

REVIEW

The Appropriate Use of Diagnostic Services (vii) The Management of Diabetes : Trust the Patient

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INTRODUCTION

The patient, the general practitioner and the staff of the diabetic clinic are the three parties most concerned with the well being of a person with diabetes: none more so than the diabetic himself.

Once the diagnosis of diabetes has been established and appropriate treatment initiated, most patients can be shown how to keep a check on their own diabetic control by regular blood or urine glucose tests at home and adjusting their therapeutic regimen on the basis of the results of their tests.

THE DIAGNOSIS OF DIABETES : WHEN IS A GLUCOSE TOLERANCE TEST NECESSARY?

In 1980, WHO proposed specific criteria for the diagnosis of diabetes and introduced a category of "impaired glucose tolerance" with its own prognostic, therapeutic and socio-economic implications¹ (Table 1).

The diagnosis of diabetes is established when a patient who has typical clinical symptoms of diabetes also has a random or fasting blood glucose level which is higher than one of the stated values; or, in the absence of symptoms if two glucose levels exceed

them. In this situation, it is not necessary to perform an oral glucose tolerance test to establish the diagnosis and in only about 10% of patients referred to a diabetic clinic is this test ever necessary.

WHAT TESTS ARE NECESSARY TO ASSESS THE CONTROL OF DIABETES?

Once the diagnosis has been established and treatment started, it is the patient who is in the best position to assess the control of diabetes and take action to maintain satisfactory control.

(A) Tests done by the patient at home

(1) *Height and weight*

In adults, a stable, near "ideal" weight generally indicates satisfactory control; in children, measuring their growth rate helps to assess progress and control of the diabetes.

(2) *Urine sugar tests*

Practically all patients are taught to test their urine for sugar as an index of diabetic control and most of them keep a careful record of the results for months and years. Yet there are still too many patients who do not know how to use the results of these tests to take appropriate action for themselves between visits to the diabetic clinic.

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Table 1: WHO classification of diabetes¹

Diabetes Mellitus	mmol/l	venous plasma	venous blood	capillary blood
	Fasting glucose 2 hour* or random glucose	> 8.0 >11.1	> 8.0 >10.1	> 7.0 >10.1
Impaired glucose tolerance	Fasting glucose	< 8.0	< 7.0	< 8.0
	2 hour* or random glucose	8-11	7-10	8-12

* Glucose level 2 hours after taking 75 g glucose in 200 ml water.

Figure 1 shows a flow chart for adjusting the dose of oral hypoglycaemic drugs which many of our patients have found helpful as a guide for this purpose.

The test should be performed with one of the glucose-oxidase impregnated strips that give a quantitative measure of glucose concentration ('Diastix' or 'Diabur Test'). 'Clinistix' strips are more difficult to read and are excessively sensitive to quite small amounts of glucose. It is time now to abandon the messy, elaborate and potentially poisonous 'Clinitest'.

(3) *Urine ketone tests*

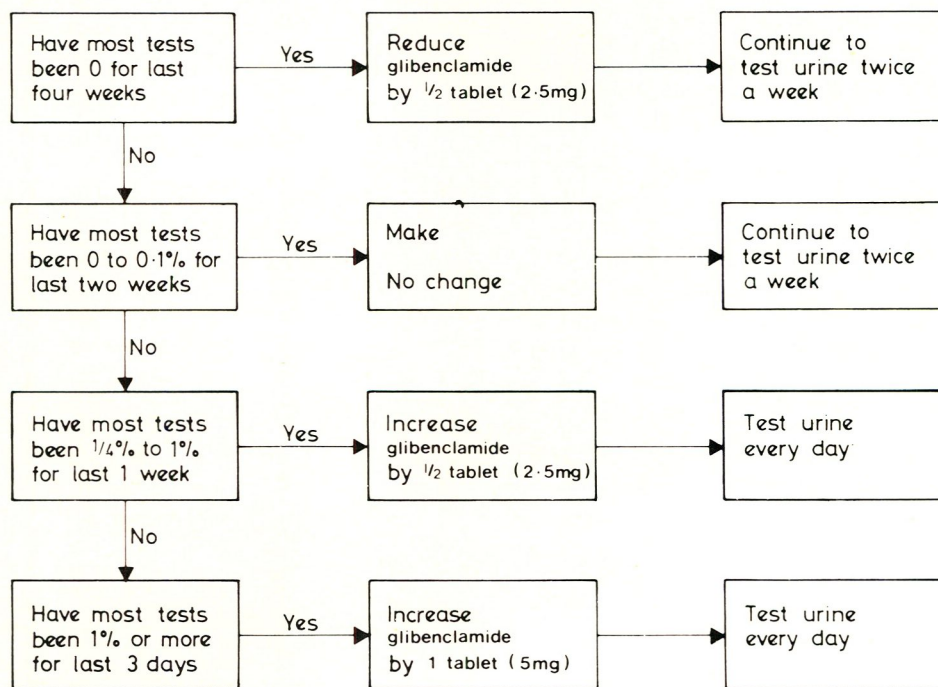
Routine testing for ketones is unnecessary, but when a diabetic patient feels unwell and has moderate to heavy glycosuria, he should test his urine for ketones with 'Ketostix'. If positive, he should

