simple, useful, and reliable basis for selecting those patients who require more invasive investigation in the form of direct cholangiography for suspected choledocholithiasis.

1 Tobin MV, Gilmore IT, Lamb GHR. Choledocholithiasis: discrepancies between ultrasound and retrograde cholangiogram findings. *Gut* 1984;25:A560.
2 Laing FC, Jeffrey RB. Choledocholithiasis and cystic duct obstruction: difficult ultrasonographic diagnosis. *Radiology* 1983;146:475-9.
3 Muhletaler CA, Gerlock AJ, Fleischer AC, *et al*. Diagnosis of obstructive jaundice with nondilated bile ducts. *American Journal of Roentgenology* 1980;134:149-52.
4 Hamilton I, Ruddell WSJ, Mitchell CJ, *et al*. Endoscopic retrograde cholangiograms of the normal and postcholecystectomy biliary tree. *Br J Surg* 1982;69:343-5.

(Accepted 21 April 1986)

Gastroenterology Unit and Department of Radiology, Royal Liverpool Hospital, Liverpool L7 8XP
M V TOBIN, MB, MRCP, registrar in gastroenterology
R M MENDELSON, FRCR, senior lecturer and consultant radiologist
G H LAMB, FRCR, consultant radiologist
I T GILMORE, MD, FRCP, consultant physician and gastroenterologist

Correspondence to: Dr Tobin.

Accuracy of home blood glucose monitoring by children

Monitoring of blood glucose at home must be reasonably accurate to be effective. Visually read glucose strips can be read accurately by selected and supervised patients,[1] but there are no long term studies on the accuracy of monitoring blood glucose in the home by children under the real conditions of daily living. We report our experience with 160 children over the age of 4.

Patients, methods, and results

Between 1980 and 1984, 160 children (85 girls, 75 boys) were introduced to home blood glucose monitoring. Their mean age on entry was 12 years (range 2·4-19·9), and the mean period of study per child was 35 months (range 1-57, median 41). The children were asked to test their blood glucose at least six times a week using a BM-Test-Glycemie 20-800 strip (Boehringer Corporation London Limited). The technique was shown to them and reinforced regularly in the clinic and at home by health visitors. Every three months the children measured their blood glucose concentration on eight occasions over a 24 hour period. Simultaneously they placed a drop of blood on filter paper (Whatman No 4619), wrote the reagent strip result below it, and posted it to the laboratory for analysis.[2]

The results of the blood glucose analyses were sent to the children for comparison with their reagent strip readings. When serious discrepancies occurred their technique was reassessed. The children recorded their reagent strip reading either to the most appropriate of the eight colour markings or to an integer value. For the purpose of data analysis the reagent strip readings and the laboratory glucose concentrations greater than 13 mmol/l (234 mg/100 ml) were coded as 13 mmol/l.

The 160 children provided 5402 reagent strip readings (mean per child 34, median 25); 2647 (49%) of the readings were within 2 mmol/l (36 mg/100 ml) of the true glucose value. Of the reagent strip readings, 3840 (71%) predicted the true glucose value within the ranges less than 3 mmol/l (54 mg/100 ml), 3·0-12·9 mmol/l (232 mg/100 ml), and 13 mmol/l (234 mg/100 ml) or more, but only half of them detected "hypoglycaemia" (less than 3 mmol/l) or "hyperglycaemia" (13 mmol/l or more). Of the reagent strip readings, 2688 (75%) correctly identified glucose concentrations of 10 mmol/l (180 mg/100 ml) or more. The sensitivity (true positives) of the reagent strips in detecting hypoglycaemia was 44%, although the specificity (true negatives) was 95%. In terms of detecting hyperglycaemia the sensitivity was 54% and the specificity was 86% (table).

Percentage of correct visual readings of blood glucose by children at home

Blood glucose (mmol/l):	<3·0	3·0-12·9	≥13·0	All values
No of readings	124	3687	1591	5402
No (%) in which visual reading correct	55 (44)	2924 (79)	861 (54)	3840 (100)

Conversion: SI to traditional units—Glucose: 1 mmol/l ≈ 18 mg/100 ml.

The accuracy of the readings did not correlate with the child's age, sex, or social class, or with the time of day or season of the year. Neither did it correlate with the level of control (as assessed by haemoglobin A_1) or improve with the number of profiles performed (analysis of variance). No individual children were particularly accurate or inaccurate readers.

