

The Basics of Insulin Pump Therapy



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The Basics of Insulin Pump Therapy

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Introduction



Welcome!

We are glad you have chosen to manage your diabetes with a Medtronic insulin pump. We are eager to assist you in learning about this amazing technology. Managing your diabetes with an insulin pump should improve your glucose control and provide you with newfound freedom and flexibility in your lifestyle.

It's All About You

Medtronic developed this training program with you in mind. Remember, it is about your health, your life, and your choice to become the most active member on your healthcare team. Thank you for inviting Medtronic to join your team.

Medtronic's Commitment To You

Medtronic strives to develop exciting, rewarding, and successful partnerships with you and your healthcare provider. Our goal is to exceed your expectations in product quality, education, and customer service.



IMPORTANT Any attempt to infuse insulin into your body without the guidance of a medical professional is dangerous. Only a trained medical professional is qualified to determine the correct insulin pump settings for your individual needs. Do not attempt to use insulin in your pump without professional training.

Introduction

What Are Your Goals?

People choose insulin pump therapy for different reasons. Why did you choose insulin pump therapy?



Realistic Goals and Expectations

- I want to have better glucose control
- I want to add flexibility to my lifestyle and eating habits
- I want to avoid having frequent or severe low blood glucose
- I want to be able to sleep late
- I want to be able to exercise without my blood glucose going too low or too high
- Other: _____

Unrealistic Goals and Expectations

- I don't want to give myself insulin shots ever again
- I don't want to check my blood sugar more than 3 times a day
- I don't want to carry diabetes supplies everywhere
- I don't want to worry about diabetes

Introduction

The Training Process

An insulin pump is a wonderful tool that assists you in the management of your diabetes. However, the pump is a tool and can only provide the greatest benefit to those who learn to use it properly. This workbook will help you become competent in the use of your pump so you can enjoy and receive the benefits of improved glucose control.

Medtronic divides pump training into four phases.

PHASE 1: INTRODUCTION TO INSULIN PUMP THERAPY

The Basics of Insulin Pump Therapy

- Balancing Glucose and Insulin
- Managing Pump Therapy
- How to Calculate Boluses

A Step-By-Step Guide

- Basic Programming
- Menu Map
- Troubleshooting
- Post Classroom Review

PHASE 2: INSULIN PUMP START

When you have completed your Phase 1 training, please schedule your Pump Start Training with your Medtronic representative or your healthcare provider.

PHASE 3: ONGOING SUPPORT

Once you have started using your insulin pump, your Medtronic representative or healthcare provider will be available to assist as you learn.

PHASE 4: CONTINUING EDUCATION

Continuing education classes provide additional information on advanced pump features and diabetes self-management skills. Please consult your Medtronic representative for class times and locations.

Phase 1 Training Details

The introduction to insulin pump therapy training is available in three formats. You choose the training combination that best suits your learning needs and advance at the pace that is right for you. Training can be obtained through:

- **Workbook** (independent study)
- **Web-based training**
- **Classroom** (group or individual session)

Your health is valuable. Please make time to invest in yourself and take advantage of the training and support Medtronic offers.

The information in each chapter of this workbook is divided into small sections. If you are already familiar with the information in a section, feel free to skip to the end of that section, read the key learning points, and complete the review exercise.

The training you receive in your Pump Start Training class will build on the information provided in this workbook and the Step-By-Step Guide. Please complete this workbook and the Step-By-Step Guide prior to attending your Pump Start Training class.

For additional practice and training on your insulin pump, refer to the web-based training or review the instructional CD-ROM.

Introduction



Items to Bring to Insulin Pump Start Class

- Pump and supplies
 - Your insulin pump and the small box that it came in
 - 3 reservoirs, 3 infusion sets, insertion device for the infusion set
 - 3 IV Prep™ wipes (or 3 alcohol wipes)
 - Transparent dressing (IV3000™), if shipped with your pump
- A vial (bottle) of rapid-acting (U100) insulin
- Meter and supplies
 - Blood glucose meter, test strips, and lancets
- Pump Start Instructions
 - Form completed and signed by your healthcare provider with your initial pump settings (basal rate, insulin to carbohydrate ratio, insulin sensitivity factor, active insulin time, and target range) — your certified product trainer may already have this form
- This workbook and your Step-By-Step Guide
- Other
 - Glucose tablets or some form of fast-acting carbohydrate
 - A snack

Additional Items That May Be Requested (Check With Your Trainer):

- Your product User Guide
- Blood glucose logbook
(with at least the previous week's readings)
- Certificate of completion for your online learning
- Ketone test strips



NOTE The reservoir that holds your 2 to 3 day supply of insulin and fits into the reservoir compartment of your pump cannot be filled with insulin from an insulin pen. You will need a vial (bottle) of rapid-acting U100 insulin as prescribed by your healthcare provider to fill the reservoir.



