**Blood Glucose Monitoring and Management**

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**ABSTRACT:**

As we know that diabetic patients in the country are increasing manifold. This is because of eating habits and unhealthy lifestyles and thereby changing blood sugar levels. Generally, blood sugar levels over 180 mg/dL or under 70 mg/dL are considered unhealthy. High blood sugar levels above 180 mg/dL maybe a sign of not enough insulin, caused by overeating, lack of exercise, or other factors. Low blood sugar levels below 70 mg/dL may be caused by taking too much insulin or other diabetes medicines, skipping or delaying a meal, over exercising, drinking too much alcohol, or other factors.

Regular blood glucose monitoring is the most important thing a person can do to manage type 1 or type 2 diabetes. A person will be able to see what makes numbers go up or down, such as eating different foods, taking medicine, or being physically active. With the monitoring and proper management can help delay or prevent diabetes complications such as heart attack, stroke, kidney disease, blindness, and amputation. Blood sugar levels that go up and down a lot can damage the body in different ways. Very high (hyperglycemia) or low (hypoglycemia) blood sugar levels can be serious, and even life-threatening when not treated quickly.

Many things (like the foods eating, sports a person play and the lifestyle) can affect the blood sugar levels. A person’s body can also be unpredictable. Sometimes, the body can have a reaction that even healthcare providers don’t always understand. All of these factors can make managing diabetes challenging, even while thinking as doing everything right.

This book chapter discusses about the blood glucose monitoring and its management through Continuous Glucose Monitoring (CGM), With healthy eating, moving more and healthy life style, a person can manage the blood glucose in a better way to lead a healthy long life. The chapter shall be helpful for diabetic patients and even to healthy persons as well.

**Keywords:** Unhealthy lifestyles, blood glucose monitoring, hyperglycemia, hypoglycemia and Continuous Glucose Monitoring (CGM) etc.

1. **INTRODUCTION**

Diabetes is a chronic and long-lasting health condition of a person that affects how the body turns food into energy. The body breaks down most of the food when eaten, into glucose and also releases it into the bloodstream. When the blood glucose goes up, it signals the pancreas to release insulin. Insulin acts like a key to let the blood glucose into the body’s cells for use as energy. There are three main types of diabetes: type 1, type 2, and gestational diabetes i.e. diabetes while pregnant.

### Type 1 Diabetes

Type 1 diabetes is believed to be caused by an autoimmune response, wherein the body attacks itself by mistake. This response stops the body from making insulin. Those who have diabetes, around 5-10% of the people have type 1. Symptoms of type 1 diabetes often grow speedily. It’s typically diagnosed in kids, teens, and young adults. While having type 1 diabetes, must take insulin every day to survive. Currently, no one recognizes how to prevent type 1 diabetes.

### Type 2 Diabetes

With type 2 diabetes, the body doesn’t use insulin well and can’t keep blood glucose at normal levels. Around 95% of people having with diabetes, generally have type 2. It develops over many years and is usually diagnosed in adults, whereas found more and more in children, teens, and young adults. Thereby, it’s important to get the blood glucose tested if there is risk. Type 2 diabetes may be prevented and delayed with healthy lifestyle changes, these are: being active, losing weight and eating healthy food.

### Gestational Diabetes

Gestational diabetes develops in pregnant women who have never had diabetes. If a person is having gestational diabetes, then the baby might be at higher risk for health issues. Gestational diabetes usually goes away after the baby is born. Though, it increases the risk towards type 2 diabetes later. The baby then, is more expected to have obesity during early as a child/teen and develop type 2 diabetes later.

For measuring glucose in the body, through a small device called a glucose meter or glucometer that measures how much sugar is in the blood sample. The drop of blood a person get with a finger prick is often enough to use on a test strip. A finger prick can be done with a special needle (lancet) or with a spring-loaded device that quickly pricks the fingertip.

Blood glucose monitoring helps to recognize patterns in the variation of blood glucose (sugar) levels that occur in response to diet, exercise, medications, and pathological processes associated with blood glucose fluctuations, such as diabetes mellitus. Unusually high or low blood glucose levels can potentially lead to life-threatening conditions, both acute and chronic. Blood glucose level (BGL) or blood sugar level (BSL) monitoring conducted outside of clinical facilities, such as the home, are often referred to as capillary blood glucose (CBG) tests. In contrast, blood glucose tests performed at clinical facilities may include CBG and plasma glucose venous blood tests. [1] [2]

1. **Pathophysiology**

If a person is having symptoms like feeling excessively thirsty and drinking more than normal, wanting to urinate frequently, an increase in appetite, fatigue, cuts or bruises that heal slowly, and/or sometimes blurry vision, the concern doctor may advise for an A1C test to check for blood glucose in the body or diabetes. Further symptoms may be like weight loss or pain, including tingling/numbness in hands or feet.

The study of abnormal changes in body functions that are the causes, consequences, or concomitants of disease processes. Most food products contain complex carbohydrates, which are broken down to supply energy to the cells in our body. Once ingested, food containing carbohydrates is broken down in the gastrointestinal system into simpler sugars such as glucose. In the small intestine, glucose molecules are absorbed into the bloodstream and transported to cells across the patient’s body, including the liver. [3] Pancreatic beta-cells produce the insulin in response to elevated blood glucose levels.

