Pattern Management: The Key to Excellent Glycemic Control is supported by an educational grant from Novo Nordisk Inc. It has been accredited by the American Association of Diabetes Educators (AADE) for nurses, dietitians, and pharmacists.
The following program is a recorded presentation by Jerry Meece.

Jerry Meece is owner and Director of Clinical Services of Plaza Pharmacy and Wellness Center in Gainesville, Texas, one of the first freestanding pharmacies in the country to achieve Provider Education Recognition from the American Diabetes Association.

In addition to serving on numerous consultant and advisory boards for health care and pharmaceutical companies, he has served on the Board of Directors for the American Association of Diabetes Educators and was elected to their Executive Board in the position of Vice President.

Mr. Meece speaks both nationally and internationally on the subject of diabetes and clinician/patient behavior in the health care setting. He has also written many articles on diabetes care and insulin use in the patient with diabetes.

Mr. Meece has won many awards including the Innovative Practice Award by the Texas Pharmacy Association, the Legislative Leadership Award by the American Association of Diabetes Educators, and the Individual Educational Excellence Award by the Texas Pharmacy Association.

We will now join Mr. Meece.
After completing this activity, participants should be better able to:

• Describe how pattern management can be used as a powerful, practical tool for optimizing blood glucose control

• Design a blood glucose monitoring plan to help patients interpret their blood glucose data to perform self-management of their blood sugars

• Discuss actions that could be taken in response to the interpretation of blood glucose patterns

• Summarize the ways in which blinded and real-time continuous glucose monitoring (CGM) can assist selected patients with pattern management
Pattern management is the systematic process of keeping blood glucose (BG) levels at individualized targets by identifying the relationship between BG values and patient behaviors and acting on this knowledge to improve glycemic control.¹,²

This process is also referred to as "pattern analysis," "pattern recognition," and "structured self-management of blood glucose" (SMBG).²,³


Pattern management can begin once the patient knows his or her individualized target preprandial and postprandial BG ranges. Next the patient gathers several days of data on BG levels, food intake, physical activity levels, medication doses, and stressors, such as acute illness or family problems. Then the patient, initially with the help of a health care provider and then independently, looks for patterns and assesses possible relationships between BG levels and behavior, such as elevated levels after several days of physical inactivity.

Once patterns are recognized, the patient determines whether suboptimal BG levels are caused by food or activity-related choices, medication doses, or unusual stressors.

Based on this determination, the patient either follows the current regimen more consistently or makes necessary changes to the regimen, often in incremental steps.

There are several reasons why pattern management (PM) is a powerful, practical tool for optimizing BG control. PM is a proactive, rather than a reactive, approach to BG management. Its aim is to keep problems, such as major glucose excursions, from recurring.

Pattern management is a comprehensive process that takes into account the many factors that affect glycemic control.

Sophisticated monitoring devices, such as BG meters with elaborate functionality and continuous glucose monitors, can be used for pattern management, but effective pattern management can be performed with any accurate BG monitor that the patient can use correctly and a paper log that the patient completes consistently and accurately.

Pattern management promotes diabetes self-management and patient engagement. It combats clinical inertia—the failure to intensify therapy when indicated—by empowering the patient to be a full partner in his or her own care.

Pattern management is often used by people who take insulin, but it is also a powerful tool for those who take other glucose-lowering medications or control their BG levels by lifestyle modification alone.

It is a tool that helps both the patient and provider “play detective” and helps them problem solve why an A1C level may be high (when the few SMBG numbers they do have are within target), or why BG levels may run higher (or lower) than target and what actions can be taken to bring them back to target.

Effective pattern management depends on the presence of several patient or caregiver characteristics. These include regular performance of SMBG or a willingness to increase the frequency of SMBG to assess the treatment plan, willingness to perform pattern management, intact cognitive function, health literacy, a sound knowledge of diabetes self-care skills and behaviors, and solid problem-solving skills.

Pattern management can be a short-term tool that helps a patient who checks fasting readings only to identify the discrepancy between in-range fasting readings and an elevated A1C level.

SELF-MANAGEMENT OF BLOOD GLUCOSE
The accurate measurement and recording of BG values is a prerequisite for pattern management.

BG data are obtained by performing SMBG at prespecified times for a prespecified number of days. In selected patients, SMBG data are supplemented by continuous glucose monitoring (CGM) data. Later in this activity, we will discuss the patient populations who are most likely to benefit from CGM.

Paper or electronic logs are used to record BG data and data pertaining to lifestyle (eg, food, physical activity, medication, stressors). We will discuss the preparation of logs later in this activity.
It is generally agreed that daily SMBG is essential for all patients with type 1 diabetes and patients with type 2 diabetes who take insulin.\textsuperscript{1–3}

However, there are divergent opinions about the value of SMBG in patients with type 2 diabetes who do not take insulin.\textsuperscript{1,4,5} Some experts consider SMBG in this population to be an inappropriate use of resources.\textsuperscript{5} The American Diabetes Association (ADA),\textsuperscript{1} American Association of Clinical Endocrinologists (AACE),\textsuperscript{2} and the International Diabetes Federation (IDF)\textsuperscript{3} recommend that decisions about the use of SMBG be made on a patient-by-patient basis. According to the ADA, the need for SMBG should be re-evaluated at each routine visit to the health care provider.\textsuperscript{1} The IDF recommends that SMBG be used when patients and/or providers have the knowledge, skills, and willingness to make adjustments to the diabetes care plan on the basis of BG data.\textsuperscript{3}


SMBG is effective only if patients have a BG meter that is well suited to their physical capabilities and they understand how to use it correctly. They need to know when to check their BG and why consistent monitoring is important.