Balancing Glucose and Insulin



“I started using the insulin pump and everything changed! I could eat when I wanted to, not when I had to. I could make my own choices again. I didn’t feel like diabetes controlled me anymore, but I could control it.

Using the pump has made managing my diabetes a lot easier and living with diabetes a lot less painful.”

—Jenna, age 13

Chapter 1:

Balancing Glucose and Insulin

The human body has a remarkable ability to maintain tight glucose control when someone does not have diabetes. This tight control is possible because the pancreas and the liver work as a team to make sure that the right balance of glucose and insulin is in the body at all times.

When diabetes develops, the body is unable to maintain this balance. Your insulin pump is a wonderful tool that can help make the task of balancing glucose and insulin easier.

Before learning how to operate your insulin pump, we will review a few basic principles about how the human body works. Knowing how your body worked and how your pancreas delivered insulin before you developed diabetes will help you use your pump in a way that more closely mimics the way your pancreas would deliver insulin if it could.

Balancing Glucose and Insulin



DID YOU KNOW?

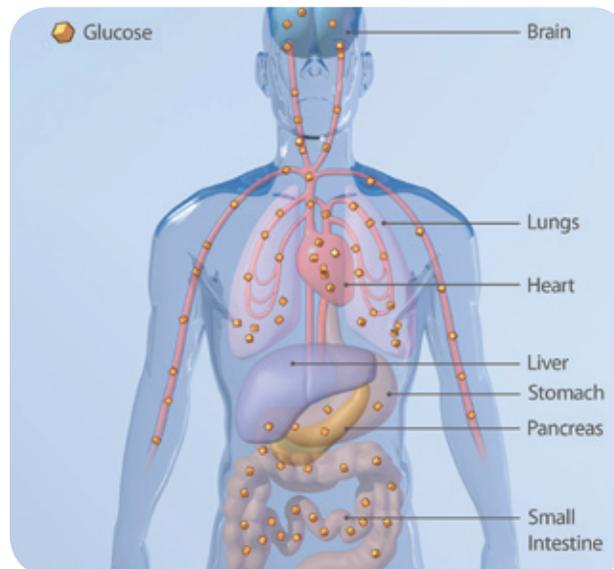
Glucose can be found and measured throughout the body. Glucose is typically measured in the blood. This is why it is often called “blood glucose” or “blood sugar.”

Section 1:

Glucose, the Body’s Fuel

What Is Glucose?

Glucose is a type of sugar your body uses for energy. Energy is needed for every single movement and every function your body performs. In fact, energy is necessary for your heart to beat, your lungs to breathe, and your brain to think. Your body is made up of millions of cells. Every cell uses glucose for energy. This is why it is important for you to have a certain amount of glucose in your body at all times, even while sleeping.



Glucose is distributed throughout the body. Every cell uses glucose for energy.



NOTE Glucose is the fuel your body uses for energy. Just like a car needs gas to run, the body needs glucose to run.

How Much Glucose Does Your Body Need to Have Available?

