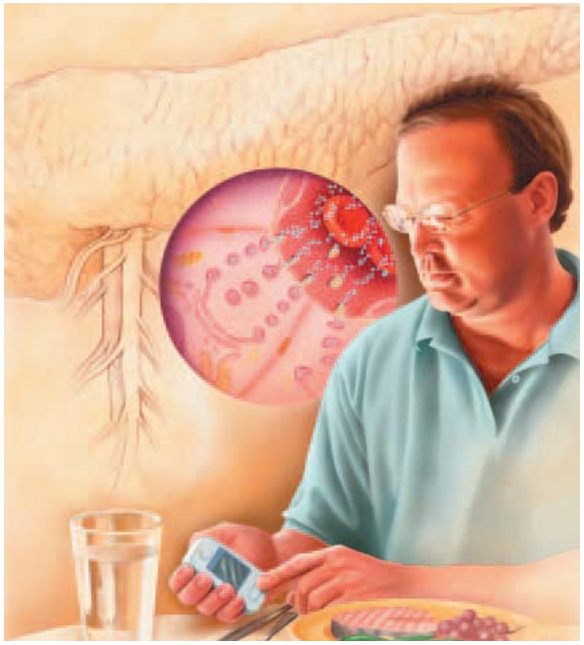
Managing Type 2 Diabetes in the Primary Care Setting: *The Importance of Self-Monitoring of Blood Glucose (SMBG)*



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Diabetes is a serious disease with far-reaching consequences.[1,2] In 2002, the disease and its complications cost the United States about $132 billion. Direct costs had doubled since 1997 and costs are expected to continue to increase. Type 1 and type 2 diabetes currently affect over 18 million Americans, or 6.3% of the population.[3] Additionally, an estimated 5.2 million people remain undiagnosed, and more than 40 million Americans have pre-diabetes, a precursor condition characterized by plasma glucose levels that are above normal but below the values diagnostic of diabetes.[3,4] Primary healthcare professionals will care for the majority of the dramatically enlarging type 2 diabetes patient population, ranging from teenagers to the elderly. They face a tremendous challenge in diagnosing and managing patients with type 2 diabetes in order to reduce the risk of costly, life-threatening complications, and help their patients maintain a high quality of life.

What Contributes to the Development Of Diabetes?

Unlike type 1 diabetes, which is associated with a marked deficiency of insulin, patients with type 2 diabetes have two defects. They have at least a relative deficiency of insulin secretion, but they also have a resistance to the action of both endogenous and exogenous insulin. The insulin resistance has both genetic and acquired components. Other than a few rare mutations, the common forms of the genetic abnormalities are largely unidentified. Acquired insulin resistance is related to overeating and the resultant obesity, physical inactivity, aging, illness, some medications, and other factors. The insulin resistance is often accompanied by abnormalities such as hypertension, central obesity, a characteristic dyslipidemia with high triglycerides, low HDL, and the presence of smaller denser and more atherogenic LDL particles and high levels of PAI1, as well as other indications of a hypercoagulable state. Thus, these patients often have multiple components of the insulin resistance or metabolic syndrome.[5]

The Importance of Glycemic Control

Appropriate treatment of type 2 diabetes requires addressing all abnormalities in

Learning Objectives

Upon completion of this course, you should be able to:

- Discuss the current prevalence of type 2 diabetes
- Summarize the current guidelines for glycemic control in patients with type 2 diabetes
- Describe the ability of self-monitoring of blood glucose (SMBG) to empower patients and facilitate improved glycemic control

For information on how to earn CME/CE credit, see inside front cover. To view disclosure information, see page 5.

Participation in this self-study activity should be completed in about 1 hour.