If SMBG is to be effective, patients must also know what their BG data mean. They need to understand the relationship between their BG levels and their A1C. Pattern management is especially important for patients who have out-of-range A1C values, although it can also benefit patients whose A1C is within range.

Additionally, patients need to know how to respond to out-of-range SMBG values.

Common SMBG Problems

- False low BG results possible
  - Sensor strip not fully inserted
  - Not enough blood applied to strip
  - Fingertip squeezed too hard
- False high results possible
  - Sample site contaminated with glucose source
- False high or low results possible
  - Test strips or control solution damaged

All patients who will be performing SMBG should receive SMBG education, and health care providers should reevaluate their patients’ SMBG technique periodically.\(^1\) Technical errors and some medical conditions can result in inaccurate BG readings, even if the meter itself is functioning properly.\(^2\)

False low BG results can occur if the sensor strip is not fully inserted into the meter, not enough blood is applied to the test strip, or the fingertip is squeezed too hard because blood is not flowing.\(^2\)

False high results may occur if the sample site is contaminated with a glucose source, such as juice.\(^2\)

Either false high or false low results are possible if test strips or the control solution are damaged.\(^2\)

Although an increased or decreased hematocrit level sometimes led to inaccurate results with older BG meters,\(^2\) newer meters have very wide acceptable hematocrit ranges.

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Health care providers have a number of responsibilities for their patients’ SMBG data. It is important to remember that SMBG provides feedback to patients. It is the provider’s responsibility to reinforce the idea that SMBG is a critical self-management tool.

When patients bring in their records, the provider should begin by praising their efforts. Then, it is important for the provider to ask what the results mean to the patient, clarifying, teaching, and filling in details along the way. Providers must interpret preprandial and postprandial results in the light of individualized BG targets. SMBG data should be analyzed in a nonjudgmental manner.

Providers need to respond to suboptimal SMBG results by adjusting the patient’s lifestyle and/or medication regimen, developing a clear action plan in collaboration with the patient.

Following development of the initial plan, the provider should continue to monitor the patient’s SMBG data on a regular basis, helping the patient to adjust the treatment regimen when needed.

Today, SMBG data can be recorded, analyzed, and transmitted to the health care provider in various ways.

The simplest method is by using a paper log sheet or book. The main advantages of this system are its simplicity and low cost, making it an option for virtually all patients. However, inadvertent or deliberate recording errors are common and the data analysis process is not automated. Furthermore, patients may forget to take their log with them when they visit their health care provider.
Several electronic SMBG recording, analysis, and transmission methods are currently available. In each instance, SMBG data are recorded by the BG meter and analyzed automatically. Analyzed data can be transmitted electronically to the health care provider and, in some cases, printed out.

The first electronic option is to download software provided by the BG meter’s manufacturer from the Internet onto the patient’s computer. The patient can then upload SMBG data into the software program using cable or wireless transmission. Another option is to transmit SMBG data from the BG meter to a central server. From the server, data can be sent automatically to the patient’s computer or smart phone for analysis. Yet another electronic option is to transmit data from the BG meter directly to the patient’s smart phone, either via cable or wirelessly, for analysis.

Advantages of electronic systems are that reporting errors are avoided, data analysis is automated, pattern recognition is facilitated by graphics, and data can be transmitted electronically to the provider. Disadvantages are that computer and smart phone costs are prohibitive for most low-income patients. Many patients, and especially many elderly individuals, lack the interest and expertise to use an electronic system. Initial system set-up is often challenging. Additionally, many patients express concerns about the security of their data.

The accurate statement is: __________.

a. the sole purpose of PM is to determine what changes need to be made to the patient's glucose-lowering drug regimen

b. prerequisites for PM are an accurate BG meter and a computer to which BG data can be downloaded

c. experts agree that daily SMBG is essential for all patients with diabetes

d. it is the health care provider's responsibility to analyze SMBG results in a nonjudgmental manner
The correct answer is d.

It is the health care provider’s responsibility to analyze SMBG results in a nonjudgmental manner.
PERFORMING PATTERN MANAGEMENT
Data from large outcomes studies, such as ACCORD, ADVANCE, and VADT, suggest that algorithm-based approaches to glycemic management should be avoided in patients with type 2 diabetes.¹

According to the 2012 position statement of the ADA and the European Association for the Study of Diabetes (EASD), glycemic targets and glucose-lowering therapies must be individualized, because not everyone benefits from aggressive glucose management.¹

In addition to recommending the use of individualized targets, the ADA–EASD statement advocates a patient-centered approach to diabetes management.¹ The authors recommend that “all treatment decisions, where possible, should be made in conjunction with the patient, focusing on his/her preferences, needs, and values.”

Decisions about an individual patient’s A1C and preprandial and postprandial BG targets should be made collaboratively with the patient.¹ Setting these targets must precede pattern management.²


Although both the ADA and the AACE emphasize the importance of individualizing glycemic targets, each organization has published guidelines that are appropriate for many nonpregnant adults with diabetes.¹–³

For A1C, the ADA recommends a level of <7.0%¹ and the AACE recommends a level of ≤6.5%.²,³

Preprandial plasma glucose values of 70 to 130 mg/dL are recommended by the ADA,¹ and a value of <110 mg/dL is recommended by the AACE.²,³

Regarding peak postprandial plasma glucose, the ADA recommends a level of <180 mg/dL measured 1 to 2 hours after the start of a meal.¹ The AACE recommends a level of <140 mg/dL, measured 2 hours after the start of a meal.²,³

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Several types of records are necessary for effective pattern management. The duration of record-keeping must be individualized, but data should usually be recorded for at least 3 days.

BG results should consist of manually generated BG logs or a meter download. Deviations from the typical eating pattern should be noted. In some instances it is important for the patient to keep a detailed food log, documenting the amount and timing of all foods eaten. Detailed records of this type are valuable when it appears that the patient may be consuming substantially more than the prescribed amount of carbohydrate, eating very small meals, or skipping meals altogether.