In the postprandial stage, insulin enables the transportation of glucose from the bloodstream into cells. The insulin also inhibits gluconeogenesis in the liver and facilitates the storage of glucose (glycogenesis) in the form of glycogen and fats (earlier lipogenesis. DNL), that serve as short and long term stores of energy, respectively. The human body attempts to merely maintain homeostasis of 4 to 6 mmol or about 72 to 108 mg/dL in blood glucose levels (BGL). Homeostasis is generally influenced by the useful capacity of pancreatic beta-cells along with cellular (skeletal muscles, liver, and adipose tissue) sensitivity to insulin. [4]

In conditions supposed as diabetes mellitus, there might be either a lack of insulin or the no proper response of the body to the actions of insulin; the latter one (no response) is termed as insulin resistance. In which, cellular uptake of glucose or the storage of additional glucose is impaired. Dysfunction in the production or uptake of insulin can potentiate impaired BGLs. Patients with impaired blood glucose homeostasis and elevated fasting blood glucose are at high risk for developing diabetes mellitus. Patients may be diagnosed with diabetes mellitus if their BGLs are high. [5] Some organs, like the kidneys, brain, liver, and erythrocytes, do not have insulin receptors and also they do not necessitate insulin for glucose uptake. These organs, particularly brain, are significantly affected by chronic, acute, or recurrent drops in BGLs; morbidity in such situations might be noteworthy. [6] [7]

Insulin is mainly used to manage type 1 diabetes mellitus and some cases of type 2 diabetes mellitus. Insulin therapy has the well-known adverse side effect of hypoglycemia while its administration has not been not managed efficiently. It is a fact that patients with insulin-dependent diabetes will benefit from regular blood glucose monitoring. Regular daily blood glucose monitoring has been suggested to those with diabetes mellitus with insulin therapy.

Blood glucose monitoring (BGM) might sustenance diagnosing and managing the client with impaired glucose metabolism or diabetes. Regular monitoring of blood glucose levels (BGL) may not be recommended for each and every patient with type 2 diabetes mellitus on oral antidiabetic drugs or dietary management alone. However, blood glucose monitoring might be necessary through titration of oral hypoglycemic medications identified to cause hypoglycemia, like sulfonylureas. [8] [9]

1. **Blood Sugar Monitoring (BSM)**

Regular blood sugar monitoring (BSM) is the utmost vital thing, a person can do to manage type 1 or type 2 diabetes. A person will be able to understand what makes numbers go up or down, such as eating diverse foods, taking medicine, or being physically active. With this, a person can work with his health care team to make decisions about the best diabetes care plan. These decisions can help delay or prevent complications of diabetes such as heart attack, stroke, kidney disease, blindness, and amputation. The doctor will suggest, how often to check person blood sugar levels.

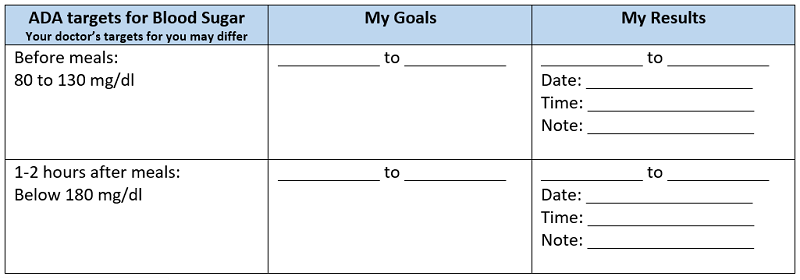
Most blood sugar meters allow to save the results and a person can use an app on cell phone to track and monitor the desired levels. When a person doesn’t have a smart phone, then put a written daily record like the one in the table given here. A person should bring the meter, phone, or paper record along with him each time during his visit to the health care provider.

The following standard recommendations are from the American Diabetes Association (ADA) for people who have diagnosed diabetes and are not pregnant. Work with the doctor to identify the personal blood sugar goals based on the age, health, diabetes treatment, and whether to have type 1 or type 2 diabetes. [10]

The basic BGL range may be different if a person has other health conditions or if the blood sugar is often low or high. Always follow the doctor’s recommendations.

Below is a sample record to apprise the doctor in understanding a better way.

Table1: Written daily record of blood glucose levels (BGL)



## **A1C Test (or HbA1c test)**

The A1C test, also known as an HbA1C, hemoglobin A1C, glycated hemoglobin, or glycosylated hemoglobin test, is a blood test used to diagnose and monitor diabetes in a person’s body. This test result shows the average blood sugar levels for the past two to three months. This A1C test is a wider test than using conventional home glucose monitor, which measures the blood sugar at any given moment.

Make sure to get an A1C test at least twice or thrice a year. Some people may need to have the test more often with doctor’s advice. A1C (HbA1c test) results tell the average blood sugar level over 3 months. A1C results may be different in people with hemoglobin problems such as sickle cell anemia. Work with the doctor to decide the best A1C goal for the patient. [10] Follow thereafter doctor’s advice and recommendations.

