Deacon's Challenge No. 91 Answer

A patient attending a renal clinic for the first time has a serum creatinine concentration of 110 µmol/L and GFR (measured by Cr-EDTA clearance) of 60 mL/min/1.73 m². It is proposed to monitor his progress by measurement of plasma creatinine at each clinic visit. Given that the analytical CV of the plasma creatinine method at this level is 2.8% and the average intra-individual CV of plasma creatinine is 7.7 %, estimate the smallest significant fall in GFR (p<0.05) which can be detected by plasma creatinine measurement alone.

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Step 1

Calculate the total *CV*, bearing in mind that it is the squares of the *CVs* which are additive:

$$CV^2_{Total} = CV^2_{Analytical} + CV^2_{Intra\text{-}individual}$$
$$= 2.8^2 + 7.7^2$$
$$= 7.84 + 59.29$$
$$= 67.13$$
$$CV_{Total} = \sqrt{67.13} = 8.19\% \text{ (3 sig figs)}$$

Step 2

Convert this *CV* to *SD* at the initial creatinine concentration of 110 µmol/L using the fact that the *CV* is the *SD* expressed as a percentage of concentration:

$$CV\ (\%)_{Total} = \frac{SD\ (\mu mol/L)_{Total} \times 100}{\text{Concentration } (\mu mol/L)}$$

$$8.19 = \frac{SD\ (\mu mol/L)_{Total} \times 100}{110}$$

$$SD_{Total} = \frac{8.19 \times 110}{100} = 9.0\ \mu mol/L \text{ (2 sig figs)}$$

Step 3

For two results to be significantly different ($p<0.05$) they have to be at least 2.8 *SDs* apart. Calculate the smallest significant *increase* (corresponding to a fall in GFR) in plasma creatinine:

Smallest significant *increase* = 2.8 x *SD* = 2.8 x 9.0 = 25 µmol/L (2 sig figs)

Therefore a rise in plasma creatinine will not be significant until it reaches a concentration of 110 + 25 = 135 µmol/L.

Step 4

Convert this creatinine concentration to the new *GFR*. The well known formula for *GFR* is:

$$GFR = \frac{UV}{P}$$

Where P = plasma creatinine concentration and *UV* = urinary creatinine excretion. Rearrangement gives:

$$P \times GFR = UV$$

In a steady state *UV* is equal to the rate of creatinine production (mainly determined by muscle mass) and can be considered *constant*. Therefore the relationship between the initial creatinine concentration and *GFR* (P_1 and GFR_1) and the new values (P_2 and GFR_2) is:

$$P_2 \times GFR_2 = P_1 \times GFR_1$$

Substitute P_1 = 110 µmol/L, GFR_1 = 60 mL/min/1.73m² and P_2 = 135 µmol/L then solve for GFR_2:

$$135 \times GFR_2 = 110 \times 60$$

$$GFR_2 = \frac{110 \times 60}{135} = 49 \text{ mL/min/1.73m}^2 \text{ (2 sig figs)}$$

Step 5

Calculate the fall in *GFR* i.e. the difference between the initial and new values.

Smallest significant fall in *GFR* =

$GFR_2 - GFR_1 = 60 - 49 =$ **11 mL/min/1.73m²**

Question 92

As part of a research project, you are developing a new assay for thiamine in plasma. In order to perform a recovery experiment, 100 µL of an aqueous primary standard with a thiamine concentration of 18.1 µg/L is spiked into 900 µL normal serum with a thiamine concentration of 1.7 µg/L. The thiamine concentration of the mixture is 3.2 µg/L. Calculate the recovery of the thiamine added to the normal serum.

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