Figure 1: Example of a flow-chart for a patient taking glibenclamide 5 mg twice a day

This chart may help you keep your diabetes well controlled by adjusting the dose of tablets as necessary.

1. Make a change in dose only if you have first paid careful attention to your diet.
2. Aim to get most (more than half) of the urine tests free of sugar.
3. Test urine with glucose impregnated strips before breakfast and again one to two hours after the main meal of the day.
4. Test urine twice a week (one week day one week end day) if morning and evening results are no higher than 0.1%.
5. Test urine every day if results are 1/4% or higher

Present dose Glibenclamide 1 tablet (5mg) morning and evening



Do not increase dose of GLIBENCLAMIDE Beyond 2 tablets (10mg) twice a day

know that he must take immediate steps to improve his diabetic control. This applies particularly to children who may rapidly develop serious ketoacidosis. On no account must he stop or reduce his insulin dose, even if he is not eating or if he is vomiting; indeed he should take an extra dose of a slow-acting insulin and repeat this 3 to 4 hours later if ketones and glycosuria are still strongly positive, drink plenty of fluids and seek medical help to deal with the precipitating cause.

(4) *Blood glucose measurements*

The introduction of glucose oxidase strips to measure capillary blood glucose at home with or without a meter has added a new dimension to the management of diabetes. Patients who do this regularly for themselves quickly learn what action to take to achieve continuing good control of their diabetes. Figure 2 shows a flow-chart for adjusting the dose of insulin on the basis of the patient's own blood glucose measurements. Unlike the urine test, a blood glucose measurement can give warning of impending hypoglycaemia; it quickly shows the response to a change in treatment and so makes it possible for the patient to achieve fine adjustment of the dose of insulin. An indication of overall control can readily be obtained by measuring and recording blood glucose several times a day to achieve a daily "profile"; in conjunction with testing the urine for ketones, a patient with increasing hyperglycaemia can adjust his insulin dose quickly to prevent further deterioration of diabetic control with accelerating ketoacidosis.

The frequency and timing of home blood glucose measurements depends on the patient's metabolic state and on what type of insulin or hypoglycaemic drug he is using.

The choice of strips and meters is a matter of personal preference. In general, a patient who can confidently recognise readings above 10 mmol/l and below

4 mmol/l does not need a meter to read the strips. Reliability depends on using the proper technique and to this end the manufacturers' instructions need to be followed precisely. Glucose oxidase strips are not available on a family practitioner's prescription and are generally issued by hospital pharmacies. Bulk purchase by hospitals makes them so much cheaper that the savings offset the inconvenience.

(B) **Which laboratory test is worth doing in the diabetic clinic ?**

It is customary to measure the urine and blood sugar concentration on every patient every time he comes to the clinic. This one-off test is much less informative than the many tests done by the patient at home during his usual daily routine. It is more informative to measure the glycosylated haemoglobin as an additional and objective indication of glycaemic control during the preceding eight to twelve weeks. If there is a major discrepancy between it and the patient's own records, the patient's technique for blood glucose testing may need to be reviewed. Measuring it once a year is enough for patients who have other evidence of satisfactory control, but even in unstable diabetics no useful purpose is served by measuring it at less than three monthly intervals.