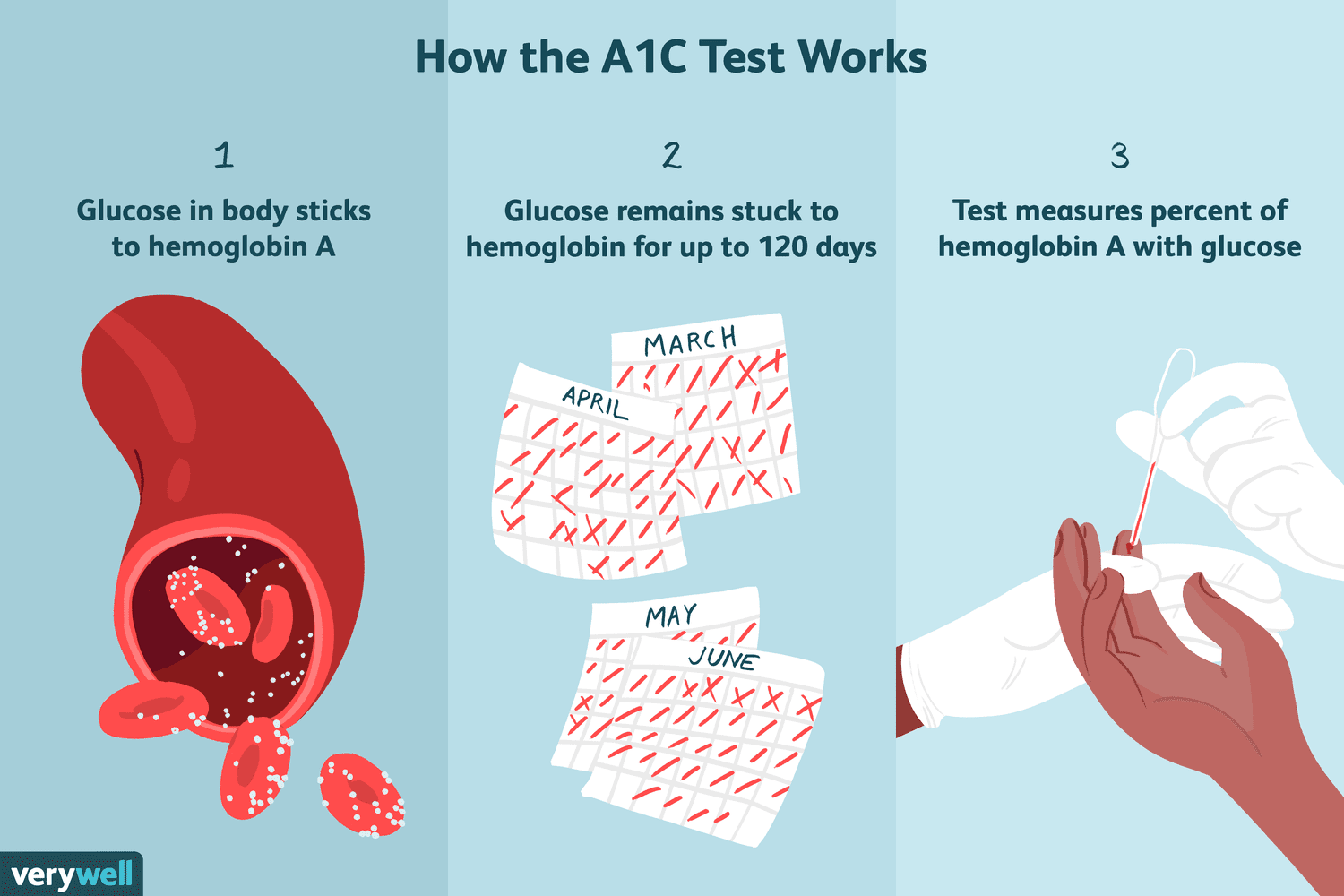


Figure1: working principle of A1C Test. Source: https://www.verywellhealth.com/diabetes-and-a1c-levels-1087678

The A1C result will be reported in two ways:

* A1C as a percentage.
* Estimated average glucose (eAG), in the same kind of numbers as the day-to-day blood sugar readings.

If after taking this test the results are too high or too low, then the diabetes care plan may need to be adjusted. Below are ADA’s standard target ranges:

Table2: Blood Glucose Levels (BGL) as per ADA



The ADA's Standards of Medical Care in Diabetes for 2022 note the following A1C targets:

| Table3: A1C Targets for Diabetes Management | |
| --- | --- |
| Source: https://www.verywellhealth.com/diabetes-and-a1c-levels-1087678 | |
| Person | Ideal A1C |
| Most non-pregnant adults without significant hypoglycemia | <7% |
| Adults in which blood sugar can be managed safely without significant hypoglycemia or other adverse effects of treatment (based on provider judgment and patient preference) | Target may be set lower than <7% |
| Adults with limited life expectancy or when the harms of treatment outweigh the benefits | <8% |

Experts disagree somewhat on what the A1C target should be. The ADA recommends a general A1C target of less than 7% without significant hypoglycemia (low blood sugar), while the American Association of Clinical Endocrinologists (AACE) recommends a general target level of 6.5% or below. [18]

