A fasting plasma glucose level $\geq 7.8$ mmol/l was sensitive but not specific for identifying poor glycaemic control


**QUESTION:** In patients with type 2 diabetes mellitus who are not using insulin, how do fasting plasma glucose (FPG) measurements compare with those of glycosylated haemoglobin (HbA$_1c$) in determining glycaemic control?

**Design**  
Comparison of 2 laboratory tests.

**Setting**  
A family practice in Amsterdam, the Netherlands.

**Patients**  
1020 patients who were $> 40$ years of age (mean age 64 y, 67% women), had type 2 diabetes (median duration 24 y), were not pregnant, and were not taking insulin.

**Description of test and diagnostic standard**  
FPG levels were measured in venous plasma by the glucose oxidase method (Boehringer-Mannheim, Mannheim, Germany) and by the glucose dehydrogenase method (Merck, Darmstadt, Germany). HbA$_1c$ was measured using high performance liquid chromatography. The sensitivity and specificity of an FPG level of 7.8 mmol/l was calculated with reference to the HbA$_1c$ diagnostic standard cut points of 6.5% and 7.0%. These cut points were chosen in accordance with guidelines of the European NIDDM Policy Group and the American Diabetes Association.

**Main outcome measures**  
The predictive value of different levels of FPG as an indicator of HbA$_1c$ level was analysed using receiver operating characteristic curves. Change in FPG level at 3 months was also assessed as an indicator of change in HbA$_1c$ level.

**Main results**  
For the 2 HbA$_1c$ cut points that separated good from poor levels (6.5% and 7.0%), the areas under the curve did not differ (0.87 and 0.88, respectively; $p = 0.55$). An FPG level $\geq 7.8$ mmol/l detected 90% of patients with an HbA$_1c$ level $> 7.0%$. An FPG level $< 7.8$ mmol/l detected 60% of patients with an HbA$_1c$ level $< 7.0%$. A change in FPG levels at 3 months of $\leq 0$ (ie, no change or worsening) had a sensitivity of 57% and a specificity of 88% for detecting a deterioration in HbA$_1c$ of $> 0.5%$. 

**Conclusions**  
In patients with type 2 diabetes mellitus who were not receiving insulin, fasting plasma glucose level was highly correlated with glycosylated haemoglobin level. Except at extreme values ($< 7$ and $> 12$ mmol/l), fasting plasma glucose level was too imprecise to substitute for glycosylated haemoglobin level as a measure of glycaemic control.

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**COMMENTARY**

Clinicians have always considered the blood glucose and HbA$_1c$ tests as different—each valuable for complementary purposes. Therefore, the finding that a single FPG level does not accurately predict the HbA$_1c$ level is not surprising and will not change clinical practice.

Nevertheless, some details in the article by Bouma and colleagues offer clinical utility. Because clinicians naturally distinguish between glucose levels as disparate as 8 mmol/l and 12 mmol/l (141 mg/dl and 216 mg/dl), it is clinically inappropriate to consider all values $> 7.8$ mmol/l as equivalent. Likelihood ratios (LRs) allow for more useful clinical distinctions. When the data are recast as likelihood ratios, it appears that an FPG level $> 12$ mmol/l effectively rules in poor glycaemic control (HbA$_1c$ level $> 7%$), with an $+LR$ $> 40$. Similarly, an FPG level $< 7.8$ mmol/l lowers the odds of poor glycaemic control by a factor of 0.15.

Although the correlation found by Bouma and colleagues ($r = 0.77$) is remarkably high (meaning that an FPG level can “explain” $> 50%$ of the variability in HbA$_1c$ level), perhaps a more clinically relevant question could be posed: can one accurately predict HbA$_1c$ levels from the average value of several glucose levels over an extended period? Older studies have suggested that averaging at least 3 FPG values can improve the correlation with HbA$_1c$ level almost to $r = 0.9$. Other studies have noted that non-fasting glucose levels may more accurately predict poor glycaemic control than do fasting levels. For example, HbA$_1c$ levels were more highly correlated with post lunch glucose levels ($r = 0.81$) than with fasting levels ($r = 0.62$), and post lunch glucose values of $> 11.1$ mmol/l (200 mg/dl) ruled in poor glycaemic control (HbA$_1c$ level $> 7%$).

Clinicians must also be mindful that HbA$_1c$ values are not a perfect measure of glycaemic control. There are substantial interindividual variations in the affinity of haemoglobin and glucose, and rapid erythrocyte turnover can give a false sense of good glycaemic control.

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