Course ID: AB0333

TABLE 1. SUMMARY OF DIABETES RISK-REDUCTION TRIALS

TRIAL	MEASURE EVALUATED	RELATIVE RISK REDUCTION IN EYE DISEASE	RELATIVE RISK REDUCTION IN KIDNEY DISEASE	RELATIVE RISK REDUCTION IN CARDIOVASCULAR DISEASE
UK Prospective Diabetes Study	A1C reduction of 0.9%; blood pressure of 144/82 mm Hg compared with average blood pressure of 154/87 mm Hg	Retinopathy, 21% Cataract extraction, 24% Retinopathy progression, 34% Vision deterioration, 47%	Albuminuria, 33% N/A	Myocardial infarction, 16% Stroke, 44% Heart failure, 56%
Hypertension Optimal Treatment Study	Diastolic treatment goal: 80 mm Hg	N/A	N/A	Cardiovascular events, 51%
Heart Outcomes Prevention Evaluation Study	Ramipril in patients with diabetes	N/A	N/A	Stroke, myocardial infarction, or cardiovascular death, 25% to 30%
Captopril Prevention Project	Captopril in patients with diabetes	N/A	N/A	Cardiovascular death, 48%

Reprinted with permission from Gavin JR III, Peterson K, Warren-Boulton E. Reducing cardiovascular disease risk in patients with type 2 diabetes: a message from the national diabetes education program. *Am Fam Phys*. 2003;68(8):1569-1578.

TABLE 2. SUMMARY OF RECOMMENDATIONS FOR ADULTS WITH DIABETES

GLYCEMIC CONTROL	
AIC	<7.0%*
Preprandial plasma glucose	90–130 mg/dL (5.0–7.2 mmol/l)
Postprandial plasma glucose†	<180 mg/dL (<10.0 mmol/l)
Blood pressure	<130/80 mm Hg
LIPIDS‡	
LDL	<100 mg/dL (<2.6 mmol/l)
Triglycerides	<150 mg/dL (<1.7 mmol/l)
HDL	>40 mg/dL (>1.1 mmol/l)§

Key concepts in setting glycemic goals:

- Goals should be individualized
- Certain populations (children, pregnant women, and elderly) require special considerations
- Less intensive glycemic goals may be indicated in patients with severe or frequent hypoglycemia
- More stringent glycemic goals (i.e., a normal A1C, <6%) may further reduce complications at the cost of increased risk of hypoglycemia (particularly in those with type 1 diabetes)
- Postprandial glucose may be targeted if AIC goals are not met despite reaching preprandial glucose goals

*Referenced to a non-diabetic range of 4.0%–6.0% using a DCCT-based assay. †Postprandial glucose measurements should be made 1–2 h after the beginning of the meal, generally peak levels in patients with diabetes. ‡Current NCEP/ATP III guidelines suggest that in patients with triglycerides >200 mg/dL, the "non-HDL cholesterol" (total cholesterol minus HDL) be utilized. The goal is <130 mg/dL. §For women, it has been suggested that the HDL goal be increased by 10 mg/dL.

Adapted from the American Diabetes Association.[14]

EBCME

Practice Recommendation: Lowering glycated hemoglobin (A1C) has been associated with a reduction in microvascular and neuropathic complications of diabetes.

Source of Evidence: Standards of medical care in diabetes. *Diabetes Care*. 2004 Jan;27(suppl 1):S15-35.

Strength of Evidence A

Web Site: www.guideline.gov/summary/summary.aspx?ss=15&doc_id=4679&nbr=3413

order to reduce the associated microvascular (eye and kidney disease), neurologic, and macrovascular complications. Patients need therapy aimed at achieving recommended targets for increased blood pressure and dyslipidemia in addition to hyperglycemia if complications are to be averted (Table 1).[6-13]

A key component of good management is glycemic control. The American Diabetes Association (ADA) advocates a goal A1C of <7%. The latest ADA Standards of Care indicate that more stringent goals (Table 2) (i.e., a normal A1C of <6%) can be considered in individual patients.[14] The American College of Endocrinology (ACE) advocates a target of ≤6.5%.[15] Ideally, one should strive for A1C values as close to normal as can be achieved without an unacceptable incidence of adverse events, especially hypoglycemia, because there is no evidence for a glycemic threshold for diabetic complications. Obviously, all goals should be individualized and certain populations, including children, pregnant women, and the elderly, require special considerations. Less intensive glycemic goals may well be indicated in those with or at risk for severe or frequent hypoglycemia.

Benefits of Glycemic Control

Achieving glycemic goals established by the ADA, ACE, and other organizations will significantly reduce the risk of microvascular disease, and there is increasing evidence that it will also

reduce macrovascular complications in type 1 and type 2 diabetes patients. The epidemiologic analysis of the landmark United Kingdom Prospective Diabetes Study (UKPDS) of individuals with type 2 diabetes demonstrated that for each 1 percentage-point reduction in A1C, there was a 14% reduction in myocardial infarction and all-cause mortality, a 21% reduction in diabetes-related death, and a 37% reduction in microvascular disease.[7] In UKPDS 35, the risk of diabetic complications was strongly associated with previous hyperglycemia. Thus, the benefits of glycemic control are well-demonstrated.

