ABC of Diabetes

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ASSESSMENT OF DIABETIC CONTROL:
ADJUSTMENT OF INSULIN DOSE**Blood glucose measurement**

Blood glucose concentrations can now be very simply measured by nurses at the bedside or by patients at home. Many diabetics, especially those on insulin, find this technique extremely valuable, but it is neither suitable nor desirable for every diabetic and should not be attempted until it has been discussed with the diabetic clinic physician. Even then it is best for patients to borrow the equipment for a trial before deciding whether to embark on the technique and acquire the necessary equipment. Those who do learn to measure their own blood glucose should also be taught very carefully how to interpret the results.

For many who decide to measure their own blood glucose concentrations it is sufficient to use blood glucose strips read by eye (see below), and expensive meters are unnecessary. Others obtain better results using a meter and gain considerable reassurance from the readings. A high degree of accuracy is not needed, but if the technique of performing the test is poor results will be hopelessly inaccurate whichever method is used.

Technique

Obtaining the blood—The blood can be obtained by pricking a finger or, less easily, an earlobe (using a mirror). The best instrument to use is a purpose-made needle (Monolet). It is less painful to prick the side of the finger than the centre of the pulp. The finger is squeezed because the drop of blood must be large enough to cover the test strip.

The test strip—The test strips are read by eye or by meter. The best strip for reading by eye is the BM-Test-Glycémie 20-800. Dextrostix read by eye are unsatisfactory. Reflotest strips and BM 20-800 retain their colour unchanged for three to four days, especially if kept in a dessicated container, but Dextrostix do not. Poor technique results in grossly misleading blood glucose values. In hospital, results overall are of little value for this reason: the technique should be used only by properly trained staff, both medical and nursing.

It is very important to remember that blood glucose readings at the top of the Dextrostix scale (13.9 mmol/l) and at the top of the first BM 20-800 scale (13 mmol/l) represent minimum values and actual blood glucose levels could be much higher.

Blood glucose meters—Several meters are now available and others likely to be marketed soon. The manufacturers' instructions should be followed carefully.

Capillary blood samples—If patients cannot cope with self-measurement of blood glucose but can manage to take capillary blood they can take their samples to hospital in simple plastic tubes coated with heparin and fluoride (Sarstedt tubes) and have their home blood glucose profiles measured at the diabetic clinic.

Purposes of home blood glucose measurements—The purposes of monitoring blood glucose are threefold: (a) as a spot check to detect hypoglycaemia; (b) as a spot check to detect hyperglycaemia; (c) to assess the blood glucose profile over 24 hours.

Detecting hypoglycaemia

Sarstedt tubes for collecting capillary blood

Detection of hypoglycaemia is one of the most important benefits of home measurement of glucose values. Thus the blood glucose concentration may be measured if the patient is uncertain about suspected hypoglycaemic symptoms, or if relatives suspect hypoglycaemia when a child behaves abnormally, becomes unconscious, or develops an epileptic convulsion. Home measurement is invaluable in preventing serious hypoglycaemia, since a diabetic can discover for himself the times of day when he is most susceptible to this hazard. In particular, measurement at bedtime in those prone to nocturnal hypoglycaemia is valuable: if the blood glucose is low (in general less than 5 mmol/l) extra carbohydrate may prevent hypoglycaemia. The same applies on other occasions when hypoglycaemia could be hazardous—for example, before driving for a long distance.

Detecting hypoglycaemia

The discovery of isolated high blood glucose readings in a symptomless diabetic is of limited value. During illness, however, when blood glucose concentrations tend to be high and accompanied by heavy glycosuria, raised blood glucose values may be a valuable guide to the need for extra insulin. If the level is above about 15 mmol/l an additional dose of a soluble insulin (approximately 8 units) would usually be quite safe. Random blood glucose readings may also help when particularly fine control is needed—for example, during pregnancy.

Blood glucose profiles

Assessment by insulin-treated diabetics of the daily fluctuations of their blood glucose values results in a much greater understanding by patients and doctors of both diabetic control and the effects of different insulin preparations. Home blood glucose measurement is now an important educational exercise for seriously motivated and well-organised diabetics. It is not suitable for all diabetics, and those who lack the necessary enthusiasm are better off using more traditional methods of urine testing: their blood glucose profiles may in any case be chaotic and differ from day to day and may thus be unhelpful in improving control.