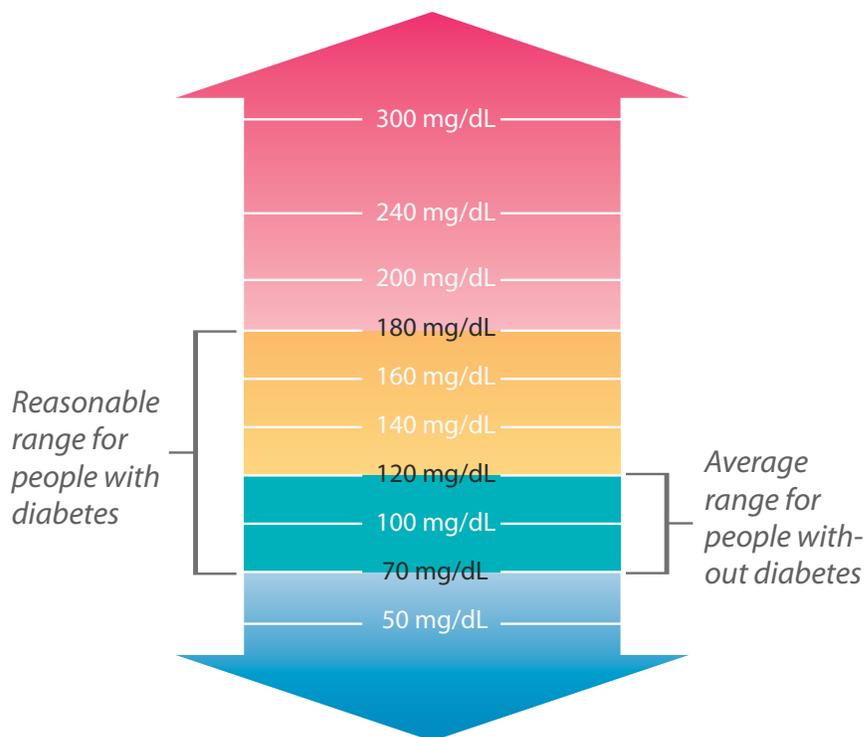
When a person does not have diabetes, the body keeps enough glucose in the blood to maintain glucose levels between 70 mg/dL to 120 mg/dL. Most medical professionals consider this to be the average glucose range for people who do not have diabetes.

When diabetes develops, it is very difficult to keep glucose levels within such a tight range. It is important, however, to keep your glucose levels within a reasonable range and to avoid frequent highs and lows. Your healthcare provider will help you determine the best glucose range for you.



DID YOU KNOW?

mg/dL stands for milligrams per deciliter, and is the measurement used to determine how much glucose is in your bloodstream.



ADA Recommendations:	Pre-Meal	90 – 130 mg/dL,
	Post-Meal	< 180 mg/dL
AACE Recommendations:	Pre-Meal	<110 mg/dL,
	Post-Meal	< 140 mg/dL

ADA: American Diabetes Association

AACE: American Association of Clinical Endocrinologists

Balancing Glucose and Insulin

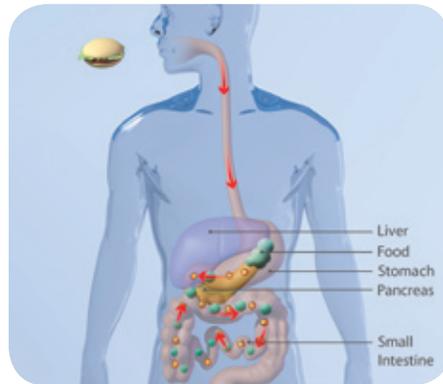


DID YOU KNOW?

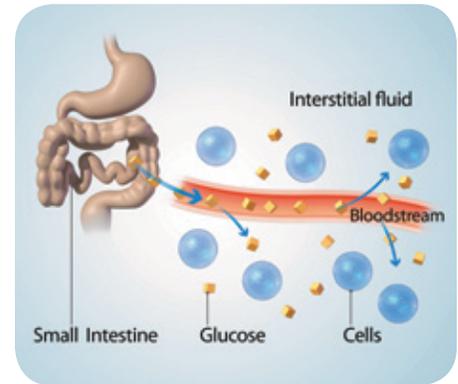
The bloodstream acts like a 24-hour transportation system that constantly picks up and transports glucose throughout your body. A supply of glucose must remain in the bloodstream and the interstitial fluid at all times.

Where Does Glucose Come From?

Glucose primarily comes from foods that contain carbohydrate (sugar and starches). When you eat, food is broken down into nutrients such as glucose. Nutrients are absorbed from your stomach and small intestine (digestive tract) into your bloodstream. The bloodstream transports glucose and other nutrients throughout your body, so you will be well nourished and have energy.



The body digests and converts food into nutrients including glucose.