Exercise 1

Which of the following is correct regarding optimal glycemic control of diabetes?

a. Optimal glycemic control means maintaining blood glucose levels as close to non-diabetic levels as possible without an unacceptable incidence of adverse events like hypoglycemia
b. Optimal glycemic control is likely to reduce the risk of macrovascular complications in type 1 and type 2 diabetes patients
c. Optimal glycemic control has been shown to reduce the risk of eye, kidney, and nerve complications of diabetes
d. All of the above

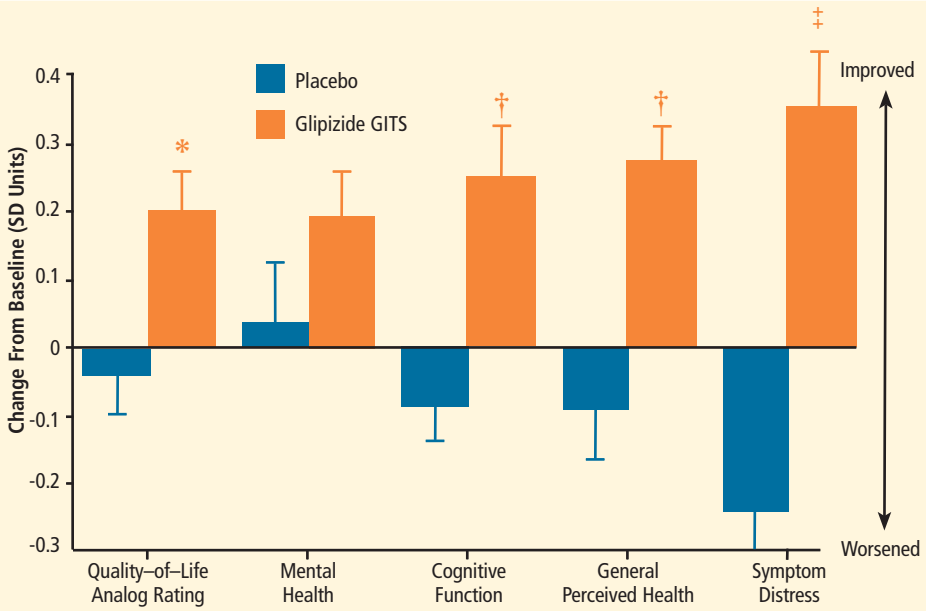
Answer on page 24.

How Do We Achieve Glycemic Targets?

A recent study assessing NHANES 2000 data noted that only 37% of participants with diabetes achieved an A1C of <7%, and 37% were above 8%.[16] This finding is discouraging—especially given the dramatic increase in the number of people with diabetes—and suggests that the burden of both micro- and macrovascular complications will increase, adversely affecting the national healthcare picture. There are likely many factors contributing to the failure of many people with diabetes to achieve glycemic targets:

- Physicians and other primary healthcare professionals often have time constraints and competing priorities during visits
- Patients may have difficulty adhering to recommendations for lifestyle changes, medications, or performance of SMBG
- Insurers sometimes fail to adequately support self-monitoring at a frequency that provides a complete picture of glucose levels
- In the management of type 2 diabetes, physicians and patients may be reluctant to initiate insulin therapy when it is needed

FIGURE 1. IMPROVEMENT IN QUALITY-OF-LIFE ENDPOINTS



Mean changes from baseline to week 15 for the global scales of quality-of-life for patients randomized to diet and placebo or diet and glipizide gastrointestinal therapeutic system (GITS).

* indicates $P<.05$; † indicates $P<.01$; and ‡ indicates $P<.001$.

Source: Testa MA, Simonson DC. Health, economic benefits, and quality of life during glycemic control in patients with type 2 diabetes mellitus. *JAMA*. 1998;280:1490-1496.

