INTRODUCTION

It is well recognised that the free or ionised component of calcium (Ca) in the blood is the biologically important fraction (1). However, ionised Ca measurement is not routinely available and adjusted Ca is often used to get a better measure of calcium status.

Serum albumin levels are usually measured by automated dye-binding assays, such as bromocresol green (BCG) or bromocresol purple (BCP). However, BCP overestimates the albumin value since it binds other proteins. The BCP is more specific to albumin as it does not suffer from various interferences.

Serum-adjusted calcium formulae are commonly used to adjust for differences in albumin concentration. Previously published equations to adjust calcium for albumin concentration may vary depending on factors such as the type of reagents used and the different patients' populations. Equations to adjust total calcium for albumin, such as the frequently cited 'adjusted [Ca][mmol/L] = total [Ca][mmol/L] + 0.02 (40 - [albumin][g/L])' are routinely used in clinical practice to give an estimate of calcium concentration in patients with hypoalbuminaemia (2-4).

Our laboratory uses a standard correction formula to report adjusted calcium values; however this was based on a BCG analysis method. As our laboratory now uses a BCP albumin analytical method we reviewed the standard correction formula we had used.

AIM OF THE STUDY

As we are using the BCP reagent for albumin measurement, the purpose of this study was to derive and internally validate a calcium-adjusted calcium equation by applying linear regression to our own laboratory data for individual patient total calcium and serum BCP-albumin measurements.

SUBJECTS & METHODS

We reviewed 19,535 consecutive outpatients over a five month time period who had simultaneous calcium and albumin measurements. There were 11,050 females and 8,482 males. Demographic data of the study cohort are presented in Table 1. Most of our patients were referred by General Practitioners to Healthscope Pathology.

Biochemistry:

Both serum calcium and albumin were measured using Siemens analysers, mostly ADVIA 2400 analyser using Siemens reagents and Calibrators. Tests were conducted using the Arsenazo III dye binding method for calcium and the BCP reagent for albumin.

Statistical Analysis:

The linear regression equation between calcium and BCP-albumin was determined (Figure 2) and a new corrected calcium formula was derived from this data. To assess agreement between the derived equation and the previously published equation, we compared adjusted calcium results using the locally derived equation and the published equation to all the subjects. The regression equation was then cross-validated in the validation sample.

RESULTS

The cohort’s mean (SD) of calcium and albumin concentrations were 2.31 (0.14) mmol/L and 39.0 (3.6) g/L respectively. The relationship between serum total calcium and albumin obtained from the derivation subset (n = 19,535) is shown in Figure 2. The slope of the BCP albumin and total calcium = 0.015. This was used to adjust the Ca result back to the median albumin value of 40g/L (Figure 1).

This gives the equation:

Adjusted [Ca][mmol/L] = total [Ca][mmol/L] + 0.015 (40 - [albumin][g/L]).

The equation showed evidence of good internal validity (r2 = 0.997) between the old and the new formulas. There was no sex related difference in the slope of the regression equation between males and females.

DISCUSSION

We derived an albumin-adjusted calcium formula using our local laboratory data that differs from those previously published (4-7).

Application of the new formula illustrates a clinically important difference in the classification of calcium status of our outpatients. This resulted in fewer patients being categorised as hypocalcemic and a smaller difference in those classified as hypercalcemic. The difference between our equation and other published versions (4-7) may be due to the changes in the formulation of the albumin binding BCP reagent that we currently use, differences in analytical techniques employed and also the difference in patients’ population.

CONCLUSION

Based on the total calcium and albumin measurements in our outpatient population, we derived and internally validated a local BCP-albumin adjusted calcium equation. Our new equation resulted in important differences in classification of calcium status compared to results from a previously published study.

REFERENCES