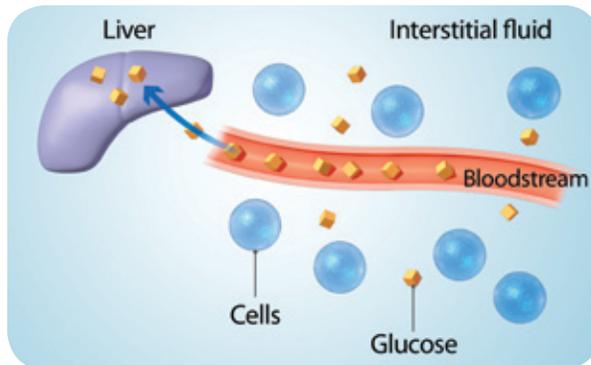


Glucose moves from the digestive tract into the bloodstream.

How Does Glucose Move Into Cells?

Within minutes after you begin to eat and while food is digesting, glucose slowly moves from the digestive tract into the bloodstream. It passes from the bloodstream into a fluid surrounding the cells (interstitial fluid). Once glucose moves into the interstitial fluid, it is available for cells to use for energy. However, your body cannot use glucose for energy until it moves inside the cells.

Glucose that is not used for energy immediately after eating is stored in the liver. This stored glucose becomes a reserve fuel supply that is released back into the bloodstream when it is needed. The body uses this fuel supply when extra energy is required (as in exercise) or when the body goes for a long period of time without eating (such as overnight).



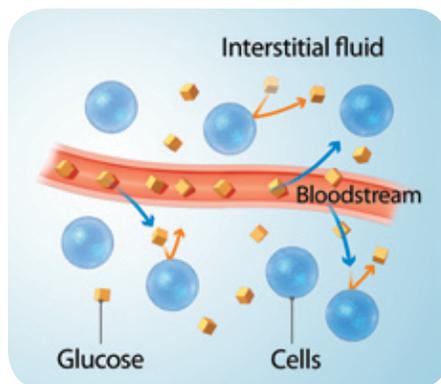
Just like a car stores extra gas in its tank, your body stores extra fuel in your liver.



DID YOU KNOW?

If you eat more carbohydrate than the body needs and more than the liver can store, the excess glucose is stored as fat.

Even though glucose freely moves from the digestive tract into the bloodstream and from the bloodstream into the fluid surrounding the cells, it cannot move into most cells without the help of insulin. Insulin is a hormone made by the pancreas. Insulin's primary responsibility is to move glucose from the blood and interstitial fluid into cells. When there is not enough insulin available, glucose cannot move into cells. Glucose builds up in the blood and interstitial fluid, causing glucose levels to become high.



Glucose cannot move into the cell without insulin.

Balancing Glucose and Insulin



KEY LEARNING POINTS

- Glucose (sugar) is your body's main source of energy.
- Your body gets most of the glucose it uses from foods that contain carbohydrate (starches and sugars).
- Glucose cannot provide energy for your body until it moves inside your cells.
- The body must have insulin available in order for glucose to move into most cells.
- Some of the glucose that your body does not immediately use for energy after eating is stored in the liver.

Review Questions

(Circle the best answer)

- 1. The body's main source of fuel or energy is:**
 - a) protein
 - b) fat
 - c) glucose
- 2. How does the body obtain most of the glucose it uses for energy?**
 - a) from foods containing carbohydrate
 - b) from fat
 - c) from water
- 3. Some of the glucose that is not immediately used after eating is stored in the:**
 - a) heart
 - b) liver
 - c) stomach
- 4. Glucose moves from the bloodstream into the interstitial fluid (fluid that surrounds the cells) where it is available for the cells to use for energy. However, glucose must move inside the cell before it can actually be used for _____ .**
 - a) water
 - b) heat
 - c) energy
- 5. Glucose cannot pass into the cell and provide energy for your body without the assistance of insulin.**
 - a) true
 - b) false

Balancing Glucose and Insulin



DID YOU KNOW?

If there is not enough insulin available your body is forced to use fat for energy. Even if you have high amounts of glucose in your blood, your body cannot use glucose if there is no insulin.