Monitoring Therapy: A1C and Self-Monitoring of Blood Glucose (SMBG)

Assessment of glycemia is obviously a crucial component of optimal diabetes care. A1C levels provide the "big picture" and correlate with end-organ impact; they have been used as a surrogate for the development of complications. SMBG values are also important and provide the day-to-day data on patterns of glycemia that are used to select and manage antihyperglycemic therapy. Thus, SMBG allows the design and implementation of treatment programs that more closely mimic the non-diabetic physiology.

Current SMBG recommendations for patients with type 1 diabetes are explicit and are based on the research protocols of the DCCT and the Stockholm Diabetes Intervention Study.[8,17] For many years, there were no widely accepted guidelines for patients with type 2 diabetes and, for the most part, decisions were left up to the treating physician.

The ADA recommendations on SMBG include the following statements: "SMBG is an integral component of diabetes therapy and it should be included in the management plan. Clinicians are advised to instruct the patient in SMBG and routinely evaluate the patient's technique and ability to use data to adjust therapy. Frequency and timing of SMBG should be dictated by the particular needs and goals of the patients. Daily SMBG is especially important for patients treated with insulin to monitor for and prevent asymptomatic hypoglycemia. For most patients with type 1 diabetes and pregnant women taking insulin, SMBG is recommended 3 or more times daily." The ADA indicates that optimal frequency and timing of SMBG for patients with type 2 diabetes is not known but should be sufficient to facilitate reaching glucose goals. When adding to or modifying therapy, type 1 and type 2 diabetic patients should test more often than usual.[14]

Recently, an AAFP Panel on Self-Monitoring of Blood Glucose, a group that included experts in diabetes care, epidemiology, and family medicine, addressed this need and published their findings in a monograph.[18] The panel made the following recommendations about the

frequency of SMBG in patients with type 2 diabetes. Patients who use multiple daily injections of insulin should perform SMBG as often as those who have type 1 diabetes (at least three times per day). Many patients taking oral antidiabetic agents who have not achieved their A1C goal may require SMBG multiple times per day (two to four). The SMBG monograph also recommends:

- All patients who have diabetes should own a glucose meter and know how to use it
- Patients whose diabetes is not well-controlled should test multiple times per day for several days to produce sufficient data for clinical decision-making

SMBG provides the most reliable data to assess the combined effect of medications, diet, exercise, and physiology on patients' daily glycemia. SMBG also provides important feedback that may motivate patients to better adherence.

Exercise 2

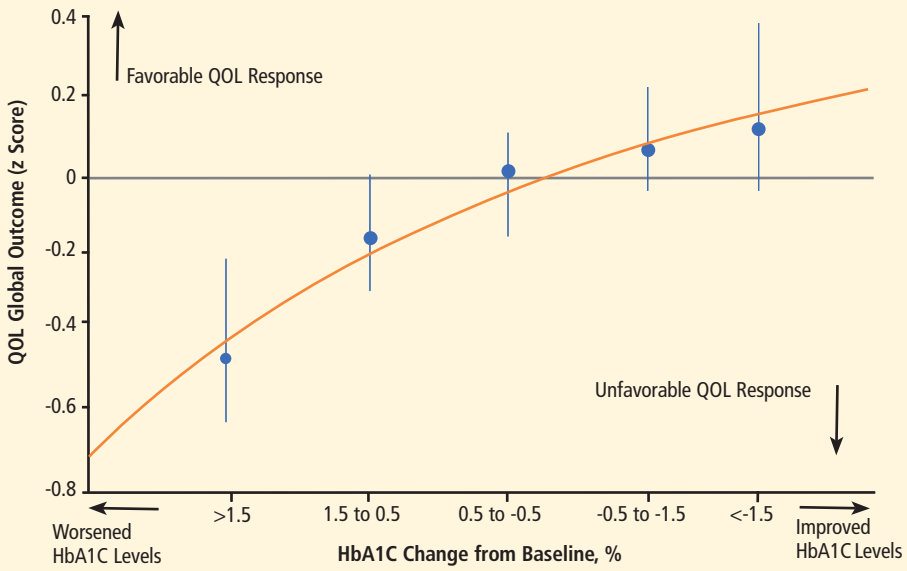
Which of the following suggestions were made by the AAFP Panel on Self-monitoring of Blood Glucose?

a. All patients who have diabetes should own a glucose meter and know how to use it
b. Type 2 diabetes patients who use multiple daily injections of insulin should perform SMBG as often as those who have type 1 diabetes (at least three times per day)
c. Many type 2 diabetes patients taking oral antidiabetic agents who have not achieved their A1C goal may require SMBG multiple times per day (two to four)
d. All of the above

Answer on page 24.

