MANAGING CYSTIC FIBROSIS-RELATED DIABETES (CFRD)

An Instruction Guide for Patients and Families | 7TH EDITION

CYSTIC FIBROSIS FOUNDATION®

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Special thanks to the current authors of the manual and to those who have contributed to past editions.

CYSTIC FIBROSIS FOUNDATION®

This information meets the guidelines and standards of the Cystic Fibrosis Foundation's Education Committee.

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INTRODUCTION

If you are reading this, you or someone you love has likely been told they have cystic fibrosis-related diabetes (CFRD). This guide was written to add to the information given to you by your diabetes and cystic fibrosis care teams. The chapters cover the topics you will need to know about how to manage CFRD. To help you focus on the main points, learning goals are listed at the start of each chapter.

If you have been told that you have CF and diabetes, you might feel stressed by the added health care responsibilities. You are not alone. In fact, CFRD is one of the most common complications of CF in adults. You might feel hopeless when you think you cannot do one more thing. Diabetes is not the "last straw," though. To manage it well, learn as much as you can. You should be able to do all the things you want to do — and continue to eat your usual diet as recommended by your CF care team. Learning the skills from this book can help keep you as healthy as possible.

Some people have a hard time affording food or medications, and that can make managing CFRD more difficult. If you are having a hard time affording these things, discuss this with your CF care team and consider calling CF Foundation Compass. Compass case managers can provide information and identify resources to help you meet your unique challenges related to life with CF, including food and medications.

For support, call 844-COMPASS (844-266-7277), Monday through Friday, 9 a.m. until 7 p.m. ET; visit cff.org/compass and fill out an online service request; or email compass@cff.org.

An Important Note for People With CF and Their Caregivers

The Cystic Fibrosis Foundation is a leader in the efforts to advance and promote specialized care that improves and extends the lives of people with CF. Thanks in large part to the care provided by the Foundation's Care Center Network, the median predicted age of survival for people with CF is more than 50 years and is increasing. To ensure this trend continues, the Foundation provides its accredited care centers with up-to-date clinical practice guidelines based on the latest research.

The Cystic Fibrosis Foundation, together with the American Diabetes Association and the Pediatric Endocrine Society, sponsored a consensus conference on CFRD in 2009. The guidelines and definitions presented here reflect the consensus by experts in CF and diabetes. The authors and the CF Foundation hope this guide will help you and your family understand how CFRD is unique, and help you manage it and live well with diabetes.

CHAPTER 1: CYSTIC FIBROSIS-RELATED DIABETES (CFRD)

Learning Goals

At the end of this chapter, you should be able to

- Understand how the body uses ***insulin**** to turn food into fuel for the body.
- See that CFRD is common among people with ***CF***, especially in adults.
- List the differences between CFRD and type 1 or type 2 diabetes.
- State the causes of CFRD.
- Understand the symptoms of CFRD.

**Words that appear italicized and bolded are defined in the glossary starting on page 68.*

Background

When people eat, the ***carbohydrates***, fat, and ***protein*** in food is broken down in the ***intestines*** and absorbed. ***Sugar*** (from the carbohydrates) enters the bloodstream and ***blood sugar*** (also known as ***blood glucose***) levels rise. The increase in blood sugar signals the ***pancreas***, an organ in the abdomen, to ***secrete*** insulin. Insulin works by helping protein, fat, and sugar leave the blood and enter the cells where they are used for fuel. People with ***diabetes*** either do not make enough insulin or do not respond to insulin the right way, so sugar cannot leave the blood and enter the cells. People with diabetes do not convert food into fuel very well. When blood sugar is not controlled well, people can lose weight (especially muscle weight), lack energy, and have other problems.

Diabetes

DID YOU KNOW?

Blood sugar and blood glucose mean the same thing!

Diabetes is very common in people with ***cystic fibrosis***. It most often occurs as they get older. People with CF and diabetes have a unique type of diabetes called ***cystic fibrosis-related diabetes (CFRD)***. Few people with CF have normal ***glucose*** levels. One study found that up to 75% of adults with CF have some form of ***glucose intolerance*** where their bodies have trouble converting sugar into fuel. CFRD affects about 20% of adolescents and 40 to 50% of adults with CF. CFRD is not the same as diabetes found in people without CF. There are important differences in the way it is ***diagnosed*** and treated. You and those who care for you need to know how CFRD is unique.

Non-CF Diabetes

The most common types of diabetes in the general population are type 1 and type 2 diabetes. CFRD has some features that are common in both. ***Type 1 diabetes*** occurs most often in childhood. You may have heard it called "juvenile diabetes." People with type 1 diabetes cannot make insulin, so they must take insulin to stay alive. This is why type 1 diabetes is often called ***insulin-dependent diabetes***. People with type 1 diabetes who miss insulin doses get very sick, which can lead to ***ketoacidosis*** (a life-threatening change in blood acidity).

Type 2 diabetes is sometimes called ***non-insulin-dependent diabetes***. It is caused by the lack of a normal response to insulin, also called ***insulin resistance***. This means the body's cells require more insulin than normal to change food into fuel and keep blood sugar levels under control.

When people with CF become insulin resistant, their body's cells do not use insulin the right way, which leads to high blood sugar levels. In addition, in type 2 diabetes, the pancreas does not make enough insulin. This type of diabetes occurs most often in adults who are overweight. People with type 2 diabetes do not often get ketoacidosis, but they can get very sick when their blood sugar is too high. Some people with type 2 diabetes use insulin. Some take pills. Most are asked to lose weight. Some people can manage type 2 diabetes through diet and exercise alone.

TYPES OF DIABETES:

Type 1: The body stops making insulin.

Type 2: The body lacks normal responses to insulin (most important) and does not make enough insulin.

CFRD: The body does not make enough insulin (most important) and sometimes lacks normal responses to insulin.

CFRD Causes

CFRD is unique to people with CF, though it shares features with both type 1 and type 2 diabetes in people who do not have CF. The pancreas does not make enough insulin, similar to type 1 diabetes. Because of this, people with CFRD have ***insulin deficiency*** and require insulin replacement. Insulin deficiency is primarily due to scars in the pancreas (fibrosis) caused by thick, sticky mucus. Even people with CF who do not have diabetes have partial scarring of the pancreas and make less insulin than normal.

People with CFRD can also develop insulin resistance like people with type 2 diabetes, especially when they are ill. With insulin resistance, insulin does not work as well in your body.

Insulin resistance in CF can be caused by

- ***Underlying infection***, which can lead to low-grade, ***chronic inflammation*** and insulin resistance. Insulin resistance becomes much worse during an acute exacerbation. This is why diabetes is often first diagnosed during an acute illness — the sudden spike in insulin resistance "unmasks" insulin deficiency in the person who cannot make extra insulin.
- ***Steroid*** drugs such as prednisone or methylprednisolone that are sometimes needed to treat lung disease. Insulin resistance is a side effect of steroid medications. Blood sugar levels are often higher during steroid treatment and can reach diabetic levels.
- Pregnancy. During pregnancy, all women need very high amounts of insulin. Because of their underlying insulin deficiency, women with CF often cannot make the extra insulin and develop high blood sugar. If the high blood sugar occurs only during the pregnancy (not before or after), it is called ***gestational diabetes*** rather than CFRD.

In the past, many problems seen in type 2 diabetes, such as obesity, high ***cholesterol***, and heart disease, were not thought to be a part of CFRD. However, due to the use of CFTR modulators, people with CF are living longer and their symptoms are starting to resemble those of the general population. Issues such as obesity, high cholesterol, and heart disease are occurring more frequently. Being overweight or obese has not traditionally been a cause of insulin resistance in CF, but this is changing with CFTR modulators.

Once you are diagnosed with CFRD, whether while hospitalized or as an outpatient, you will always have CFRD. However, you may not always need to take insulin. If your blood sugar is high only when you are sick or on steroids, you may need insulin only at those times. If your blood sugar is high when you are well, you will need insulin at all times. Even if your blood sugar is normal after an illness, your doctor may recommend that you stay on insulin so you do not lose weight. This is personalized depending on your unique needs.

Health Problems Caused by CFRD

Although CFRD is unique, many of the problems caused by diabetes are the same for all types.

Problems common to all types of diabetes include eye, kidney, and nerve issues. Cardiac issues are commonly associated with type 1 and type 2 diabetes mellitus, but this is a rising concern in CFRD with the aging CF population and changes in medical therapy over the years. More studies are underway to understand this issue.

YEARS OF BLOOD SUGAR THAT IS TOO HIGH CAN CAUSE PROBLEMS WITH

- Eyes
- Kidneys
- Nerves
- Maintaining weight and muscle mass (in CFRD)
- Maintaining lung function (in CFRD)

Insulin plays a role in glucose uptake into fat and muscle and stimulates the creation of body fat and muscle build up. When patients have insulin deficiency, they have high blood glucose levels as well as difficulty maintaining a healthy weight as the energy from food cannot be fully absorbed into cells.

Their unintentional weight loss, loss of muscle mass, and elevated blood glucose levels in turn lead to decreased lung function. This affects a patient's overall survival.

These problems get worse after many years of blood sugar levels that are too high. **Every person's goal for diabetes treatment, no matter what kind the person has, is to keep blood sugar levels as normal as possible.** This helps to prevent problems caused by diabetes.

CFRD Symptoms

CFRD often has no symptoms, so you might not know you have it. Other diabetes symptoms are similar to CF symptoms that you may already have.

Having to ***urinate*** often (***polyuria***) and needing to drink often (***polydipsia***) are classic symptoms of diabetes. These symptoms are caused by high blood sugar levels (***hyperglycemia***). It is easy to overlook these symptoms in CF. People with CF often drink more (and then use the bathroom more) because of dry mouth. Other symptoms

of CFRD include feeling very tired, losing weight without trying or having a hard time gaining weight, and a loss of lung function that you cannot explain. Infection and lung disease can also cause these symptoms, so diabetes may not be found unless certain blood tests are run to look for it. Unlike people with type 1 diabetes, it is very rare for people with CFRD to get ketoacidosis.

CFRD SYMPTOMS

- There may be no symptoms
- Polyuria
- Polydipsia
- Being very tired
- Losing weight
- Not able to gain weight
- Loss of lung function

Any time you have weight loss that you cannot explain or have a hard time gaining weight, your CF care team should run diabetes tests. If you know you have diabetes and are having problems keeping your weight up, review how you manage diabetes with your *diabetes care team*. Treatment of your CFRD should be included as part of your overall CF treatment plan. Contact your CF care center to learn more about diabetes.

CHAPTER 2: HOW CFRD IS DIAGNOSED

Learning Goals

At the end of this chapter, you should be able to

- List the tests used to ***diagnose*** CFRD.
- Understand the criteria for diagnosis.

Diagnosis of CFRD can be made at different time points, and the criteria for diagnosis differ slightly. You can be diagnosed with CFRD while healthy in clinic, while ill in the hospital, during pregnancy, or while receiving tube feeds. Once a CFRD diagnosis is made at any of these time points (for example, when ill), then the diagnosis remains, even if blood glucose levels return to normal when healthy. It remains to be seen whether the improvements we are seeing with CFTR modulators will change how diagnosis is made.

Tests Used to Diagnose CFRD

Oral Glucose Tolerance Test

The ***oral glucose tolerance test (OGTT)*** is recommended annually by age 10, and any other time CFRD is suspected. You must ***fast*** overnight (nothing to eat or drink except plain water) for eight hours so your care team can see what your blood sugar is when you have gone without eating or drinking. First, your blood is drawn to measure your ***baseline*** or ***fasting blood glucose*** level. You will then be asked to drink a glucose drink. Your blood sugar is measured again two hours later, and many centers will also test your blood sugar levels at 30, 60, and 90 minutes. Your blood sugar results will show if you have CFRD. If your fasting blood sugar is 126 mg/dL (7.0 mmol/L*) or more, or if your blood sugar at two hours is 200 mg/dL (11.1 mmol/L) or more, then you likely have CFRD. This should be confirmed twice before making a final diagnosis. A normal level would be a fasting level less than 100 mg/dL (5.6 mmol/L) and at two hours less than 140 mg/dL (7.8 mmol/L). Levels in between are consistent with a diagnosis of impaired glucose tolerance. The table at the end of this chapter describes this in more detail.

Results of your annual OGTT are compared with previous OGTT tests to see what is happening with your CFRD over the years. Make sure you get your annual OGTT when you are well and not fighting an infection. Insulin resistance is common during illness or when you are on or have recently been on steroids, and this can temporarily raise blood glucose levels.

**In the United States, blood sugar levels are reported as milligrams per deciliter (mg/dL). In Canada and Europe, they are reported as millimoles per liter (mmol/L). Both are used in this guide.*

Fasting Blood Glucose

Fasting blood glucose measures your blood glucose after you have not eaten or had anything but plain water to drink for at least eight hours. You do not need to drink a glucose drink for this test. If your blood glucose level is more than 126 mg/dL (7.0 mmol/L), you have CFRD.

Casual Blood Glucose Levels

A ***casual (random) blood glucose*** level is drawn regardless of what time of day it is or when a meal was last eaten. If this level is 200 mg/dL (11.1 mmol/L) or more, and you have symptoms of diabetes — having to urinate more often, drinking more liquids than usual, unintentional weight loss, feeling more tired than usual — then diabetes is likely. You will need to follow up with a fasting blood glucose test or an OGTT to confirm the diagnosis of diabetes. If you do not have symptoms of diabetes, you will need an OGTT to determine whether the high casual random glucose is related to diabetes or impaired glucose tolerance.

Hemoglobin A1c

Hemoglobin A1c (also written as HbA1c) is a test that is used to diagnose diabetes in people without CF. If it is high (>6.5%), it means you have diabetes. If it is low, this does not mean you do not have diabetes, because HbA1c is often falsely low in people with CF. Further testing using the OGTT is recommended to confirm whether you have diabetes.

Continuous Glucose Monitor

A ***continuous glucose monitor (CGM)*** is a device that people wear on their skin. It measures interstitial blood glucose levels every one to five minutes and tracks someone's blood glucose over 24 hours. It is not approved for diagnosis, although there are studies looking into this. CGM is often recommended for people with diabetes to help guide insulin therapy.

TESTS USED TO DIAGNOSE CFRD				
Test		**Results**	**Diagnosis**	**Next steps**
OGTT	Done in the morning after an 8-hour fast	2-hour glucose ≥200 mg/dL (≥11.1 mmol/L)	CFRD	You will be followed by your CF and endocrinology team and may be treated with insulin.
		2-hour glucose 140–199 mg/dL (7.8–11.0 mmol/L)	***Impaired glucose tolerance (IGT)***	You are at higher risk for developing diabetes; you will be closely monitored by your CF team. Repeat OGTT annually or earlier if symptoms occur.
		Mid-OGTT glucose ≥200 mg/dL (≥11.1 mmol/L), OGTT otherwise normal	***Indeterminate glycemia (INDET)***	You are at higher risk for developing diabetes; you will be closely monitored by your CF team. Repeat OGTT annually or earlier if symptoms occur.
		2-hour glucose <140 mg/dL (<7.8 mmol/L)	Normal	Repeat OGTT annually.
Fasting blood glucose	Done first thing in the morning after an 8-hour fast	<100 mg/dL (<5.6 mmol/L)	Normal	Starting at age 10, or earlier if symptoms occur, do OGTT annually.
		100–125 mg/dL (5.6–6.9 mmol/L)	***Impaired fasting glucose (IFG)***	You are more likely to develop diabetes; you will be closely monitored by your CF team. Repeat OGTT annually or earlier if symptoms occur.
		≥126 mg/dL (≥7.0 mmol/L)	CFRD	You will be followed by your CF and endocrinology team and may be treated with insulin.
Casual (random) blood glucose	Done at any time regardless of time of last meal or snack	<200 mg/dL (11.1 mmol/L)	***Non-diagnostic***	Starting at age 10, or earlier if symptoms occur, do OGTT annually.
		≥200 mg/dL (≥11.1 mmol/L)	High risk of CFRD	If symptoms are present, do a fasting blood glucose test; otherwise, do OGTT.
Hemoglobin A1c (HbA1c)	Done at any time regardless of time of the meal or snack. Typically done at 3 month intervals once diabetes is diagnosed	>6.5%	CFRD	This test should not be solely used for screening since a normal test could miss cases of CFRD. However, if the level is above 6.5%, then this is diagnostic.

CHAPTER 3: BLOOD SUGAR TESTING

Learning Goals

At the end of this chapter, you should be able to

- Explain the blood sugar goals for each age group and time of the day.
- State when blood sugar should be tested.
- List the steps taken to check and record blood sugar levels.
- Understand factors that may lead to incorrect results.

Testing Times and Blood Sugar Goals

Most doctors advise that you check your blood sugar three to six times a day to help decide how much insulin you need. Typical testing times for people with diabetes are

- Before breakfast
- Before lunch
- Before dinner
- Before a bedtime snack or at bedtime if no snack is eaten

Blood sugar also rises after eating, so you may be asked to check your blood sugar two to three hours after a meal to make sure your insulin doses are set correctly. Blood sugar readings taken after a meal are called ***postprandial blood glucose readings***. Those readings should be taken

- 2–3 hours from when you started eating breakfast.
- 2–3 hours from when you started eating lunch.
- 2–3 hours from when you started eating dinner.

Your diabetes care team will let you know what your blood sugar goals are. See the table below for typical goals.