The patient should also record the intensity, duration, and times of physical activity. The type, dose, and administration time for all prescription and over-the-counter medications should be reported. Other events that could affect BG values, such as having a cold or a problem at work, should be recorded.

We will discuss the process of setting up a patient log later in this activity.
In 2009, the IDF published a detailed guideline about SMBG in patients with type 2 diabetes who do not take insulin.

According to the IDF, it is often unnecessary for these patients to perform daily SMBG. The SMBG schedule should be the product of shared decision-making by the patient and provider. Patients may benefit from focused SMBG over short intervals, initially and periodically during the course of their disease.

- 5- or 7-point regimen
- Staggered regimen

A 5- or 7-point SMBG regimen may be used to create a representative glucose profile. Alternatively, a staggered regimen can be used to obtain BG levels before and after alternating meals over a 2- to 3-week period.

Examples of these regimens are shown on the next two slides.
This diagram illustrates two focused SMBG regimens recommended by the IDF for patients with type 2 diabetes who do not take insulin.¹

With the 5-point profile, which is represented by the black “×” symbols, SMBG is performed for 3 consecutive days before and after breakfast, after lunch, and before and after dinner. With the 7-point profile, which is represented by both the black and the red “×” symbols, SMBG is also performed before lunch and at bedtime.¹

Both the 5-point and the 7-point profiles are valuable pattern management tools because they provide insight as to when out-of-target BG values are occurring on a given day.²

Patients find these approaches both manageable and reasonable. They choose 3 days and focus on checking when they agreed to check. The pattern feedback is extremely valuable, so their efforts are immediately rewarded.

Providers need to explain that even if all of the BG readings are out of range, the purpose of information gathering is to guide treatment, not to judge the patient. Patients often feel that their BG log is like a report card and that they will be judged on their performance. Structured SMBG is only successful when the provider describes realistic expectations of the patient and the process.

Some patients are hesitant to check their BG after meals because they know that their readings will be elevated and they are reluctant to see them.


This diagram illustrates the staggered SMBG regimen recommended by the IDF for patients with type 2 diabetes who do not take insulin.¹

As indicated by the position of the “×” symbols, staggered SMBG requires only 2 checks per day over the course of 6 days. The patient performs SMBG before and after the same meal on 1 day—an approach called “paired testing.” The patient then performs paired testing for other meals on successive days.¹

By the end of the test period, 2 sets of premeal and postmeal data are available for each meal, enabling the patient to gain insight into the effects of his or her meals on BG excursions.² If the results are inconclusive or the patient is highly motivated, staggered SMBG using paired testing can continue for additional days, yielding 3 or more sets of BG data.


Parkin and colleagues recommend the use of paired testing in combination with a 1-day, 7-point BG profile.

This approach is useful because it helps to pinpoint specific times of the day when significant BG excursions occur without requiring a demanding 7-point profile for more than 1 day per test period.

Both the ADA and the AACE have made recommendations about SMBG schedules for patients treated with nonintensive insulin regimens.

According to the ADA, the frequency and timing of SMBG should be dictated by the particular needs of the individual patient.\(^1\) The optimal frequency of SMBG for patients on nonintensive regimens, such as those taking basal insulin only, is not known. However, a number of studies have used fasting SMBG as the basis for titrating the basal insulin dose.

The AACE recommends that all patients taking insulin perform SMBG at least twice daily and ideally before any insulin injection.\(^2\)

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According to the ADA, most patients treated with multiple-dose insulin (MDI) or insulin pump therapy should perform SMBG:

- At least before meals and snacks
- Occasionally postprandially
- At bedtime
- Before exercise
- When they suspect low BG
- After treating low BG until they are normoglycemic
- Before critical tasks such as driving

For many patients, this will require testing 6 to 8 times daily, although individual needs may be greater.

Patients should be taught that there are a number of situations in which the frequency of SMBG should be increased. Increased frequency is warranted when the patient needs to adjust to a change in the treatment plan. This might involve taking a new glucose-lowering medication or an increased dose of a medication, particularly when hypoglycemia is a possible side effect. Greater SMBG frequency would also be warranted when the patient is making a significant change to the lifestyle aspect of the treatment plan, such as starting a very-low-calorie diet.

Increased SMBG frequency is also important when the patient needs to identify and treat hypoglycemia, make decisions about food intake or medication adjustment when exercising, determine the effect of food choices or portions on BG levels, manage intercurrent illness, manage hypoglycemia unawareness, or monitor BG control during the preconception period and pregnancy.

Test strip availability affects the frequency of SMBG for many patients.¹

For each 3-month period, Medicare Part B currently covers 100 test strips for individuals who do not take insulin and 300 strips for those who take insulin.² Most private health plans follow Medicare guidelines for strip quantity.¹

Coverage for additional strips requires documentation of medical necessity.² As part of the documentation process, the patient may need to provide a record of how often SMBG is actually being performed.

Because many patients with type 2 diabetes who do not use insulin will most likely have access to 100 strips over 3 months, the clinician or diabetes educator should work with the patient to determine how the strips can be used to provide the most valuable information.¹ In this situation, there will be days when SMBG is not performed.


It is important for patients to learn that many factors can affect their BG levels. Taking an insufficient amount of glucose-lowering medication, eating more carbohydrate than usual, and decreasing the intensity or amount of physical activity can raise BG levels. Conversely, taking an excessive amount of glucose-lowering medication, eating less carbohydrate than usual, and increasing the intensity or amount of physical activity can lower BG.

Physical stressors, such as illness, infection, or surgery, can increase BG. Emotional stress may result in increased BG from the release of catecholamines, but may also be linked to a decrease in BG if the individual responds to the stress by not eating.