There is increasing evidence for the benefit that can be accrued from the performance of SMBG. A report of 24,312 adults with diabetes in a large, group-model managed care organization (MCO) noted that those with type 1 diabetes who performed SMBG three or more times per day and those with pharmacologically treated type 2 patients who performed SMBG one or more times per day had A1C levels that were 1% and 0.6% less, respectively, than those who performed less frequent monitoring ($P<0.0001$).[19] Even those with nonpharmacologically treated type 2 diabetes who practiced SMBG (at any frequency) had a 0.4 percentage point lower A1C level than those not practicing at all ($P<0.0001$).

FIGURE 2. RELATIONSHIP BETWEEN IMPROVEMENTS IN A1C AND QUALITY OF LIFE



Calibration of baseline to week 15 change in the quality-of-life (QOL) global outcome factor scores to change in hemoglobin A1C (HbA1C) expressed as 5 categories. Coordinates shown are mean (±SE) QOL change scores within each HbA1C change category with corresponding log-linear fitted function for the 5 mean coordinates ($P<.001$). Full regression sum of squares for QOL changes as a function of actual change in HbA1C was statistically significant at $P=.008$.

Source: Testa MA, Simonson DC. Health, economic benefits, and quality of life during glycemic control in patients with type 2 diabetes mellitus. *JAMA*. 1998;280:1490-1496.

Schwedes and colleagues[20] showed that meal-related (pre- and 1-hour postprandial) SMBG within a structured counseling program improved glycemic control in individuals with non–insulin-treated type 2 diabetes. Self-monitoring also resulted in a marked improvement of general well-being, with significant improvements in the subitems of depression ($P<0.032$) and lack of well-being ($P<0.02$).

Quality of Life and Economic Benefit Of Improved Glucose Control

It's logical to assume that improved glucose control leads to improved quality of life. The advent of new oral agents and the development of better tools for SMBG have prompted studies of both quality of life and economic benefit.

One measure of quality of life would be the delay or prevention of long-term complications, as shown by the DCCT and UKPDS. But Testa and Simonson[21] have shown that quality of life can also be improved by alleviating the short-term symptoms of hyperglycemia. In this randomized, placebo-controlled study, the quality of life and economic benefit—in terms of lost workdays, bed days, and restricted activity days, were compared between a group using placebo and diet to control glucose levels and a group using the glipizide gastrointestinal therapeutic system (GITS) and diet. The better control attained from glipizide GITS produced a clear advantage in quality-of-life endpoints (Figure 1).

Quality of life rises with A1C improvements from baseline (Figure 2). The economic impact of improved glycemic control is also clear. At the beginning of the study, health-related absenteeism, bed days, and days of restricted activity were similar between the placebo and glipizide GITS groups. As glycemic control improved over time in the glipizide GITS group, differences became apparent in all endpoints, including productivity and retention of employment.

In considering economic benefit, we should also look at the overall cost of

treatment. The same study showed that improved glycemic control reduced the use of non–study-related healthcare services resulting in a savings of $11 per month per patient.

In a cost-effectiveness study from the UKPDS, the cost of intensive treatment (sulfonylureas and insulin) versus conventional treatment (diet alone) in type 2 diabetes patients was weighed against the cost of treating complications.[22] Intensive control increased treatment cost by £695 per patient over the course of the study. However, this was offset by a reduction in the cost of complications of £950 per patient, indicating an economic benefit to improved control. Additionally, intensive control netted a mean of 1.14 event-free years over a patient's lifetime.

Another study by Testa and Simonson[23] demonstrated that variability in daily QOL ratings of an individual with diabetes was explained by both the absolute level and the day-to-day variation in blood-glucose levels. This study provides additional evidence of the benefits of both improving A1C values and reducing fluctuations in daily glucose profiles. This cannot be achieved without the regular performance of SMBG and utilization of the resultant values to adjust therapy.

