

## Debate

# What price a diagnosis? Targeting patients for diabetic screening

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### ABSTRACT

The natural history of impaired carbohydrate metabolism has not been established although the importance of identifying patients with abnormally high blood glucose levels has been highlighted internationally. This survey quantifies the direct cost of applying relatively low thresholds for screening targeted patients within the context of primary care in the UK National Health Service. Patients in one practice 'at-risk' of diabetes mellitus and with a random blood glucose of 5.5 mmol/l or greater were offered a fasting blood glucose, and oral glucose tolerance test if results were inconclusive. Data for all 306 patients with a random blood glucose at or above 5.5 mmol/l from Jan 2002 to April 2003 were available

for analysis. In this cohort, with nearly 41% of cases having abnormal blood glucose levels, a policy of selecting a random blood glucose of 6 mmol/l or greater for initiating further screening tests would have resulted in a failure to identify four patients with impaired carbohydrate metabolism. Of these four patients only one required treatment with oral hypoglycaemic agents and that patient presented with symptoms, and therefore testing was clinically indicated. The cost of identifying these four patients was calculated at around £247 each. This excludes the cost and inconvenience to patients with normal results.

**Keywords:** cost, diabetic screening, diagnosis

### Background

Screening for diabetes in primary care may identify a number of asymptomatic patients with diabetes mellitus.<sup>1</sup> It has been suggested that screening should be targeted at patients with multiple risk factors.<sup>2,3</sup> Depending on the results of a random blood glucose (RBG) test, a fasting blood glucose (FBG) and or an oral glucose tolerance test (OGTT) will help to make a

definitive diagnosis. The RBG level used as a cut-off for initiating further screening is set by clinicians locally. The current standard practice in this locality in South Yorkshire is to further screen patients with an RBG at or above 5.5 mmol/l as has been adopted by researchers elsewhere.<sup>4</sup> Bates *et al* suggest that the workload implications of setting lower thresholds in primary care may be considerable and are in addition to the cost and inconvenience to patients with normal test results.<sup>5</sup> This study seeks to highlight the costs to

one NHS practice of setting a cut-off at or above 5.5 mmol/l for RBG as opposed to 6 mmol/l for screening high-risk patients.

## Setting

The investigation used a group practice in South Yorkshire. The practice is fully computerised and paperless with a list size of 9200, 4.5 whole-time equivalent partners, three practice nurses and a practice-based diabetic clinic. It has an urban practice population with pockets of deprivation.

## Methods

During the period from January 2002 to April 2003, 306 patients were identified from a nursing log diary as presenting with symptoms of diabetes mellitus or risk factors for diabetes including essential hypertension, atheromatous vascular disease, obesity, hyperlipidaemia or diabetogenic medication and having an RBG of 5.5 mmol/l or greater. It was not always possible to identify the precise indication for the test in this retrospective review although most cases presented with hypertension or established atheromatous vascular disease. The average age of the patient was 57 years (range 10–96 years) and 48% were male. Only two of the 306 patients had a non-European name. Patients were subsequently offered an FBG and OGTT where indicated by the practice protocol outlined in Box 1.

### Box 1 Practice protocol for assessing patients with random blood glucose > 5 mmol/l

#### Normal if:

RBG < 5.5 mmol/l

If RBG  $\geq$  5.5 mmol/l proceed with FBG

If FBG 6–6.9 mmol/l proceed with OGTT

#### Diabetic if:

RBG  $\geq$  11 mmol/l or FBG  $\geq$  7 mmol/l

#### Impaired glucose tolerance (IGT) if:

RBG  $\leq$  11 mmol/l and FBG  $\geq$  7.8 mmol/l (screen annually)

#### Impaired fasting blood glucose (IFG) if:

RBG < 7.8 mmol/l and FBG > 6 mmol/l (screen annually)

The sensitivity, specificity and post-test probabilities of the RBG and FBG tests were calculated for three cut-off points as shown in Table 1. The number of false negatives was compared to the number of false positives. The implication for the practice in choosing different cut-off points was estimated in terms of:

- cost of negative tests (tests on false positive patients)
- cost of nurse time in performing these tests
- cost in relation to general practitioner (GP) appointments specifically made to discuss the results of blood tests.