While helpful, these targets are the only general guidelines. Both the ADA and the AACE stress that A1C goals should be individualized based on factors such as:

* Age
* Other medical conditions
* Length of time you've had diabetes
* How well you comply with your treatment plan
* Your risk of developing complications from hypoglycemia
  1. **Healthy blood glucose level (BGL) ranges**

BGLs over and above 180 mg/dL (milligrams of glucose per deciliter of blood) or below 70 mg/dL are considered as unhealthy. High blood sugar levels (HBGL) on and above 180 mg/d) might be a sign of not enough insulin, due to lack of exercise, overeating, or other factors. Low blood sugar levels (LBGL) below 70 mg/dL may be caused by taking too much insulin or other diabetes medicines, delaying or skipping a meal, over exercising, drinking too much alcohol, or other factors.

Table4: ADA Healthy blood sugar level ranges

|  |  |
| --- | --- |
| > 180 mg/dL | Too high; considered unhealthy |
| 80 - 130 mg/dL | Good range for most people |
| < 70 mg/dL | Too low; considered unhealthy |

The American Diabetes Association (ADA) advises a before-meal (preprandial) plasmaglucose level of 80mg/dL to130 mg/dL. The ADA has set the after-meal (postprandial) plasma glucose level of less than 180 mg/dL.

1. **Continuous Glucose Monitoring (CGM)**

Continuous Glucose Monitoring (CGM) devices help a person to manage Type 1 or Type 2 diabetes with fewer finger stick tests. A sensor just under a person’s skin measures the glucose levels 24 hours a day. A transmitter sends results to a wearable device or cell phone. It takes time to learn how to use CGM, but it can help a person more easily to manage the health. [12] CGM is a wearable technology that makes it easier to track the blood sugar levels over time. Blood sugar is another term for blood glucose.

### CGM measures

CGM is a tool for the people having with diabetes. It measures the glucose levels for the 24 hours a day, when a person is wearing the monitoring device. Insulin is a hormone that helps the person’s body to regulate BGLs. If a person has been suffering with Type 1 diabetes, his body doesn’t produce enough/or any of the hormone insulin. In Type 2 diabetes, the body makes insulin but doesn’t use it effectively. People with diabetes need to give themselves insulin regularly to keep blood sugar levels steady.

### Tracking blood sugar levels (BGL)

Tracking blood glucose levels (BGL) expresses that how much insulin a body needs and when. Blood sugar levels that go up and down a lot can damage the body in different ways. Very high (hyperglycemia) or low (hypoglycemia) blood sugar levels can be serious, and even life-threatening when not treated quickly.

Many things (like the foods eating, sports a person play and the lifestyle) can affect the blood sugar levels. But diabetes affects everyone differently. How a food or activity affects one person’s glucose levels is often different from how that same thing affects someone else.

A person’s body can also be unpredictable. Sometimes, the body can have a reaction that even healthcare providers don’t always understand. All of these factors can make managing diabetes challenging, even while thinking as doing everything right. [12]

# **Low Blood Sugar (Hypoglycemia)**

Blood sugar levels (BSL) change often during the entire day. When they drop to below 70 mg/dL, this is called having low blood sugar. At this level, a person needs to take action to bring it back up. Low blood sugar is especially common in people with type 1 diabetes.

Knowing how to identify low blood sugar is important because it can be dangerous if left untreated. [13]

## **Causes of low blood sugar**

There are many reasons why a person may have low blood sugar, including:

* Taking too much insulin.
* Not eating enough carbs for how much insulin one takes.
* Timing of when taking the insulin.
* The amount and timing of physical activity.
* Drinking alcohol.
* How much fat, protein, and fiber are in the meal.
* Hot and humid weather.
* Unexpected changes in the schedule.
* Spending time at a high altitude.
* Going through puberty.
* Menstruation.

## **Symptoms of low blood sugar**

How a person react to low blood sugar may not be the same as how someone else with low blood sugar reacts. It’s important to know the signs. Common symptoms may include:

* Fast heartbeat
* Shaking
* Sweating
* Nervousness or anxiety
* Irritability or confusion
* Dizziness
* Hunger

A person may not have any symptoms when his blood sugar is low (hypoglycemia unawareness). If someone doesn’t have symptoms, it will be harder to treat the low blood sugar early. This increases the risk of having severe lows and can be dangerous. This is more likely to happen if a person:

* Has had diabetes for more than 5-10 years.
* Frequently have low blood sugar.
* Take certain medicines, such as beta blockers for high blood pressure.

If a person meets one or more of the above and has hypoglycemia unawareness, he may need to check the blood sugar more often to see if it’s low. This is very important to do before driving or being physically active. [13]

## **Types of low blood sugar**

### Nighttime low blood sugar

While low blood sugar can happen at any time during the day, some people may experience low blood sugar while they sleep. Reasons this may happen include:

* Having an active day.
* Being physically active close to bedtime.
* Taking too much insulin.
* Drinking alcohol at night.