ADA preprandial and peak postprandial plasma-glucose goals are 90 to 130 and <180 mg/dL, respectively.[14] ACE advocates for preprandial and 2-hour postprandial values of <110 mg/dL and <140 mg/dL, respectively.[15]

Home Glucose Meters and Software

In the U.S., there is a wide choice of home glucose meters from more than a dozen manufacturers. While older devices were more difficult to use, current meters are fully automatic and require only a drop of peripheral blood from the patient. Some of the newest meters, such as the OneTouch Ultra, take only 5 seconds to provide a result, require only a 1-µL blood sample, and its strips automatically draw up blood by capillary action and indicate to the user if the sample is adequate.

Meters provide glucose values calibrated to either whole blood or plasma, but not both. Plasma values are higher than whole blood values, so it is incumbent on patients and their providers to know to which their unit is calibrated. Plasma calibration is more easily compared with laboratory methods. Meters can also report glucose levels either in milligrams/deciliter or millimoles/liter. Plasma glucose is rapidly becoming the preferred standard and, in the U.S., glucose levels are most commonly presented in mg/dL.

Meters employ one of two technologies:

- Reflectance Photometry: the meter measures light reflected from the strip. Increasing glucose concentrations produce increasing amounts of dye resulting in less light reflected. The meter then uses custom algorithms to convert this signal into glucose results.
- Electrochemical measurements are made when current is generated by the glucose in the solution being tested. Increasing glucose concentrations produce increasing currents that are measured by the meter. Custom algorithms are used to convert the measured current into glucose results.

Meters should be chosen on the basis of the following criteria:

- Accuracy: Manufacturers may calibrate meters using different reference standards, but should correlate with the reference method
- Precision: How reproducible are the results of each meter
- Reliability: How consistent are repeated results with multiple test strips
- Ease of use: In general, the fewer demands made on the user, the better and the more likely patients will be to use the meter
- Safety: A meter should accept strips designed exclusively for it; some meters will reject out-of-date test strips and test solutions
- Memory and data management: Result storage and download capabilities maximize the value of monitoring data
- Power: Meters should use commonly available batteries and have low-battery indicators
- Durability: Construction should be strong enough to survive typical use and abuse
- Ease of maintenance: Meters should be easy to clean and disinfect, if necessary

Exercise 3

There is a wide choice of home glucose meters available in the marketplace today. Which of the following is not an accurate statement about meters?

a. Meters employ one technology: absorptive photometry
b. Meters provide glucose values calibrated to either whole blood or plasma, but not both
c. Meters can report glucose levels either in milligrams/deciliter or millimoles/liter
d. Newer meters are fully automatic and need only a drop of peripheral blood

Answer on page 24.

Problems with meters often lie more with users than with the units themselves. Patients must be thoroughly trained in cleaning and lancing the skin to obtain a small amount of blood, applying it to the test strip, and reading the results. They must make sure not to reuse strips, use outdated strips, or expose test strips to adverse humidity and temperature conditions. Control solutions are available for patients to verify that the strips have not deteriorated. Physicians must also recognize that patients sometimes report lower values than their meter reveals, either because they don't remember the value or they "fudge" the value because they want to please the provider. The vast majority of modern meters have memory and download capabilities.

Exercise 4

There are a number of possible problems that arise with meters. Which of the following are true statements?

a. Problems with meters lie mainly with the units themselves
b. Patients must be thoroughly trained in cleaning and lancing the skin to obtain a small amount of blood, applying it to the test strip, and reading the results
c. Patients sometimes report lower values than their meters indicate
d. Careful handling of test strips is necessary in order to get an accurate reading from the meter

Answer on page 24.

ECRI, a nonprofit agency that evaluates all health devices—from disposables to complex anesthesia machines—has a 2002 review of home blood glucose meters that compares all available units according to a comprehensive list of relevant parameters. You can contact the ECRI Healthcare Product Comparison System Hotline at 610-825-6000, ext. 5265; 610-834-1275 (fax); or hpcs@ecri.org.

Minimally Invasive and Noninvasive Monitors

Currently there are two such devices approved for use in the U.S.:

- Medtronic MiniMed's Continuous Glucose Monitoring System (CGMS), using a sensor implanted just under the skin, measures glucose levels every 5 minutes over a 72-hour period, after which time, data must be downloaded into a computer. Currently, this device cannot provide glucose reading in real time, and data cannot be viewed until it is downloaded.
- Cygnus GlucoWatch Biographer. Worn like a wristwatch, this device uses a noninvasive method to extract glucose containing interstitial fluid through the skin using an applied electrical potential (a process known as reverse iontophoresis). Glucose in the extracted sample is measured using an electrochemical enzymatic sensor. It requires some time for the device to warm up and it can then provide 6 glucose measurements per hour for up to 13 hours. The GlucoWatch displays data that the wearer can read in real time as it is obtained.

