Deacon's Challenge No. 20 Answer

A new diagnostic test has been introduced into your laboratory. Only one request for this test was received in July 1998: in January 1999, 27 requests were received. For forward planning you need to be able to anticipate future demand.

Assuming that the increase in number of tests is exponential, what is the predicted workload for July 1999?

MRCPath, May 1999

The key to this question is the word 'exponential'. The relationship between the number of requests and time takes the form:

$$N_t = N_0 e^{kt}$$

The integrated form of this equation is simpler to use:

$$\boxed{\log_e N_t = \log_e N_0 + k.t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(i)$$

The only difference between this and the 1st order drug elimination equation is that +k.t is used rather than –k.t.

N_t = number of requests at time t
N_0 = number of initial requests i.e. requests in the 1st month
t = time in months
k = constant

The first step is determine the value of the constant k:

i.e. N_t = number of requests in month 6 (Jan 1999) = 27
N_0 = number of requests in 1st month (July 1998) = 1
t = time in months = 6

Substitute these values into equation (i) and solve for k:

$$\log_e 27 = \log_e 1 + 6\,k$$

$$3.296 = 0 + 6\,k$$

$$6k = 3.296$$

$$k = \frac{3.296}{6} = 0.5493 \quad \text{months}^{-1}$$

This value for k can now be inserted into equation (i) to determine N_t when t = 12 months (July 98-July 99):

$$\log_e N_{12} = 0 + 12 \times 0.5493$$

$$\log_e N_{12} = 0 + 6.592$$

$$N_{12} = \text{antilog}_e\ 6.592 = \textbf{729 requests}$$

Alternative approaches to this question:

1 This question could also be solved graphically by plotting $\log_e N$ against t (when t = 0, $\log_e 1 = 0$; when t = 6, $\log_e 27 = 3.30$), joining the two points by a straight line, then extrapolating to where t = 12 months, reading $\log_e N_{12}$ then taking its antilog to give the number of requests.

2 The number of tests forms a natural geometric progression with time. Therefore after 1 year (i.e. 2 six month periods) the number of tests per month will be $27^2 = 729$, after 18 months (3 six month periods) the number of tests per month is given by $27^3 = 19683$. This approach only works when the initial value in the series is 1. ■

Question No. 21

A 25 year old woman was seen at an orthopaedic clinic. Since the age of 5 she had "knock knees" and had several osteotomies over the years to correct the deformities. Her height was 158 cm. Her mother and grandmother had mild knock knees. Laboratory results obtained on morning fasting samples were as follows:

Plasma phosphate	=	0.52 mmol/L
Plasma creatinine	=	89 µmol/L
Urine phosphate	=	13.5 mmol/L
Urine creatinine	=	6.52 mmol/L

She was on a reasonably constant diet, with moderate phosphate and calcium intake for several days before sample collection. Calculate:

a. The fractional excretion of phosphate (FEP)
b. The fractional tubular reabsorption of phosphate (TRP)
c. The renal tubular reabsorption of phosphate (TMP/GFR).

MRCPath, November 2001 - modified