Some drugs increase BG levels, whereas others, including alcohol, decrease them. Alcohol reduces BG levels by blocking hepatic glucose production. Patients with diabetes—especially those who take insulin or another glucose-lowering medication—should be advised that, if they are going to drink alcohol, to drink it with food to reduce the risk of hypoglycemia. As with other adults, alcoholic drinks should be limited to 2 or less per day for men and 1 or less per day for women. One drink contains about 15 grams of alcohol and is defined as 12 ounces of beer (preferably light), 5 ounces of wine, or 1.5 ounces of distilled spirits, such as scotch or vodka.

Examples of other drugs that can affect BG are shown on the next slide.


Many drugs can affect the BG concentrations of people with diabetes. This slide lists drugs or drug classes that can raise or lower BG levels through a drug-disease interaction.\(^1\)

Drug-drug interactions can also affect BG concentrations. For example, a patient taking a sulfonylurea might experience a decreased BG level during concomitant treatment with a sulfonamide and an increased BG level during treatment with some oral contraceptives.\(^2,3\) A patient taking a thiazolidinedione might have a lower BG concentration during treatment with gemfibrozil and a higher level during treatment with rifampin.\(^4,5\)

Because of the potential for a clinically significant drug-disease or drug-drug interaction, clinicians must maintain a current record of their patients’ medications, including over-the-counter products.\(^6\) They must also caution their patients about the importance of informing other clinicians about all of the medications they are taking and advise them against taking an over-the-counter product until they have confirmed with a health care provider that it is safe to do so. Patients should be instructed to increase the frequency of SMBG when they start taking a new medication.

A useful patient log records BG values at prespecified times of day, medication doses, and daily events that may have affected BG control.

The design of a patient’s BG log depends on the functionality of the patient’s BG meter and how the patient chooses to use it. Most currently available meters save at least 100 test results, and downloading BG data to a personal computer is often possible. Some meters have enhanced note-taking capabilities, enabling the patient to enter information about medication and daily events.

Patients with less sophisticated BG meters or those who prefer to do so use a paper log to record some or all of their data. Patients who sit in the waiting room and transcribe numbers from the meter to a piece of paper or the back of an envelope are not using BG readings for pattern management; they are typically providing the data to please their providers. BG readings must be viewed as a pattern to be useful. Otherwise, patients simply respond to the most recent BG value and make decisions in a vacuum.

We will describe the process of designing a paper log on the next 3 slides.

To maximize their usefulness, logs should be customized for the individual patient. There should only be spaces to report BG results for which the patient will actually check. For example, the log should not include a column for middle-of-the-night BG values if the patient will not be checking during the night.

The log should be configured so that the patient or provider can read across a row and see values for various times on a given day. It should also be possible to scan down a column and see the values for a particular time of day on multiple days.

The BG results section should not be encumbered by other data, such as medication doses, because these data will make it difficult to scan and get an impression of the average BG value and substantial variations.

A separate section should be used to record medication doses. As shown on the next two slides, the complexity of this section depends on the patient’s treatment regimen. Patients taking stable doses of insulin and/or other glucose-lowering drugs do not need to record each dose of medication, whereas patients who are adjusting their insulin doses based on the results of SMBG should report the size of each insulin dose.

Patients should be taught to make brief notations about daily events that may have affected their BG control. Comments such as “pizza for lunch,” “walked for 45 minutes after dinner,” “sore throat,” or “stressful day at work” can aid in the interpretation of BG results.

Here is a transcription of a paper log completed by Carol, a patient who completed a 7-point SMBG profile on 3 consecutive days.\textsuperscript{1,2}

Because Carol took metformin at a dose of 1000 mg twice daily throughout the test period, the dose and timing are noted only once.

In the comments section, Carol reported that she took a 30-minute walk after dinner on Friday. This may explain her relatively low BG reading at bedtime on that day. She also noted that she went out for breakfast on Saturday, a likely cause of her high postbreakfast and prelunch BG levels.


Here is an example of a detailed medication record that would be included in the log of a patient whose regimen includes MDI therapy that is adjusted on the basis of SMBG results.

Note that the patient reported taking varying doses of a rapid-acting insulin analog before meals and varying doses of a long-acting insulin analog at bedtime.

The patient also took a fixed dose of metformin at a dose of 1000 mg twice daily.

**Addition to Paper Log for Patient with Adjustable MDI Regimen**

<table>
<thead>
<tr>
<th>Insulin Doses (Units)</th>
<th>Other Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Breakfast: RAI</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Pre-Lunch: RAI</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>36 LAI</td>
</tr>
<tr>
<td>Pre-Dinner: RAI</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>36 LAI</td>
</tr>
<tr>
<td>Bedtime: LAI</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>34 LAI</td>
</tr>
<tr>
<td></td>
<td>MET</td>
</tr>
<tr>
<td></td>
<td>MET</td>
</tr>
</tbody>
</table>

LAI = long-acting insulin analog; MDI = multiple-dose insulin; MET = metformin; RAI = rapid-acting insulin analog.
The interpretation of BG data by the health care provider consists of 3 stages. First, the provider should make sure that the patient has provided sufficient data about BG levels, the timing and amount of food intake, the timing and intensity of physical activity, and other relevant lifestyle factors, such as high stress levels. The provider should also identify information that is clearly inaccurate and check to see whether the patient has reported possible contributors to glucose excursions. After discussing any inaccuracies and omissions with the patient, the provider should decide whether the patient can provide missing information from memory, if it is better to repeat the data-gathering process, or if some other approach is warranted.

Second, the provider should identify all possible interpretations of the BG data. Are the patient’s behaviors and schedule consistent from day to day, or are there marked fluctuations related to food intake, physical activity, taking medication, or other relevant factors? Is there an overall trend in the BG results or are fluctuations isolated?

