Deacon's Challenge No. 26 Answer

A urine collection was handed in by a patient which he said he had collected over the previous day. Calculate the creatinine clearance given that the sample was found to have a creatinine concentration of 7.2 mmol/L in a volume of 3.2 L. The serum creatinine concentration taken during the collection was 94 µmol/L. Give the most likely cause for this result.

MRCPath, November 2002

In principle this problem is simple to solve substituting values into the well known equation:

$$\text{Clearance} = \frac{U \times V}{P}$$

Where U = concentration in urine
V = rate of formation of urine
P = concentration in plasma

However, difficulties frequently arise since the units of the three parameters are often not compatible. These difficulties can be overcome if the calculation is carried out starting from basic principles. The creatinine clearance is the rate of clearance of creatinine from plasma i.e. the volume of plasma from which creatinine is completely removed in a given time period. Conventionally creatinine clearance is expressed in **mL/min**. Urine is collected continuously over a timed period (usually 24 h), its volume (V) measured in litres and the concentration of creatinine measured in an aliquot of the collection (U). The total amount of creatinine excreted is calculated by multiplying the creatinine concentration by the volume:

Creatinine excreted in 24h = Creatinine concentration (U) x 24 h urine volume (V)

Creatinine concentration in urine (U) = 7.2 mmol/L

24h urine volume (V) = 3.2 L

Therefore creatinine excreted per 24h = U x V

= 7.2 x 3.2

= 23 mmol (2 significant figs)

Note that the volume of the urine collection must be in the same units as the volume term in the concentration (i.e. litres).

The volume of plasma cleared of creatinine in 24 h will be the volume of plasma which contains 23 mmol creatinine. Therefore division of the amount of creatinine excreted in the urine by the plasma concentration of creatinine will give the volume of plasma which contained the excreted creatinine i.e. the volume cleared:

$$\text{Volume of plasma cleared} = \frac{\text{Amount excreted in the urine } (U \times V)}{\text{Plasma concentration } (P)}$$

It is important that the units of the amount excreted in urine (in this case 23 **mmol**) and the plasma concentration (in this case 94 **µmol**/L) are the same. Multiplication of the creatinine excreted in the urine by 1000 converts it from mmol/L to µmol/L which is compatible with the plasma concentration (expressed in µmol/L).

$$\text{Volume of plasma cleared in 24h} = \frac{23 \times 1000}{94} = 245 \text{ L}$$

This is the creatinine clearance expressed as L/24 h. It is usual to express the result as ml/min. Therefore the clearance is multiplied by 1000 (to convert from L to mL) and divided by the number of minutes in 24h (i.e. 60 x 24):

$$\text{Clearance (ml/min)} = \frac{245 \times 1000}{24 \times 60} = \mathbf{170 \text{ ml/min}}$$

The expected clearance for a normal individual is 80-130 ml/min. A value of 170 ml/min seems unlikely. The most likely cause is apparent on inspection of the urinary creatinine output (largely dependent upon lean body mass) which, at 23 mmol/24 h, is improbable. The large 24 h urine volume (3.2 L) is also unlikely. Therefore it is likely that the urine was collected over a longer period than 24 h, possibly 2 x 24h.

It cannot be emphasised too strongly that the largest potential source of error in a urinary clearance measurement is the accuracy of the timed urine collection. Accuracy is unlikely to exceed 2 significant figures and so there is no point in expressing the plasma and urine concentrations to a greater degree of accuracy. The final calculated result (which is even less precise since it is derived from three individual measurements) should only be expressed to 2 significant figures. This is easier if the clearance is expressed in L/min rather than ml/min i.e. the above result would become 0.17 L/min. ■

Question No. 27

A new method for HCG in urine is being evaluated. The concentration in a sample from a pregnant woman is measured at 8240 IU/L. A 50 µL aliquot of an international standard containing 50,000 IU/L is added to 450 µL of the same urine sample and the sample mixed. On measuring the mixed sample, the new concentration is found to be 12100 IU/L. What is the recovery of HCG by this method?

MRCPath, Spring 2002