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FROM THE FAMILY PRACTICE INQUIRIES NETWORK

Does daily monitoring of blood glucose predict hemoglobin A1c levels?

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EVIDENCE-BASED ANSWER

Hemoglobin A1c (HbA1c) levels correlate closely, though not perfectly, with blood glucose levels in patients with diabetes (strength of recommendation [SOR]: **A**, based on systematic reviews).

Correlation is higher for blood glucose levels later in the day than earlier in the day, higher for blood glucose levels in the most recent 30 days than from the prior 31–120 days, and higher for patients with type 2 diabetes compared with patients with type 1 diabetes (SOR: **A**, based on cohort studies).

EVIDENCE SUMMARY

Four cohort studies of patients with diabetes have compared overall mean blood glucose levels with HbA1c levels.[1-4] All but one[4] were limited to patients with type 1 diabetes. Study periods ranged from 1 to 6 months, and frequency of blood glucose measurement ranged from 2 to 4 times per day.

Correlation coefficients between mean blood glucose levels and HbA1c levels ranged from 0.71 to 0.86, implying that 50% to 74% of the variance in HbA1c is explained by the mean blood glucose (in each study, correlation was significant [P<.02]).

We found 5 studies comparing blood glucose measurements at specific times of day with HbA1c levels see (**Table**). Data from 3 studies comparing blood glucose values after lunchtime with those earlier in the day suggest that the lunchtime levels are more closely associated with HbA1c levels.[5,7,9] No consistent difference was shown between preprandial and postprandial blood glucose levels in their strength of association with HbA1c levels. In 1 of these studies, a blood glucose level of 150 mg/dL 2 hours after lunch predicted a HbA1c of 7% with 85% sensitivity and 85% specificity.[7] One study provided only limited information on blood glucose–

HbA1c correlations in relation to mealtimes but did report that the times of day at which the 2 were best correlated were in the periods from midnight to 5:00 AM and between noon and 3:00 PM.[9] One study compared patients with type 1 and type 2 diabetes and found a higher correlation between blood glucose and HbA1c levels in the latter.[6]

The relationship between HbA1c and blood glucose levels is such that blood glucose levels from the preceding 30 days determine about 50% of the total HbA1c.[10] This relationship may be altered by uremia, intake of vitamins C or E, and conditions that affect erythrocyte turnover.[11]

It remains unclear whether management strategies that focus on minimizing HbA1c levels are optimal for prevention of diabetic complications.

Although HbA1c levels correlate with the risk of some complications, aspects of glycemia not reflected in the HbA1c level, such as the heights of glycemic "excursions" from the mean, may independently affect the risk of complications of diabetes.[12] If so, quantitative analysis of day-to-day blood glucose levels might yield a better estimation of the risk of diabetic complications than HbA1c levels.

Correlation coefficients between blood glucose levels and hemoglobin A1c levels

Study	Rohlfing et el, 2002[5]	Prendergast et al, 1994[6]	Prendergast et al, 1994[6]	Avignon et al, 1997[7]	Bastyr et al, 2000[8]	Levetan et al, 2001[8]
Diabetes type	Type 1	Type 1	Type 2	Type 2	Type 2	Unspecified
N	1439	104	234	66	135	44
Frequency of blood glucose measurement*	Quarterly over 6.5 y	"Periodically" over 3 y†	"Periodically" over 3 y†	Once only	Twice on separate days	Continuously for 3 days
Correlation coefficients						
Pre-breakfast	0.69	0.38	0.61	0.62	0.22	<0.30
Post-breakfast	0.67	0.27	0.51		0.33	
Pre-lunch	0.72			0.65		

Post-lunch	0.77			0.81		
Pre-dinner	0.75			0.78		
Post-dinner	0.78					0.34
Bedtime	0.76					

*Blood glucose measurements from Avignon et al, 1997[7] were taken at fixed times of day; time designations are based on average mealtimes in the study population. †Frequency of blood glucose measurements not specified.

RECOMMENDATIONS FROM OTHERS

No official statement by any organization was found relating to the quantitative relationship between blood glucose levels from daily monitoring and HbA1c levels. However, the American Diabetes Association (ADA) specifies treatment goals for both HbA1c and blood glucose levels. An ADA expert panel recently concluded, "There are insufficient data to determine accurately the relative contribution of fasting plasma glucose and postprandial plasma glucose to HbA1c."[13]

CLINICAL COMMENTARY

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In practice, glycemic control is fundamental in managing patients with diabetes. I believe that treatment targets need to be individualized. Patient education about the importance of both HbA1c and self blood glucose monitoring are crucial in accomplishing this goal. While HbA1c <7% is strongly associated with reduction of microvascular complications, the blood glucose results are very useful in preventing hypoglycemia, as well as adjusting medication and insulin doses, diet, and exercise. The new, minimally invasive at-home glucometers and HbA1c test kits, which were recently approved by the Food and Drug Administration, improve compliance and help patients take control of their diabetes management.

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