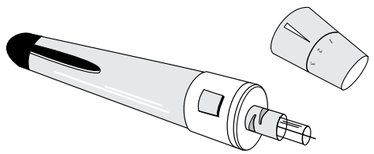
BLOOD SUGAR GOALS			
	Fasting and Premeal mg/dL (mmol/L)	**2–3 hours after eating mg/dL (mmol/L)**	**Bedtime mg/dL (mmol/L)**
Adults	80–130 (4.4–7.2)	<180 (10.0)	90–150 (5.0–8.3)
Adolescents	90–130 (5.0–7.2)	<180 (10.0)	90–150 (5.0–8.3)
School-age children	90–180 (5.0–10.0)	<200 (11.1)	100–180 (5.6–10.0)
Children <6 years	100–180 (5.6–10.0)	<200 (11.1)	100–200 (5.6–11.1)
Pregnant women	<95 (<5.3)	<120 (6.7)	60–99 (3.3–5.5)

Sometimes your treatment plan dictates the testing times. Some examples of this are

- If you take ***intermediate-acting insulin (NPH)*** in the evening, check your blood sugar in the middle of the night once every two to three weeks to make sure that low blood sugar does not occur while you sleep. NPH insulin is often prescribed for people on ***nighttime tube feedings***.
- If you take nighttime tube feedings, check your blood sugar before the ***tube feeding*** starts, three to four hours after the tube feeding has started (once or twice a week), and at the end of the tube feeding. You will likely need more insulin if your blood sugar level is more than 150 mg/dL (8.3 mmol/L) in the middle of the tube feeding.
- If you get feedings all at once, also called ***bolus*** feed, check your blood sugar before the feeding and two hours after the feeding. You will likely need more insulin if your blood sugar level is more than 150 mg/dL (8.3 mmol/L) two to three hours after a bolus feeding.

How blood glucose testing affects management

- If your blood sugar level is often higher than 180 mg/dL (10 mmol/L), you need more insulin. Depending on the timing of the high blood sugar, you might need more rapid-acting insulin before your meal, or you might need more ***long-acting*** insulin.
- If your blood sugar level is less than 100 mg/dL (5.6 mmol/L) at bedtime, add 15 grams of carbohydrates to your bedtime snack. If your blood sugar level is less than 70 mg/dL (3.9 mmol/L) at bedtime, add 15–30 grams of carbohydrates and recheck your blood sugar in the middle of the night to make sure you are not too low. If this happens more than once in a week, contact your care team to adjust your insulin.



LANCET

The only sure way to check blood sugar levels at home is with a blood *glucose meter* or with a continuous glucose monitor (CGM). Studies show that you cannot guess your blood sugar levels based on how you feel.

How to Check Blood Sugar

Finger "Sticks"

You will need a finger poke device called a ***lancet*** to check your blood sugar. A lancet has a tiny spring-loaded needle made to gently get a drop of blood from the tip of your finger to check your blood sugar. Before using a lancet, wash your hands with warm water to clean them and increase blood flow. Washing your hands also helps remove any sugar on your finger so your reading will not be falsely high. You may need to use an alcohol swab to clean your finger if you cannot wash your hands. Do not use alcohol if you can wash your hands, because alcohol dries out the skin.

FINGER STICKS

- Prepare the lancet.
- Wash your hands or clean your finger with an alcohol swab.
- Prick the side of your finger.
- Put a drop of blood on the test strip.

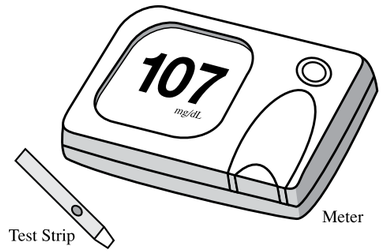
It can help to put your hand on top of a table. Prick the side of the finger rather than the fleshy pad. That will hurt less. If you do not get a drop of blood after pricking your finger, hold your hand down at your side to

increase blood flow to your finger. Change the finger you use each time so your fingers do not get sore.

Blood Glucose Meters

There are many brands of blood glucose meters for sale. All meters are similar and work in the same general way. Each meter has its own brand of test strips and lancets meant to go with that specific meter. This means supplies for one meter will not always work with another. The kind of meter you get may depend on which one your insurance will cover.

Most meters have apps, and the blood glucose meter can connect to your phone by Bluetooth. The apps give valuable information about blood sugar patterns and make it easy to send reports to your diabetes care team. The meters can be set up to stream your results to a cloud-based secure website. This allows your care team to log in and see your glucose data.



GLUCOSE METER

Other features you may consider are

- Allowing the user to add comments concerning the results like "activity" or "sick" to explain a low or a high reading.
- There are some apps that help you calculate the mealtime insulin dose if you have your blood sugar level and know how many grams of carbohydrate you are about to eat.

Testing your blood sugar with a meter

- Gather your supplies: blood glucose meter, lancing device, lancets, and blood glucose test strips.
- Wash and thoroughly dry your hands. Washing with warm water will increase blood flow to the fingers and make it easier for you to get a blood drop. If you cannot wash your hands, an alcohol-based hand cleanser or alcohol swabs work as well. However, these dry out your skin and should not be used routinely.
- Prepare your lancing device by loading it with a lancet.
- Prepare your meter by putting a test strip in it. The meter will let you know when it is ready for blood by a small flashing blood drop on the screen.
- Use your lancing device to poke the side of your fingertip. If you do not bleed right away, use the other hand to push blood from the base of your fingertip out to the hole at the end.
- Bring the end of the test strip, still in the meter, up to the blood drop and watch it feed in the small window designed for this.
- You should have your results in five seconds.

Blood Sugar Testing Results

Reviewing your glucose results gives you immediate feedback about food choices and activity and helps you and your diabetes care team get your insulin doses set correctly. By reviewing the reports available through the meter software, you can get detailed information about blood sugar patterns. Make a point to look at the reports

every one to two weeks. Establishing this habit early on will serve you well as you learn which factors improve your overall blood sugar control and which factors do not. This will lead you to better blood sugar control.

Factors That Affect Meter Accuracy

- Handwashing and drying. (If you have traces of food sugar on your fingers, it may give you a falsely high level. If your finger is wet, it might dilute the blood and give you a falsely low level.)
- ***Expired*** test strips.
- Test strips that are exposed to temperature extremes.
- Difficulty getting a blood drop.
- Not following the meter's instructions for use.
- Meter date and time. (Make sure the meter date and time are accurate, as this can affect how you and your health care providers interpret the data. Do not forget about daylight savings time.)

Continuous Glucose Monitors

A continuous glucose monitor (CGM) measures interstitial blood glucose levels every one to five minutes and provides tracing of someone's blood glucose over 24 hours. CGMs are discussed in further detail in Chapter 6.

Summary

Good blood sugar control is important for your health. There are more options than ever to assess blood sugar using the latest software. Taking notes with a pencil and paper works well, too. Be sure to bring your meter and glucose records to every clinic visit so it can be downloaded. Bringing notes to your appointments concerning anything that will affect your blood sugar such as food, stress, or activity makes for a productive visit with your care team.

There is no one way that works best for everyone. Knowing what you are comfortable with and communicating with your team is a step toward better blood sugar control. **Remember that you are the most important member of your care team!**

CHAPTER 4: TREATING CFRD

Learning Goals

At the end of this chapter, you should be able to

- State how insulin helps lower blood sugar and improve ***nutrition***.
- Understand the effect of insulin deficiency in CF.
- List the different types of insulin and explain how they work.
- Explain circumstances in which other diabetes medications may be used.

Insulin

What is Insulin?

Insulin is a ***hormone*** that lowers blood sugar levels. It is made in the pancreas by ***beta cells*** located in a part of the pancreas known as the ***endocrine pancreas***. A separate part of the pancreas—the ***exocrine pancreas***—makes ***digestive enzymes*** that flow into the intestine to help digest food. Most people with CF have damage to the whole pancreas and do not make enough digestive enzymes. They take digestive ***enzyme supplements***. People with CF who do not need enzyme supplements are not as likely to get CFRD.

What Insulin Does

Insulin helps your body's cells use the energy (calories) from the food you eat for fuel and growth. Food contains three kinds of nutrients: carbohydrates (sugars and ***starches***), protein, and fat. Insulin helps the body's cells absorb these nutrients.

Carbohydrates are changed to sugar for the body's instant fuel needs. Insulin allows the sugar to move from the blood into the cells where it is burned for fuel. The body cannot turn sugar into fuel without insulin. Without enough insulin, sugar builds up in the blood until it spills into the urine. This loss of sugar through the urine makes people with diabetes need to go to the bathroom a lot and feel thirsty.

Muscles are made of protein. Insulin allows the body's cells to take up the building blocks of protein (***amino acids***) and build muscle tissue. Without enough insulin, protein breakdown and muscle loss occur. Muscle loss can affect breathing because lung function depends on muscle strength.

Lastly, insulin allows the body to use and store fat from food as body fat. Without enough insulin, the body's fat stores are drained and weight loss occurs.

People with CF make less insulin, which can lead to CFRD. Insulin is the most common treatment for CFRD. Insulin can only be delivered by a shot. There are several types of insulin, and it is important for you to know about the way in which the insulin you are taking works.

INSULIN HELPS

- Sugar in the blood get into the cells to be used for energy.
- The body turn sugar into fuel.
- The cells use amino acids to build muscle.
- The body use and store fat.

Insulin Types

Insulin types are grouped by how fast they work and by how long they last in the body. There are four broad classes of insulin:

- Rapid-acting
- ***Short-acting (regular)***
- Intermediate-acting
- Long-acting or basal

Insulin action (when it peaks in strength and how long it lasts) may vary from person to person. Use your meter or continuous glucose monitor (CGM) to figure out how long your insulin works for you.

Insulin comes in different concentrations. Most insulin in the United States has a concentration called "U100," which means there are 100 units in every 1 mL. There are more-concentrated insulins (U200, U300, and U500) for people who are on very large insulin doses to reduce the volume of the injection. These insulins are usually only for people who have type 2 diabetes and are very insulin resistant. Most people with CFRD will use a U100 insulin.

Rapid-Acting Insulin

Lispro, ***aspart***, and ***glulisine*** start working 15 to 25 minutes after they are taken. They peak in strength at 30 to 90 minutes, and most of the effect has worn off in three to four hours. These insulins are usually taken 5 to 15 minutes before you eat. They are most often used to cover the carbohydrates in meals and snacks and for quick correction of high blood sugar. They are also used in ***insulin pumps***. Insulin pumps are discussed further in Chapter 6.

Short-Acting Insulin

Short-acting (regular) insulin starts working 30 minutes after it is taken. It has its peak effect in two to three hours and lasts six to eight hours. Regular insulin should be given at least 30 minutes before eating so that it is working as the food is being digested.

Intermediate-Acting Insulin

The body uses NPH insulin more slowly than short- or rapid-acting insulin. It has its peak effect in six to eight hours and lasts about 13 hours. NPH can be used with regular insulin, and they are often used together for nighttime tube feedings since the regular insulin can cover the first part of the feed and the NPH the last part. NPH may also be used to control blood sugar when people are being treated with steroids because it peaks at about the same time the steroids are affecting the blood sugar.

Long-Acting Insulin

Detemir is a long-acting insulin that can sometimes be taken once a day but usually is required twice a day. This ***basal insulin*** is not strong enough to control your blood sugar for meals and snacks. Detemir should not be mixed in a syringe with other insulins.

Glargine is called a basal insulin because one dose gives a constant background amount of insulin for about 24 hours without a peak in strength. Basal insulin controls your blood sugar when you are not eating. Basal insulin is not strong enough to control your blood sugar when you eat. People who use basal insulin still need to cover meals and snacks with rapid-acting insulin. Glargine cannot be mixed with other insulins in the same syringe.

Glargine with brand name Toujeo® U300 is a more concentrated form of glargine (U300 means it is three times stronger) peak-less basal insulin. It will help control blood sugar for 24 hours after it is taken. It is used with a rapid-acting insulin to cover meals and snacks. It should never be mixed with another insulin in a syringe. This is typically used in patients who are on very large insulin doses.

Degludec (also called ultra-long insulin) is another choice for a basal insulin. It comes in two strengths, U100 or U200. It has glucose-lowering properties that can last up to 42 hours (about two days) after taking it. It is not as sensitive to timing, so there is greater flexibility as to when it should be injected. It is generally given once a day. Degludec should not be mixed in a syringe with other insulins.

Class of Insulin	Time to Start Working	Peak	Lasts	*Generic* Name	Note
Rapid-acting	15 to 25 minutes	30 to 90 minutes	3 to 5 hours	Lispro Aspart Glulisine	Covers carbohydrates in meals and snacks. Usually taken 5 to 15 minutes before eating. Used in insulin pumps.
Short-acting	30 minutes to 1 hour	2 to 3 hours	6 to 8 hours	Regular	Covers carbohydrates in meals. Take 30 minutes before eating. May also be used for tube feedings.
Intermediate-acting	1 to 1.5 hours	6 to 8 hours	12 to 18 hours	NPH	Covers carbohydrates in meals. May also be used for tube feedings or during steroid use.
Long-acting	3 to 4 hours	Minimal peak 6 to 8 hours	Up to 24 hours	Detemir	Most people need to take detemir twice a day.
Basal insulin	Glargine: 2 hours	Basaglar peakless Glargine peakless Degludec peakless	Glargine 24 hours Basaglar 24 hours Degludec 24+ hours	Glargine Degludec	Basal or ***background insulin***. Necessary for all-day insulin needs but not strong enough to cover carbohydrates. Typically given once a day.

Understanding Multiple Daily Injections

Multiple daily injections of insulin are used to mimic how the body would normally respond to insulin needs throughout the day.

Basal Insulin (also long-acting insulin)

Everyone needs a small amount of insulin at all times. This background, or basal, insulin is made by the pancreas. Most people with CF make less insulin than people without CF who do not have diabetes. People with CFRD may or may not need to take long-acting insulin, depending on whether they make enough of their own basal insulin. The fasting blood sugar level helps to decide if you are making enough basal insulin.

Carbohydrate Coverage

Normally, the pancreas secretes insulin as a bolus (all at once) to cover the spike in blood sugar that occurs when you eat. People with diabetes take rapid-acting insulin before meals and snacks because their pancreas is not putting out this bolus or is not putting out enough of the bolus to keep the blood sugar controlled after meals or snacks. The preferred way to dose the bolus is to use an ***insulin-to-carbohydrate ratio***. This allows greater flexibility because the insulin dose is customized to the amount of food on the plate. You need to know how to carb count food before you can use an insulin-to-carbohydrate ratio. You and your care team will judge the effectiveness of your insulin-to-carbohydrate ratio by looking at your blood sugar two hours after a meal. The insulin-to-carbohydrate ratio is discussed in more detail in Chapter 10.

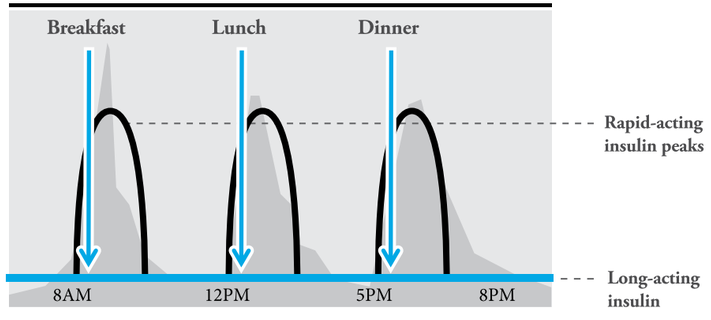
Blood Sugar Correction

DID YOU KNOW?

Often 1 unit of rapid-acting insulin will lower blood sugar about 50 mg/dL (2.75 mmol/L) in most people when they are in their usual state of health.

If your blood sugar is too high before a meal, you can add extra rapid-acting insulin to your meal bolus to "correct" or lower your blood sugar. For example, one unit of rapid-acting insulin may lower your blood sugar about 50 mg/dL (2.75 mmol/L). This must be individualized. Work with your diabetes care team to see how much one unit of insulin will lower your blood sugar. Correction is often written out in the form of a sliding scale for ease of use. Your care team will look at your blood sugar two hours after you correct to see if it is bringing you into the target range.

SAMPLE BASAL AND BOLUS INSULIN REGIMEN



The Importance of Insulin Timing

Most people with CFRD need three or more rapid-acting insulin shots per day to control blood sugar levels. Typically, the more carbohydrates you eat, the more insulin you need. Taking insulin before you eat and customizing the insulin dose to match the food on your plate (by using an insulin-to-carbohydrate ratio) usually equates with a better post meal blood sugar level. This offers greater flexibility with your food choices.

Taking your rapid-acting insulin boluses 5 to 15 minutes before you eat is often recommended. Having some active insulin waiting for the rise in blood sugar related to food helps keep blood sugar controlled after meals. **Do not try this in restaurants or in other situations where the delivery of the food is unpredictable.** Wait for the food to be delivered in this situation.

Most people with CFRD have high blood sugar levels after meals but their blood sugar levels return to normal again four or more hours after eating. If this is the case, rapid-acting insulin may be ordered without adding a basal insulin to it. Long-acting insulin is added if your fasting blood sugar is too high. It is typically given once or twice per day.

Your insulin type and the time it is given should be matched to your eating, activity, and sleeping schedule. Giving your diabetes care team as much accurate information as you can about your habits ensures that your insulin regimen will be tailored to fit your lifestyle. This will help you to achieve the best blood sugar control possible.

Some people with CF only have high blood sugar during nighttime ***nasogastric*** or ***gastrostomy*** drip feeding (also called tube feedings). If this is the only time you have high blood sugar, you may be given insulin in one of the following ways:

- One shot of intermediate-acting insulin or
- One shot of a mix of short-acting and intermediate-acting insulin

Tube feedings can also be covered by an insulin pump. Insulin pumps are discussed further in Chapter 6.

Times When You May Need More Insulin

Think of your insulin dose as something that will need to be changed as the circumstances of your life change. Illness stresses your body, and this will make your blood sugar rise, but this is very individual. Occasionally, people may need less under these circumstances. Here are some situations when blood sugar tend to go up:

- You are getting sick or are sick.
- You are stressed.
- You have forgotten to take your insulin or have not taken enough insulin to match your food.
- You are taking steroids like prednisone.

