Short Communications

Capillary Tubes for Blood Glucose Sampling

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Summary. A formal evaluation of the Sarstedt capillary tube system for blood glucose sampling was undertaken. Results obtained with the method were found to be highly reproducible (coefficient of variation = 4.7%) and accurate (mean $\pm$ SD difference between this system and a reference system = -0.14 ± 0.45 mmol/l). A decline in glucose values by 10%

occurred when they were stored for 48 h before analysis, and this decline persisted in samples kept at room temperature, but was abolished by storage at 4 °C.

Key words: Home glucose monitoring, capillary tubes.

Blood glucose monitoring is assuming a central role in the management of diabetes [1]. Values obtained in hospital are often not representative of metabolic control under normal living conditions, hence the growing use of home monitoring with glucose sensitive enzyme-tipped strips, with or without reflectance meters [2–4]. Such methods have great value but may be subject to a degree of error and bias which is sometimes unacceptable and it may then be desirable for samples to be collected at home by the patients, but estimated in the laboratory.

Several methods of home blood sample collection have been developed and used with variable success. Sample collection into glass capillary tubes was first used in the Whitehall Study [5], and this has been developed into the commercially available Sarstedt tube system (Walter Sarstedt, Leicester, UK) for home sample collection. This system has proved of great practical value and its potentially wide application has led us to undertake formal assessment.

Material and Methods

The Sarstedt tube system consists of a polythene capillary tube coated with sodium fluoride to inhibit glycolysis and coagulation. Blood from a finger-prick is automatically drawn into the tube by capillary attraction when its tip is allowed to penetrate the surface of the drop. The tube is then capped, placed in the container and stoppered. The volume of the package is 6 ml, its weight 2 g, and cost 5–10 p per tube.

On receipt the whole assembly is briefly centrifuged (2000 $\times$ g for 2 min), and plasma sampled directly with a fine tipped pipette for rap-

id(enzymatic) glucose analysis (Yellow Springs or Analox analyser). The total volume of the capillary cavity of the tube is 300 μ l, although a 50 μ l sample is sufficient for glucose analysis.

In order to assess the reproducibility and stability of capillary tube samples and to compare the results with conventional fluoride/oxalate blood samples, we charged several capillary tubes to a usual half-full level (approximately 150 μ l) from a selection of freshly drawn venous blood samples. The samples were either analysed within 3 h or were stored at 4 °C or at room temperature for analysis.

Glucose estimation in this study was performed with an Analox GM6 glucose oxidase analyzer (Alpha Laboratories, Eastleigh, Hants, UK) with suitable standards and quality control plasma samples.

Results

Reproducibility

The mean coefficient of variation of 20 replicates made up from venous samples from each of 10 patients and covering a glucose range of 2.2–23.2 mmol/l was 4.7%. The coefficient of variation did not change significantly across the range of values examined.

Accuracy

Sarstedt tube glucose samples from 24 subjects were compared with venous blood analysed by the reference method. The mean ($\pm$ SD) difference between methods was -0.14 ± 0.45 mmol/l over the glucose range 2.2–26.0 mmol/l. The correlation between values from the two methods was $r = +0.99$, (slope = +1.000, intercept = +0.14 mmol/l).

Fig. 1. Stability of glucose stored in Sarstedt tubes at room temperature (●—●) and at 4 °C (○—○). Each point is the mean $\pm$ SEM of samples from 10 patients

Stability

Thirteen tubes were charged with blood from each of 10 diabetic subjects. One was estimated immediately, and of the rest, half were stored at room temperature and half at 4 °C, then analysed in duplicate at 24-h intervals up to 10 days. A similar mean fall of 10% was shown over the first 48 h by both refrigerated and room temperature samples. The latter steadily fell by a further 10% by 10 days (at a steady rate); the former remained stable (Fig. 1).

Effect of Tube Filling

Ten blood samples were used to fill each of two tubes, one being well filled ($> 250 \mu\text{l}$ blood volume), and the other being poorly filled ($< 100 \mu\text{l}$). There was good agreement between results for each set of tubes ($r = +0.99$; slope = $+1.08$; intercept = -0.5 mmol/l) with a tendency for underfilled tubes to give greater values.

Discussion

Several methods of home self-sampling for laboratory estimation elsewhere have been described. The filter paper spot method, first described in 1962 [6], has similar precision and accuracy to the present method, but may not be used to give such immediate results, and requires special processing [7], as does the vacuum-bottle method [8]. The preserved 'Reflotest' method [8] depends on correct technique initially, and is subject to the error inherent in strip reflectance methods.

Capillary tube samples are collected with speed and ease, and the glucose concentration may be rapidly esti-

mated on receipt. The accuracy of this system rivals that of any other home glucose sampling method. The small progressive fall in glucose concentration over time – a feature of other storage methods [7, 8] is minimized by storage at 4 °C.

We suggest that the system is particularly suitable in a number of situations: (1) large epidemiological studies, (2) research studies in which a long term effect on glycaemic control is in question, (3) management of diabetic outpatients in whom 'strip' or 'strip and meter' methods are unsuitable, and (4) glucose estimation on inpatients.

It is quicker and cheaper than drawing venous samples for blood glucose, and more accurate than 'strip and meter' systems.

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