Neither the CGMS nor the GlucoWatch is currently approved for use alone, but rather should be used to supplement and support data obtained from a conventional glucose meter.

Glucose Monitoring Software

Computer software available for modern meters allows blood glucose data to be organized and structured into information that individuals with diabetes and healthcare professionals can analyze and synthesize to facilitate adjustments in therapy and improve glycemic control. These programs can average all readings and in some cases do so by time of day, day of the week, or meal period. The software can plot graphs and create charts of glucose trends over time.

Some newer meters can show blood glucose averages by time of day for the past several days and present the information to users without requiring downloading to a computer. Individuals who take insulin can have information immediately available to guide insulin adjustments. Some meters allow the entry of additional data, such as insulin doses administered, meals or snacks eaten, grams of carbohydrates consumed, and physical activity.

Reimbursement Issues

Most healthcare insurance providers reimburse the cost of meters and test strips. The only significant issue is the frequency of monitoring they support, since the test strips represent an ongoing expense. Reimbursement is variable among different insurers. Some insurance providers cover strips for only one glucose reading a day for non–insulin-using type 2 patients. A single daily reading (or fewer) will be inadequate for many patients with type 2 diabetes to achieve control. This is especially true for many newly diagnosed patients and those who have not yet achieved their glycemic targets and who are modifying their therapy. The AAFP SMBG monograph notes that many patients taking oral antidiabetic agents who have not achieved their A1C goal may require SMBG multiple times per day (two to four).[18]

Motivating Your Patients

Diabetes is a serious, complicated disorder that is increasing at epidemic proportions. Patients and healthcare professionals often find treatment to be complex and challenging. Diabetes self-management training is one of the most critical components of care and is often associated with enhanced adherence. Self-management of diabetes requires knowledge of the disease, the treatment options, and the relationship between glucose levels, diet, weight, and exercise. There are many other educational needs, including learning how to perform SMBG and to use the data obtained appropriately. Primary healthcare professionals can provide their patients with needed education through referral to certified diabetes educators, registered dietitians, and other certified nutritionists, preferably working in a team diabetes education program that has achieved ADA Recognition.

Motivational models abound in the literature. The most important ones focus on a collaborative effort between patients and their healthcare professionals. Such models give significant responsibility to patients and a number of studies suggest that the resultant patient empowerment enhances adherence.

From a psychological perspective, patient empowerment fits the model proposed by self-determination theory,[24] which focuses on the fact that people feel better when they perceive that they're more in charge of their own destiny. They feel powerful and important, and validated for their successes. Consequently, primary care professionals should try to motivate patients by communicating that their own efforts can have a major positive impact on their healthcare outcomes.

Exercise 5

Which of the following is true about motivating patients with diabetes?

a. Management of the patient's diabetes should be viewed by the physician as a collaborative effort
b. Studies suggest that patient empowerment is a key to adherence
c. Both a and b
d. Neither a nor b

Answer on page 24.

Conclusions

Type 2 diabetes is dramatically increasing in incidence and prevalence. Primary healthcare professionals will continue to need to provide the majority of care for the increasing numbers of patients with this disorder. In order to help meet this challenge, they should focus on the following key points:

- Achieving ADA and/or ACE targets for glycemic control can reduce complications in patients with type 2 diabetes just as it can for those with type 1 disease
- All patients with diabetes should receive diabetes education focused on self-management training
- Regular monitoring of both A1C and SMBG will be required for patients to achieve optimal glycemic control
- All patients should be taught how to perform SMBG and how to interpret and use the results to improve glycemic control
- Physicians should obtain and use software designed to analyze SMBG readings; such software can also be of value to many patients
- SMBG empowers patients, provides necessary feedback, and increases the likelihood of success ■

For More Information Visit These Web Sites:

