Deacon's Challenge No. 82 Answer

A man has been arrested for suspected drink-driving shortly after arriving back home. He claims to have drunk two half-litre bottles of beer in the hour previously to driving, and on returning home had drunk a double brandy (50 mL), immediately prior to being arrested and providing a blood sample.

His plasma ethanol concentration was 1.15 g/L.

The alcoholic strength of the beer was 4.0% (alcohol by volume, ABV), and the brandy was 40% (ABV). Liquid ethanol has a density of 0.789 g/mL.

The man weighs 90 Kg; the volume of distribution for ethanol is 0.68 L/Kg.

Is the man's claim credible? State any assumptions you make in your answer.

MRCPath, May 2007

First convert the concentration of alcohol in beer and brandy to g/100 mL:

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}} \quad \textit{so that} \quad \text{Weight} = \text{Density} \times \text{Volume}$$

and ethanol (g/100 mL) = 0.789 x ethanol (% by vol)

Ethanol in beer = 4.0 mL/100 mL = 0.789 x 4.0 =
3.16 g/100 mL (3 sig figs)

Ethanol in brandy = 40 mL/100 mL = 0.789 x 40 =
31.6 g/100 mL (3 sig figs)

Next calculate the total weights of ethanol consumed in each drink:

Each 100 mL beer contains 3.16 g ethanol, therefore
2 x 0.5 L contains 3.16 x 10 = 31.6 g.

Since brandy contains 31.6 g/100 mL,
50 mL contains $\frac{31.6}{2}$ = 15.8 g ethanol

Claimed total ethanol consumed = 31.6 + 15.8 = 47.4 g

This amount of ethanol is contained in its total volume of distribution (V_d).

$$\text{Total } V_d = \text{Body wt (Kg)} \times V_d \text{ (L/Kg)}$$
$$= 90 \times 0.68 = 61.2 \text{ L}$$

If the total weight of ethanol consumed is distributed throughout its V_d (i.e. if totally absorbed and not metabolized or excreted) then the maximum plasma concentration is given by:

$$\frac{\text{Weight consumed (g)}}{\text{Total } V_d \text{ (L)}} = \frac{47.4}{61.2} = \mathbf{0.77\ g/L}\ \ \textbf{(2 sig figs)}$$

Since this is likely to be an overestimate (due to incomplete absorption and some metabolism and excretion) and the measured concentration (1.15 g/L) is far in excess of this, the man's claim is not credible.

Question 83

It has been suggested that a proposed analytical goal for an analyte is that the between batch analytical coefficient of variation should not exceed one half of the "true biological" inter-individual coefficient of variation. Calculate the percentage "expansion" of the measured reference range over the true biological reference range when this analytical goal is exactly met.