Urine should be tested in the clinic for protein with 'Albustix' as an index of renal damage. If positive, a midstream specimen of urine needs to be cultured and examined microscopically for a treatable infection. If infection is not the cause, blood urea, serum creatinine and creatinine clearance measured every year give an indication of the degree and progress of renal damage, which at this stage, is already irreversible. In the near future it may become routine to detect the presence of microalbuminuria by radioimmunoassay: when albuminuria is still at this minimal stage, renal damage may be reversible if excellent glycaemic control is maintained throughout the day for several weeks using a continuous infusion of insulin.²

LABORATORY TESTS WHEN DIABETIC CONTROL IS SEVERELY DISTURBED

(1) *Ketoacidosis*

This metabolic disturbance occurs predominantly in insulin dependent diabetics. The immediate investigations are designed to assess the degree of hyperglycaemia and metabolic acidosis, the associated water and electrolyte disturbance, the state of arterial blood oxygenation, and to identify a possible precipitating cause, most commonly an infection (Table 2). When treatment is under way, with intravenous saline and insulin at a rate of 6–10 units/hour, progress needs to be monitored with care. In the first two hours half-hourly measurements of blood glucose and potassium provide valuable guidance in addition to clinical and ECG observations. Once the major disturbances have returned to near normal, intravenous 5% dextrose and potassium chloride (20 mmol/hour) should be infused until the patient feels well enough to eat normally, when twice daily injections of insulin can be resumed. Any infection must be treated vigorously with appropriate drugs.

Table 2: Investigations used in diabetic ketoacidosis

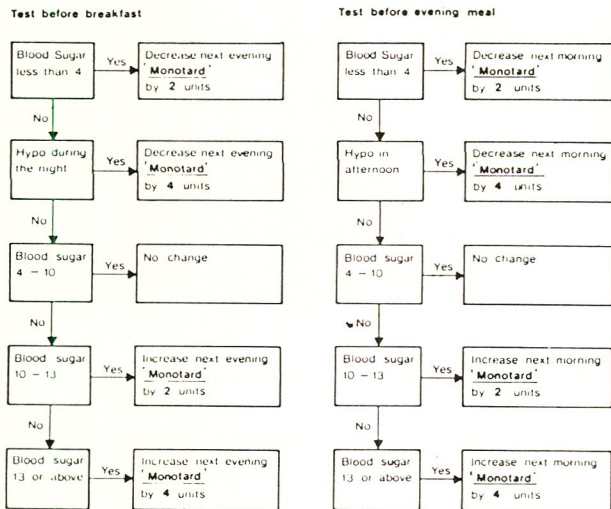
1. For diagnosis and monitoring progress
 - Blood glucose
 - Blood urea
 - Plasma sodium
 - Plasma potassium
 - Arterial blood p^H, p^O₂, p^{CO}₂, bicarbonate occasionally blood lactate.
2. For identifying a precipitating cause
 - Chest X-ray
 - ECG
 - Creatine kinase
 - Blood culture
 - Urine microscopy and culture.

(2) *Non-ketotic hyperosmolar diabetic coma*

This metabolic disturbance occurs more commonly in non-insulin dependent diabetics and is not infrequently associated with myocardial damage, although it is not always easy to decide which came first. Hyperglycaemia, hypernatraemia and plasma hyperosmolarity without major acid-base disturbance are the biochemical characteristics of this disorder and need to be treated with adequate amounts of intravenous fluid. Serial measurements of plasma glucose, sodium and osmolarity are helpful guides to the effectiveness of treatment with intravenous insulin and 0.075M saline.

Figure 2: Example of a flow-chart for a patient taking 'Actrapid' + 'Monotard' insulin twice a day

To help you adjust the insulin dose to improve control of your diabetes. Make a change only if blood sugar has been less than 4 or above 10 on two successive days.



(3) *Hypoglycaemia*

In the majority of cases hypoglycaemia occurs because a meal has been delayed or because of unaccustomed exertion; in others it is due to accidental insulin overdosage. Most of these patients respond quickly and completely to glucose by mouth. If unconscious, they must not be made to drink, but intravenous glucose, 30 ml of a 20% solution should be given. This may be enough to make them sufficiently conscious to swallow and they can then be given a drink containing 20 g glucose. In some cases, it may be more convenient to give 1 mg glucagon intramuscularly (a close friend or relative can be taught to do this) and once the patient

can swallow, this is followed by a glucose drink. Unfortunately, deliberate insulin overdosage is not uncommon and occurs even in non-diabetic people, often combined with excess alcohol, or drugs. Such patients often relapse again after initial improvement and may require continuous infusions of large amounts of glucose with a supplement of potassium. If there is any suspicion that this may be the case, it is good practice to take a blood sample for alcohol and drug measurements and keep some of it in case plasma insulin levels need also to be measured for forensic purposes.

