# Deacon's Challenge

## No 200 - Answer

*Your laboratory performs a screening test on patients referred by their GPs with symptoms suggestive of a rare disease (prevalence 1 in 50 of patients referred). The cost is £20 per sample. Follow up of patients with a positive result includes extensive imaging studies and biopsy and your clinical colleagues estimate that the cost is approximately £2000 per patient. They have expressed concern at the high number of false positives (the sensitivity of the test is 99% but the specificity only 85%). The option of adjusting the decision level is unattractive since a significant number of patients with the disease will be missed and the cost of omitting the screening step is prohibitive. You have discovered that an alternative test has become available with a sensitivity of 99% and a specificity of 96% but its implementation involves the purchase of a dedicated analyser and increased reagent and labour costs. You have negotiated a leasing deal with the supplier and you calculate that the total cost of the new test will be £120 per sample. You have been asked to prepare a business case with an assumed annual workload of 2500 samples. Estimate the potential annual savings if the new test is introduced.*

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As the prevalence of the disease is 1 in 50, out of the 2500 patients tested each year 50 (i.e. 2500/50) will have the disease whereas the remainder, 2450 will not.

Both tests have the same sensitivity so the number of true positives will be 50 x 99/100 = 49.5 for each test.

**Using the current test**
Number of true negatives = Number of disease free patients x specificity = 2450 x 86/100 = 2107

The remainder of disease free patients will constitute false positives i.e. 2450 - 2107 = 343

Therefore the total number of positive results is 49.5 + 343 = 392.5

The cost of further investigation is 392.5 x £2,000 = £785,000

The total number of tests is 2500 with a total cost of 2500 x £20 = £50,000

Therefore the total cost involved is £785,000 + £50,000 = £835,000

**Using the proposed new test**
Number of true negatives = Number of disease free patients x specificity = 2450 x 96/100 = 2352

The remainder will constitute false positives = 2450 - 2352 = 98

Therefore the total number of positive results is 49.5 + 98 = 147.5

The cost of further investigation is 147.5 x £2,000 = £295,000

The total number of tests is 2500 with a total cost of 2500 x £120 = £300,000

Therefore the total cost involved is £295,000 + £300,000 = £595,000

**Projected annual saving** = £835,000 - £595,000 = **£240,000**

A further consideration is that introducing the new test will spare 343 - 98 = 245 patients the inconvenience and anxiety of further investigation.

**Comment**
We are increasingly relying on statistical techniques in the modern laboratory. However, it is important to remember that the normal distribution is only a mathematical model, albeit a useful one, which we often apply to very limited data and should be used carefully. For example the reference range quoted for serum potassium is usually in the order of 3.6-5 mmol/L, which if normally distributed corresponds to a mean of 4.3 mmol/L with a standard deviation of 0.35 mmol/L. Using a *z*-score of ±5.7, which corresponds to a range of 2-6 mmol/L gives a probability of an individual lying outside these limits of approximately 1 in 1.7 million. With a UK population of 65 million there should be 40 completely healthy individuals with a serum potassium outside the range 2-6 mmol/L! ■

- In the last issue we reported that Allan Deacon was hanging up his pen, paper and calculator after 200 Challenges over 18 years. Many of our Members, especially those studying for FRCPath, will not have had the pleasure of earlier Challenges. We are therefore, with Allan's permission, revisiting some of the Challenges. These will be selected by Sophie Barnes, who has been involved with the Challenge throughout the 18 years.

# Deacon's Challenge Revisited

## Question 1

a) Calculate the hydrogen ion concentration of blood with a pH of 7.12.

b) Treatment with bicarbonate halves the hydrogen ion concentration, what is the new pH?

*MRCPath November 2000*