If the body is forced to use fat as its main source of energy, waste products called ketones are produced. Ketones are acids and are unhealthy when they begin to accumulate in the bloodstream. High glucose levels paired with high ketone levels can result in a serious condition called diabetic ketoacidosis (DKA). You will learn more about DKA in Chapter 2 of this workbook.

Section 2:

Insulin

All people, with or without diabetes, must have a constant supply of insulin in order for glucose to move into the cells. When insulin is not available, glucose stays in the blood and interstitial fluid. This causes blood glucose and interstitial glucose levels to become high and the cells are starved for energy.

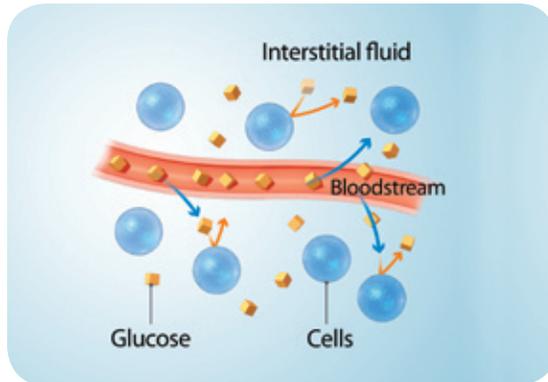
How does insulin help glucose move into the cell?

Insulin helps glucose move into the cells by attaching to a special place on the cell wall called the receptor (or binding) site. Once insulin is attached at the cell wall, a chemical reaction occurs that allows glucose to move into the cell. This is why insulin is said to be the “key” that unlocks the cell.

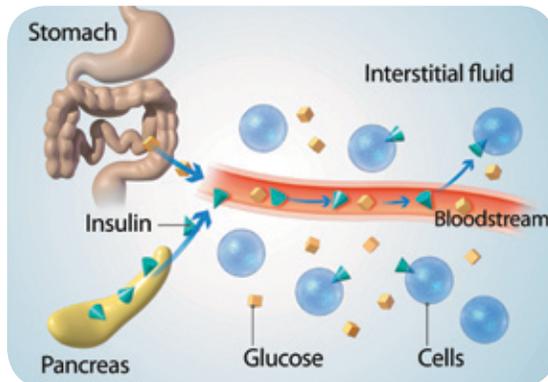
Before you developed diabetes, your pancreas produced insulin almost continuously. The amount of insulin it made depended on how much glucose was in your body. Your pancreas monitored the amount of glucose in your blood and made exactly the right amount of insulin needed to keep your blood glucose levels in balance. When there were small amounts of glucose, such as between meals or during sleep, your pancreas made small amounts of insulin (called **basal insulin**). When there were large amounts of glucose, such as after meals, your pancreas made larger amounts of insulin (called **bolus insulin**).



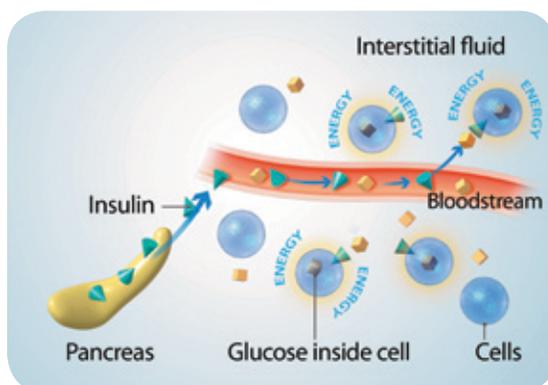
NOTE No Insulin = High Glucose Levels and Starved Cells



Without insulin, glucose cannot move into the cells.



The pancreas secretes insulin into the bloodstream. Insulin moves from the bloodstream into the interstitial fluid and attaches to the cell wall.

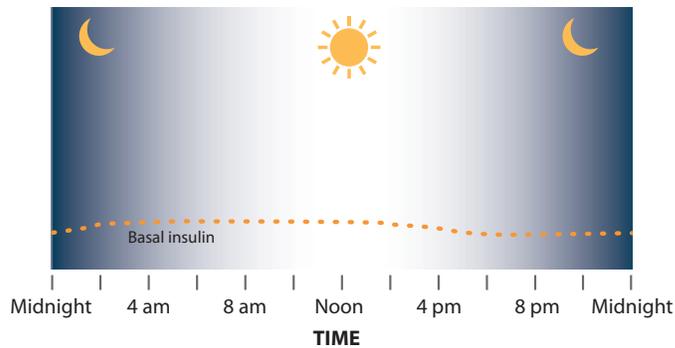


When insulin attaches to the cell wall, glucose can move into the cell.