Third, the provider should develop individualized plans and recommendations in collaboration with the patient. What should the short-term management goal and focus be? Should changes in food intake or physical activity be made? Does the medication regimen need to be adjusted? Are there other factors that need to be addressed, such as the patient’s response to job-related stress?

Although the health care provider should play an active role in initiating the pattern management process, the ultimate goal of pattern management is for patients to be more active and capable self-managers. Here are some tips to help patients interpret their own BG patterns.\(^1,2\)

First, gather enough data.\(^1,2\) Random readings throughout the week are not sufficient. Data for at least 3 successive days, gathered at the same times of day, are essential for establishing a pattern.

Then, look for patterns.\(^1,2\) To make detection easier, consider circling “highs” with a red pen and “lows” with a pen of a different color.

Next, analyze possible causes of out-of-range values.\(^1,2\) Could these values be related to food, physical activity, medication, stress, or more than one of these factors? For patients who take insulin, the provider should assess patients’ understanding of their different insulin doses so that they know which insulin dose is reflected in which BG reading. For example, an insufficient dose of prebreakfast insulin will be reflected in higher prelunch readings. (We will discuss this issue further in an upcoming slide.)

After that, make the appropriate change or changes in response to preliminary findings.\(^1,2\)

Finally, gather data again to assess the impact of the change.\(^1,2\)


An important pattern management skill for patients to master is interpreting high or low BG values by asking relevant questions and then taking appropriate action based on the answers to these questions.

This table shows some specific questions related to eating and physical activity that patients should be taught to ask themselves when they are analyzing their BG data. It also shows actions that patients should be encouraged to take when their answer to a question is “yes.”


### Responding to High and Low Values: Eating and Activity

<table>
<thead>
<tr>
<th>Cause</th>
<th>Ask These Questions</th>
<th>Take Action*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and drink</td>
<td>• Have you had more or less calories, carbohydrates, or snacks than usual?</td>
<td>• You may need to measure food more accurately to check portion control</td>
</tr>
<tr>
<td></td>
<td>• Have you changed your habits by eating different foods or eating at different times?</td>
<td>and carbohydrate content.</td>
</tr>
<tr>
<td></td>
<td>• Do you struggle with following a meal plan?</td>
<td>• If your eating pattern is changing, your medication or exercise plan might need to change.</td>
</tr>
<tr>
<td>Physical activity</td>
<td>• Have you changed your usual activity level?</td>
<td>• Make your health care team aware of your struggle with food.</td>
</tr>
<tr>
<td></td>
<td>• Do you need a snack before or after exercise?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Did you plan for exercise and reduce your insulin?</td>
<td></td>
</tr>
</tbody>
</table>

*If the answer to the question is “yes.”*
As part of their pattern management training, patients should also be encouraged to ask questions related to taking medication. The table shows some general and insulin-specific questions related to medication, as well as actions that should be taken if an answer is "yes."

### Responding to High and Low Values: Medication

<table>
<thead>
<tr>
<th>Cause</th>
<th>Ask These Questions</th>
<th>Take Action*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medication (general)</strong></td>
<td>• Have you been taking the prescribed doses at the right time?</td>
<td>• Take the right dose at the right time. If you have questions, ask a diabetes educator</td>
</tr>
<tr>
<td></td>
<td>• Have you started a new medication?</td>
<td>• Make your health care team aware of the new medication so they can help you make the necessary treatment changes</td>
</tr>
<tr>
<td><strong>Medication (insulin-specific)</strong></td>
<td>• Are you injecting the same site over and over? Do you have lumps?</td>
<td>• Use new injection sites</td>
</tr>
<tr>
<td></td>
<td>• Does insulin leak out of your site?</td>
<td>• Review your injection technique with a nurse</td>
</tr>
<tr>
<td></td>
<td>• Do you have “spoiled” insulin?</td>
<td>• Throw away the insulin bottle and open a new bottle</td>
</tr>
<tr>
<td></td>
<td>– Does it look different?</td>
<td>• Check the expiration date on the bottle</td>
</tr>
<tr>
<td></td>
<td>– Was it exposed to very hot or cold temperatures?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Has it expired?</td>
<td></td>
</tr>
</tbody>
</table>

*If the answer to the question is "yes."

Patients should also be encouraged to ask questions related to monitoring. The table shows some questions pertaining to SMBG, as well as actions that should be taken if an answer is “yes.”

Health care providers also need to teach their patients to ask questions related to physical and emotional stressors. The table shows some questions pertaining to stressors, as well as actions that should be taken if an answer is “yes.”

It is important for health care providers to ask their female patients to ask relevant questions about menses, pregnancy, and yeast infections. The table shows some important questions pertaining to women’s issues, as well as actions that should be taken if an answer is “yes.”

<table>
<thead>
<tr>
<th>Cause</th>
<th>Ask These Questions</th>
<th>Take Action*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menses, pregnancy, yeast infections</td>
<td>• Where are you in your menstrual cycle?</td>
<td>• Ask your health care team about insulin adjustment</td>
</tr>
<tr>
<td></td>
<td>• Have you started a new birth control pill?</td>
<td>• Monitor BG more frequently</td>
</tr>
<tr>
<td></td>
<td>• Are you pregnant?</td>
<td>• Tell your health care team that your BG levels are high or low or if you suspect that you are pregnant</td>
</tr>
<tr>
<td></td>
<td>• Do you have a yeast infection or vaginal irritation?</td>
<td>• Ask your doctor about treating your yeast infection</td>
</tr>
</tbody>
</table>

"If the answer to the question is "yes."  Joslin Diabetes Center, Inc. Interpreting Your Blood Glucose. 2007."
As part of their pattern management training, patients need to learn about when the insulins they are taking have their greatest effect on BG and when they should perform SMBG to determine the effect of their insulin. For example, a patient who takes a rapid-acting insulin analog before breakfast needs to understand that this insulin has its major effect on BG values between breakfast and lunch. Therefore, the time to perform SMBG to determine the effect of this insulin is before lunch.