Women may need more or less insulin either right before or during their menstrual period. Most women establish their pattern and eventually know what to expect. During pregnancy, almost all women with CF need extra insulin.

People without diabetes can make more insulin in their pancreas when they are sick. People with CFRD cannot, so their blood sugar rise. Keeping a close eye on blood sugar levels will help you evaluate whether your insulin dose needs to change.

Sudden rises in blood sugar levels may mean your body is stressed or you are getting sick. This may be the first sign that a "little cold" is really a bigger illness requiring stronger treatment. Reach out to your diabetes care team if your usual blood sugar pattern changes without warning.

Insulin does not work as well when people receive ***corticosteroids*** like prednisone. The higher the dose of the steroid, the more insulin you will likely need. Reach out to your care team if you need steroids so a plan can be made to increase your insulin.

Getting enough insulin during illness is important because it will prevent weight loss (muscle loss in particular) and help you to heal faster. Checking your blood sugar with a meter often or using a CGM are ways to assess your insulin doses. This will help you to see patterns of low or high blood sugar at certain times of the day. Evaluating these patterns is called ***pattern management***. There are more tools than ever to find your patterns. Your diabetes care team can help you identify blood sugar patterns and adjust your insulin accordingly.

NAME:

DIABETES SELF-CARE RECORD

Time	Insulin		Blood Sugar	Food Intake		Carbohydrate Information	Physical Activity		Other Factors
	Type	Amount		Amount	Type of Food/ Drink	Grams	Type	Amount	Stress/ Illness
Breakfast			Before 2 hours after						
Snack									
Lunch			Before 2 hours after						
Snack									
Dinner			Before 2 hours after						
Snack									

Storing and Handling Insulin

Unopened insulin should be stored in the refrigerator and can be used until the expiration date on the box. Once opened, insulins vary in the length of time they are good at room temperature. Your diabetes care team or your pharmacist can tell you how long your insulin is good at room temperature.

Many people like to inject room temperature insulin because cold insulin may sting. To warm insulin, roll the bottle or pen between your hands for one to two minutes. Use alcohol wipes to clean the top of the bottle or pen before taking the insulin out.

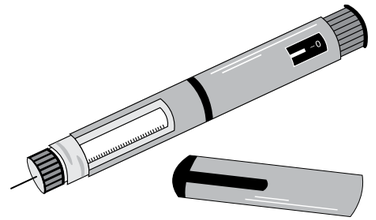
Except for NPH, insulin is clear and should be thrown away if it looks cloudy. Any bottle or pen of insulin that looks "clumpy" should be thrown away. Insulin should be thrown away if it freezes or gets hotter than 86°F. Rapid insulins are stable to 98.6°F.

Insulin in a vial, pen, or ***cartridge*** for use with an ***insulin injection device*** (often referred to as an ***insulin injection pen***), should be stored in the refrigerator until opened. To avoid damaging your insulin, never leave it in the car or any other place where it may get too hot or too cold.

Insulin Delivery System

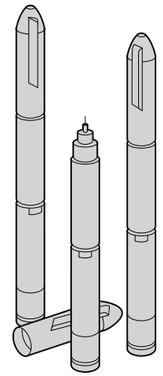
Insulin Pens

There are many different types of insulin pens. They are called "pens" because they are about the size of an ink pen. They use a disposable pen needle, which is short and thin and comparable in size to an insulin syringe needle. Most pens come prefilled with insulin, but there are varieties of pens that use cartridges that are prefilled. If your pen uses cartridges, it is not disposable. Do not throw it away when you use all your insulin; just change your cartridge.



INSULIN PEN

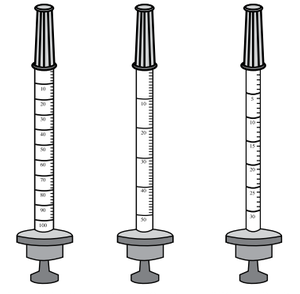
The type of insulin in an insulin pen or cartridge varies. Some contain a single type of insulin such as long-acting insulin or rapid-acting insulin. Some contain a mixture of short-acting insulin like regular and an immediate-acting insulin like NPH. Mixtures of insulin are not used as often because there is not as much flexibility in adjusting the dose. Your doctor will tell you which kind of insulin is best for you.



SMART PENS

Because you may be on more than one kind of insulin, it is important to make sure you have the right pen before you inject it. Some manufacturers have color coded the pens so you can easily distinguish between your rapid-acting and long-acting insulin. This has helped reduce medication errors.

Insulin pens are generally thought to be more convenient to use than a vial and syringe. They are small and easy to carry. They eliminate the need to draw up your dose from a multiuse vial; instead, you dial up your dose. This is much more precise. There are devices or special pens referred to as "Smart Pens," that can help you keep track of your insulin doses and help you figure out your insulin dose. The more often you take insulin, the more important it is to make it as convenient as possible.



INSULIN SYRINGES

Vial and Syringe

Insulin can also be given using a syringe that is specifically made to deliver insulin. Insulin syringes measure insulin as units per cubic centimeter (cc) and are meant to be used with U100 insulin. There are three sizes of insulin syringes. A 3/10 cc (30 units), ½ cc (50 units), or 1 cc (100 units). The size of your insulin dose will determine which size syringe you need.

Needles have varied widths. Smaller widths have larger numbers. A 32-gauge needle is thinner than a 20-gauge needle. Most insulin syringes have 29- to 31-gauge needles. Needles come in varied lengths, anywhere from 12.7 mm to 4 mm. The shorter needles are generally thought to be easier to use.

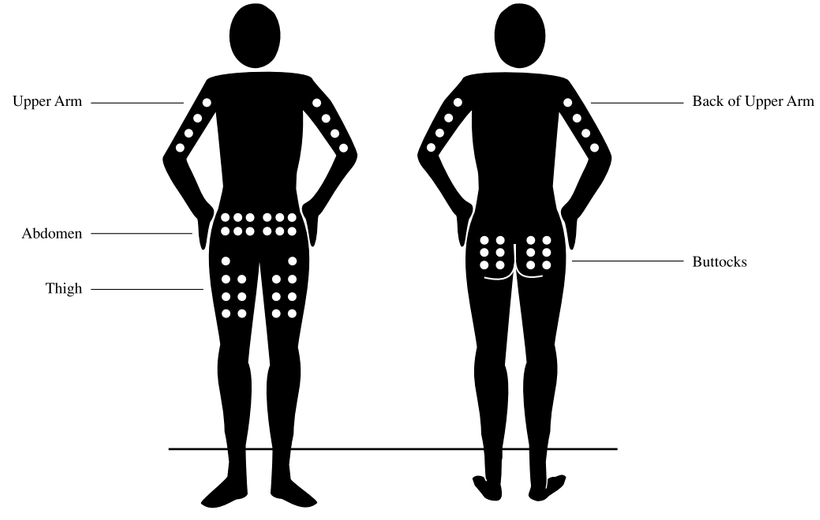
Tips for Injecting Insulin

- Before taking an insulin shot, always check the vial or pen and make sure you are getting the right type of insulin. Check the expiration date as well. This is also a good time to notice if the insulin looks as you expect it to. Is your insulin clear?
- If you are mixing short-acting insulin and intermediate-acting insulin in a syringe, always draw the short- or rapid-acting insulin out of the vial first.
- Never mix long-acting insulin into a syringe with other insulins. These insulins are not made to be mixed, and they will not work correctly if this is done.
- If you use insulin pens and need two types of insulin, you will have to take two injections. While the extra injection is a nuisance, many still consider this easier than using a vial and syringe and mixing insulins in one syringe.
- Clean your injection site with soap and water or alcohol prior to injections. Alcohol can be more drying to the skin than soap and water, so use it sparingly. If you do not have access to soap or water, any cleansing wipe that is safe to use on the skin will work.
- Work with your diabetes educator to make sure your injection technique is correct.

Insulin Injection Sites

Insulin can be given in the thigh, buttocks, upper arms, and abdomen. The needle is inserted just under the skin into the fat. It may help to pinch up a fold of skin and fat before putting the needle in. Be sure to hold the needle under the skin for 10 seconds before you take it out to make sure all the insulin was delivered.

It is important to make sure you choose a new spot on your body for each insulin shot. This is called "rotating your injection site." Injecting insulin in the same spot repeatedly can cause inflammation or fat tissue buildup called ***lipohypertrophy***. Over time, this can cause lumps or thickening under the skin, and this can prevent insulin from absorbing properly. Keep track of where you give your shots and make sure to rotate the site to help prevent this from happening. There are phone apps to help with this.



INSULIN INJECTION SITES

Other Diabetes Drugs Besides Insulin

Drugs that increase insulin secretion or improve the body's response to insulin are commonly used in type 2 diabetes. They are rarely used in CF because the CF pancreas is usually already making as much as it can, and because people with CF are sensitive to that insulin. There are some patients, however, that may benefit from non-insulin treatments. This is something you need to discuss with your ***endocrine*** team. In particular, with effective modulator therapy, improving function of the CF chloride channel means that CF patients are starting to look more like the general population. This includes dealing with health issues such as obesity and high blood pressure. With these changes, CFRD may begin to look more like type 2 diabetes, and this may influence your endocrine team's choice of drugs.

GLP-1 Inhibitors

This group of injectable medications deserves special mention because they are becoming increasingly common in type 2 diabetes. They lower blood sugar in four ways:

- Slowing the speed of food leaving your stomach
- Helping the liver stop releasing too much sugar into your bloodstream
- Helping the pancreas to release more insulin when blood sugar is high
- Decreasing your ***appetite***

There are several brands of GLP-1 inhibitors on the market. Victoza®, Bydureon®, Trulicity®, and Ozempic® are all drugs in this class. There are daily forms of this drug and weekly forms. All of these drugs come in pre-filled pens that look like insulin pens. In the past, these drugs have rarely been considered in CF because they cause significant weight loss. Because of the increasing prevalence of overweight or obesity

in CF, there are select patients for whom these may be considered. The potential side effects of these medications include

- Nausea
- Decreased appetite
- ***Hypoglycemia*** (particularly if used with insulin)
- Significant weight loss

Your diabetes care team will help you decide if they would be helpful for you.

SGLT2 inhibitors

These drugs, which cause excess blood glucose to be excreted in the urine, are widely used in type 2 diabetes. There is concern about using them in CF because they also lower the amount of salt in the body. This may become less of an issue if CFTR modulator drugs are able to decrease salt loss in the sweat.

CHAPTER 5: HOW CFRD IS MONITORED

Learning Goals

At the end of this chapter, you should be able to

- List the tests used to manage diabetes.
- Explain how the diabetes care team and ***ophthalmology*** visits help to manage CFRD.

Tests to Help Monitor CFRD

Hemoglobin A1c: Goal is less than 7%

The hemoglobin A1c test gives a three-month picture of your blood sugar. It does this by analyzing how much sugar is stuck to your red blood cells. The more sugar that is attached, the higher the average blood sugar.

Typically, a red blood cell lives for three months. In people with CF, the red blood cells may live less than three months because of inflammation, so this test result can be artificially low. This means that the daily blood sugar readings taken by meter or sensor may provide a more accurate picture of overall blood sugar control in patients with CFRD. We use hemoglobin A1c to track trends in blood glucose control over time. The hemoglobin A1c test can be done during an office visit, and you do not need to fast for it.

Urine Microalbumin: Goal is less than 30 mg/g creatinine

Uncontrolled diabetes can eventually lead to kidney damage. Measuring the amount of protein in your urine is a way to check the health of your kidneys. After you have had CFRD for five years, your care team will check the protein in your urine once a year. If your test is abnormal, repeat testing will be done. If two out of three urine tests over a period of six months are abnormal, you may have kidney damage. Good blood sugar control can help prevent kidney damage. There are also medications available to treat kidney damage.

Blood Pressure: Goal is less than 130/80 mmHg

Uncontrolled blood pressure can lead to kidney disease and other health problems. Your blood pressure will be checked at each clinic visit. If it is above 130/80 mmHg, it should be checked again on a different day to confirm the diagnosis of high blood pressure. There are medications to treat high blood pressure. Controlling your blood pressure is important to prevent many other health problems. Unlike people without CF, those with CFRD have traditionally been told not to decrease their salt intake to help lower blood pressure, because they are already losing salt in their sweat. It is possible that CFTR modulators may change this recommendation. Be sure to check with your CF care team before adjusting your salt intake.

Urine or Blood Ketone Testing

When the cells use fat for fuel instead of sugar, the body makes ***ketones***. Ketones are an acid that can be found in the blood and in the urine. People with CFRD are not prone to having elevated ketone levels and are not typically instructed to do ketone testing. Your doctor will tell you if you need to do ketone testing.

Lipid Profile

Blood ***lipids*** (fats) are cholesterol and ***triglycerides***. People with type 1 and type 2 diabetes are at risk for heart disease and stroke if their cholesterol and triglyceride levels are high. ***Lipid profiles*** are checked every year in people with type 1 and type 2 diabetes for that reason. People with CFRD who need enzyme supplements to digest food appear to be at very low risk of heart disease and stroke. They do not routinely need to have yearly lipid profile testing. This recommendation may change as we learn more about the impact of modulator therapy. People with CFRD who do not need enzyme supplements should have their lipids checked on a yearly basis. If you have a strong family history of heart disease or stroke, or if you are taking immunosuppressant medications after a transplant, you will need an annual lipid profile.

Foot Exam

Nerve damage (***neuropathy***) can occur in people with uncontrolled blood sugar over time. This is a result of glucose toxic byproducts affecting a nerve cell's function. Common symptoms are tingling or pain in the fingers and toes that is symmetrical (the same on both sides of the body). When you have had CFRD for five years, your diabetes care team will begin adding a yearly foot exam to your screening tests. To test for nerve damage, your doctor may touch your feet with a gentle tool called a ***monofilament*** to see if you can feel it. Controlling your blood sugar will help to prevent nerve damage.

Other Tools to Monitor CFRD

Diabetes Care Team Visits

Besides your routine visits to the CF Foundation-accredited care center, you should also be seen by a diabetes care team every three to four months. These visits are important to help you manage your CFRD. Your team will examine you, review your usual diet and ***carbohydrate counting*** ability, assess your overall blood sugar control and your insulin doses, and work with you to meet your unique CFRD goals. Always bring your blood glucose meter or continuous glucose monitor to these appointments. Uncontrolled blood glucose can delay healing, so you should always show your diabetes team any new wounds or wounds that are not healing as they should. During these visits, discuss any questions you have about your diabetes treatment plan.

Diabetes education is also key in managing your diabetes. It is recommended to attend sessions with a diabetes educator when you are first diagnosed and every 6 to 12 months depending on your needs.

Communication is key in controlling blood sugar and preventing future problems.

Yearly Ophthalmology Visits

Over time, uncontrolled blood sugar can cause eye disease (***retinopathy***). This is a result of glucose toxic byproducts affecting the eye. This type of damage does not happen quickly. It can cause blurred vision at first and blindness later. After you have had CFRD for five years, you should schedule an ophthalmology visit yearly. The ***ophthalmologist*** (eye doctor) will do a complete exam to look for retinopathy. If high blood sugar has damaged your eyes, there are treatments available. These

are highly effective if the damage is caught early, which is why it is important to have these visits. The number one thing you can do to prevent retinopathy is to control your blood sugar.

SCHEDULE OF DIABETES ASSESSMENTS AND EDUCATION

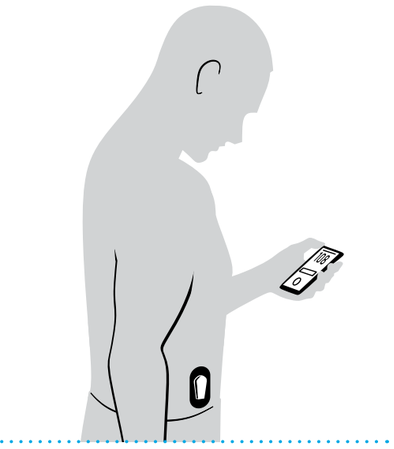
Test	Frequency	Goal
Hemoglobin A1c	Every 3–6 months	Less than 7%
Urine microalbumin	After 5 years of diabetes, this should be done yearly	Less than 30 mg/g creatinine
Blood pressure	Every visit	Less than 130/80 mmHg Less than the 90th percentile for age and sex for pediatric patients
Lipid profile	Every year, only if you • Have no need for pancreatic enzymes • Have a family history of cardiovascular disease or stroke • Are obese (have a ***body mass index [BMI]*** greater than 30) • Are taking immunosuppressants	Low-density lipoprotein (LDL) cholesterol <130 if you are not on lipid-lowering drugs, <100 if you are on lipid-lowering drugs
Foot exam	After 5 years of diabetes, this should be done yearly	Normal exam
Diabetic eye exam	After 5 years of diabetes, this should be done yearly	Normal exam
Diabetes education	When first diagnosed and every 6–12 months as needed	Not applicable

CHAPTER 6: DIABETES TECHNOLOGY

Thanks to medical advancements, there is new diabetes technology available to make managing diabetes easier.

This chapter will briefly review what diabetes technology exists, how it is used, and each device's pros and cons. While these devices are certainly useful to people with CFRD and members of the CFRD care team, they are not appropriate for everyone. The decision to use a device to help manage your diabetes should be made by you and your CFRD care team.

Continuous Glucose Monitors

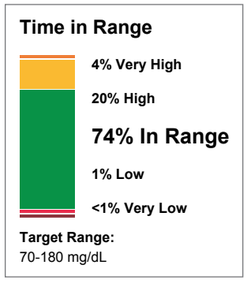


CONTINUOUS GLUCOSE MONITOR

Continuous glucose monitors (CGMs) record your glucose levels around the clock. A sensor is placed in the ***subcutaneous tissues*** (fat tissue just under the skin) for 10 to 14 days. During that time, the monitor takes in glucose from the ***interstitial fluid*** (fluid between the cells of the tissues) and converts it to blood glucose data. The data is then displayed on a receiver—a small handheld device that looks like a meter—or an app on your cell phone. The continuous sensor does not alter the insulin dose, but instead provides glucose data on which to base treatment decisions. Sensor use is becoming more common to manage CFRD.