Comment

We have shown that children at home do not read glucose reagent strips accurately, a finding that agrees with other studies, in which results in unsupervised patients or staff were distinctly different from those of trained personnel.[3,4] Common sources of error were smeared test areas, imprecise timing, hastily read colour changes, and occasionally deliberate falsification. Glucose meters are susceptible to most of these errors, and their use in the home may be equally unreliable.

Our children are taught to vary the amount of quick acting insulin, lowering it if the reading is less than 3-4 mmol/l (54-72 mg/100 ml) and increasing it if the reading is 13 mmol/l (234 mg/100 ml) or more. The results suggest that they would have often reacted inappropriately. We now ask them to increase their insulin dose if the reagent strip reading is 10 mmol/l (180 mg/100 ml) or more because the data suggest that an appropriate increase in dose might then be made more often. This level of accuracy of monitoring would not appear to be precise enough to improve control—a conclusion also reached in a recent prospective study.[5]

These findings emphasise the importance of quality control in home blood glucose monitoring, the need to review results critically, and the need periodically to reappraise monitoring techniques.

CRK was funded by the Augustus and Francis Newman Trust Fund. We thank the Boehringer Corporation (London) Limited for financial support and Dr C A Pennock for the biochemical data.

1 Anonymous. Symposium on home blood glucose monitoring. *Diabetic Care* 1981;4:392-426.
2 Baumer JH, Edelstein AD, Howlett BC, *et al*. Impact of home blood glucose monitoring on childhood diabetes. *Arch Dis Child* 1982;57:195-9.
3 Hutchinson AS, Shenkin A. BM strips: how accurate are they in general wards? *Diabetic Medicine* 1984;1:225-6.
4 Petranyi G, Petranyi M, Scobie IN, *et al*. Quality control of home blood glucose concentrations. *Br Med J* 1984;288:757.
5 Mann MP, Noroha JL, Johnston DI. A prospective study to evaluate the benefit of long-term selfmonitoring of blood glucose in diabetic children. *Diabetes Care* 1984;7:322-6.

(Accepted 2 April 1986)

Diabetic Clinic, Bristol Royal Hospital for Sick Children, St Michael's Hill, Bristol BS2 8BJ
C R KIRK, MA, MRCP, diabetic research fellow
H BURKE, medical student
D C L SAVAGE, MD, FRCP, consultant paediatric endocrinologist

Department of Epidemiology and Community Medicine, University of Bristol
A O HUGHES, MSC, MPHIL, senior lecturer in medical statistics

Correspondence to: Dr Savage.

Investigation of cholinesterase in amniotic fluid

Recent attention focused on the fetal origin of many amniotic substances may cause us to forget the maternal origin of many amniotic fluid proteins.

Case report

A 39 year old woman, the mother of three healthy children, underwent amniocentesis at 16 weeks of pregnancy because of her age. The acetylcholinesterase gel test for open neural tube defect, when performed on the amniotic fluid, did not show any non-specific cholinesterase band.[1] This was unique in our experience of testing 1120 specimens; the only report of a similar finding is from a retrospective study of stored amniotic fluid, in which the absence was explained by loss of enzyme activity due to frequent freezing and thawing.[2] Our test had been done on fresh amniotic fluid that had normal α fetoprotein concentrations and characteristics on cell culture. Realising that abnormalities in cholinesterase may be associated with prolonged apnoea after administration of succinyl choline, we interviewed the mother to determine whether she had a family history of sensitivity to anaesthetics. She presented us with a card that showed that she was sensitive to suxamethonium: after receiving the drug during surgery for a squint when she was 18 she had had prolonged apnoea.

Laboratory records showed that she had a deficiency of cholinesterase (EC 3.1.1.8) of the atypical type (E_A^1), with a concentration of 0·34 kU/l, dibucaine number 21, and fluoride number 34. We tested her husband, who was found to be normal (cholinesterase concentration 1·47kU/l, dibucaine number 77, fluoride number 59). The obstetrician was warned about her abnormality, but the delivery was uncomplicated. The baby was perfectly normal on examination and showed no difficulties in starting to breathe; when tested at the age of 6 days she had a cholinesterase concentration of 0·67 kU/l, dibucaine number 67, and fluoride number 52, values that are compatible with the heterozygous state for atypical cholinesterase.