The table on this slide provides an overview of insulin action and the adjustment of insulin doses.
Patients who take insulin need to know how to adjust their insulin dose when their BG is high. This slide shows a step-by-step procedure for insulin adjustment in response to high BG values.

It is important to emphasize to the patient that all insulin adjustments must be made under a physician’s order.

Patients who take insulin also need to know how to adjust their insulin dose when their BG is low. This slide shows a step-by-step procedure for insulin adjustment in response to low BG values.

Again, the patient needs to understand that all insulin adjustments must be made under a physician’s order.
The accurate statement is: __________.

a. before beginning PM, the patient must decide between the use of ADA or AACE glycemic targets

b. to conduct effective PM, the patient must be willing to perform 7-point SMBG

c. for each 3-month period, Medicare Part B currently covers 300 test strips for all patients with diabetes

d. before interpreting BG records, the provider must confirm that the patient has provided sufficient, accurate data
The correct answer is d.

Before interpreting BG records, the provider must confirm that the patient has provided sufficient, accurate data.
CONTINUOUS GLUCOSE MONITORING FOR PATTERN MANAGEMENT
CGM, a rapidly evolving technology, is a useful pattern management tool for selected patients.\(^1\)–\(^3\) It permits ongoing, minimally invasive sampling of glucose in the interstitial fluid, identifying glucose excursions and trends that would go unnoticed with SMBG. CGM can help patients to attain or maintain BG targets while limiting the risk of hypoglycemia. Because a CGM device must be calibrated with SMBG readings, CGM is currently an adjunct to rather than a replacement for SMBG.

Although CGM devices are most commonly used by patients with type 1 diabetes, they can also be beneficial for some individuals with type 2 diabetes.\(^1\)–\(^3\)

Both “real-time” (RT) and “blinded” CGM devices are currently available.\(^1\)–\(^3\) We will contrast these devices on the next slide.

With RT-CGM, the wearer can view displays showing glucose concentrations and upward and downward glucose trends.\textsuperscript{1–3} Depending on the device, there is a lag time of about 5 to 15 minutes between measurement of the glucose level and display of the data. Customized alarms alert the wearer to high or low glucose values and rapid changes in glucose concentrations. RT-CGM is also called “personal” CGM because the device is generally owned by the patient. RT-CGM devices are usually intended to be worn every day. Typically, they are used by individuals with type 1 diabetes, although they have also been used intermittently by people with type 2 diabetes in clinical trials. Examples of RT-CGM devices that were available in the United States in December 2013 are shown on the next slide.

With blinded CGM, no data are visible and no alarms alert the wearer to problematic glucose values or trends. Patients, who usually wear the device for 3 days, are unaware of their data until the health care provider downloads and analyzes them. Blinded CGM is also called “professional” CGM because the device is owned by the provider. It is also called “retrospective” CGM because data are reviewed after they are gathered. Blinded CGM devices are intended to be worn intermittently. They are primarily used for patients with type 1 or type 2 diabetes who are not at their individualized A1C target, have recurrent hypoglycemia or hypoglycemia unawareness, or are pregnant. Insurance reimbursement is more readily available for blinded CGM than for RT-CGM.

\begin{itemize}
\end{itemize}
CGM devices consist of 3 parts: a sensor, transmitter, and receiver.¹ The sensor, which consists of a very narrow plastic tube enclosing a catheter, is inserted under the skin to measure the glucose concentration of interstitial fluid. An electric current is generated as the glucose is oxidized by the sensor, and the transmitter sends the electric current to the receiver without the need for a cable.² The receiver displays and stores data, which can be downloaded to a personal computer so that data can be read more easily or printed out.¹ A patient undergoing blinded CGM would wear a sensor but would not have a receiver.

In addition to these basic components, the Medtronic MiniMed® Paradigm REAL-Time Revel™ and the MiniMed® 530G with Enlite® devices offer a CGM device that is integrated with an insulin pump.³,⁴

The pictures on this slide show 3 of the RT-CGM devices available in the United States in December 2013: the Dexcom G4 Platinum, the Medtronic Diabetes Guardian® REAL-Time, and the MiniMed® 530G with Enlite®.³,⁴


According to the ADA, RT-CGM in conjunction with intensive insulin regimens can be a useful tool for lowering A1C in adults 25 years and older with type 1 diabetes. Although the evidence for A1C lowering is less strong in children, teens, and younger adults with type 1 diabetes, the technology may also be helpful for members of these populations who use it consistently. The ADA also recommends RT-CGM as a supplement to SMBG in individuals with hypoglycemia unawareness and/or frequent hypoglycemic episodes.

Studies have shown that soon after initiating use of RT-CGM, many patients begin using the system infrequently or discontinue use altogether. Common reasons for reduced use or discontinuation are dissatisfaction with inaccurate BG data, frequent sensor malfunction, and pain, discomfort, or irritation at the sensor site.

CGM is a rapidly evolving technology and the performance and wearability of these devices is improving steadily. Patient education is essential for optimizing the function and comfort of currently available devices. For example, patients should be cautioned against inserting the sensor into a lipohypertrophic area. The best time to calibrate the CGM is before meals, when glucose levels are most stable. Because the accuracy of the CGM system depends on the accuracy of the BG meter used to calibrate it, the meter’s accuracy should be checked regularly and an inaccurate meter should be replaced. Because patients frequently report pain during sensor insertion, the health care provider should observe the patient’s insertion technique initially and if problems arise. Patients should be cautioned against wearing a sensor for a longer period than that recommended by the manufacturer.