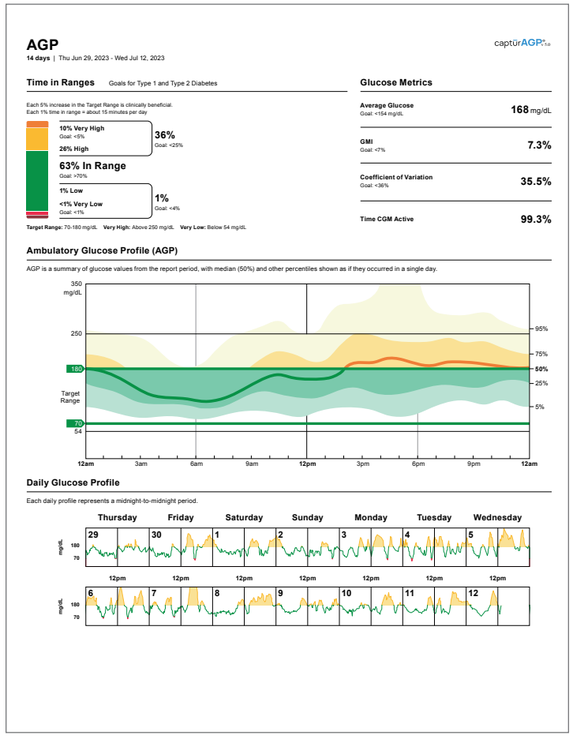
A blood glucose meter measures the glucose level in the bloodstream, and a sensor measures the glucose in the interstitial fluid. While these two values mirror each other, it is helpful to know that after eating, glucose gets to the bloodstream first and then makes its way out to the interstitial fluid where the sensor can read it. This 10- to 15-minute lag time can result in a difference between meter glucose and sensor glucose values.

CGM downloads provide data to help with diabetes management, including time-in-range (TIR), which is the percentage of time spent in the target zone of 70–180 mg/dL. This is an important value to understand, because it will be used by your care team to guide CFRD management. This value is closely tied to your hemoglobin A1c level and average blood glucose level.



Example of time-in-range (TIR) values.

The goal for good management of CFRD is that you spend at least 70% of time as time-in-range (green), less than 4% of the time in low (<54–70 mg/dL), less than 1% time very low (<54 mg/dL), and no more than 25% time spent in high (181–240 mg/dL) and very high (>240 mg/dL).



This is an example of CGM tracing and information that is obtained from the sensor.

Using a CGM is an effective way to identify glucose patterns and allows insight into how food choices affect your glucose levels. It is also helpful to judge the effectiveness of your insulin doses. There are alarms that can be set to alert the user to impending low or high glucose levels, and data can be shared with loved ones who can "follow" your blood sugar levels via mobile app. This can allow another person to take a more active role in helping you manage your CFRD.

Helpful tips for CGMs

- After treating a low glucose level, use a blood glucose meter (finger stick) to judge the effectiveness of treatment. Because glucose gets to the bloodstream first, it will take the sensor extra time to reflect your recovery.
- CGMs can be sensitive to movement. Talk to your diabetes care team to find places on your body to place the sensor. Staying away from the areas of your body that bend will help ensure a better sensor session.
- Stay hydrated. You need to be adequately hydrated to have enough interstitial fluid to get the glucose out to the sensor.

- Ten to 14 days is a long time for something to stick to your body. There are many products to improve sensor adhesiveness, which can become an issue during the hotter months when people sweat. Reach out to your diabetes care team or go to the sensor company's website if this is an issue.
- Some people get skin irritation from the sensor tape. Contact your diabetes care team if this becomes an issue. There are many solutions to this problem.
- Remember that CGM technology is relatively new in the treatment of diabetes. Sometimes sensors do not last for the full intended wear time (10 to 14 days depending on the brand). If this happens, the sensor companies will replace the sensors free of charge. Calling the tech support number and reporting the circumstances and the lot number on the sensor box is required, so make sure you keep this information.
- Some radiology procedures require you to remove the CGM, so it is important to bring an extra sensor with you if you are hospitalized or if you have a planned radiology procedure. In these instances, you can contact the sensor company to get a replacement. While in the hospital, the team may still need to perform finger sticks for insulin dosing and clinical care decision-making. Policies on diabetes technology can vary between hospitals.

Advantages

- You can see your blood glucose level at any time, not just when you poke your finger. This can give you confidence in management!
- Arrows tell you the direction your blood glucose is going—are you stable, climbing, or dropping?
- CGMs produce graphs that help you see blood glucose patterns.
- The CGM will alert you with an alarm if your blood sugar becomes too high or dangerously low.

Disadvantages

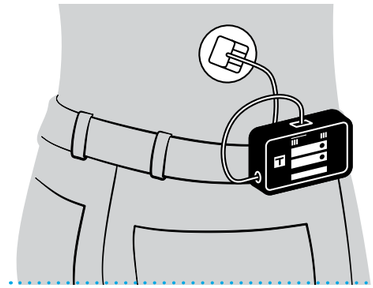
- The device is worn on your body at all times.
- The device needs to be changed every 10 to 14 days.
- The device is not always accurate in the extreme levels. You should always test when you receive an alarm saying your blood sugar is low!
- Skin infections can occur.
- The device may not stick well to your skin.

Insulin Pumps

Some people prefer to use insulin pumps (also called ***continuous subcutaneous insulin infusion***) instead of taking insulin shots. Insulin pumps deliver insulin in two ways:

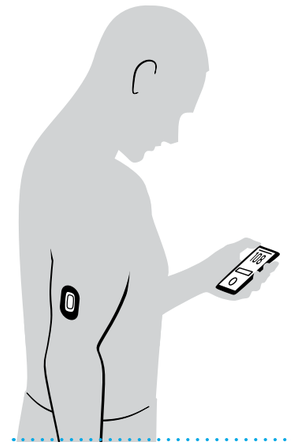
- ***Basal rate*** is the background or continuous drip of rapid-acting insulin that is delivered 24 hours a day. It takes the place of basal (background) insulins such as glargine or detemir.
- ***Bolus dose*** is given to cover the carbohydrates that are consumed and for a correction if blood sugar is high.

A pump delivers insulin through an ***infusion set*** (a short plastic tube), which is put into the skin using a tiny needle. Think of it like an ***IV*** except it goes into the fat tissue instead of a blood vessel. The needle is used to get the infusion set into the fat and then is removed. The plastic cannula is short, fine, and flexible, so you usually cannot feel it after it is inserted. The infusion set is the size of a quarter and stays on the skin using medical-grade adhesive tape for two to three days. The infusion set is connected to the pump. Many people find insulin pumps much more convenient than injections. It is important to remember that the pump still needs the user to be engaged to function properly; it is not a hands-off device. People on insulin pumps should always enter the grams of carbohydrates they will be eating and press the button to tell the pump to give a bolus. They may also need to enter a correction bolus to correct for a high blood glucose level.



PUMP INSERTED IN THE SKIN WITH TUBE

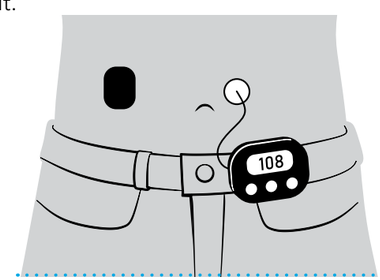
Insulin pumps will calculate mealtime insulin doses based on the amount of carbohydrates entered by the wearer, and the insulin can be delivered with the push of a button. They calculate the doses down to a fraction of a unit so doses can be customized to a degree that is not possible with injections. Insulin pump rates can be adjusted so you are getting the right amount of insulin at the times you need it based on your personal glucose patterns. For example, you may need more basal insulin overnight and less during the day when you are up and moving. You may need less insulin for a specific period such as when you are exercising. Things like tube-feeding become easier to manage because the rates can be turned up during the tube-feeding and programmed to come back down when it stops. The pump can easily be set to deliver 10% to 20% more insulin during a course of steroids when blood sugar is most likely higher. This level of convenience draws a lot of people toward using the pump.



TUBELESS PUMP

The pump itself is smaller than a cell phone. It must be worn 24 hours a day. Most pumps connect to the body with tubing, and the tubing comes in different lengths. There is, however, a tubeless system where the user places a "pod" full of insulin on their body. The cannula comes out of the pod so there is no tubing needed for that system. The pod is run using a device that connects by Bluetooth and looks like a cell phone. It is called "OmniPod," and there are different versions of it.

Some insulin pumps are connected wirelessly with continuous glucose sensors. You may see this type of pump referred to as a "***hybrid closed-loop system***." These are becoming more common and can automatically help prevent both high and low blood sugar. For example, the sensor will relay to the pump that sugars are dropping. Based on an algorithm in the pump, it will self-adjust by reducing the basal rate. On the other hand, if the sensor says that your blood glucose levels are low, then it can pause the pump for a short period of time until blood glucose is at a safe level.



CLOSED-LOOP PUMP SYSTEM

There is a skill set that is required to use an insulin pump. Successfully using an insulin pump requires close monitoring of blood sugar, accurate carb counting, and the ability to problem-solve blood sugar highs or lows. Work with your diabetes care team to prepare for an insulin pump.

Advantages

- Fewer injections are needed—insertion is only done every three days
  - Easier to take additional boluses
- Insulin delivery is guaranteed as long as the device is placed properly (especially the long-acting insulin or basal delivery)
- The pump will automatically calculate how much insulin to give
- You may have different basal rates at different times of the day
- You have more flexibility with food, activity level, sleep, etc.
- Increased blood glucose control when used properly
- Reduced hypoglycemia, especially with the closed-loop system
- Better glucose control means less complications!

Disadvantages

- Insurance coverage or cost
- The device is always on your body
- You need to be comfortable with technology
- Changing the infusion site is more complex than an injection
- Skin infection is possible
- Tubing can get caught in objects

CHAPTER 7: THE DIABETES CARE TEAM

Learning Goals

At the end of this chapter, you should be able to

- Describe the members of the diabetes care team.

Although you may know your ***pulmonologist*** (lung doctor) well, you may not know an ***endocrinologist*** (diabetes doctor). If you have CFRD or abnormal glucose tolerance, you should see a diabetes doctor and a lung doctor. The diabetes doctor will design a treatment plan to meet your diabetes needs and maintain your health.

Most diabetes doctors work with ***certified diabetes care and education specialists (CDCES)***. These are often nurses, dietitians, and pharmacists with special training to manage diabetes. Get to know the diabetes educators who work with your CF and endocrine doctors. Diabetes educators can help you manage your diabetes by teaching you about blood sugar control, insulin dosing, and when insulin doses need changing. They also help you understand how diet and exercise and other factors affect blood sugar and teach you about diabetes technology.

Other members of the diabetes care team may include a social worker and a mental health provider. These professionals can help you address any financial stressors you may be experiencing and provide you with resources to assist you. Your social worker or psychologist may also provide you with additional support to help you cope with the additional diagnosis of diabetes. You may end up not meeting all of the diabetes care team members if you already work closely with the CF dietitian, social worker, or psychologist.

Your diabetes doctors, CF doctors, and you need to work as a team to manage your diabetes. Your total care team includes YOU and your family; your CF doctor, nurse, dietitian, social worker, and mental health provider; and your diabetes doctor, diabetes educators (nurse, dietitian, pharmacist), social worker, and mental health provider.

You are the most important member of your care team!

Your role on the team is to tell the others what you need and how you feel. **Bring your blood glucose meter to all clinic visits.** Tell them about your medicines (particularly prednisone/steroids) and physical activity. Tell them about your schedule (when you wake up, go to bed, eat meals and snacks, and exercise) so they can help you create a routine that works for school or workdays and weekends. This makes it simpler to manage diabetes. Being open with the diabetes and pulmonary team members allows the total care team to match your treatment to your needs as a person with CF and CFRD.

CHAPTER 8: LOW BLOOD SUGAR (HYPOGLYCEMIA)

Learning Goals

At the end of this chapter, you should be able to

- List the common signs of low blood sugar.
- Explain how to treat low blood sugar.
- Describe how to manage diabetes on days when you are too sick to eat your normal diet.
- Explain how to avoid low blood sugar during exercise.

What Is Hypoglycemia?

Hypoglycemia is low blood sugar. Levels less than 70 mg/dL (3.9 mmol/L) are too low and can be dangerous. Blood sugar levels this low do not often occur unless a person is taking insulin.

People who are taking insulin shots can have very low blood sugar levels. **Blood sugar levels can drop fast and must be treated fast!** When you are newly diagnosed with CFRD, you and the people you live and work with must learn the symptoms of hypoglycemia and how to treat it.

Low Blood Sugar Symptoms

The body gives a warning when blood sugar is getting low. **WARNINGS VARY FROM PERSON TO PERSON.** Others may see these symptoms in you before you do. If your blood sugar is low and you do not treat it, you may pass out, have a ***seizure***, or have ***convulsions***. If you are taking insulin, you must treat your low blood sugar right away so that symptoms do not worsen. Symptoms often occur when blood sugar levels are not yet low enough for you to pass out.

The early signs of low blood sugar is caused by the release of a hormone called ***adrenaline***. Adrenaline is also called the "fight-or-flight" hormone because most people release it when they are excited or scared. Among other things, it dilates the pupils, raises the heart rate, and makes people feel shaky and sweaty. If you experience these symptoms, check your blood sugar. If it is less than 70 mg/dL (3.9 mmol/L), you need to treat it quickly by eating foods or drinking liquids that contain carbohydrates.

Common symptoms of low blood sugar

- Sudden hunger
- Upset stomach (nausea)
- Shaky hands or body
- More sweat than normal (often a "cold" sweat)
- A pale face color
- Weakness
- Headache
- Confusion (you may feel or look "spaced out" or "dazed")
- Blurred vision or double vision
- A change in the way you act or feel (crying, feeling nervous, acting "drunk" or angry, etc.)
- Fast heartbeat
- Tingling or numbness in your lips and mouth

Low Blood Sugar Causes

When your body does not have enough sugar to burn for fuel, your blood sugar level drops. Low blood sugar tied to insulin use is often called an ***insulin reaction*** or a ***reaction***.

Low Blood Sugar in CF Without Diabetes

People with CF who are not taking insulin may have slightly low blood sugar levels and feel the warning symptoms listed in the "common symptoms of low blood sugar" box. These symptoms occur because your body's own insulin secretion is not well timed to when you eat your meals. Although slightly low blood sugar can feel bad, it is not a danger. Your blood sugar should never drop really low unless you are taking insulin.

People not taking insulin who feel low blood sugar symptoms can stop or prevent them by eating small meals every two to three hours. These meals should be well-balanced and contain healthy complex carbohydrates. Ask your dietitian to help you with a meal plan if you have low blood sugar.

Low blood sugar with insulin use is often caused by

- Late or missed meals and snacks.
- Extra exercise that burns more sugar.
- An insulin dose that is too high.
- Absorbing the insulin too fast, which can happen with exercise or if the shot is given in the muscle instead of just under the skin.
- Lack of low blood sugar warning symptoms (for example, when you are asleep).
- Getting too much insulin or wrongly mixed insulin types.
- Drinking alcohol on an empty stomach when taking insulin.

Low Blood Sugar Treatment

The best treatment for very low blood sugar is to eat or drink a simple sugar source. If your blood sugar is less than 70 mg/dL (3.9 mmol/L), you should take 15–20 grams of glucose or carbohydrates (such as three or four glucose tablets; ½ cup of regular soda, juice, or lemonade; 1 tablespoon of sugar or honey; one piece of medium-sized fruit; four glucose gummies; or one glucose gel pack). If your blood sugar is less than 50 mg/dL (2.75 mmol/L), you should take 30 grams of carbohydrates (a double serving of the carbohydrate sources listed above). If you are taking insulin, you should always carry a carbohydrate source with you, such as glucose tablets. Use them when you feel "low" but do not have time to test or when you have no other sugar source.

It is easy to overtreat low blood sugar because the body craves sugar when you are low. Follow the recommendations above and retest in 15 minutes. If your glucose level is still low, retreat every 15 minutes until your blood sugar level is above 70 mg/dL (3.9 mmol/L). It is important to wait 15 minutes because it takes this long for the carbohydrates to start working.

It is not safe to feed a person who has passed out because they will likely choke. If your blood sugar is so low that you pass out or cannot drink, someone else needs to give you a ***glucagon*** shot or glucagon nasal spray and call 911. Glucagon is a hormone that "squeezes" extra sugar out of the liver and raises the blood sugar level. Those who live with you should know how to give it. Glucagon can cause nausea and vomiting for up to six hours after it is given.

Even if the package is not opened, glucagon expires after one year. Check your glucagon often to see when it expires and replace it when needed. Always wear an ID bracelet or necklace stating that you have diabetes and CF. This is the first thing that rescue workers look for. It tells them that you might need glucagon or ***intravenous (IV)*** sugar if your blood sugar is dangerously low.

To treat low blood sugar, eat or drink one of these:

- Three or four glucose tablets
- ½ cup of regular soda, juice, or lemonade
- 1 Tbsp of sugar or honey
- 1 piece of medium-sized fruit
- 4 glucose gummies
- 1 glucose gel pack

Driving and Low Blood Sugar

You can drive with diabetes, but you must take extra precautions to stay safe. The following are steps you can take to prevent low blood sugar while driving.

IMPORTANT:
ALWAYS HAVE A QUICK-ACTING SUGAR WITH YOU, AND WEAR AN ID THAT STATES YOU HAVE DIABETES AND CF.