Eating regular meals and not skipping them can help to avoid nighttime low blood sugar. Eating while drinking alcohol can also help. If a person is thinking at risk for low blood sugar overnight, he may have a snack before bed. A person may wake up when having low blood sugar, but shouldn’t rely on that. A continuous glucose monitor (CGM) can alert with an alarm if the blood sugar gets low while sleeping.

### Severe low blood sugar

As and when low blood sugar gets worse, it may experience more serious symptoms, including:

* Feeling weak.
* Having difficulty walking or seeing clearly.
* Acting strange or feeling confused.
* Having seizures.

Severe low blood sugar is below 54 mg/dL. Blood sugar this low may make patient faint (pass out). Often, then it will need someone to help and treat severe low blood sugar.

People with diabetes may experience low blood sugar as often as once or twice a week, even when managing their blood sugar closely. Knowing how to identify and treat it is important for the health.

* + 1. **Treatment of low blood sugar**

Carry supplies for treating low blood sugar. If a person feels shaky, sweaty, or very hungry or have other symptoms, check the blood sugar immediately. Even if a person doesn’t have symptoms but thinking of having low blood sugar, check it. If the blood sugar is lower than 70 mg/dL, do one of the following immediately:

* Take four glucose tablets.
* Drink four ounces of fruit juice.
* Drink four ounces of regular soda, not diet soda.
* Eat four pieces of hard candy.

Wait for 15 minutes and then check the blood sugar again. Do one of the above treatments again until the blood sugar is 70 mg/dL or above and eat a snack if the next meal is an hour or more away. If a person has problems with low blood sugar, ask the doctor if treatment plan needs to be changed.

## **Ketones**

Ketones are a type of chemical that the liver produces when it breaks down fats. The body uses ketones for energy typically during fasting, long periods of exercise, or when a person doesn’t have as many [carbohydrates](https://www.diabetes.org.uk/guide-to-diabetes/enjoy-food/carbohydrates-and-diabetes). One can have low levels of ketones in the blood without it being a problem.

But high levels of ketones in the blood is a sign that something is not quite right. A person can tell if he has high levels of ketones in the blood.

Now it can be expressed that ketones are a kind of fuel produced when fat is broken down for energy. The liver starts breaking down fat when there’s not enough insulin in the bloodstream to let blood sugar into cells.

# If a person is ill and blood sugar is 240 mg/dL or above, use an over-the-counter ketone test kit to check the urine for ketones and call the doctor if the ketones are high. High ketones can be an early sign of diabetic ketoacidosis, which is a medical emergency and needs to be treated immediately.

* 1. **Building up of Ketones**

A person is at much risk of a building up of ketones if he doesn’t inject enough insulin or miss a dose of insulin. It’s important to know that sometimes it is needed more insulin than usual and need to check for high blood sugars more regularly, like when a person:

* is not feeling well
* has had an injury or surgery
* is pregnant
* is having period.

All of these times are just part of normal life and that can be a reminder that diabetes is always there in the background. If a person is struggling to cope with the diabetes, and when he is feeling down or tired with managing the diabetes, get support from the counsellor or doctor.

## **Ketones symptoms**

Take proper steps to stop ketones from building up in the body. Noticing when the body is starting to produce ketones is an important step. May check for ketones in the blood or urine if a person notices the following:

* breath that smells fruity (this is the ketones in the breath)
* high blood sugar levels (this is called a hyper)
* going to the toilet a lot
* being really thirsty
* feeling more tired than usual
* stomach pain
* changes to the breathing (usually deeper)
* confusion
* fainting
* feeling or being sick.

### High levels of ketones in the blood or urine can mean the person is at risk of developing [diabetic ketoacidosis](https://www.diabetes.org.uk/guide-to-diabetes/complications/diabetic_ketoacidosis). This can be life-threatening, so it's important to be aware of ketone level.

* 1. **Keto Diet**

Some people follow a ketogenic diet to lose weight, sometimes called the keto diet. This is a very low carb diet that produces ketones in their blood. But, following the keto diet for treating diabetes, there is not enough evidence to say it is safe or effective.

# **Diabetic Ketoacidosis**

When too many ketones are produced too fast, they can build up in the body and cause Diabetic Ketoacidosis (DKA). DKA is very serious complication of diabetes that can be life-threatening and can cause a coma or even death. DKA is most common among people with type 1 diabetes. People with type 2 diabetes can also develop DKA.

DKA develops when the body doesn’t have enough insulin to allow blood sugar into the cells for use as energy. Instead, the liver breaks down fat for fuel, a process that produces acids called ketones. When too many ketones are produced too fast, they can build up to dangerous levels in the body. [14]

## **DKA Signs and Symptoms**

DKA usually develops slowly. Early symptoms include:

* Being very thirsty.
* Urinating a lot more than usual.

If untreated, more severe symptoms can appear quickly, such as:

* Fast, deep breathing.
* Dry skin and mouth.
* Flushed face.
* Fruity-smelling breath.
* Headache.
* Muscle stiffness or aches.
* Being very tired.
* Nausea and vomiting.
* Stomach pain.
  1. **Causes of DKA**
* Very high blood sugar and low insulin levels lead to DKA. The two most common causes are:
* Illness. When a person gets sick, he may not be able to eat or drink as much as usual, which can make blood sugar levels hard to manage.
* Missing insulin shots, a clogged insulin pump, or the wrong insulin dose.