Although the effects of CGM have been less thoroughly studied in individuals with type 2 diabetes than in those with type 1 diabetes, data also support the use of CGM in adults with type 2 diabetes.

In an open-label study, patients who were not treated with insulin wore a blinded CGM device for 72 hours. The study showed that CGM provided valuable information about the effect of eating patterns and physical activity on BG values.\(^1\) Short-term CGM was well tolerated.

A randomized study that included adults treated with various nonpharmacologic and pharmacologic therapies except mealtime insulin compared the mean A1C value in adults who used intermittent RT-CGM and in those who used SMBG alone.\(^2\)–\(^4\) Over the first 12 weeks, participants in the CGM arm used RT-CGM for 4 2-week cycles, with 1 week off between cycles. After 12 weeks, the mean decrease from baseline in the A1C level was significantly greater in the CGM group.\(^2\) At the end of a 40-week follow-up period during which no patients received CGM, participants initially randomized to RT-CGM continued to have a significantly greater mean reduction in A1C from baseline than those initially randomized to SMBG alone.\(^3\) An analysis of response patterns showed that some patients randomized to CGM experienced steady improvement in glycemic control over the 4 CGM cycles, whereas others experienced initial improvement followed by decreased control.\(^4\) These trends suggested that some patients benefitted from long-term CGM use, whereas others experienced burnout as the study progressed. Ways of determining the optimal duration of CGM for individual patients with type 2 diabetes are needed.

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This slide shows an example of the way in which blinded CGM can be used for pattern management. Roger is a 52-year-old man with a 10-year history of type 2 diabetes. He recently had major surgery for internal injuries sustained in a motor vehicle accident. He had multiple blood transfusions and sustained significant weight loss.

When he returned home from the hospital, Roger resumed his former MDI regimen, taking 50 units of a long-acting insulin analog before breakfast and dinner and 10 units of a rapid-acting insulin analog before each meal. His appetite was poor and he was constantly drinking juice to prevent hypoglycemia. His BG log revealed fluctuating readings. Because of his recent blood transfusions, the results of an A1C test would have been unreliable.

As part of a complete re-evaluation of his insulin doses based on his current weight and eating patterns, Roger underwent 3 days of blinded CGM. Monitoring confirmed marked BG fluctuations, with intervals of severe hyperglycemia and long periods of hypoglycemia.

The intervention was targeted toward reducing the frequency and severity of hypoglycemia. Based on these findings, Roger’s dinnertime dose of long-acting insulin analog was reduced on the basis of his new weight and his prebreakfast dose of rapid-acting insulin analog was calculated to match his reduced appetite. He has begun working with a registered dietitian nutritionist (RDN) to develop a meal plan that will promote healing and be more appetizing for him. He will continue to perform paired SMBG at regular intervals and will have another 3-day period of blinded CGM in about 2 months.
The accurate statement is: __________.
a. CGM permits ongoing, minimally invasive sampling of capillary plasma glucose
b. CGM identifies glucose excursions and trends that would go unnoticed with SMBG
c. CGM is a valuable tool because it eliminates the need to perform SMBG
d. during professional CGM, the patient has access to current information about glucose trends
The correct answer is b.

CGM identifies glucose excursions and trends that would go unnoticed with SMBG.
PATTERN MANAGEMENT
CASE STUDIES
We will now discuss 2 patient cases that show how pattern management can be used to improve glycemic control in patients with type 2 diabetes.

We begin with the case of Maria, a 68-year-old Hispanic woman who has had type 2 diabetes for 8 years. Maria is married and lives with her husband, daughter, and 3 grandchildren, one of whom has serious behavioral issues. She is a retired hairdresser. Maria is 65 inches tall, weighs 188 pounds, and has a body mass index (BMI) of 31.3 kg/m². Her A1C is 8.4%. Her glucose-lowering drugs are metformin, 1000 mg twice daily, taken at breakfast and dinner, and glyburide 20 mg/day, taken at breakfast.

Maria reports that she prepares nutritious food for herself and her family, but tends to overeat when she feels stressed out. She walks in her development when she can persuade a friend to accompany her—once or twice a week. Maria says that her life has been extremely stressful in recent months because of her grandson’s behavioral problems. He has just transferred to a new preschool that is better equipped to deal with his issues and Maria is optimistic that things will start improving at home.

Maria says that she checks her BG when she thinks about it.
Maria has adopted the glycemic targets recommended by the ADA for many nonpregnant adults with diabetes. Therefore, her target preprandial range is 70 to 130 mg/dL and her peak postprandial target is <180 mg/dL.

Maria's initial patient log had 2 BG values: a prebreakfast reading of 88 mg/dL and a bedtime reading of 128 mg/dL, both of which are at goal.

As you look at these numbers, do you see a problem? Because both values are within range, does that mean that everything is fine?

Because Maria's A1C level is 8.4% we know that her average BG levels are around 180 to 200 mg/dL, but the 2 recorded values do not reflect that. Clearly, more readings are needed to shed more light on what is contributing to Maria's high A1C.
When questioned about her patient log, Maria remembers that she had written 2 additional BG values on a separate piece of paper but had not transferred them to her log sheet. Here is her patient log showing the 2 additional values. Readings that exceed the target range are shown in red.

With this additional information, Maria’s glycemic profile is changing, with half of her values above the target range. However, there are still not enough readings to show a pattern.

Therefore, the health care provider asks Maria to perform additional BG checks and to return to the office in a week.