- Check your blood sugar before you drive. NEVER drive if your blood sugar is less than 100 mg/dL (5.6 mmol/L).
- Eat a snack with carbohydrates before you drive.
- Pack plenty of snacks with carbohydrates for long trips.
- Pull over and check your blood sugar if you feel shaky. If it is low, eat a snack. Wait until your blood sugar is >70 mg/dL (3.9 mmol/L) before you start driving again.
- Do not take insulin on an empty stomach before driving to a restaurant. Take insulin when you get your food.
- Keep glucose tablets in your car.

Sick Days and Low Blood Sugar

When you are not able to eat your normal diet, it can be hard to control blood sugar. Your blood sugar often rises when you are sick, even if you are not eating much, because your insulin does not work as well. However, people can also have low blood sugar when they are ill. You are also more likely to get dehydrated if you have a fever, ***diarrhea***, high blood sugar, or are throwing up. If you are throwing up or have lost your appetite, tell your diabetes care team.

These guidelines will help you manage your blood sugar when you cannot eat your normal diet:

- Check your blood sugar every three to six hours or pay attention to your blood sugar on your continuous glucose monitor (CGM).
- Tell your doctor if your blood sugar is higher than normal.
- Use your normal insulin dose unless your doctor tells you to change it.
- If you cannot eat meals, try to eat or drink 50 grams of carbohydrates every four hours, such as 1 ½ cups of applesauce or 1 ½ cups of fruit juice. If you are nauseated or vomiting, you may need to go spoonful by spoonful.
- Sip at least 8 to 12 ounces of ***fluids*** every hour. Alternate fluids that contain carbohydrates (juice, milk, supplements, soda) with fluids that do not (water, sugar-free drinks).
- Even if your blood sugar is not high, call your doctor if you cannot eat your normal diet for more than 24 hours or if you have diarrhea or are throwing up for more than six hours.
- If you are supposed to check your urine for ketones when well, check them more often when you are sick. Call your doctor if your urine ketones are moderate or high.
- Do not miss CF treatments when sick!
- Tell your doctor or CF care team when you have a fever!
- Higher than normal blood sugar levels may mark the start of a more severe illness. Always tell your CF care team and your diabetes care team if your blood sugar is high for more than two days.

Exercise and Low Blood Sugar

Routine exercise is good for many reasons. It can help control your blood sugar by making your body respond better to insulin. Exercise can strengthen your lungs and help you feel better. Exercise can help with depression. All people with CFRD should do some type of moderate aerobic exercise for at least 150 minutes per week. It is important to work with your CFRD care team! Each person responds to activity differently. You may even respond differently to various kinds of activities.

Exercise may also cause low blood sugar because muscles use sugar for fuel. People with CFRD can work out safely as long as they understand the following:

- If you are taking insulin from an insulin pen or syringe, you may need to adjust your pre-meal rapid-acting insulin dose to match your activity level before your exercise. Even if your blood sugar is more than 100 mg/dL (5.6 mmol/L), eating an extra carbohydrate snack before starting is wise. Discuss this with your doctor or diabetes educator.
- You may need an extra 15 to 30 grams or more of carbohydrates for each hour of intense or lengthy exercise. Watch your blood sugar patterns after different types of exercise to determine how many grams of carbohydrate you need.
- If you are on an insulin pump that is integrated with a continuous glucose monitor, you can use the pump's exercise setting starting 1–2 hours before you exercise and 1–2 hours after you finish. This setting increases your blood sugar target

during exercise and helps prevent low blood sugar. Be sure to ask your doctor or diabetes educator about how to use this setting in the pump when exercising.

- Low blood sugar after a workout can last as long as 12 to 24 hours, so you may need to eat an extra bedtime snack with carbohydrates on the days you have exercised really hard.

Record your exercise in your diabetes self-care record so that your doctor will know if exercise caused low blood sugar. An example of a diabetes self-care record can be found in Chapter 4.

Tips for exercising

- Check your blood sugar before, during, and after your workout so you can watch your blood sugar patterns.
- Eat a snack with carbohydrates before you begin if your blood sugar is less than 100 mg/dL (5.6 mmol/L).
- Have a source of carbohydrates with you (such as glucose tablets).
- To prevent low blood sugar, eat or drink 15 to 20 grams of carbohydrates for every 30 minutes to one hour of continuous exercise.

CHAPTER 9: ABNORMAL GLUCOSE TOLERANCE IN CF

Learning Goals

At the end of this chapter, you should be able to

- Describe the other types of abnormal glucose tolerance in CF and know treatment for each.

The oral glucose tolerance test (OGTT) discussed in Chapter 2 is used to diagnose not just CFRD but also the other types of abnormal glucose tolerance that are very common in people with CF. Abnormal glucose tolerance is not the same as diabetes, but people who have abnormal glucose tolerance are at high risk for developing diabetes in the future. This is why it is important to test every year (or earlier if recommended) once you have a diagnosis of abnormal glucose tolerance.

Other Types of Abnormal Glucose Tolerance

Indeterminate Glycemia

If your fasting OGTT and two-hour OGTT results are normal, but you have a high blood glucose reading (>200 mg/dL [11.1 mmol/L] at 30 or 60 minutes of the OGTT), this is called indeterminate glycemia (INDET).

Impaired Fasting Glucose

Impaired fasting glucose (IFG) occurs when your fasting blood glucose is 100 mg/dL to 125 mg/dL (5.6 mmol/L to 6.9 mmol/L).

Impaired Glucose Tolerance

Impaired glucose tolerance (IGT) occurs when your blood glucose levels are 140 mg/dL to 199 mg/dL (7.8 mmol/L to 11.1 mmol/L) at two hours during the OGTT.

Treatment

IFG and INDET are considered pre-diabetic and they carry a high risk of developing diabetes in the future. They also predispose people to having problems such as decline in lung function, weight loss, and more hospitalizations.

In children with CF who have not reached puberty, both IGT and INDET could indicate the potential for an early diagnosis of CFRD during the early teenage years. The CF Foundation recommends that all people with CF have an annual OGTT starting at least by the age of 10 to screen for abnormal glucose tolerance or CFRD. Your blood glucose should be followed more carefully if you have diabetes symptoms, when you are sick, and when you are taking steroids.

There is not enough evidence to suggest that insulin needs to be started when someone is diagnosed as being pre-diabetic. However, it is still important to watch your diet and medication use during this time. It is a good idea to avoid sweetened drinks such as soda, large amounts of fruit juice, or other sweetened beverages. Talk with your dietitian about balancing your meals and snacks throughout the day to even out your blood sugar.

CHAPTER 10: NUTRITION AND CFRD

Learning Goals

At the end of this chapter, you should be able to

- Describe a well-balanced, healthy CF diet.
- Figure out carbohydrate content from a standard food label and adjust insulin.
- Manage late meals, alcohol, and sugar substitutes.

A Well-Balanced, Healthy CF Diet

To ensure good health, it is important to maintain a healthy body weight. People with type 1 or type 2 diabetes are often advised to eat a low-fat, low-salt, and sometimes low-calorie diet if weight loss is desired. People with CF often have different nutrition needs, and each person's needs may differ. The use of CFTR modulator therapy has improved the overall health of many people with CF, and some people have found that they have gained unwanted weight by following a traditional CF diet that is high in calories, fat, and salt. Ultimately, the overall goal for good health is to achieve and maintain a healthy body weight.

THE SIX MAJOR FOOD GROUPS

1. Grains
2. Fruits
3. Vegetables
4. Meats
5. Dairy
6. Fats

If you are concerned about your body weight being too high or too low, your CF dietitian can provide you with personalized information on your nutritional status in the context of CF and CFRD. It is particularly important to review any ideas you have regarding changes to your diet with your CF and diabetes care teams.

Many people gain some weight after starting insulin to manage their diabetes. It is important to note that insulin helps build lean body mass, so this weight gain is often beneficial, especially if you have experienced weight loss or have had a hard time gaining weight. Developing a regular exercise regimen is also key to building and maintaining muscle mass. Be sure to discuss this with your CF dietitian to assist you in meeting your nutrition and weight goals.

There is currently no evidence that a low-carbohydrate diet is beneficial or safe in individuals with CF. Keeping your blood sugar at near-normal levels will help to maintain your weight and ensure good health. You can learn to manage your blood sugar by balancing your food, insulin, and physical activity.

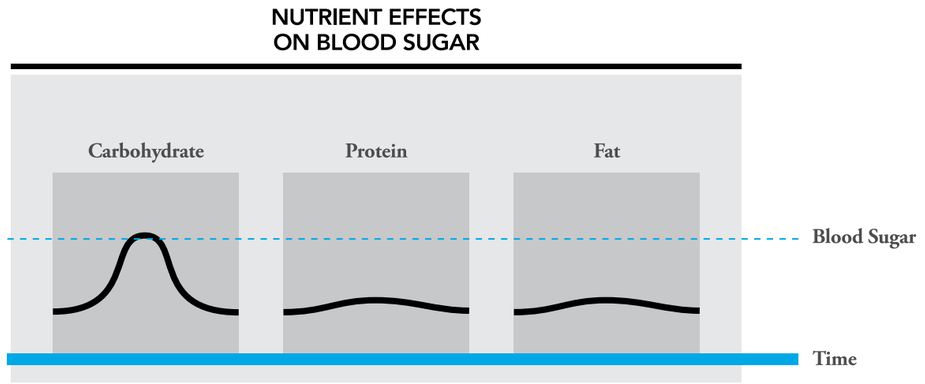
A healthy diet means eating a variety of foods from all food groups. When eaten in the right amounts, these foods can help you reach and maintain a healthy body weight. The only change is that, now that you have CFRD, you need to learn how to measure or count the foods that affect your blood sugar the most.

How Food Nutrients Affect Blood Sugar

The six major food groups contain different nutrients: carbohydrates, protein, fat, vitamins, minerals, and water. Carbohydrates, protein, and fat provide fuel (calories) for

our bodies. Foods that contain carbohydrates affect blood sugar the most because the body turns them into sugar. Foods that are made up mostly of protein and fat have much less of an effect on blood sugar. However, for some people, large amounts of protein and fat may affect blood sugar for up to five hours after a meal.

The graphs below show how carbohydrates, protein, and fat affect blood sugar.



Carbohydrates

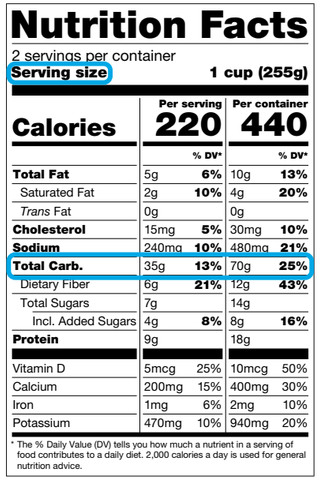
The main way to control blood sugar with diet is to monitor the carbohydrates in your meals and snacks. **This does not mean that you should avoid carbohydrates entirely.** Healthy carbohydrates contain important nutrients and are the body's main source of fuel.

Carbohydrates are turned into sugar that is then used as fuel for all body functions. The two main types of carbohydrates in these foods are sugars and starches. **Try to consume healthy carbohydrates** from ***whole grains***, fruits, vegetables, milk or milk alternatives, and beans, peas, and legumes. **Try to avoid unhealthy carbohydrates** such as soda and juice. By checking your blood sugar or your continuous glucose monitor (CGM) and watching the amounts and kinds of carbohydrates you eat, you will learn how varied combinations of foods (carbohydrates, proteins, and fats) affect your blood sugar levels. Make sure that you eat carbohydrates at times when there is enough insulin in your body to change them into fuel.

If you are on a fixed insulin dose (two or three shots per day with the same dose each time), you can manage blood sugar by eating the same amount of carbohydrates during each of your daily meals and snacks. Try to eat at about the same times each day, too.

People who take four or more shots of rapid-acting insulin per day or use an insulin pump have more options when choosing when and how much to eat. If you want more options, your doctor or diabetes educator can teach you how to adjust your rapid-acting insulin, based on how many carbohydrates you plan to eat during meals and snacks. This is called an insulin-to-carbohydrate ratio. Your dietitian can help you learn carbohydrate counting so you can use this method. You may also use apps to help you

count your carbohydrates such as Calorie King®, MyFitnessPal™, and Figwee. You can also use Siri and Google to help you!



Nutrition Facts

2 servings per container

Serving size **1 cup (255g)**

Calories	Per serving **220**		Per container **440**	
		% DV*		% DV*
Total Fat	5g	**6%**	10g	**13%**
Saturated Fat	2g	**10%**	4g	**20%**
Trans Fat	0g		0g	
Cholesterol	15mg	**5%**	30mg	**10%**
Sodium	240mg	**10%**	480mg	**21%**
Total Carb.	35g	**13%**	70g	**25%**
Dietary Fiber	6g	**21%**	12g	**43%**
Total Sugars	7g		14g	
Incl. Added Sugars	4g	**8%**	8g	**16%**
Protein	9g		18g	
Vitamin D	5mcg	25%	10mcg	50%
Calcium	200mg	15%	400mg	30%
Iron	1mg	6%	2mg	10%
Potassium	470mg	10%	940mg	20%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

FOOD LABEL

Reading Food Labels for Carbohydrates

Food labels will tell you the carbohydrate content in the foods you eat using "grams of carbohydrate." On this food label, the serving size is one cup, or 255 grams if you were to weigh this food on a food scale. The weight of the food should not be confused with the total carbohydrate grams; they are not the same. All of the nutrient values listed below the serving size are based on one cup of this food. As you can see, the total carbohydrate ("Total Carb.") content in one cup of this food is 35 grams.

If you plan to eat more than the listed serving size, multiply the amount shown on the label by how many servings you plan to eat. If you plan to eat the whole container of this food, the total carbohydrate content is 70 grams. The total carbohydrate includes the amount of dietary fiber, total sugars, and added sugars. You can ignore those amounts listed. You may also use apps to help you count your carbohydrates such as Calorie King®, MyFitnessPal™, and Figwee. You can also use Siri and Google to help you!

Daily Meal Plans

Here is an example of a meal plan using carbohydrate grams for someone needing about 2,500 calories per day who is using fixed doses of insulin. Servings of meat, non starchy vegetables, and fat (they have no or very little carbohydrates) would be added to foods for a well-balanced diet.

Meal	Carbohydrate Grams
Breakfast	60 to 80 g
Morning Snack	20 to 30 g
Lunch	60 to 80 g
Afternoon Snack	20 to 30 g
Dinner	60 to 80 g
Bedtime Snack	20 to 30 g

Basing your diet on carbohydrate grams gives you options and helps you control your blood sugar levels (along with insulin and physical activity). You and your dietitian can base your own meal plan on your normal eating habits. If you are using multiple daily injections of insulin or an insulin pump, talk to your doctor, dietitian, or diabetes educator about using an insulin-to-carbohydrate ratio.

Insulin-to-Carbohydrate Ratios

Using an insulin-to-carbohydrate ratio will give you the most options about when and how much you eat. To use this method, you need to know

- How to count the carbohydrates in the foods you eat (see Chapter 12, "Carbohydrates in Common Food Items").
- How insulin works (see Chapter 4, "Treating CFRD").

- How to "match" or adjust your rapid-acting insulin to the carbohydrates you plan to eat.
- How to use a "***correction dose***" of insulin when your blood sugar is outside your target range.

Many people with CFRD need about one unit of rapid-acting insulin for every 15 grams of carbohydrates. Some people need more than this (one unit of insulin for every 7 or 8 grams of carbohydrates). Some people need less (one unit of insulin for every 30 grams of carbohydrates). You and your care team can figure out the ratio that is right for you. You will need to keep a detailed record for at least three days to figure out your ratio. It is important that you bring your record with you to clinic visits so that you and your care team can figure out the right ratio for you. An example of a diabetes self-care record can be found in Chapter 4.

Your record should contain

- The time of shot, meal, and blood sugar check.
- The type and dose of insulin(s).
- Your blood sugar before the meal or snack and two hours after.
- The amount of food eaten (using cups, teaspoons, etc.).
- The carbohydrate count of the food eaten (in grams).
- Any physical activity (type and how long).
- Any stress, illness, or other medicines (such as steroids) you are taking that may affect your blood sugar.

Your ratio may change from time to time because of illness, stress, weight changes, medicines, and physical activity. Work with your care team if your ratio stops working well. Once you have figured out your ratio, you can use it to cover meals and snacks. For instance, if you need about one unit of rapid-acting insulin for every 15 grams of carbohydrates and you planned to eat 90 grams of carbohydrates for lunch, then you would take six units of rapid-acting insulin to cover your lunch (90 ÷ 15 = 6).

Lunch Example

Food Item	Carbohydrate Grams
1 turkey and cheese sandwich with mayonnaise	30
2 ounces of potato chips	30
1 cup plain yogurt	16
1 small apple	14
Total	**90**

For this lunch, you would take six units of rapid-acting insulin to cover 90 grams of carbohydrates.

Insulin Correction Doses

A correction dose is extra insulin given before meals when your pre-meal blood sugar is higher than the range you want. For instance, if your pre-meal blood sugar is 170 mg/dL (9.4 mmol/L) and your blood sugar goal is less than 120 mg/dL (6.7 mmol/L), then you need one unit of rapid-acting insulin to "drop" or "correct" your blood sugar by about 50 mg/dL (2.75 mmol/L) to meet the top of your goal range. The total dose needed for the lunch example on the previous page would then be seven units of insulin: six units for the meal and one extra unit for correction.

- The formula for this is (your high glucose number – your target glucose) divided by your sensitivity (correction) factor.

Your doctor or diabetes care team will give you a correction scale that is individualized to you when needed. **Only rapid-acting insulins are used for correction.** If you are using an insulin pump, the pump will make the correct adjustments based on the settings in the pump as prescribed by your diabetes care team for both your insulin-to-carbohydrate ratio and your correction factor.