THE COST OF REGULAR BIOCHEMICAL TESTS FOR DIABETES IN A HEALTH DISTRICT

The Northwick Park Hospital diabetic clinic in Harrow (population just under 200,000) has about 2,500 patients on its books. 1,525 patients were seen in the clinic during 1984, 580 of these patients are treated with insulin and 380 of them regularly measure their own blood sugar: they do this on average 6 times a week, using half a glucose oxidase strip at a time. In addition, about 100 non-insulin requiring patients also measure their own blood sugar regularly. Practically all other patients, as well as 35% of the insulin-treated patients test their urine for glucose, also on average 6 times a week.

Table 3: Regular biochemical tests for diabetic patients in Harrow Jan-Dec 1984

A. Number of tests*			
Home monitoring		Clinic Tests	
(a)	<i>Blood glucose</i>	(a)	<i>Blood glucose</i>
	Number of patients		Number of patients
	560		1,525
	Glucose tests		Clinic attendances
	175,000		2,900
	'BM-Glycemie' strips		Glucose tests
	87,400		1,600
	'Autolet' Lancets		Glycos. Hb tests
	44,000		2,250
			Syringes used
			2,250
(b)	<i>Urine glucose</i>	(b)	<i>Urine tests</i>
	Number of patients		Clinic attendances
	1,300		2,900
	Urine tests		Glucose/protein tests
	405,600		2,900
	'Diastix' strips		'Labstix' strips
	405,600		2,900

* All figures in this table are within 10% of actual values

B. Cost of tests (Consumables only)

Cost of home monitoring		£	Cost of clinic tests		£
(a)	<i>Blood glucose</i>		(a)	<i>Blood tests</i>	
	*'BM-glycemie' strips	13,100		Blood glucose	250
	*'Autolet' Lancets	1,100		Glycos. HB.	2,250
				Syringes	250
(b)	<i>Urine tests</i>		(b)	<i>Urine tests</i>	
	'Diastix' strips	10,100		*'Labstix' strips	350

* Strips and lancets for blood testing are bought by bulk purchase and issued by the hospital pharmacy: costed at hospital prices.

** Strips for urine testing are available on family practitioner's prescriptions: costed at NHS Price.

*** Labstix: costed at hospital price.

Most patients are seen in the clinic twice a year, at which time urine is tested for glucose and protein, and blood for glucose and glycosylated haemoglobin (glycos. Hb). Table 3 shows in details the number and cost of these tests (consumable materials only). Additional biochemical tests, requested only when there is a clinical indication for them, add only a small extra burden and cost.

Summary of estimated cost of regular biochemical tests for diabetics in Harrow Health District in 1984

	(£s sterling)
Home monitoring (blood and/or urine glucose)	£23,000—£25,000
Clinic tests (blood and urine)	£2,500—£3,500
Total cost for diabetic population of Harrow	£25,000—£29,000
Overall cost of tests per diabetic patient	£16 — £19
(a) Cost of tests for each insulin dependent patient (' <i>BMstix</i> ')	£37
(b) Cost of tests for each non-insulin dependent patient (' <i>Diastix</i> ')	£7

COMMENT

Diabetes is a complex metabolic disorder. In most cases it can be confidently diagnosed with only one or perhaps two measurements of the blood glucose level, without further investigations. The control of diabetes is best assessed by patients themselves measuring their blood glucose at home. In 1984, the cost of the materials used for conventional biochemical home and clinic testing was under £20 for each patient attending a diabetic clinic. Not a large sum, but even this money is wasted unless patients are taught how to make use of the information derived from these tests to improve the control of their diabetes.

REFERENCES

1. World Health Organization. WHO Expert Committee on diabetes mellitus: 2nd report. Geneva: World Health Organization, 1980. (WHO technical report series: 646).
2. Viberti GC, Keen H. The patterns of proteinuria in diabetes mellitus: relevance to pathogenesis and prevention of diabetic nephropathy. *Diabetes* 1984; 33: 686—692.