Reproducible blood glucose profiles are valuable in making rational adjustments to treatment. They can show not only the times of the peaks and troughs of blood glucose but also the duration of action of a given insulin preparation in an individual patient. Indeed, the effect of individual insulins varies considerably between patients, to the extent that a soluble insulin may have a more prolonged effect in one person than isophane in another.

To obtain a blood glucose profile blood samples are taken at the following times: fasting, 2 hours after breakfast, before lunch, 2 hours after lunch, before the evening meal, at bedtime, and possibly during the night.

Advice on improving diabetic control must be given individually, but some general guidelines are presented here. Changes in insulin dose at any one time should normally be kept within 10-20% of the existing daily dose: for example, a change of 4-8 units may be made in a patient taking a total daily dose of 40 units. At least three to four days should normally pass before a further change is made.

Adjustments after assessment of blood glucose profiles

When consistent daily fluctuations of blood glucose have been shown treatment should be modified, aiming chiefly to eliminate hypoglycaemic episodes and thereafter to obtain better control by increasing the blood glucose in the troughs and decreasing it at the peaks.

To *increase* blood glucose in the troughs:

(a) Eat more carbohydrate at or before the times when blood glucose values are at their lowest; the exact amount of extra carbohydrate can be determined only by trial and error.

(b) Reduce the appropriate dose of insulin.

To *decrease* blood glucose:

(a) Reduce by a little the amount of carbohydrate taken at the meals which precede the peaks by two to three hours.

(b) Increase the appropriate dose of insulin.

Soluble insulin should be altered to change blood glucose concentration within six hours. Medium-acting insulin should be altered to change blood glucose in six to 12 hours. The duration of insulin action varies considerably, however, and these figures provide only a rough guide.

Adjusting the insulin dose according to urine tests

URINE TEST				
	Breakfast	Lunch	Dinner	Bedtime
Weekly	✓	✓	✓	✓
Alternate days	✓			✓
Daily	✓ Day 1	✓ Day 2	✓ Day 3	✓ Day 4

For patients on mixed insulins (with soluble and medium-acting insulin each given twice daily)—If the urine test shows a large amount of glucose:

Before breakfast—*increase* the evening medium-acting insulin.

Before lunch—*increase* the morning soluble insulin.

Before evening meal—*increase* the morning medium-acting insulin.

Before bedtime—*increase* the evening soluble insulin.

For patients on twice daily unmixed insulin injections—If the urine test shows a large amount of glucose:

Before lunch or evening meal—*increase* the morning dose.

Before bedtime or breakfast—*increase* the evening dose.

Haemoglobin A₁ (glycosylated haemoglobin)

1982	MAY						1982
SUN	MON	TUE	WED	THUR	FRI	SAT	
						1	
2	3				7	8	
9	10	Haemoglobin A ₁ in May					15
16	17						21
23	24						28
30	31						29

Reflects

1982	APRIL						1982
SUN	MON	TUE	WED	THUR	FRI	SAT	
				1	2	3	
4	5				9	10	
11	12	Blood glucose in April					16
18	19						23
25	26						30

Persistent hyperglycaemia modifies (glycosylates) haemoglobin A. Measurement of this haemoglobin fraction is a relatively new method of assessing diabetic control and is unique in reflecting blood glucose concentrations in a period of about four weeks before the sample is taken. Unlike blood glucose concentrations, glycosylated haemoglobin concentrations do not fluctuate from hour to hour, so they are useful in the long-term assessment of control and may identify patients whose control is not good but who prepare themselves for their clinic attendance. When pregnancies are planned haemoglobin A₁ measurement may prove helpful in establishing optimum control before conception. It is frustrating to find that even in those whose control is thought to be satisfactory haemoglobin A₁ values are often raised; and sometimes a normal haemoglobin A₁ is achieved only at the dangerous expense of nocturnal hypoglycaemia.

Haemoglobin A₁ values vary according to methods and laboratories, and no reference standards are yet available.

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