Eating a Balanced CF Diet

Fats

A healthy diet includes a variety of foods and beverages. Most people with type 1 and type 2 diabetes are advised to eat a diet rich in unsaturated fats and ***omega-3 fatty acids*** to help prevent ***atherosclerosis*** and heart disease. People with CF who need to gain weight will need a high-fat, high-calorie diet. **Fats are high in calories.** Choose a variety of fats, including healthy unsaturated and omega-3 fats. Adding healthy monounsaturated, polyunsaturated, and omega-3 fats in your diet will help to increase your total calories. Some people with CFRD have high cholesterol levels. If this is the case, then dietary recommendations may be different and should be discussed with your care team.

The ***enzymes*** you may take when you eat help your body to absorb the nutrients and calories that fats provide. Even with enzymes, you may still end up losing or ***malabsorbing*** some of the fat you eat. If you have a lot of malabsorption, it can affect how your insulin works. Work with your dietitian to make sure your enzyme doses are correct so you can get the most nutrients from the food you eat.

Fat does not have a big effect on blood sugar when eaten in normal amounts. Meals that are high in fat can slow carbohydrates from being released by the stomach, which can affect blood sugar for up to five hours after a meal. The more fat in your food, the later your blood sugar may peak. However, this is not true in all people. The best way to tell if high-fat meals affect your blood sugar later on is to monitor your blood sugar or watch your CGM to determine if you may need more insulin later on to prevent your blood sugar from becoming too high.

High-Fat Food Choices

Monounsaturated Fats: Olive oil, peanut oil, canola oil, avocados*, olives, almonds*, cashews*, peanuts*, pecans*, peanut butter*, tahini*, sesame seeds*

Polyunsaturated Fats: Corn oil, sunflower oil, safflower oil, sesame oil, soybean oil, margarine, soft tub or squeeze bottle mayonnaise, salad dressing*, pumpkin seeds*, sunflower seeds*, walnuts*

Omega-3 Fats: Mackerel, herring, salmon, albacore tuna, sardines, anchovies, trout, flaxseed oil, soybean oil, canola oil, flaxseed*, walnuts*

Saturated Fats: Fatty meats, bacon, sausage, salt pork, fatback, chitterlings, poultry with skin, butter, lard, shortening, hydrogenated fats, partially hydrogenated fats, coconut, coconut oil, coconut milk*, palm and palm kernel oils, cocoa butter, whole milk*, two percent milk*, most cheese, cream cheese, sour cream, half and half, heavy cream, whipped cream*

**These foods contain some carbohydrates.*

Protein

Eating adequate amounts of protein is important for a well-balanced diet. The body uses protein to build, repair, and maintain muscles and other body tissues. It also helps to regulate the immune system and other body processes.

Protein does not have a big impact on blood sugar levels. However, large amounts of protein may affect blood sugar up to five hours after a meal in some people, especially when eaten with high-fat foods. Check your blood sugar or watch your CGM to help you determine if a high-protein meal has any effect on your blood sugar and if you need to add extra rapid-acting insulin.

Meats and meat substitutes have varied amounts of fat. You can increase calories by choosing higher-fat meats and cheeses and using high-fat cooking methods such as frying and deep-frying. Talk with your dietitian about your specific protein requirements.

Milk/Dairy and Milk Alternatives

Milk, milk alternatives, and other dairy products are important sources of protein, carbohydrates, and fat. They also provide calcium and other vitamins and minerals. Eat or drink at least three to four servings per day. A serving size of milk is 8 ounces, or 1 cup. With the exception of cheese, most dairy products contain carbohydrates and need to be counted.

Fruits

Fruits, fruit juices, canned fruit, and dried fruit provide carbohydrates, vitamins, minerals, and fiber. Fresh fruit is an excellent source of fiber and is an important part of a balanced diet. Fruit juice contains a concentrated amount of carbohydrates. Try to eat at least 2–3 servings of fruit per day. One serving equals approximately ½ cup of most fruits. See the food lists in Chapter 12, "Carbohydrates in Common Food Items."

Vegetables

Vegetables are an important part of a balanced diet. Try to eat several different colored vegetables including dark green, red, orange, and other colors every day to ensure you are getting a good variety of vitamins, minerals, and fiber in your diet. Try to eat at least three servings of vegetables per day. A serving size is typically ½ cup of cooked vegetables or vegetable juice or 1 cup of raw, leafy vegetables. Non starchy vegetables have about 5 grams of carbohydrates per serving. Because vegetables are

low in calories, try stir-frying them with oil or adding cheese sauce, butter, margarine, or dips if you need extra calories. Starchy vegetables, including corn, peas, winter squash, and potatoes have more carbohydrates than non starchy vegetables. See the food lists in Chapter 12, "Carbohydrates in Common Food Items."

Grains, Grain Products, and Beans, Peas, and Legumes

Breads, cereal, rice, pasta, grain products, and beans, peas, and legumes provide an important source of fuel in the form of carbohydrates as well as fiber, vitamins, and minerals. You should eat at least six servings of grains every day. Try to eat at least three servings of whole grains every day. Look for "100% Whole Grain" on food packages. See the food lists in Chapter 12, "Carbohydrates in Common Food Items."

Salt and Other Vitamins and Minerals

The use of some CFTR modulators may lower the amount of salt that people with CF need to consume in their diet. It is not known currently how much salt is needed for those who use modulators. Talk with your CF care team about the amount of salt that is right for you. In general, extra salt is needed because people with CF lose more salt when they sweat. The lost salt can be replaced by using extra table salt and eating salty foods.

Eating many types of foods from all the food groups each day plus taking your multivitamin pills will help you get all the vitamins and minerals you need. Your dietitian can tell you which CF multivitamin is right for you.

Free Foods

"Free foods" are foods that have less than 20 calories or less than 5 grams of carbohydrates per serving. Individually they do not usually require insulin, but if you consume a lot of them, they add up. Do not fill up on them. You need lots of calories each day to maintain a healthy body weight. Be careful to watch the portion size or just count it as a carbohydrate unit if the serving size you plan to eat adds up to a carbohydrate unit (such as three or four servings eaten at once).

FREE FOOD EXAMPLES	
Beverages/Liquids	Bouillon, broth, gelatin, coffee, tea, lemon and lime juice, club soda, diet soft drinks, sugar-free tonic, water
Sugar Substitutes	***Aspartame, acesulfame-K, saccharin, sucralose, neotame, stevia, advantame***, monk fruit
Condiments	BBQ sauce (1 tablespoon), ketchup (1 tablespoon), horseradish, mustard, relish, salsa, soy sauce, hot pepper sauce, taco sauce, teriyaki sauce, pickles, vinegar
Herbs and Spices	All

High-Calorie Supplements

At times, you may not feel like eating or may not be hungry. You may struggle to gain or maintain weight. ***High-calorie supplements*** are a great source of extra calories during these times. They can help you gain and maintain weight and improve nutrition status. You can make them part of your daily meal plan using the chart on the next page. The calories of each supplement will vary. Your dietitian can help you choose the right one for you.

Supplement	Serving Size	Carbohydrate Grams per Serving
Boost Breeze™	8 ounces	54 g
Boost Plus™	8 ounces	45 g
Boost Pudding™	1 serving (5 ounces)	32 g
Boost VHC™	8.45 ounces	46 g
Carnation Instant Breakfast™	1 serving (1 packet mixed with 8 ounces whole milk or half-and-half)	39 g
Duocal™	2 tablespoons	12 g
Ensure Clear™	6.8 fluid ounces	43 g
Ensure Plus™	8 ounces	50 g
Ensure Pudding™	4 ounces	30 g
Power Milk	1 cup whole milk with 1 tablespoon heavy cream and 1 tablespoon chocolate or strawberry syrup	30 g

Insulin Coverage of High-Calorie Supplements and Tube Feedings

People with CFRD need to cover the food they eat and their high-calorie supplements with insulin. Some people get many cans of supplement while sleeping by gastrostomy or nasogastric tube. Often, a single shot of combined regular plus NPH insulin given before the drip starts will cover the whole feeding. Check blood sugar three to four hours after the tube feeding starts and when it ends. This will help to fine-tune the insulin dose. An insulin pump can also be used to cover supplemental feedings with a gastrostomy or nasogastric tube.

Special Cases

Late Meals

The timing of meals and snacks matters when you are taking insulin! Review the time-action of your insulin dose with your diabetes care team so you can plan meals and snacks when the insulin is most effective. This will help you avoid low blood sugar. If your meal is late but you have taken your insulin, eat or drink something with 15 to 30 grams of carbohydrates while you are waiting. Try not to delay meals for more than one hour. If your meal is late, check your blood sugar more often to avoid low blood sugar.

Alcohol

Ask your doctor if it is safe for you to drink alcohol. If you plan to drink alcohol, know the effect it has on blood sugar. Do not drink alcohol on an empty stomach when taking insulin because drinking alcohol without food increases the risk of low blood sugar. If you are not careful, alcohol can cause blood sugar to go either too high (e.g. from the sugar in mixed drinks) or very low. Do not count the carbohydrates in alcohol toward your insulin dose. Check your blood sugar more often while you drink alcohol.

When you are drinking alcohol, your liver is busy breaking down the alcohol so it will release less glucose into the blood. This puts you at risk for low blood sugar. See Chapter 8, "Low Blood Sugar (Hypoglycemia)." Signs of being drunk are a lot like signs of low blood sugar. If alcohol has clouded your thinking, you may not treat your low

blood sugar the right way. Those around you may not know that you have low blood sugar. This puts you in grave danger!

If you drink alcohol

- Ask your doctor if any amount of alcohol is safe for you.
- Always wear a diabetes ID bracelet or necklace.
- Only drink alcohol when blood sugar is well-controlled.
- Eat foods that contain carbohydrates when drinking alcohol.
- Never drink alone. Be sure to tell friends that you have diabetes when you drink alcohol.
- Limit alcohol to one drink for women and two for men. One drink is 12 ounces of beer, 4 to 5 ounces of wine, or 1.5 ounces of distilled spirits, cordials, or liqueurs.
- Check your blood sugar after drinking to learn your response to alcohol. You may also need to check your blood sugar during the night, especially if you drank too much or you have been physically active while drinking.
- Ask your doctor how your CF medicines interact with alcohol.

Sugar Substitutes

Daily use of sugar substitutes is approved by the Food and Drug Administration and is generally recognized as safe. There are eight approved for use in the United States by the Food and Drug Administration. They are aspartame, acesulfame-K, saccharin, neotame, advantame, sucralose, monk fruit, and stevia. Sugar alcohols are another type of low-calorie sugar substitute. ***Sorbitol***, ***mannitol***, and ***xylitol*** are examples of these. Eating too many foods with sugar alcohols can cause diarrhea. Use them with caution.

Some foods that contain sugar substitutes, such as sugar-free yogurts, may contain other sources of carbohydrates, such as milk. It is important to read labels to include all carbohydrates in your total count.

Many food items with sugar substitutes are low in calories. If you have CF, you may need extra calories. You may be better off eating the regular, rather than low-calorie, version of food, except when it comes to regular soda. Drinking regular soda or other sweet beverages may cause high blood sugar because of its high carbohydrate content. A 12-ounce can of regular soda has about 40 to 45 grams of total carbohydrates. Plus, regular soda and other sweet beverages contain no vitamins or minerals for good health. Eat a balanced CF diet and use good sense when choosing high-calorie foods.

CHAPTER 11: NUTRITION AND CFRD WHEN PREGNANT

Learning Goals

At the end of this chapter, you should be able to

- Explain how gestational diabetes is treated.
- Describe the nutrition guidelines for CF and pregnancy.
- Know how to manage special diet concerns while pregnant.

For your health and your baby's health, it is important to eat a healthy diet and control your blood sugar before and while you are pregnant. You should eat many types of nutritious foods. Because of CF, some people may need more calories than what is advised for people without CF. If you have CF and are pregnant, you need even more! You will have to eat three meals and many snacks each day to meet your and your baby's nutritional needs. Because your need for calcium, iron, and folic acid are increased, you need to take extra vitamins.

Check your blood sugar many times each day. Take the right amount of insulin to cover your carbohydrates. Control your blood sugar (see Chapter 10, "Nutrition and CFRD"). Know what your blood sugar goals are. It is very important to work closely with your CF dietitian and CF care team while you are pregnant.

Women with CF and gestational diabetes should eat a healthy CF diet to gain the right amount of weight to have a healthy baby. Discuss any dietary questions with your CF care team.

Planning for Pregnancy

People with CF who do not have diabetes and who are planning a pregnancy should be tested for diabetes before getting pregnant. They also should have an OGTT as soon as they find out they are pregnant. The OGTT should be repeated again at the end of both the first and second trimesters to check for diabetes. Diabetes that is diagnosed during pregnancy is called gestational diabetes. Be sure to notify your CF team if you develop gestational diabetes.

Insulin should be started when diabetes is diagnosed, to preserve both the baby's and the mother's health and ensure a healthy pregnancy with adequate weight gain for both the mother and the baby. People with CF who already have diabetes should consult their doctors before getting pregnant.

Good blood sugar control is important before pregnancy. People with CF who are pregnant need to check their blood sugar more often and take the right amount of insulin. Insulin needs increase during pregnancy, especially during the second and third trimesters.

Any person with CF who gets pregnant should be treated by a high-risk obstetrician. A high-risk obstetrician is a doctor who takes care of people who are pregnant with medical conditions that can affect pregnancy, or the baby. If they have diabetes before getting pregnant or get gestational diabetes, they also should see an endocrinologist.

An endocrinologist is a doctor with special training in the treatment of diabetes and other diseases of the glands in the body that make hormones. Uncontrolled blood sugar or poor nutrition status can hurt both mother and baby and can lead to poor weight gain and possible problems with the baby.

Gestational Diabetes Mellitus

People with CF are at high risk for gestational diabetes mellitus (GDM). This type of diabetes occurs while you are pregnant and goes away when the baby is born. While pregnant, the body naturally makes more insulin. Gestational diabetes occurs when the pancreas cannot keep up with the extra demand for insulin. Sometimes gestational diabetes may become CFRD after the baby is born. You will need to have your blood sugar checked by your doctor 6 to 12 weeks after you deliver your baby to check for CFRD.

If you have gestational diabetes, learn how to count carbohydrates so you can manage your blood sugar until the baby is born. Eating three meals and at least three or four snacks each day will help. Spreading out foods with carbohydrates throughout the day will also help. Avoid drinking too many sweet drinks, including regular soda, juice, punch, and lemonade. Your CF dietitian can help create a plan with the same amounts of carbohydrates throughout the day.

Try to gain the weight you have been advised to gain. Do not lose weight by not eating certain foods as a way to control blood sugar. People who have gestational diabetes but do not have CF can watch what they eat, limit weight gain, and control blood sugar. For people with gestational diabetes and CF, this way to control blood sugar is not safe for you or your baby. You will likely need insulin at some point to help you gain weight and control blood sugar.

Blood Sugar Goals While Pregnant With GDM or CFRD

To have a healthy baby, you must keep your blood sugar levels as close to normal as you can while pregnant.

Blood sugar goals while pregnant are

- Less than 95 mg/dL (5.3 mmol/L) while fasting.
- Less than 140 mg/dL (7.8 mmol/L) one hour after meals.
- Less than 120 mg/dL (6.7 mmol/L) two hours after meals.

Weight Gain While Pregnant

The amount of weight you should gain while pregnant depends on your body mass index (BMI) before getting pregnant. Ask your doctor about your special needs. Work with your dietitian while pregnant to help you gain the right amount of weight. This is crucial for your health and your baby's health.

BASIC GUIDELINES FOR GAINING WEIGHT WHEN PREGNANT		
Body Mass Index (BMI) Before Getting Pregnant	**Advised Weight Gain in Pounds (*lbs*) or Kilograms (*kg*)**	**Twin Pregnancy**
BMI less than 21.9	28 to 40 lbs or 12.5 to 18.0 kg	Not enough data. Talk with your physician.
BMI 22 to 24.9	25 to 35 lbs or 11.5 to 16.0 kg	37 to 54 lbs or 17.0 to 25.0 kg
BMI 25 to 29.9	15 to 25 lbs or 7.0 to 11.5 kg	31 to 50 lbs or 14.0 to 23.0 kg
BMI greater than 30	11 to 20 lbs or 5.0 to 9.0 kg	25 to 42 lbs or 11.0 to 19.0 kg

Nutrition When Pregnant

Calories and Protein

If your weight was normal before you got pregnant, you need to add at least 340 calories per day during the second trimester and 450 calories per day during the third trimester to meet your weight gain and nutrition goals. You also need to eat more protein. Add an additional three ounces of protein each day to your diet to meet your increased protein needs while pregnant. If you were underweight, you will need to add even more calories. Eating larger portions and adding extra fat will help add extra calories. If you are having a hard time gaining weight, add high-calorie supplements to your diet. Be sure to adjust your digestive enzymes so your body can use the extra calories you are taking in.

Great sources of protein are beef, pork, poultry, fish, seafood, eggs, dairy products, dried peas and beans, tofu, nuts, and peanut butter.

Calcium

All pregnant people need at least 1,000 milligrams of calcium daily. They can get this by eating four servings of dairy products per day. People with CF need more than this because not all of the calcium they eat is absorbed from their intestines. You can get about 300 to 400 milligrams of calcium in 8 ounces of milk or yogurt. You can get about 200 to 300 milligrams in 1½ to 2 ounces of cheese. Other good sources of calcium include calcium-fortified soy milk and other fortified plant milks, calcium-fortified grain and enriched cereal products, fortified orange juice, green leafy vegetables, dried peas and beans, and canned salmon or sardines with bones. You may need a calcium supplement if you cannot get enough calcium in food.

Iron

While pregnant, your need for iron increases to 27 milligrams per day. Great sources of iron are red meats, poultry, some seafood, liver, eggs, dried peas and beans, dark green vegetables, and enriched or whole grain breads and cereals.