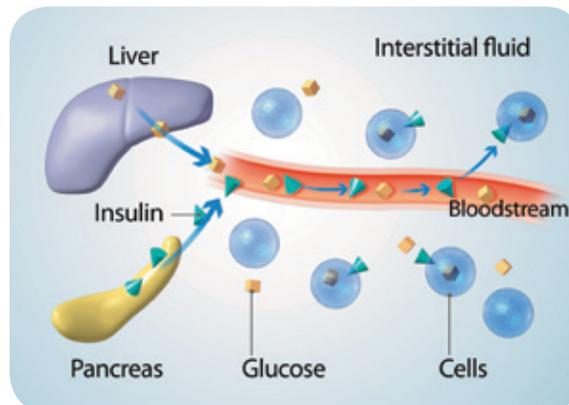
Balancing Glucose and Insulin

Basal Insulin

Basal insulin is often referred to as “background” insulin. Basal means base, or baseline amount. A healthy pancreas produces insulin every few minutes, 24 hours a day. Basal insulin is produced between meals and during sleep so glucose (that is released from the liver) can move into the cells and provide energy for your body. A healthy pancreas monitors glucose levels and increases or decreases the amount of basal insulin it makes based upon the amount of glucose in the blood.



The pancreas produces tiny amounts of basal insulin every few minutes, 24 hours a day.

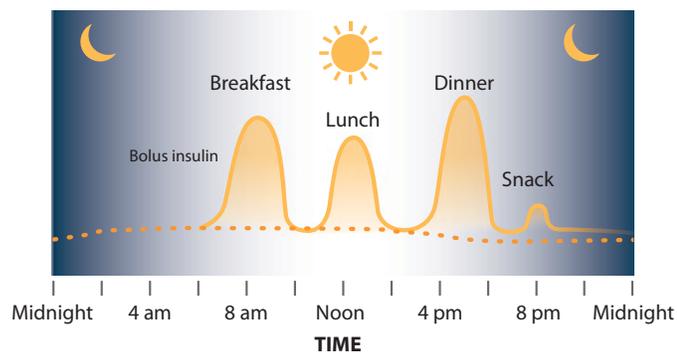


Basal insulin moves glucose into the cells between meals and during sleep. Basal insulin covers the glucose that the liver releases back into the bloodstream.

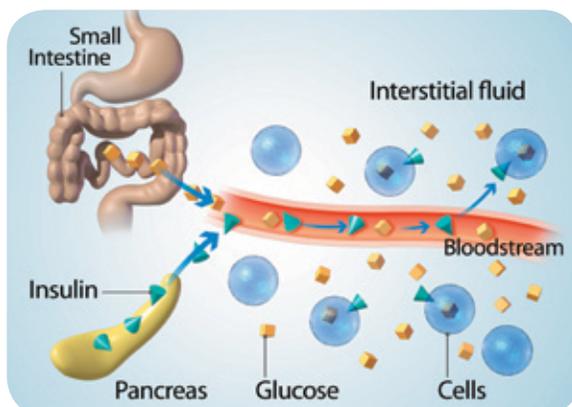
Bolus Insulin

The pancreas also produces larger amounts of insulin called bolus insulin. Bolus means a large amount. The body requires larger amounts of insulin to cover the increased amount of glucose that enters the bloodstream when a person eats. A healthy pancreas monitors the amount of glucose that enters the blood after eating, and makes the exact amount of insulin needed to match the glucose that enters the blood.

When diabetes develops, your pancreas cannot produce basal and bolus insulin properly. You must replace basal and bolus insulin by injection or with an insulin pump.



The pancreas also produces larger (bolus) amounts of insulin.



Bolus insulin covers the glucose that enters the bloodstream from the digestive tract after eating.

