Blood Glucose Monitoring: Necessary and Sufficient?

Barry H. Ginsberg, M.D., Ph.D.

In 1971, a salesman first brought an Eyetone, the earliest commercial blood glucose meter to the diabetes clinic at Jacobi Hospital in the Bronx. As a third-year medical student I was fascinated by the technology, but, because it was difficult to use, it was classified as a physician device. Blood glucose meters today are small, virtually pain free, and reasonably accurate. The process of monitoring blood glucose can be expensive, but small increases in hemoglobin A1c can lead to increased complications, which are even more expensive.[1] So who should monitor their plasma glucose and when?

Blood glucose monitoring (BGM) fulfills four roles: (1) it provides data to the person with diabetes that can be used to self-adjust medication; (2) it provides averages that give the person with diabetes rough information about how well they are doing (both for avoiding hypoglycemia and in terms of blood glucose control); (3) it reminds the person with diabetes that they have the disease, perhaps altering behavior; and (4) it is used by the health care providers to evaluate and make changes in the diabetes regimen of the patient. All of these functions are important, and all require education and skill to perform properly.

There is little doubt of the need for self-monitoring of blood glucose (SMBG) in patients using insulin. I believe that all patients with type 1 diabetes should be using intensive insulin therapy. For this treatment, SMBG is needed for calculating the insulin dose before each meal and for determining the values of the carbohydrate-to-insulin ratio and the insulin sensitivity ratio (correction ratio). Intensive insulin therapy is becoming common in type 2 diabetes as well, and frequent SMBG is similarly needed in these people. Although some people on less intensive insulin therapy monitor little or not at all, this is an ineffective practice, as well-controlled patients need SMBG to avoid hypoglycemia, and poorly controlled patients need SMBG to come under better control. Indeed, the American Diabetes Association position statement on SMBG states: "SMBG is recommended for all insulin-treated patients with diabetes. SMBG may be desirable in patients treated with sulfonylureas or other insulin secretagogues and in all patients not achieving glycemic goals.[2]"

Studies of the role of SMBG in patients with type 2 diabetes using oral agents are numerous and confusing. Using National Health and Nutrition Examination Survey data, Harris found no role for SMBG[3], whereas Blonde and colleagues clearly showed the need.[4] Results found depend on the conditions studied. Successful use of blood glucose monitoring requires more than a meter and strips; motivation, knowledge, and skill are just as important. Blonde and co-workers, studying patients with type 2 diabetes, mostly on oral agents, found that of those who monitored their glucose two or more times per day and had documented BGM discussions with their health care provider, 70% had hemoglobin A1c values less than 8.[4] Of those who monitored less than two times per day or did not have documented BGM discussions with their health care provider, only 20% had hemoglobin A1c less than 8.

Author Affiliation: Diabetes Technology Consultants, Wyckoff, New Jersey

Abbreviations: (BGM) blood glucose monitoring, (SMBG) self-monitoring of blood glucose

Corresponding Author: Barry H. Ginsberg, M.D., Ph.D., President, Diabetes Technology Consultants, 501 Lydia Lane, Wyckoff, NJ 07481; email address *diabetes_consultants@yahoo.com*

The interesting question of the role of glucose monitoring in the well-controlled person with type 2 diabetes on oral agents was explored in the DiGem study.[5] Using three groups with no SMBG, some SMBG but no training on self-adjustment, or SMBG with training on adjustment of diet and exercise, they followed patients for 12 months. They came to the conclusion that glucose monitoring did not improve glucose control in "well-controlled" patients with diabetes. There are, however, some methodological flaws in the study that may have significantly influenced the results.

1. These were not "well-controlled" patients with type 2 diabetes. The average hemoglobin A1c was about 7.5, below the mean of patients with type 2 diabetes, but significantly higher than the goals set by all of the diabetes associations. Given data on control and complications,[6,7] the protocol called for medication adjustment in all groups using the National Institute for Clinical Excellence guidelines. There are no details of whether therapy was altered, but there was no significant change in hemoglobin A1c in any of the groups. It appears that there was little actual attempt to alter therapy.

2. The patients had little ability to alter their fate. Patients were given a session on motivation and the experimental group was taught to alter their behavior based on their blood glucose monitoring, but it is unclear whether they received sufficient education about diabetes and therapy. The only behaviors they were allowed to alter, however, were diet, exercise, and medication compliance. The average patient in this study had diabetes for an average of 3 years and 70% were on one or more oral agents. Patients were not allowed to increase their medication dose or to titrate themselves to a target.

3. The amount of monitoring was insufficient. Patients monitored less than once daily at the start of the study. Half of the patients had given up monitoring by the end of the study. Even this amount of monitoring may have been overstated by patient falsification, as data were taken from logbooks rather than from meter memory.[8] Occasional random blood glucose values are not likely to correlate well with medications, meals, or exercise, and trying to use these inconsistent data to alter behavior must have been very frustrating for the patients, causing them to stop monitoring.

4. The study may have been underpowered for the result expected. There was a much greater fall in hemoglobin A1c in both groups that performed monitoring compared to the control group that did not monitor. The study was powered at an 80% probability to reach a $p < 0.05$, but because half of the patients stopped monitoring, it was almost certainly underpowered (for the question of the role of SMBG).

One could easily argue that the results of this study show that an inadequate amount of monitoring, coupled with inadequate training and inadequate attention to medication, does not lead to better diabetes control. Perhaps what we need in these patients is more monitoring, better understanding of their disease and medications, and intensive management by the health care system.

As a result, we are left with the conclusion that SMBG in type 2 diabetes is critical for insulin-treated patients, it is important for patients who are not well controlled, and its role in the well-controlled patient is still unclear.

References:

1. Herman WH, Eastman RC. The effects of treatment on the direct costs of diabetes Diabetes Care. 1998 Dec;21 Suppl 3:C19-24.

2. American Diabetes Association. Position statement: tests of glycemia in diabetes. Diabetes Care. 2004;27(Suppl 1):91-3.

3. Harris MI; National Health and Nutrition Examination Survey (NHANES III). Frequency of blood glucose monitoring in relation to glycemic control in patients with type 2 diabetes. Diabetes Care. 2001 Jun;24(6):979-82.

4. Blonde L, Ginsberg BH, Horn S, Hirsch IB, James B, Mulcahy K, Nettles A, Smout R, Wright H. Frequency of blood glucose monitoring in relation to glycemic control in patients with type 2 diabetes. Diabetes Care. 2002 Jan;25(1):245-6.

5. Farmer A, Wade A, Goyder E, Yudkin P, French D, Craven A, Holman R, Kinmonth AL, Neil A. Impact of self monitoring of blood glucose in the management of patients with non-insulin treated diabetes: open parallel group randomised trial. BMJ. 2007 Jul 21;335(7611):132.

6. The DCCT Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med. 1993 Sep 30;329(14):977-86.

7. The UKPDS Research Group. Intensive blood-glucose control with sulfonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes. Lancet. 1998 Sep 12;352(9131):837-53.

8. Mazze RS, Shamoon H, Pasmantier R, Lucido D, Murphy J, Hartmann K, Kuykendall V, Lopatin W. Reliability of blood glucose monitoring by patients with diabetes mellitus. Am J Med. 1984 Aug;77(2):211-7.