Comparison of four methods for determining serum magnesium

M. P. RYAN AND D. HINGERTY *From the Department of Biochemistry, University College, Dublin*

The diagnostic implications of changes in serum magnesium levels have become evident in recent years (Hanna, 1961; Wacker and Vallee, 1964). Serum magnesium levels, however, like serum calcium, normally are maintained within very narrow limits so that highly accurate and specific analytical methods are required to detect the relatively small changes which may occur in certain disease states. Although highly specific methods for magnesium analysis now are available, some discrepancies appear in mean values recently reported for normal human serum, the figures varying from 1.60 m.equiv./l. to 2.18 m.equiv./l. (MacDonald and Watson, 1966; Hughes and Tonks, 1965.)

As we required an accurate and reproducible method for estimating serum magnesium in a study of magnesium-lipid relationships, it was decided to investigate a number of currently used procedures. The methods chosen were (1) colorimetric (Titan Yellow procedure as modified by Spare, 1962, and Rice, 1964) using the Unicam S.P. 600 spectrophotometer; (2) flame emission spectrophotometric (Alcock, MacIntyre, and Radde, 1960) using the Zeiss P M Q II; (3) atomic absorption spectrophotometric (MacDonald and Watson, 1966) using the Techtron AA 100; and (4) fluorimetric (Schachter, 1961) using the Locarte single-sided Mk 4 instrument. Analyses were performed in duplicate in procedures 1 and 4. The same magnesium standard (pure magnesium ribbon (B.D.H.) dissolved in the minimum of HCl, made up to volume with water and standardized by titration with EDTA using Eriochrome Black T as indicator) was used for all four methods. Deionized distilled water was used throughout. All pipettes used were checked for accuracy of delivery. All reagents were stored in either Pyrex glassware or polythene containers.

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TABLE I

Procedure	Mean (m.equiv./l.)	SD	Normal Range (Mean $\pm$ 2 SD)
Titan Yellow	1.92	0.127	1.67—2.17
Flame emission	1.75	0.139	1.47—2.03
Atomic absorption	1.71	0.133	1.44—1.98
Fluorimetric	1.76	0.090	1.58—1.94

The results obtained for 31 normal subjects whose serum was analysed by all four methods are shown in Table I, from which it can be seen that the Titan Yellow method gives values considerably higher than those obtained by the other methods, all of which are in good agreement with figures in recent comprehensive studies (Alcock, MacIntyre, and Radde, 1965; Stewart, Hutchinson, and Fleming, 1963).

The reproducibility of each method was checked by carrying out multiple determinations on a single sample.

Coefficients of variation $\left(\frac{SD}{Mean} \times 100\right)$ were: Titan

Yellow 4.0, flame emission 3.0, atomic absorption 1.8, and fluorimetric 2.3. Since the fluorimetric method is a simple procedure with few sources of error, is readily reproducible, and gives the narrowest range for normal subjects, we have adopted it for routine use and have applied it to sera from about 600 patients.

The subjects taking part in the investigation of these methods consisted of a younger group of 23 students and laboratory personnel aged about 18 to 30 years and an older group of 35 factory workers aged about 40 to 60 years. To investigate the possibility that the discrepancies in reports of normal values appearing in the literature could have been caused by age differences we compared the figures obtained for these two groups but found no significant difference (1.77 ± 0.103 for younger group, 1.75 ± 0.101 for older group). These findings confirm the results of other workers (Breen and Marshall, 1966; Pruden, Meier, and Plaut, 1966). It appears likely, as suggested by Alcock *et al.* (1960), that varied results obtained for normal human serum may be at least partly due to different procedures used for preparation of standards.

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