Other causes of DKA include:

* Heart attack or stroke.
* Physical injury, such as from a car accident.
* Alcohol or drug use.
* Certain medicines, such as some diuretics (water pills) and corticosteroids (used to treat inflammation in the body)

Sometimes DKA is the first sign of diabetes in people who haven’t yet been diagnosed.

* 1. **Test for Ketones**

Anytime a person is sick or blood sugar is 240 mg/dL or above, use an over-the-counter ketone test kit to check the urine or a meter to test the blood for ketones every 4 to 6 hours. A person should also test for ketones if it has any of the symptoms of DKA. Call the doctor if ketones are moderate or high. Elevated ketones are a sign of DKA, which is a medical emergency and needs to be treated immediately. [14]



Figure2: Test for Ketones

Go to the emergency room or call 911 right away if a person can’t get in touch with the doctor and are experiencing any of the following:

* blood sugar stays at 300 mg/dL or above.
* breath smells fruity.
* vomiting and can’t keep food or drinks down.
* having trouble breathing.
* have multiple signs and symptoms of DKA.
  1. **Treatment for DKA**

If a person has DKA, he’ll be treated in the emergency room or admitted to the hospital. The treatment will likely include:

* Replacing **fluids,** lost through frequent urination and to help dilute excess sugar in the blood.
* Replacing **electrolytes** (minerals in the body that help nerves, muscles, heart, and brain work the way they should). Too little insulin can lower the electrolyte levels.
* Receiving **insulin**. Insulin reverses the conditions that cause DKA.
* Taking **medicines** for any underlying illness that caused DKA, such as antibiotics for an infection.

**6.5. Prevention from DKA**

DKA is a serious condition, but a person can take steps to help prevent it:

Check blood sugar often, especially if a person is sick.

## Keep the blood sugar levels in the target range as much as possible.

## Take medicines as prescribed, even if feeling fine.

## Talk to the doctor about how to adjust the insulin based on what is eaten, how active a person is, or if sick.

## If a person is concerned about DKA or have questions about how to manage diabetes, be sure to meet with diabetes care team and ask for a referral to diabetes self-management education and support (DSMES) services for individual guidance. DSMES services are a vital tool to help and manage and live well with diabetes while protecting the health.

## **Living with Glucose**

### CGM to Manage Diabetes

A person may find education, support, and resources to improve quality of life with diabetes. Learn how to manage diabetes to prevent or delay health complications by eating well, being physically active, managing diabetes during sick days, reaching and maintaining a healthy weight, managing stress and mental health, and more.

A person can regularly check the blood glucose levels (BGL) using a finger stick blood check and a blood glucose monitor. Many people do just that.

But finger stick checks only measure blood glucose at one moment in time. It’s like reading one page of a book. Doing more finger stick checks gives more snapshots, which can offer clues to what’s happening with the blood sugar levels. [12]

## **Procedural Details**

### CGM Device’s Working

A person can choose among a handful of CGM devices available today. Each works pretty much the same way. The main differences are in a device’s look, feel and features.

In general, here’s how CGM works:

1. Place a small sensor just under the skin, usually on the belly or arm. An applicator makes this part quick and easy to do. Adhesive tape holds the sensor in place.
2. The sensor measures glucose levels in the fluid under the skin. Most CGM devices take readings every five minutes, all day and night. It is needed to change the sensor regularly based on the device. For most devices, change sensors at home every 7 to 14 days. For some long-term implantable CGM devices, the healthcare provider will change the sensor in their office a handful of times (or less) each year.
3. All CGM systems use a transmitter to wirelessly send the glucose data from the sensor to a device where anyone can view it. For some CGM systems, the transmitter is reusable and attaches to each new sensor. For other CGM systems, the transmitter is part of the disposable sensor.
4. Depending on the CGM system, glucose data from the sensor is sent to either a handheld device called a receiver (similar to a cell phone), an app on the smartphone or an insulin pump.
5. A person can download CGM data (real-time glucose levels, trends and history) to a computer anytime. Some CGM systems will send data continuously.

CGM devices are complex little machines. They generally require some of upfront time to understand their technical aspects. [12]

The patient therefore needs to learn in a way how to:

* Insert the sensor properly.
* Calibrate the device with finger stick blood glucose readings (for certain CGM devices).
* Set device alarms.
* Transfer data to a computer (for long-term analysis) or on phone.
* Respond to and make changes to the care plan based on the collected data.
  1. **Advantages of using CGM to Manage Diabetes**

Using a CGM device can make it easier to manage Type 1 or Type 2 diabetes. Some people use CGM for a week to understand their blood sugar patterns. Most use CGM long-term.