Eating foods high in vitamin C along with high-iron foods will help you better absorb the iron. Good sources of vitamin C are citrus fruits and juices, strawberries, green peppers, broccoli, green leafy vegetables, and tomatoes. You may also need an iron supplement.

Folic Acid

You must get enough folic acid in your diet at least one month before you get pregnant and during the first trimester for your baby's proper brain and spine development. You need 400 to 800 micrograms (0.4 to 0.8 mg) of folic acid per day.

Great sources are folic-acid-fortified cereals, breads, and grain products; green leafy vegetables; dried peas and beans; and citrus fruits and juices. Ask your CF dietitian if you need a folic acid supplement.

Iodine and Choline

Iodine and choline needs also increase during pregnancy. Most people have adequate iodine intake. Iodine is important for normal neurocognitive development in the fetus. Good sources of iodine are dairy, eggs, seafood, and iodized table salt. Choline supports normal growth and development of the brain and spinal cord and can be found in dairy, eggs, meat, some seafood, beans, peas, and lentils.

Vitamins A, D, and E

It is very important to get the right amounts of vitamins A, D, and E while pregnant. You may need more than normal, but too much can be just as harmful as too little. People with CF do not absorb these vitamins well. Your care team will check your blood levels to make sure you are getting the right amount.

Every day while pregnant, make sure you get

- 340–450 extra calories
- 3 ounces more protein
- 1,000 mg of calcium
- 27 mg of iron
- 400 to 800 micrograms (0.4 to 0.8 mg) of folic acid
- 8 to 10 cups of fluids

Special Concerns

Caffeinated Beverages and Sugar Substitutes

Caffeine found in coffee, tea, and other caffeinated beverages should be limited during pregnancy. Talk with your physician about how much may be appropriate for you. Sugar substitutes appear to be safe to drink in moderation while you are pregnant.

Alcohol

If you are planning to get pregnant or are pregnant now, do not drink alcohol. No amount is safe for your baby.

Fluid

Be sure to drink plenty of fluids, such as milk, water, and/or supplements while pregnant. Drink at least 8 to 10 cups per day.

Taste and Smell Changes While Pregnant

Many pregnant people notice changes in the way some foods taste and smell. Some foods may taste worse, and some smells may make you queasy. This is normal and likely related to hormone changes. Avoid foods that bother you. If food odors upset your stomach, see if someone else can cook. If you cannot eat enough because of taste and smell changes, see your dietitian.

Food cravings can also occur. Some are good, such as craving milk or fruit. Some are harmful, such as craving dirt, clay, or laundry starch. These harmful cravings are known as "***pica***" and may be a symptom of anemia. If you crave nonfood items like these, tell your doctor right away.

Chapter 11: Nutrition and CFRD When Pregnant

Feeling Sick and Throwing Up While Pregnant

Many people feel sick and throw up while pregnant because of hormone changes. These problems often (but not always) go away after the first 12 weeks. Some people really struggle and need to be watched closely by their health care team. Try to "eat through" feeling sick and throwing up so you do not lose weight. Eat smaller meals and snacks more often. Try to eat only dry food such as crackers or toast for a morning snack, avoid drinking during meals, eat cold foods to avoid food smells, and eat ice chips if fluids are hard to keep down. Get help from your dietitian if you cannot eat enough because you feel sick and are throwing up.

Constipation

Constipation is common during pregnancy. Take your enzymes regularly with meals and snacks. If you are having problems with your bowel movements, talk with your doctor or dietitian.

Eat foods high in fiber and drink lots of fluids. Fiber is found in whole grains, bran cereals, fresh fruits, vegetables, legumes, dried peas, beans, and nuts. Regular exercise helps, too.

Food Safety Concerns

Fish and Seafood

Fish is a great source of protein and other nutrients. Some seafood is safer to eat while you are pregnant than others. Some fish from polluted waters may contain harmful bacteria and chemicals. Avoid eating shark, king mackerel, swordfish, tilefish, and tuna while pregnant.

Check your local health department or department of fisheries about the safety of fish caught in your local lakes and streams. Buy only very fresh fish, and either use it within 24 hours or freeze it right away. Avoid eating raw fish such as sushi when you are pregnant. A few people have eaten raw fish that contained parasites, and others have gotten hepatitis A from raw fish. You can safely eat 12 ounces of shellfish, canned fish, smaller ocean fish, or farm-raised fish per week. Make sure fish and seafood are cooked to 145°F.

Other Foods

Unpasteurized juice, cider, milk, soft cheese, and cheese made from unpasteurized milk may contain *Listeria* and *E. coli*. Do not eat unpasteurized food products. Undercooked eggs may contain *Salmonella*, so make sure egg yolks are cooked until firm. Avoid premade deli salads containing protein or pasta prepared with mayonnaise as these may contain *Listeria*. Make these at home instead. Raw sprouts may contain *E. coli* or *Salmonella*. Cook them prior to eating. Cold hot dogs and luncheon meats may contain *Listeria*. Reheat them to 165 degrees Fahrenheit before eating. Undercooked meat and poultry may contain *Salmonella*, *E. coli*, *Campylobacter*, or *Toxoplasma gondii*. Be sure to thoroughly cook meat according to the U.S. Department of Agriculture recommendations on the package.

CHAPTER 12: CARBOHYDRATES IN COMMON FOOD ITEMS

Learning Goals

At the end of this chapter, you should be able to

- Quickly find the carbohydrate content of common food items.

Carbohydrate Counting

Carbohydrates are the main food nutrient that affects blood sugar. To control blood sugar, it is important to learn how to measure or count the carbohydrates in the foods you eat. This chapter contains lists of the carbohydrate grams in common foods. It also contains common household measurements and portion sizes. All foods are listed in cooked, ready-to-eat portions. You may also use apps to help you count your carbohydrates such as Calorie King®, MyFitnessPal™, and Figwee. You can also use Siri and Google to help you!

Review this chapter with your dietitian as you plan your own meals based on your eating habits and decide how to spread out your day's carbohydrates. At the end of this chapter, there is a sample menu and meal plan that you can use. Work with your dietitian to create your meal plan. If you do not have a dietitian, ask your doctor to refer you to one who understands both diabetes and CF.

Common Household Measurements

- 3 teaspoons (tsp) = 1 tablespoon (Tbsp)
- 4 Tbsp = ¼ cup = 2 fluid ounces
- 8 Tbsp = ½ cup = 4 fluid ounces
- 16 Tbsp = 1 cup = 8 fluid ounces
- 1 cup = ½ pint
- 2 cups = 1 pint
- 1 ounce = 30 grams (dry weight)

Estimating Portion Sizes

These handy tips will help you estimate portion size:

- 3 ounces cooked meat/protein = a deck of cards, or the size of a woman's palm
- 1 ounce cheese = four stacked dice
- ½ cup casserole, grain, or vegetable covers about ¼ of a standard size dinner plate
- ½ cup fruit = a tennis ball

Food Lists

BREADS		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Bread	1 slice (1 ounce)	15
Breadsticks (soft)	1, 6-inch (1 ounce)	17
Challah	1 ounce	37
Cornbread*	1 ounce	20
Croutons*	12 large	8
Dinner roll	1 roll (1 ounce)	13
Focaccia bread	1 wedge (2 ounces)	28
French bread	1 slice (1.5 ounces)	22
Hot dog/hamburger bun	1 bun (1.5 to 2 ounces)	22 to 30
Lefse	1 plain (1 ounce)	15
Matzo	1 ounce	24
Pita	1 (2 ounces)	33
Taco shell	2 hard shells	14
Tortilla (corn and flour)	1, 6-inch (1 ounce)	13
Tortilla (flour)	1, 10-inch (2.5 ounces)	34

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

PASTA, GRAINS, AND OTHER SIDE DISHES		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Barley	½ cup	22
Chow mein noodles*	½ cup	13
Corn meal/pasta	½ cup	19
Couscous	½ cup	18
Kasha/buckwheat	½ cup	17
Pasta	½ cup	22
Pasta side dish (packaged)	½ cup	22
Quinoa	½ cup	20
Rice (white, brown)	½ cup	22
Rice (wild)	½ cup	18
Rice-A-Roni™*	½ cup	22
Rice pilaf	½ cup	22
Stuffing*	½ cup	22
Wheat pilaf/bulgur	½ cup	17

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

BREAKFAST ITEMS		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Bagel (small)	1 (2 ounces)	29
Bagel (medium)	1 (3 ounces)	45
Bagel (large)	1 (4 ounces)	56
Biscuit*	1 cup	14
Cereal, bran flakes	1 cup	32 to 45
Cereal, cooked (oatmeal)	1 cup	27
Cereal (dry, sweetened)	1 cup	25 to 38
Cereal (dry, unsweetened)	1 cup	22 to 29
Cinnamon roll*	1 small (2 ounces)	30
Croissant*	1 (2 ounces)	26
Danish*	1 small (2 ounces)	29
Doughnut* (cake)	1 small (2 ounces)	27
Doughnut* (frosted or glazed)	1 small (2 ounces)	32
English muffin	1 muffin	26
French toast* (no syrup)	1 slice	12 to 22
Grits	1 cup	30
Hash browns*	1 cup	36
Muffin*	1 large (3 ounces)	42
Muffin* (giant)	1 giant (6 ounces)	84
Pancake* (no syrup)	1, 6-inch	22
Scone*	1 large (4 ounces)	60
Waffle* (no syrup)	1 small	15

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

STARCHY VEGETABLES AND LEGUMES (BEANS)		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Beans (baked)	½ cup	27
Beans, peas, lentils (cooked)	½ cup	15 to 20
Corn	½ cup	15
Corn on the cob	1 large ear	28
French fries*	Small order (2.6 ounces)	30
Peas	½ cup	12
Potato (baked)	1 medium (5.5 ounces)	34
Potato (mashed)	½ cup	18
Potato (sweet)	½ cup	21
Potato pancake*	1 medium	11
Potato salad*	½ cup	14
Potatoes au gratin (packaged*)	½ cup	18
Squash (winter)	½ cup	11
Tater Tots™*	½ cup	15

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

Chapter 12: Carbohydrates in Common Food Items

NON STARCHY VEGETABLES		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Lettuce or spinach, raw	1 cup	1
All other non starchy vegetables: Asparagus, beets, broccoli, brussels sprouts, cabbage, carrots, cauliflower, celery, cooked greens, cucumber, eggplant, green beans, mushrooms, onion, peppers, radish, tomato, turnip, zucchini, etc.	½ cup	2 to 6

FATS		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Butter*, margarine*, oils*	1 teaspoon	0
Cream cheese*, plain	2 tablespoons	0
Gravy*	2 tablespoons	2 to 3
Guacamole*	2 tablespoons	3
Half and Half*	1 tablespoon	0
Mayonnaise*, Miracle Whip™*	1 tablespoon	0 to 2
Olives*	5 olives	1 to 2
Salad dressings*, regular	2 tablespoons	0 to 5
Sour cream*, regular	1 tablespoon	0
Whipped cream*, regular	2 tablespoons	0 to 1

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

MEATS AND MEAT ALTERNATIVES		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Beef*, pork*, chicken, turkey, fish, seafood, lamb*, goat*, wild game	3 ounces	0
Breaded or battered meat*, chicken*, turkey*, or fish*	3 ounces	7 to 15
Egg*	1 egg	0
Cheese*	1 ounce	0
Tempeh	3.5 ounces	9 to 20
Tofu	4 ounces	2

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

CRACKERS, CHIPS, AND POPCORN		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Club™ crackers	6 crackers	15
Graham crackers	2 full crackers	21
Popcorn* (microwave)	1 bag	48
Potato chips*	12 to 18 chips (1 ounce)	15
Pretzel sticks	31 sticks (¾ ounce)	15
Rice cakes	2 large cakes	15
Ritz™ crackers*	8 crackers	16
Saltine crackers	7 crackers	15
Tortilla chips*	1 ounce	17
Triscuit™ crackers	5 crackers	16
Wheat Thins™*	12 crackers	16

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

CONDIMENTS AND SPREADS		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Agave, honey, sugar, jelly, jam	1 tablespoon	12 to 17
Peanut butter*	2 tablespoons	5 to 8
Syrup (pancake)	2 tablespoons	28
Syrup (pancake, light)	2 tablespoons	13
Syrup (pancake, sugar-free)	2 tablespoons	0 to 5

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

DRINKS		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Cappuccino (espresso, foamed milk)	16 ounces	14
Chai latte	16 ounces	45
Diet and zero-calorie beverages	All sizes	0
Hot chocolate	16 ounces	45
Iced tea, sweetened	16 ounces	34
Latte (espresso, steamed milk)	16 ounces	19
Lemonade, punch, Kool-Aid™	1 cup (8 ounces)	26 to 30
Mocha (espresso, chocolate, milk)	16 ounces	43
Soda (regular)	1 can (12 ounces)	38 to 46
Sports drink	12 ounces	21 to 25

MILK, MILK SUBSTITUTES, AND YOGURT		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Chocolate milk	1 cup (8 ounces)	26
Milk (2% or whole)*	1 cup (8 ounces)	11
Rice Dream™, vanilla	1 cup (8 ounces)	27
Soy Milk, Silk™, vanilla	1 cup (8 ounces)	10
Yogurt (fruit)	1 cup (6 to 8 ounces)	27 to 45
Yogurt (Greek)	5 ounces	6 to 19
Yogurt (light)	1 cup (6 to 8 ounces)	11 to 16
Yogurt (plain)	1 cup (6 to 8 ounces)	16

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

FRESH, FROZEN, AND CANNED FRUIT			
Food Item		**Serving Size**	**Carbohydrate Grams per Serving**
Apple		Small	14
		Medium	19
		Large	28
Avocado*		Medium	17
Banana		Small	23
		Medium	27
		Large	30
Berries	Blackberries	1 cup whole	14
	Blueberries	1 cup whole	21
	Raspberries	1 cup whole	15
	Strawberries	1 cup whole	11
Canned fruit, unsweetened		½ cup	15 to 17
Cherries		15	15
Clementine		Small	9
Dried fruit	Craisins®	2 tbsp	17
	Dates	2–3 dates	15
	Raisins	2 tbsp	15
Grapefruit		½ large	13
Grapes		15 or ½ cup	13
Kiwi		Medium	11
Mango		½ cup	12
Melon	Cantaloupe	1 cup, cubed	13
	Honeydew	1 cup, cubed	16
	Watermelon	1 cup, cubed	12
Nectarine		Large	16
Orange		Small	15
		Medium	21
		Large	33

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FRESH, FROZEN, AND CANNED FRUIT (cont.)		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Papaya	1 cup	16
Peach	Small	12
	Medium	14
	Large	17
Pear	Small	18
	Medium	25
	Large	33
Pineapple	½ cup	11
Plantain, cooked	½ cup	29
Plum	Small	7
	Medium	10
	Large	14
Pomegranate	½ cup seeds	16
Tangerine	Medium	13

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

FRUIT JUICES		
Food Item	**Serving Size**	**Carbohydrate Grams per Serving**
Apple, cranberry, grape, grapefruit, orange, pineapple	4 ounces	12 to 20

COMBINATION FOODS			
Food Item		**Serving Size**	**Carbohydrate Grams per Serving**
American	Casserole (with meat & noodles)*	1 cup	30
	Cold-cut sub sandwich*	6-inch	45
	Corn dog*	1 regular	23
	Grilled cheese sandwich*	1 sandwich	22 to 30
	Hamburger or hot dog on bun*	1 sandwich	22 to 30
	Macaroni & cheese*	1 cup	45
	Pot pie*	1 10-ounce pie	55
	Veggie burger on bun	1 sandwich	26 to 39

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COMBINATION FOODS (cont.)			
Food Item		**Serving Size**	**Carbohydrate Grams per Serving**
Asian/Indian	Chow mein (no rice)	1 cup	10
	Egg rolls*	1 large	15
	Lo mein*	1 cup	35 to 41
	Mock duck/ wheat gluten	3 ounces	3
	Naan	1 ounce	11
	Pho*	1 order	53 to 90
	Rice, basmati or jasmine	1 cup	44
	Rice, fried*	1 cup	42
	Stir-fry (meat & vegetable only)	1 cup	6 to 9
	Sweet & sour pork* (no rice)	1 cup	46
	Wonton (plain)	4 pieces	16
Italian	Calzone	1 regular	45–93
	Fettuccini alfredo*	1 cup	47
	Lasagna*	1 cup	31
	Manicotti*	2 pieces	31 to 44
	Pizza (thick, restaurant)*	1 medium slice	27 to 29
	Pizza (thin, restaurant)*	1 medium slice	21 to 23
	Ravioli*	1 cup	28 to 32
	Tomato sauce with meat*	1 cup	45
	Tomato sauce from jar	½ cup	6 to 12
	Tortellini*	1 cup	31 to 49
Mexican	Burrito*	1	39 to 65
	Fajita	2	40
	Quesadilla*	1 entrée size	32 to 66
	Refried beans*	½ cup	17
	Taco,* regular, hard shell	1 small	7
	Taco,* regular, soft shell	1 small	12 to 18
	Tamale*	1 small	18

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COMBINATION FOODS (cont.)			
Food Item		**Serving Size**	**Carbohydrate Grams per Serving**
Middle Eastern	Falafel sandwich	11.6 ounces	85
	Grape leaves, stuffed*	3 small	12
	Gyro sandwich	12 ounces	40 to 55
	Hummus*	4 tablespoons	8
	Tabbouleh	½ cup	15
Soup	Bean*	1 cup	34
	Chicken noodle	1 cup	12
	Chili (with beans)*	1 cup	25
	Cream of broccoli*	1 cup	20
	Minestrone	1 cup	20
	Miso (paste)	1 tablespoon	5
	New England clam chowder*	1 cup	21
	Tomato with milk	1 cup	22
	Vegetable beef	1 cup	14
Southern/ Creole	Hominy	1 cup	33
	Hush puppies*	5 pieces	35
	Red beans & rice	1 cup	37
	Shrimp gumbo	1 cup	19
	Succotash	½ cup	17