## Results

Of the 306 patients with an RBG > 5.5 mmol/l the practice identified 51 diabetics and a further 74 cases with impaired carbohydrate metabolism. Therefore the prevalence of diabetes or pre-diabetes in this cohort was 40.8%. The sensitivity, specificity and post-test probability for the various cut-off points were very different as illustrated in Table 1.

The implications in terms of number of patients under-diagnosed or over-investigated are considered in Table 2. The difference between choosing an RBG of 5.5 mmol/l or greater compared to 6 mmol/l is equivalent to exposing an additional 31 patients to unnecessary tests and failing to identify four patients who are diabetic or pre-diabetic.

The clinical data for these four patients with diabetes or impaired carbohydrate metabolism are summarised in Table 3. Only one patient required active treatment and this patient was screened because of her symptoms rather than some other risk factors for diabetes mellitus.

As a result of choosing a cut-off of 5.5 mmol/l, 31 additional false positive patients were subjected to screening (115 false positives @ 5.5 mmol; 84 false positives @ 6 mmol). The cost of their investigations and further care were derived from the local NHS acute hospital's trust and from data published by a UK university research unit and related to the following:<sup>6</sup>

- fasting blood glucose: 31 tests @ £13.50 each
- OGTT: 9 @ £25.50 each
- nurse time: 31 appointments @ £7 each
- GP consultations: 8 appointments specifically to discuss results of these tests @ £15 each.

The total cost was £985, this excludes any cost to the patient in terms of time off work, transport and child care costs. Within these limitations the cost of identifying four additional patients when screening those with a random blood glucose at or above 5.5 mmol/l as opposed to 6 mmol/l is £246.25 each.

**Table 1** The differences in sensitivity, specificity and post-test probability of choosing three different cut-off points for screening selected patients for diabetes mellitus

	Sensitivity %	Specificity %	Post-test probability for diabetes mellitus or pre-diabetes %
RBG (mmol/l)			
≥ 5.5	99	12.9	31.5
≥ 6	96	42	40.4
FBG (mmol/l)			
≥ 6	59.2	93.1	77.8

**Table 2** Various cut-off points for investigation compared to the impact on the practice

	Diabetics or pre-diabetics not identified (false negatives)	Patients without impaired metabolism investigated (false positives)	Patients correctly identified (true positives and true negatives)
RBG (mmol/l)			
≥ 5.5	0	115	190
≥ 6	4	84	218
≥ 6.5	7	45	254
≥ 7	11	18	277
≥ 7.5	27	13	266
FBG (mmol/l)			
≥ 6	51*	12	243

\*46 patients were diagnosed as having impaired glucose tolerance which depends on the result of the RBG

**Table 3** Patients with diabetes and allied diagnosis 'missed' if screening was limited to those with a random blood glucose of 6 mmol/l and greater

Age (years)	Sex	Diagnosis	Treatment	Comment
46	F	NIDDM	Metformin	Presented with symptoms
87	F	IFG	Nil	CVA (stroke)
89	M	IFG	Nil	Hypertension
54	M	IFG	Nil	Hypertension

NIDDM: non-insulin dependent diabetes mellitus

## Discussion

The choice of cut-off point in a diagnostic test is a matter for clinical judgement and is informed by the consequences for the patient of false negative investigation. In the cohort of patients described here, choosing a random blood glucose of 6 mmol/l or greater as the cut-off point for triggering further investigation would have resulted in a failure to diagnose four cases. Of these only one required drug therapies, whilst the others warranted annual surveillance and advice on lifestyle. The natural history of progression from normal glucose tolerance to impaired fasting glucose (IFG), impaired glucose tolerance (IGT), and type 2 diabetes is not well defined. However, there is evidence that subjects with hyperinsulinaemia and impaired glucose tolerance, so-called pre-diabetics, also have an increase in cardiovascular risk factors.<sup>7,8</sup> The outlook for these patients will be improved if the risk of progression to undetected diabetes mellitus can be reduced and treatment introduced early.<sup>9</sup> The lack of clarity about natural history raises questions about the importance of selecting diagnostic cut-off points with very high sensitivity and consequent low specificity. A recent study suggests that the cut-off point for screening should be set at a random capillary blood glucose greater than 6.7 mmol/l.<sup>10</sup> Our data imply that the cost of identifying as many cases as possible by setting even lower thresholds for initiating investigation is substantial, and warrants greater investment in primary care even if screening is targeted, but especially if it is not or if targets include patients at very low risk.

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## CONFLICTS OF INTEREST

None.

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