Balancing Glucose and Insulin



KEY LEARNING POINTS

- Insulin must be available 24 hours a day in order for glucose to move into the cells and provide energy for your body to function properly. Glucose and insulin are both needed for your body to have energy.
- If there is not enough insulin available for your body to use glucose, glucose stays in the blood and interstitial fluid. This causes blood glucose and interstitial glucose levels to become high and the cells starve for energy.
- **Basal insulin:** Insulin that is produced by the pancreas in tiny amounts 24 hours a day.
 - Basal insulin is needed to move glucose into the cells between meals and through the night.
 - Basal insulin is sometimes referred to as background insulin.
- **Bolus insulin:** Insulin that is produced by the pancreas in larger amounts.
 - Bolus insulin is produced when large amounts of glucose enter the bloodstream (such as after eating).

Review Questions

(Circle the best answer)

- 1. The body must have insulin in order for glucose to move into the cells.**
 - a) true
 - b) false
- 2. The pancreas produces tiny amounts of insulin 24 hours a day. This small amount of insulin keeps glucose levels stable between meals and during sleep. This tiny continuous production of insulin is called:**
 - a) basal insulin
 - b) bolus insulin
- 3. The pancreas produces larger amounts of insulin to cover the increase in glucose that occurs after eating. This larger amount of insulin is called:**
 - a) basal insulin
 - b) bolus insulin
- 4. When your body does not have enough insulin, glucose cannot move into the cells and must stay in the blood and interstitial fluid. This causes blood glucose levels to become high and the cells starve for energy.**
 - a) true
 - b) false

Balancing Glucose and Insulin

Section 3:

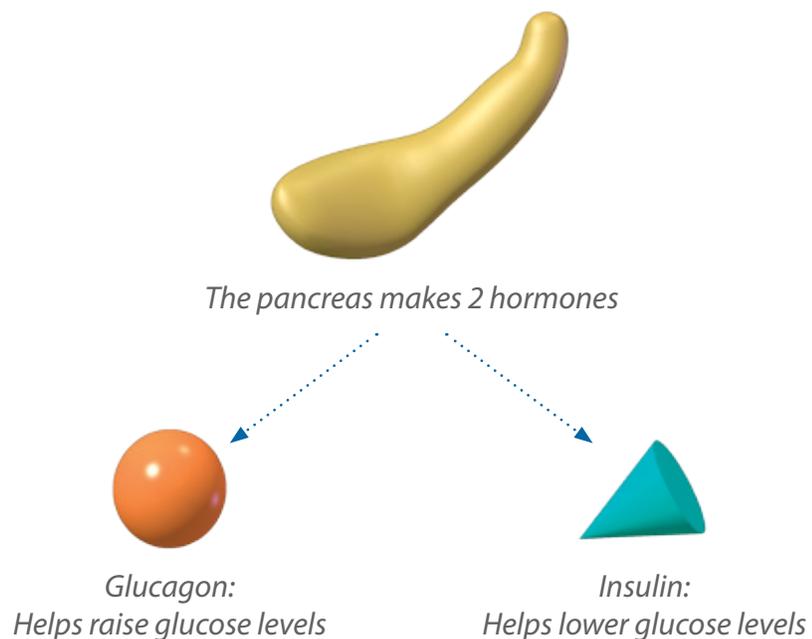
Glucose and Insulin — a Careful Balancing Act

Keeping glucose and insulin levels in balance is extremely important for good health. Before you developed diabetes, your body automatically kept the right amount of glucose and insulin in your blood. Your blood sugar rarely moved out of the average range (70 mg/dL to 120 mg/dL).

The Glucose and Insulin Balance

Prior to having diabetes, your pancreas and liver worked together using a check and balance system to keep your insulin and glucose levels in range. Your pancreas would tell your liver when too much or too little glucose was in the blood. Your liver would then store or release glucose as your body needed it.

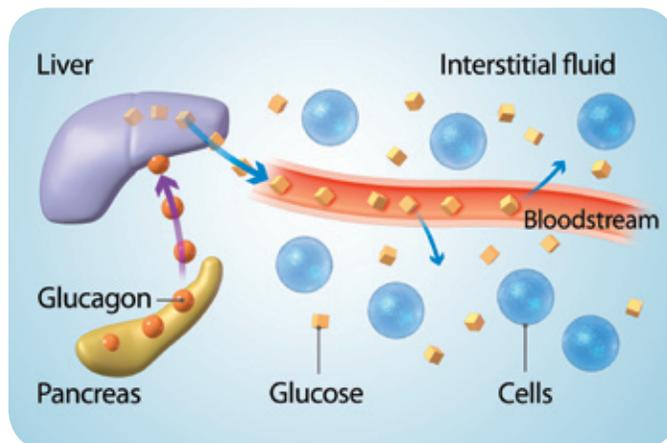
The pancreas communicates with the liver by making two hormones, **insulin** and **glucagon**. Insulin lowers glucose levels and glucagon raises them.