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

DESSERTS AND SWEETS			
Food Item		**Serving Size**	**Carbohydrate Grams per Serving**
Baked Goods	Apple crisp*	½ cup	38 to 43
	Banana bread*	2 ounces	33
	Brownie*	2 ounces	36
	Cake with frosting*	3 ounces	35 to 48
	Cheesecake (fruit topping)*	3 ounces	41 to 48
	Cheesecake (plain)*	3 ounces	26
	Cream pie*	1 slice	30 to 53
	Dessert bar*	1 small bar	24 to 30
	Fruit pie*	1 slice	43 to 55
Candy	Chocolate bar*	1 2-ounce bar	26 to 30
	Fruit Roll-Up®	1 roll-up	11
	Gummy bears	10 gummy bears	22
	Jellybeans	22 small beans	22
	M&Ms®*	regular package	34
	Peanut M&Ms®*	regular package	33
	Snickers®*	1 regular bar	36
	Twix®*	regular package, 2 bars	34
	Twizzlers®	4 pieces	36
Cookies	Chips Ahoy!®*	3 cookies	21
	Fig Newtons®	3 cookies	33
	Fortune cookie	2 cookies	12
	Granola bar	1 bar	15 to 25
	Homemade cookie*	1 small cookie, 1 ounce	14 to 22
	Kellogg's® Rice Krispie™ Treats*	1 bar	17
	OREO® cookies*	3 cookies	24
	Shortbread cookies*	3 small cookies	14
	Vanilla wafers	5 cookies	13
Frozen Treats	Frozen yogurt	½ cup	17 to 30
	Fudge bar	1 bar	17 to 30
	Ice cream*	½ cup	15 to 30
	Ice cream bar*	1 bar	15 to 30
	Sherbet	½ cup	22 to 30
Pudding/ Gelatin	Gelatin	½ cup	17 to 19
	Instant regular pudding*	½ cup	12 to 30

**If your dietitian advises you to consume more calories, eat more of these higher-fat foods.*

Sample Meal Plan

TIME	CARBOHYDRATE GRAMS
Breakfast	
AM Snack	
Lunch	
PM Snack	
Dinner	
Evening Snack	

Advised Amount of Added Fat per Day:

Advised Amount of Meat, Poultry, Fish, Cheese, or Eggs per Day:

Advised Amount of Vegetables per Day:

Sample Menu

TIME	FOOD ITEM	SERVING SIZE	CARBOHYDRATE PER SERVING
Breakfast			
AM Snack			
Lunch			
PM Snack			
Dinner			
Evening Snack			

GLOSSARY

Acesulfame-K – A sugar substitute. The generic form of Sunett® or Sweet One®.

Adrenaline – A "fight-or-flight" hormone. Made by the adrenal gland.

Advantame – A sugar substitute.

Amino acids – The building blocks of protein. Insulin allows the body to take up amino acids and build muscle tissue.

Appetite – A desire for food or drink.

Aspart – A rapid-acting insulin. The generic name for NovoLog®.

Aspartame – A sugar substitute. The generic form of NutraSweet® and Equal®.

Atherosclerosis – When fats clog the inner lining of the artery walls.

Background insulin – A low level of insulin that is needed at all times (also called basal insulin). Most people with CFRD need to take a background insulin.

Basal insulin – A low level of insulin that is needed at all times. See "Background insulin" and "Long-acting insulin."

Basal rate – Basal insulin (or background insulin) that is delivered continuously using an insulin pump. Basal insulin is released slowly over a 24-hour period to help control blood sugar between meals and overnight.

Baseline – In diabetes, the fasting glucose level.

Beta cells – Special cells in the pancreas that make the hormone insulin.

Blood glucose – The main sugar in the bloodstream. Also known as blood sugar. A major source of body cell fuel.

Blood sugar – See "Blood glucose."

BMI – See "Body mass index."

Body mass index (BMI) – A measurement of body fat, using weight-to-height ratio.

Bolus – All at once.

Bolus dose – A larger dose of insulin given with meals and snacks.

Carbohydrate counting – Counting how many carbohydrates you plan to eat and adjusting your rapid-acting insulin to cover them.

Carbohydrates – The main nutrients that affect blood sugar. There are two types: simple (sugars) and complex (starches). They are used for the body's instant fuel needs.

Cartridge – In this case, a container of insulin for use with an insulin injection pen.

Casual blood glucose – A blood glucose level drawn at any time regardless of when your last meal or snack was eaten.

CDCES – See "Certified diabetes care and education specialist."

Certified diabetes care and education specialist (CDCES) – A doctor, nurse, or dietitian with special training to manage diabetes.

CF – See "Cystic fibrosis."

CFRD – See "Cystic fibrosis-related diabetes."

Cholesterol – A lipid (fat) found in the cell membranes of all tissues and transported in the blood.

Chronic – All of the time, or long lasting.

Constipation – When it is hard to have a bowel movement because the feces are dry and hard.

Continuous glucose monitor – A tiny sensor that tracks blood glucose levels day and night. The sensor collects readings every five minutes from the interstitial fluid in the abdomen.

Continuous subcutaneous insulin infusion – A method of giving a constant infusion of insulin through an insulin pump rather than insulin taken through shots.

Convulsions – See "Seizure."

Correction dose – Extra rapid-acting insulin given before meals when the pre-meal blood sugar is higher than the target range.

Corticosteroids – Steroid-containing drugs (e.g., prednisone) used to treat lung disease.

Cystic fibrosis (CF) – A disease that affects the exocrine (mucus) glands of the lungs, liver, pancreas, and intestines, often causing frequent airway infections and poor growth.

Cystic fibrosis-related diabetes (CFRD) – A form of diabetes that occurs in people with CF where the body does not make enough insulin or use insulin properly. Diabetes is a problem in which a person's blood glucose (a type of sugar) level is too high.

Detemir – A long-acting insulin. The generic name for Levemir®.

Diabetes – A state in which the body does not make enough insulin and/or does not respond to insulin the right way.

Diabetes care team – A team of people with special training to manage diabetes. The team might include a doctor (often an endocrinologist), certified diabetes educator (often a nurse or dietitian), social worker, and psychologist.

Diagnosed – To decide what the problem or cause of the problem is.

Diarrhea – Passing large amounts of loose stool often.

Digestive enzyme – A substance made in the pancreas that flows into the intestine or that is taken in a capsule with meals and snacks to help digest food.

Degludec – Sometimes referred to as "ultra-long insulin." Has glucose-lowering properties that can last up to 42 hours (about two days) after taking it.

Endocrine – The hormone-making function of the pancreas and other glands. Insulin is a hormone.

Endocrine pancreas – The part of the pancreas that makes insulin, which helps your body cells use the energy (calories) from food.

Endocrinologist – A doctor with special training in the treatment of diabetes and other diseases of the glands that make hormones.

Enzyme – A substance made in the exocrine pancreas that flows into the intestine to help digest food.

Enzyme supplements – Enzymes, swallowed in pill form, to help the body digest food when the body does not make enough enzymes or the enzymes cannot get from the pancreas to the intestine.

Exocrine pancreas – The part of the pancreas that makes digestive enzymes, which flow into the intestine to help digest food.

Expired – Old or out-of-date medicine.

Fast/fasting – Nothing to eat or drink for at least eight hours.

Fasting blood glucose – A blood sugar level measured after not eating any food for at least eight hours. "Normal" is less than 100 mg/dL (5.6 mmol/L).

Fluid – Fluids in the diet are also known as liquids, such as water, milk, tea, etc.

Gastrostomy – An opening made through the abdomen into the stomach for a feeding tube or button.

Generic – Any drug that has the same ingredients as a brand name drug but is sold without a brand.

Gestational diabetes – Diabetes only when pregnant.

Glargine – A long-acting insulin. The generic name for Lantus®.

Glucagon – A hormone that "squeezes" extra sugar out of the liver and raises the blood sugar level. It is given as a shot and can be used to treat low blood sugar in someone not conscious.

Glucose – A simple sugar, and the main sugar in the bloodstream. A major source of body cell fuel.

Glucose intolerance – When the body has a hard time turning sugar into fuel for cells.

Glucose meter – A small machine that measures blood sugar level.

Glulisine – A rapid-acting insulin. The generic name for Apidra®.

Hemoglobin A1c – A test that shows how much sugar is "stuck" to your red blood cells. It shows long-term blood sugar control. The hemoglobin A1c goal is less than 7 percent.

High-calorie supplements – A great source of extra calories when you don't feel like eating or aren't hungry, or when you struggle to gain or maintain proper weight.

Hormone – Chemical released by cells that either carries messages to other cells or affects cells in other parts of the body.

Hybrid closed-loop system – An insulin pump that is connected wirelessly with continuous glucose sensors.

Hyperglycemia – High blood sugar levels.

Hypoglycemia – Low blood sugar levels.

IGT – See "Impaired glucose tolerance."

Impaired fasting glucose (IFG) – When the body's fasting blood glucose is 100 mg/dL to 125 mg/dL (5.6 mmol/L to 6.9 mmol/L).

Impaired glucose tolerance (IGT) – A fasting blood sugar of 100 to 125 mg/dL (5.6 to 6.9 mmol/L) and/or a blood sugar of 140 to 199 mg/dL (7.8 to 11.1 mmol/L) two hours after an oral glucose load during an oral glucose tolerance test (OGTT).

Indeterminate glycemia (INDET) – When your fasting and two-hour OGTT results are normal, but you have a high blood glucose in the middle of the OGTT.

Infection – The invasion and/or increase of disease-causing organisms, such as germs, in the body.

Inflammation – The swelling of the body tissues because of irritation or injury. Inflammation occurs with an infection.

Infusion set – A thin, short plastic tube that carries insulin from an insulin pump into the body for a baseline constant dose of insulin all day.

Insulin – A hormone secreted by the pancreas that helps sugar leave the blood and enter the cells where it is used for fuel.

Insulin deficiency – When the pancreas does not make enough insulin.

Insulin-dependent diabetes – Also called type 1 diabetes or juvenile diabetes. It most often occurs in childhood. In insulin-dependent diabetes, the pancreas does not make insulin, so insulin must be taken daily for the individual to stay alive.

Insulin injection devices – A device with a very small insulin needle and an insulin cartridge stored inside.

Insulin injection pen – See "Insulin injection devices."

Insulin pumps – Also called continuous subcutaneous insulin infusion (CSII). Insulin pumps are used to give a constant amount of insulin rather than insulin through shots.

Insulin reaction – Low blood sugar, less than 70 mg/dL (3.9 mmol/L).

Insulin resistance – When body cells cannot use insulin the right way, so more insulin is needed to lower blood sugar.

Insulin-to-carbohydrate ratio – A way to "match" or adjust your rapid-acting insulin to the carbohydrates you plan to eat.

Intermediate-acting insulin (NPH) – Insulin, usually given twice a day, that has its peak effect in six to eight hours and lasts about 13 hours. This can vary from person to person.

Interstitial fluid – The thin layer of fluid that bathes and surrounds the cells of the tissues in the body and delivers nutrients to cells.

Intestine – The part of the body where food is digested and nutrients absorbed.

Intravenous (IV) – In a vein.

IV – See "Intravenous."

Ketoacidosis – A life-threatening change in blood acidity that can occur in people with type 1 diabetes.

Ketones – A chemical the body makes when there's not enough insulin and fat is used for fuel instead of sugar.

Kg – Kilogram. A measurement of weight. 1 kg = 2.2 pounds.

Lancet – A small device with a tiny spring-loaded needle made for getting a drop of blood from the tip of your finger for blood sugar testing.

Lbs. – Pounds. A measurement of weight.

Lipid profile – A check of blood lipid (fat) levels, including cholesterol and triglyceride.

Lipids – Fats.

Lipohypertrophy – When lumps of fat or scar tissue form under your skin. This is caused by repeated injections or infusions in the same area of the body. It can be avoided by rotating injection/insertion sites.

Lispro – A rapid-acting insulin. The generic name for Humalog®.

Long-acting – A long-acting insulin only has to be taken once or twice a day to provide a consistent, background level of insulin. Basal insulins are long-acting insulins that only need to be taken once a day.

Malabsorbing – Not absorbing the nutrients from food for use by body cells.

Mannitol – A sugar alcohol, used as a sugar substitute.

Monofilament – An instrument used in the doctor's office on the bottom of your feet to check for nerve damage.

Nasogastric – A tube that runs from the nose to the stomach.

Neotame – A sugar substitute.

Neuropathy – Damage to the nervous system from uncontrolled blood sugar over time.

Nighttime tube feeding – Getting high-calorie supplements using a pump through a gastrostomy or nasogastric tube during the night or while asleep. Also known as milk drips.

Non-diagnostic – Does not indicate a disease.

Non-insulin-dependent diabetes (type 2 diabetes) – A type of diabetes caused by the lack of a normal response to insulin and/or not making enough insulin. It most often occurs in overweight people over the age of 40.

NPH – See "Intermediate-acting insulin."

Nutrition – Having to do with the body's need for and use of nutrients found in food.

OGTT – See oral glucose tolerance test.

Omega-3 fatty acids – A certain type of fat (found in some oils and seafood) with many good health effects.

Ophthalmologist – A doctor with special training in the care of people's eyes.

Ophthalmology – The branch of medicine having to do with the eyes.

Oral glucose tolerance test (OGTT) – A test used to diagnose not just diabetes and CFRD but also the varied types of abnormal glucose tolerance in CF.

Pancreas – An organ in the body that secretes digestive enzymes and makes hormones, including insulin.

Pattern management – Deciding how much insulin to take based on low and high blood sugar patterns at certain times of the day.

Pica – Wanting to eat non food items. May be a symptom of anemia.

Polydipsia – Needing to drink liquids often. A classic diabetes symptom.

Polyuria – Having to urinate (pee) often. A classic diabetes symptom.

Postprandial blood glucose reading – Blood sugar level two hours after the largest meal.

Protein – One of the nutrients found in the six main food groups. Protein is used by the body to build, repair, and maintain muscle and other body tissues. It helps to regulate the immune system and other body processes.

Pulmonologist – A doctor with special training to care for people with lung disease.

Reaction – In diabetes, low blood sugar of 70 mg/dL (3.9 mmol/L) or less.

Regular – "Regular" is the only insulin called "short-acting." It has been mostly replaced by newer insulins called "rapid-acting" because they start working more quickly and better match food intake, but there are special situations (like continuous drip feedings) where the longer action of regular insulin is preferred.

Retinopathy – A type of eye disease caused by high blood sugar levels over a long period of time that can lead to blindness. All adults with diabetes should be screened for this once per year.

Saccharin – A sugar substitute. Also known as Sweet'n Low®.

Secrete – To produce and give off (as the cells of the pancreas secrete insulin).

Seizure – Sudden and sometimes violent uncontrolled muscle movement.

Short-acting – See "Regular."

Sorbitol – A sugar alcohol, used as a sugar substitute.

Starches – A type of carbohydrate that is also referred to as a "complex carbohydrate." Starches are found in common foods such as wheat, rice, other grains, potatoes, corn, peas, and winter squash.

Steroids – A compound made in the body that regulates many body functions. (See also "Corticosteroid.")

Stevia – A sugar substitute.

Subcutaneous Tissues – Fat tissue located just under the skin.

Sucralose – A sugar substitute. Also known as Splenda®.

Sugar – A type of carbohydrate also referred to as "simple sugar." Also known as glucose or dextrose, fructose (found in fruit), galactose and lactose (found in milk), maltose (malt sugar), and sucrose (table sugar).

Triglyceride – A type of fat in the blood that is usually measured with cholesterol levels.

Tube feeding – Getting nutrition supplements using a pump and a gastrostomy or nasogastric tube.

Type 1 diabetes – See "Insulin-dependent diabetes."

Type 2 diabetes – See "Non-insulin-dependent" diabetes.

Underlying – Something in the background or at the same time.

Urinate – To pee.

Urine microalbumin – The amount of protein (albumin) in urine, which shows kidney health.

Whole grain – The unprocessed grain containing the bran and germ.

Xylitol – A sugar alcohol, used as a sugar substitute.

IMPORTANT RESOURCES

The following is a brief overview of organizations that can provide additional information about cystic fibrosis and cystic fibrosis-related diabetes (CFRD).

Cystic Fibrosis Foundation

The Cystic Fibrosis Foundation is the world's leader in the search for a cure for cystic fibrosis. The Foundation funds more CF research than any other organization, and nearly every CF drug available today was made possible because of Foundation support. The Foundation also supports and accredits a national care center network that has been recognized by the National Institutes of Health as a model of care for a chronic disease. The Cystic Fibrosis Foundation is a donor-supported nonprofit organization. For more information, visit **cff.org** or call 1-800-FIGHT-CF.

Join the CF Foundation's Facebook community: Facebook.com/CysticFibrosisFoundation

Follow the CF Foundation on Twitter: Twitter.com/CF_Foundation

Follow the CF Foundation on Instagram: instagram.com/cf_foundation

Watch the CF Foundation on YouTube: YouTube.com/CysticFibrosisUSA

American Diabetes Association (ADA)

This is a national organization of health team members committed to teaching the public about all forms of diabetes. The ADA is a good resource for health and legal information about diabetes. The ADA can be reached at 2451 Crystal Drive, Suite 900, Arlington, VA 22202; phone: 1-800-DIABETES (1-800-342-2383); website: **www.diabetes.org**.

Association of Diabetes Care and Education Specialists (ADCES)

This is a national organization of diabetes educators who focus on helping people with diabetes achieve behavior change goals, which in turn lead to better clinical outcomes and improved health status. It is a multidisciplinary profession, and members of the organization are already licensed in a related health care field. Most commonly, you will find that they are also nurses/nurse practitioners, dietitians, or pharmacists. For more information, visit **www.diabeteseducator.org**.

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