Because CSF glucose measurement has a high clinical value in the differential diagnosis of meningitis, a simple, accurate measurement of CSF glucose would have great utility to the practitioner isolated from the laboratory.

A recent report (*1*) has recommended that rural practitioners in South Africa measure CSF glucose by using reflectance meters when laboratory services are not available to them. To assess this recommendation, I have performed a brief study, measuring glucose in 75 CSF samples by the routine laboratory glucose dehydrogenase assay with a Technicon RA-1000 analyzer, and by a Boehringer-Mannheim Reflolux II reflectance photometer with the BM-Test 1-44 reagent strips.

From 54 patients, 34 CSF samples were collected in plain glass bottles and 41 were collected in fluoride oxalate-containing Vacutainer Tubes or Microtainer Tubes (Becton-Dickinson).

Replicate glucose measurements gave a CV for the comparison method (RA-1000) of 1.2% and 1.0% for fluoride oxalate-preserved and unpreserved pooled CSF samples, respectively (n = 30). The reagent strips had CVs of 3.8% and 7.4% for assays of the same pools. The reagent strip imprecision with CSF is comparable with that obtained with whole blood and plasma specimens.

Some texts (e.g., ref. *2*) recommend the use of fluoride oxalate preservation to prevent consumption of glucose in CSF. Because fluoride concentrations must be high in the small volumes of CSF typically presented, one must consider whether the high fluoride concentrations interfere with the glucose oxidase methods (*3*). However, both the glucose dehydrogenase comparison method and the glucose oxidase reagent strips gave comparable results for preserved and unpreserved specimens. Excess fluoride did not appear to significantly affect either procedure.

Unpreserved CSF samples lost no glucose content, as compared with the preserved samples from the same patient. However, recent reports emphasize that glucose can also be lost from fluoride oxalate-preserved samples (*4*).

The clinically important cutoff for CSF glucose in suspected meningitis was taken to be 2.24 mmol/L (*5*). Around this critical concentration range, the reagent strips (y) showed a positive bias in comparison with the RA-1000 method (x); Deming statistics and the imprecision data yielded $y = 0.86x + 0.75$ mmol/L (standard error of the estimate = 0.473, of the slope = 0.043, and of the intercept = 0.178; n = 75).

Thus, using reagent strips to measure CSF glucose may give false-negative results. To determine whether the bias was constant, so that a correction was possible, I assayed with both procedures aqueous glucose standards, 0 to 10 mmol/L (*6*). These standards were matched to CSF viscosity by adding bovine serum albumin, 1 g/L, to each. The importance of viscosity matching for reagent strips has been previously reported (*7*); without this adjustment, aqueous standards gave strip-defective errors on the Reflolux II glucose meter.

The comparision method (RA-1000) performed well against the aqueous standards, but the reagent strips showed a significant positive bias in the clinically important range. Linear regression of the reagent strips results (y) vs the nominal concentration of the glucose standard (x) yielded: $y = 1.19x + 0.28$ mmol/L (standard error of the estimate = 0.418, of the slope = 1.21, and of the intercept = 0.191; n = 11). This cannot be explained as a standardization problem because the patients' samples gave a different slope and intercept: $y = 0.86x + 0.75$ mmol/L. Therefore, it is not possible to correct for the reagent strip bias by using comparison with a nominal standard curve.

The measurement of CSF glucose with the Reflolux II system reagent strip would be appropriate outside the laboratory only if a suitable correction for the bias can be determined, or if a reference range for CSF glucose is established for the system.

I acknowledge Dr. P.O. Collinson for advice kindly given during preparation of this Letter.

References

1. Muller PD, Donald PR. Reagent strips in the evaluation of cerebrospinal fluid glucose levels. Ann Trop Paediatr 1987;7: 287–9.
2. Zilva JF, Pannall PR, Mayne PD. Clinical chemistry in diagnosis and treatment, 5th ed. London: Lloyd-Luke (Medical Books) Ltd., 1988:428.
3. Gowenlock AH, ed. Varley's practical clinical biochemistry, 6th ed. London: Heinemann, 1988:321.
4. Mattock M, Phillips R, Keen H. Effect of delay in separating plasma for glucose measurement upon the interpretation of oral glucose tolerance tests. Ann Clin Biochem 1990;27:604–5.
5. Eastman RD. Biochemical values in clinical medicine, 7th ed. Bristol, U.K.: Wright, 1985:150–1.
6. Percy-Robb IW, et al. A recommended scheme for the evaluation of kits in the clinical chemistry laboratory. Ann Clin Biochem 1980;17:217–26.
7. Phillipou G, Farrant RK, Phillips PJ. Aqueous-based glucose control solutions for use with glucose reagent-strips and meters. [Letter]. Clin Chem 1989;35: 2017–8.

G. M. Avery

Dept. of Clin. Biochem.
West Middlesex Univ. Hospital
Middlesex TW7 6AF, U.K.

A spokesman for Boehringer Mannheim comments:

To the Editor:

The Reflolux II is a blood glucose monitor carefully calibrated to produce accurate results in capillary whole-blood specimens. Any other sample material may present matrix effects not necessarily limited to viscosity differences. CSF samples will demonstrate biases, as would viscosity-adjusted aqueous solutions, and are therefore not recommended for use with Reflolux II.

N. Peled

Dept. of Tech. Affairs
Boehringer Mannheim Corp.
P.O. Box 50100
Indianapolis, IN 46250-0100

More on Effects of Storage Time and Temperature on Measurement of Small Concentrations of Albumin in Urine

To the Editor:

In diabetics, the assay of urinary albumin excretion (UAE) by immunological methods has recently assumed a central role in the prevention and follow-up of diabetic nephropathy (*1*). Screening for UAE has become part of routine diabetes care (*1*) and concerns all diabetic patients, so that a large number of samples have to be processed. Therefore, urine specimens often must be stored before assay. For these reasons, definite information is needed about the effect of specimen storage conditions on the accuracy of results.

Elving et al. (*2*) claimed that freezing urine samples for determination of UAE by laser immunonephelometry may yield falsely low results, and suggested that urine samples should be stored at 4 °C and assayed within two weeks. On the contrary, we previously found no reduction in albumin values measured by RIA after several (n = 4) freeze–thaw procedures performed