A CGM device can:

* **Show a bigger picture of how diabetes affects:** CGM measures glucose levels every few minutes. That data shows a more complete picture of how the blood sugar levels change over time. This information can be helpful and the provider better understand how things like food, activity, stress and illness impact the blood sugar levels.
* **Lead to more personalized care:** CGM doesn’t give the whole story of all the ways diabetes affects a person. It tells, when glucose goes up or down, not why. But the provider can download CGM data from a person’s device and review it for patterns and trends.
* **Alert to highs and lows:** Most CGM devices send an alert when the glucose levels rise or fall a certain amount. With this information, a person can make changes quickly. He may be able to treat or prevent highs or lows before they turn into a big problem.
* **Reduce how many finger stick checks needed to do:** CGM significantly reduces how many finger stick tests a person needs to do each day.

It may be noted that CGM is not a cure for diabetes. It's a tool (and not one a person can set and forget). A person need to actively use CGM for it to be helpful. But once he gets the hang of how to use it, CGM may help better manage his blood sugar levels and overall health in less time. [12]

# **Diabetes and Mental Health**

Mental health is pretty low merely on the list of priorities for managing diabetes. This may change the mind.  
Mental health affects so many aspects of daily life how a person thinks and feels, handle stress, relate to others, and make choices. Patient understands mental health problem could make it harder to stick to his diabetes care plan. [15]

### Mind-Body Connection

Thoughts, feelings, beliefs, and attitudes can affect how healthy the body is. Untreated mental health issues can make diabetes worse, and problems with diabetes can make mental health issues worse. But fortunately if one gets better, the other tends to get better, too.

### Depression: More Just a Bad Mood

Depression is a medical illness that causes feelings of sadness and often a loss of interest in activities patient used to enjoy. It can get in the way of how well he functions at work and home, including taking care of the diabetes. When a patient is not able to manage his diabetes well, the risk goes up for diabetes complications like heart disease and nerve damage.

People with diabetes are 2 to 3 times more likely to have depression than people without diabetes. Only 25% to 50% of people with diabetes who have depression get diagnosed and treated. But treatment therapy, medicine, or both is usually very effective. And without treatment, depression often gets worse, not better.

Symptoms of depression can be mild to severe, and include:

* Feeling sad or empty
* Losing interest in favorite activities
* Overeating or not wanting to eat at all
* Not being able to sleep or sleeping too much
* Having trouble concentrating or making decisions
* Feeling very tired
* Feeling hopeless, irritable, anxious, or guilty
* Having aches or pains, headaches, cramps, or digestive problems
* Having thoughts of suicide or death

If a person might have been thinking depression, get in touch with doctor right away for help getting treatment. The earlier depression is treated, the better for the person, his quality of life, and diabetes.

### Stress and Anxiety

Stress is part of life, from traffic jams to family demands to everyday diabetes care. A person can feel stress as an emotion, such as fear or anger, as a physical reaction like sweating or a racing heart, or both.

If person is stressed, he may not take as good care of himself as usual. The blood sugar levels can be affected too stress hormones make blood sugar rise or fall unpredictably, and stress from being sick or injured can make blood sugar go up. Being stressed for a long time can lead to other health problems or make them worse.

Anxiety feelings of worry, fear, or being on edge is how the mind and body react to stress. People with diabetes are 20% more likely than those without diabetes to have anxiety at some point in their life. Managing a long-term condition like diabetes is a major source of anxiety for some.

Studies show that therapy for anxiety usually works better than medicine, but sometimes both together works best. Following can also help lower the stress and anxiety by:

* Getting active: even a quick walk can be calming, and the effect can last for hours.
* Doing some relaxation exercises, like meditation or yoga.
* Calling or texting a friend who understands (not someone who is causing stress!).
* Grabbing some time. Take a break from whatever a person is doing. Go outside, read something fun whatever helps him recharge.
* Limiting alcohol and caffeine, eating healthy food, and getting enough sleep.

Anxiety can feel like low blood sugar and vice versa. It may be hard for a person to recognize which it is and treat it effectively. While feeling anxious, try checking blood sugar and treat it, if it’s low.

There will always be some stress in life. But if feeling overwhelmed, talking to a mental health counsellor/doctor can help. [15]

### Diabetes Distress

A person may sometimes feel discouraged, worried, frustrated, or tired of dealing with daily diabetes care, like diabetes is controlling instead of the other way around. Maybe person has been trying hard but not seeing results. Or he developed a health problem related to diabetes in spite of his best efforts.

Those overwhelming feelings, known as diabetes distress, may cause to slip into unhealthy habits, stop checking the blood sugar, even skip doctor’s appointments. It happens to many if not most people with diabetes, often after years of good management. In any 18-month period, 33% to 50% of people with diabetes have diabetes distress. [15]

Diabetes distress can look like depression or anxiety, but it can’t be treated effectively with medicine. Instead, these approaches have been shown to help:

* Make sure seeing an endocrinologist for the diabetes care. He or she is likely to have a deeper understanding of diabetes challenges than any regular doctor.
* Ask the doctor to refer to a mental health counselor who specializes in chronic health conditions.
* Get some one-on-one time with a diabetes educator so person can solve problem together.
* Focus on one or two small diabetes management goals instead of thinking that a person has to work on everything all at once.
* Join a diabetes support group if there, so a person can share his thoughts and feelings with people who have the same concerns (and learn from them too).