American Academy of Family Physicians (AAFP)
www.aafp.org

American Association of Clinical Endocrinologists
www.aace.com

American Association of Diabetes Educators (AADE)
www.aadenet.org

American College of Physicians
www.acponline.com

American Diabetes Association (ADA)
www.diabetes.org

Centers for Disease Control and Prevention (CDC)
www.cdc.gov/diabetes

Diabetes Complications and Control Trial (DCCT) bibliography
www.bsc.gwu.edu/bsc/studies/dcct.html

Diabetes Prevention Program (DPP)
www.diabetes.niddk.nih.gov/dm/pubs/preventionprogram

Food and Drug Administration (FDA) information on glucose meters
www.fda.gov/diabetes/glucose.html#12

Juvenile Diabetes Research Foundation
www.jdf.org

National Diabetes Education Program (NDEP)
www.ndep.nih.gov

National Diabetes Information Clearinghouse
www.diabetes.niddk.nih.gov

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Answers

Exercise 1

Which of the following is correct regarding optimal glycemic control of diabetes?

a. Optimal glycemic control means maintaining blood glucose levels as close to non-diabetic levels as possible without an unacceptable incidence of adverse events like hypoglycemia
b. Optimal glycemic control is likely to reduce the risk of macrovascular complications in type 1 and type 2 diabetes patients
c. Optimal glycemic control has been shown to reduce the risk of eye, kidney, and nerve complications of diabetes
d. All of the above

Answer: d. Research has shown that improved glycemic control can significantly reduce the development and/or progression of complications in patients with both type 1 and type 2 diabetes.

Exercise 2

Which of the following suggestions were made by the AAFP Panel on Self-monitoring of Blood Glucose?

a. All patients who have diabetes should own a glucose meter and know how to use it
b. Type 2 diabetes patients who use multiple daily injections of insulin should perform SMBG as often as those who have type 1 diabetes (at least three times per day)
c. Many type 2 diabetes patients taking oral antidiabetic agents who have not achieved their A1C goal may require SMBG multiple times per day (two to four)
d. All of the above

Answer: d. The achievement of optimal control requires an active cooperative effort to balance medications and lifestyle changes, guided by a comprehensive understanding of what is happening with the individual patient's blood glucose levels. This understanding comes primarily from test results; the more data points included, the more complete the picture.

Exercise 3

There is a wide choice of home glucose meters available in the marketplace today. Which of the following is not an accurate statement about meters?

a. Meters employ one technology: absorptive photometry
b. Meters provide glucose values calibrated to either whole blood or plasma, but not both
c. Meters can report glucose levels either in milligrams/deciliter or millimoles/liter
d. Newer meters are fully automatic and need only a drop of peripheral blood

Answer: a. Meters employ one of two technologies:

- Reflectance Photometry: the meter measures light reflected from the strip. Increasing glucose concentrations produce increasing amounts of dye resulting in less light reflected. The meter then uses custom algorithms to convert this signal into glucose results.
- Electrochemical measurements are made when current is generated by the glucose in the solution being tested. Increasing glucose concentrations produce increasing currents that are measured by the meter. Custom algorithms are used to convert the measured current into glucose results.

Exercise 4

There are a number of possible problems that arise with meters. Which of the following are true statements?

a. Problems with meters lie mainly with the units themselves
b. Patients must be thoroughly trained in cleaning and lancing the skin to obtain a small amount of blood, applying it to the test strip, and reading the results
c. Patients sometimes report lower values than their meters indicate
d. Careful handling of test strips is necessary in order to get an accurate reading from the meter

Answer: b, c, d. Problems with meters are more likely to be related to the way patients use them than due to the units themselves. To ensure data reliability, physicians should recommend meters with memory and download capabilities.

Exercise 5

Which of the following is true about motivating patients with diabetes?

a. Management of the patient's diabetes should be viewed by the physician as a collaborative effort
b. Studies suggest that patient empowerment is a key to compliance
c. Both a and b
d. Neither a nor b

Answer: c. No one has discovered the secret to universal patient motivation. What works well for one patient may not work with another, or may even have an adverse reaction. Diabetes education should be provided to every diabetic patient and can contribute to improved adherence. Management of a chronic illness like diabetes should be a collaborative effort, in which the patient and the healthcare professional are partners. As a collaborative effort, diabetes management puts great responsibility on the patient, and a number of studies suggest that patient empowerment is one key to good adherence.

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