \times 100}{Mean}$

For replicate measurements, $CV(\%) = \frac{singlicate\ SD \times 100}{Mean \times \sqrt{n}} = \frac{singlicate\ CV\%}{\sqrt{n}}$

Therefore the analytical CV for duplicate measurements $= \frac{10}{\sqrt{2}} = \frac{10}{1.41} = 7.07\%$

from which the new total CV can be calculated:

$$CV_t^2 = 11.2^2 + 7.07^2 = 125 + 50 = 175$$

$$CV_t = \sqrt{175} = \textbf{13.2\%} \blacksquare$$

Question No. 38

A man has a PSA of 5 μg/L. 22% of patients with benign prostatic hypertrophy and 38% of patients with prostatic cancer have concentrations of PSA between 4.1 and 10 μg/L. What is the positive predictive value for a diagnosis of cancer of the result for this man in this range, if the prevalence of cancer in his age group is 5% and benign prostatic hypertrophy is 20%? Assume 2% of patients without any prostatic pathology have a PSA > 4.1 μg/L.

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