1. **Blood Glucose Management (BGM)**

It’s important to keep the blood sugar levels in the target range as much as possible to help prevent or delay long-term, serious health problems, such as heart disease, vision loss, and kidney disease. Staying in the target range can also help improve the energy and mood. Find answers below to common questions about blood sugar for people with diabetes. [16]

Use a blood sugar meter (glucometer) or a continuous glucose monitor (CGM) to check the blood sugar. A blood sugar meter measures the amount of sugar in a small sample of blood, usually from the fingertip. A CGM uses a sensor inserted under the skin to measure blood sugar every few minutes. If a person uses a CGM, he will still need to test daily with a blood sugar meter to make sure that CGM readings are accurate. Often checking blood sugar depends on the type of diabetes a person has and if he takes any diabetes medicines.

Typical times to check the blood sugar include:

* first wake up, before a person eat or drink anything.
* Before a meal.
* Two hours after a meal.
* At bedtime.

## **Blood sugar targets**

A blood sugar target is the range any one try to reach as much as possible. These are typical targets:

* Before a meal: 80 to 130 mg/dL.
* Two hours after the start of a meal: Less than 180 mg/dL.

The blood sugar targets may be different depending on the age of a person, having any additional health problems, and other factors. Be sure to talk to the health care team about which targets are best for a person.

* 1. **Power to prevent Diabetes**
* **Move more.** Get up, get out, and get moving. Try walking, dancing, bike riding, swimming, or playing ball with the friends or family. It doesn’t matter what a person is doing as long as he enjoys it. Try different things so person doesn’t get bored. [17]
* **Eat the healthy plate way.** Focus on eating less and making healthy food choices. Try to eat more fruits and vegetables (5 to 9 servings a day), dried beans, and whole grains. Cut down on fatty and fried foods. A person still can eat the foods to enjoy, just eat less.

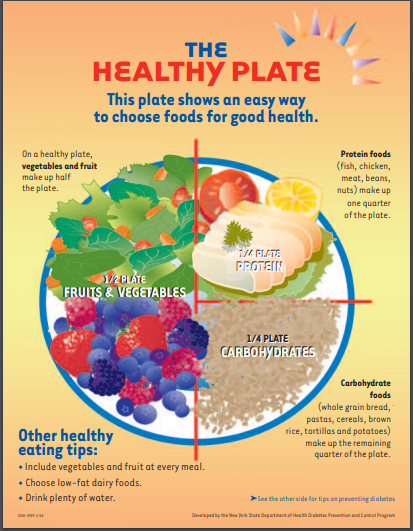


Figure3: easy way to choose foods for good health. Source: <https://www.health.ny.gov/publications/0929.pdf>

* **Take off some weight**. Once started eating less and moving more, person will lose weight. By losing even 10 pounds, then has less chances of getting diabetes.
* **Set goals to meet**. Start by making small changes. Try being active for 15 minutes a day this week. Then each week add 5 minutes until a person build up to 30 minutes 5 days a week. Try to cut 100 calories out of the diet each day (that’s one can of soda!). Slowly reduce calories over time. Talk to health care team about the future goals.
* **Record the progress**. Write down all the things while eating and drink and the number of minutes’ person is active. Keeping a diary is one of the best ways to lose weight and keep it off.
* **Get help**. Don’t prevent diabetes alone. Ask family and friends to help out. Involve them in the activities. Help each other move more, eat less, and live a healthier life. [17]

1. **Summary**

This book chapter provide a detailed learning towards that how to monitor blood glucose and its management. Blood glucose monitoring and management helps the person to identify patterns in the fluctuation of blood glucose levels which follow in response to healthy food life style, diet, medications, exercise, and pathological procedures associated with blood glucose variations. These can be termed as diabetes mellitus. Abnormally low or high blood glucose levels which can potentially lead to challenging and life-threatening conditions, both acute and chronic. Blood glucose level (BGL) or blood sugar level (BSL) monitoring and its management.

Blood glucose monitoring may support diagnosing and managing the client with impaired glucose metabolism or diabetes. Regular monitoring of blood glucose levels may not be recommended for all patients with type 2 diabetes mellitus on oral antidiabetic drugs or dietary management alone. However, blood glucose monitoring may be warranted during titration of oral hypoglycemic medications known to cause hypoglycemia.

Many things can cause high blood sugar (hyperglycemia), including being sick, being stressed, eating more than planned, and not giving enough insulin. Over time, high blood sugar can lead to long-term, serious health problems. Symptoms of high blood sugar include:

* Feeling very tired.
* Feeing thirsty.
* Having blurry vision.
* Needing to urinate (pee) more often.

Eating a healthy diet with plenty of fruit and vegetables, maintaining a healthy weight, and getting regular physical activity can all help. Other tips include: Keep track of the blood sugar levels to see what makes them go up or down. Eat at regular times, and don't skip meals. In this way a person can be healthy all his life.

One of the efforts to reduce health problems is to increase public knowledge about diabetes mellitus. according to PERKENI, the management of DM consists of five columns, namely physical activity, dietary compliance, regular regulation, education and blood sugar control.

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