<table>
<thead>
<tr>
<th>Day, Date</th>
<th>Pre-Bkfst</th>
<th>Pre-Lunch</th>
<th>Pre-Dinner</th>
<th>Bedtime</th>
<th>Medication</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun, 5/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mon, 5/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tues, 5/7</td>
<td></td>
<td>88</td>
<td></td>
<td>267</td>
<td>MET, 1000 bid, breakfast and dinner, glyburide, 20 mg/day, breakfast</td>
<td></td>
</tr>
<tr>
<td>Wed, 5/8</td>
<td></td>
<td></td>
<td></td>
<td>128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thurs, 5/9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri, 5/10</td>
<td>212</td>
<td></td>
<td></td>
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</tbody>
</table>
Maria's second BG log is much more complete, and her health care provider begins the visit by thanking her for her willingness to work on her diabetes and bringing her numbers in.

With the available values, it is apparent that Maria is often experiencing bedtime hyperglycemia that carries over into the next morning. Exceptions to this pattern are the evenings when Maria takes an after-dinner walk with a friend.
The health care provider now interprets Maria’s glycemic patterns. Most likely, her bedtime hyperglycemia is caused by the carbohydrates she is eating at dinner. However, it is also possible that her glyburide is no longer working well enough at dinner or she may be missing medication doses.

The next stage is for Maria to keep thorough record of food and medication intake for at least 3 days. If these records show that Maria is controlling her carbohydrate consumption at dinner and taking her medications as prescribed, adding basal insulin may be the next step.

The health care provider now interprets Maria’s glycemic patterns. Most likely, her bedtime hyperglycemia is caused by the carbohydrates she is eating at dinner. However, it is also possible that her glyburide is no longer working well enough at dinner or she may be missing doses of medication.

The next stage in the pattern management process is to ask Maria to keep a thorough record of her food and medication intake for at least 3 days. If these records show that Maria is controlling her carbohydrate consumption at dinner and taking her medications as prescribed, it may be time to consider adding basal insulin to her treatment regimen. This approach would be warranted because Maria is already taking the maximum dose of glyburide and is nearly at the maximum dose of metformin.
Now we will now discuss the case of Doug, a 48-year-old white man who was diagnosed with type 2 diabetes 6 years ago. Doug is married and has 2 adult daughters. He is a construction worker. Doug is 73 inches tall, weighs 231 pounds, and has a BMI of 30.5 kg/m$^2$. His current A1C is 8.9%, which is up from 8.1% 6 months earlier. Doug has been on a stable medication regimen for the past year. His glucose-lowering drugs are metformin, 1000 mg twice daily, taken at breakfast and dinner; glimepiride, 8 mg/day, taken at breakfast; and pioglitazone, 15 mg/day, taken at breakfast. Other medications are lisinopril, 20 mg/day, taken at breakfast, and atorvastatin, 20 mg/day, taken at dinner.

Doug says that he has trouble maintaining a healthful eating pattern because he is on the job site 5 and sometimes 6 days a week. Therefore, fast food makes up much of his diet. He says that he is physically active because of his work and does not engage in sports or other types of physical activity during his leisure time. Although he has a BG meter, he says that he has not used it in almost a year. He describes his life as busy, but not overly stressful.
Doug’s personal glycemic targets are a preprandial range of 100–120 mg/dL and a peak postprandial value of <180 mg/dL. Doug was initially hesitant when his health care provider asked him to prepare a patient log, thinking that his work schedule would prevent him from performing SMBG on a regular basis. Eventually he agreed to record as many prebreakfast through postdinner values as possible beginning on the day after his initial medical visit and continuing until the day before his follow-up visit—a total of 9 days.

The slide shows Doug’s initial BG log. Although the amount of checking Doug was able to do varied from day to day, paired values were available for 4 breakfasts and lunches and for 3 dinners. Note that all of Doug’s preprandial values, 4 of 5 postbreakfast values, 2 of 5 postlunch values, and all 4 postdinner values are above target. Doug provided explanations for 2 unusually high values. On June 3, having a doughnut during his morning break probably contributed to his prelunch value of 292 mg/dL, and going out to dinner on June 7 likely played a role in his postdinner value of 241.

Several things were clear from this patient log. First, Doug needed to find a way to adopt a more healthful eating pattern. Second, Doug’s medication regimen no longer met his needs. Additionally, he needed to adopt an intentional plan for engaging in physical activity outside of working hours.
Doug agreed to meet with an RDN to develop an eating plan that was realistic, nutritious, and appetizing. The RDN helped Doug plan “brown bag” lunches that were easily prepared. He also helped Doug develop strategies for healthy eating at fast-food and other types of restaurants.

Doug and his primary care provider reviewed medication options. Because his current medications were well tolerated, Doug was interested in adding an agent to his current regimen rather than making a more drastic change. Eventually they decided to add a long-acting insulin analog to Doug’s current regimen. The initial 10-unit dose was titrated, using a standard, evidence-based algorithm, to 36 units, taken at 10 PM daily.

Doug also agreed to start walking for 30 minutes, 3 to 4 times per week.
As this follow-up log indicates, Doug’s overall glycemic control had improved considerably after 3 weeks on his new regimen. Approximately half of his BG values were within range, and many other values were only slightly above target. Doug was very pleased with his progress and said that he was committed to working even harder on his new eating and physical activity patterns.

The primary care provider suggested that Doug continue his regimen for another 3 weeks. If the overall pattern persists at that point and Doug’s values remain high during the latter part of the day, the next step would likely be the addition of a rapid-acting insulin analog before dinner. In that case, the 10 PM dose of long-acting insulin analog would initially be reduced by 10%.
PM is the process of keeping BG levels at individualized targets by identifying the relationship between BG values and patient behaviors and acting on this knowledge to improve glycemic control.

PM depends on the accurate measurement, recording, and interpretation of BG values.

Effective PM takes into account the many factors that affect BG levels.

CGM is a useful PM tool for selected patients.