Glucagon's Role

When a healthy functioning pancreas senses that glucose levels are beginning to drop below the average range, it increases its production of glucagon (and decreases its production of insulin). Glucagon alerts the liver to release some of the glucose it has stored back into the bloodstream. As the liver releases stored glucose back into the bloodstream, blood glucose levels begin to rise. As blood glucose levels rise and return to the average range, the pancreas decreases its production of glucagon.

Glucagon helps to keep glucose levels in balance by signaling the liver to release stored glucose back into the bloodstream. The release of stored glucose prevents low blood sugars from occurring.



Glucagon alerts the liver to release stored glucose.

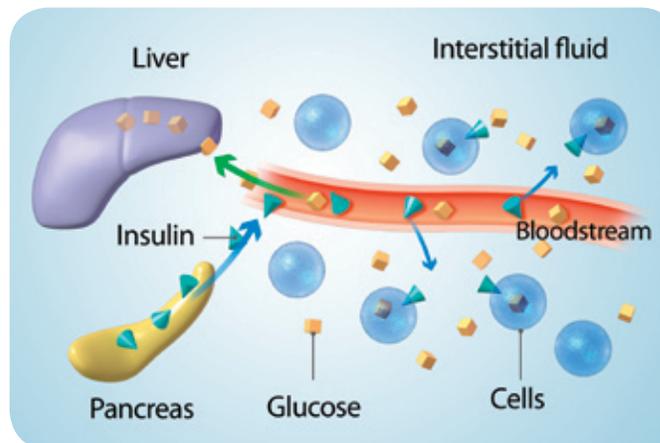
Balancing Glucose and Insulin

Insulin's Role

When the pancreas senses that glucose levels are starting to rise above the average range, it increases its production of insulin (and decreases its production of glucagon). Insulin lowers blood glucose levels in two ways:

- 1) It moves glucose out of the blood and interstitial fluid into the cells.
- 2) It notifies the liver to begin storing any extra glucose that is available.

Both of these help keep high blood sugars from occurring.



Insulin lowers glucose by moving glucose into the cells and alerting the liver to store any extra glucose that may be available.

The alternating release of glucagon and insulin by the pancreas, along with the alternating storage and release of glucose by the liver, is what allows the body to keep glucose levels in the average range and maintain the glucose and insulin balance.



IMPORTANT When you have diabetes your body cannot automatically keep blood glucose and insulin levels in balance because your pancreas no longer produces insulin.

You must take insulin either by injection or an insulin pump and balance the insulin you take with your food and activity levels.

It is important for anyone who takes insulin by injection or an insulin pump, to understand that the liver cannot release stored glucose back into the bloodstream if there is too much insulin in the bloodstream. Remember, insulin notifies the liver to store glucose, not release it.

Therefore, if you have a low blood sugar because you have taken more insulin than your body needs, your liver cannot release any stored glucose. You must eat or drink to increase your glucose levels.

You will learn about preventing and treating low glucose levels in the Managing Pump Therapy chapter.

Balancing Glucose and Insulin



KEY LEARNING POINTS

- When a person does not have diabetes, a careful balance is maintained between the amount of glucose and insulin that is in the blood.
- A healthy functioning pancreas makes two hormones, insulin and glucagon. The pancreas increases and decreases its production of insulin and glucagon based upon the amount of glucose in the blood.
 - When there are large amounts of glucose in the blood, the pancreas increases its production of insulin (and decreases its production of glucagon). Insulin lowers glucose levels by:
 - 1) Moving glucose out of the blood and interstitial fluid into the cells, and by
 - 2) Signaling the liver to store any extra glucose that may be available.
 - When there are small amounts of glucose in the bloodstream, the pancreas increases its production of glucagon (and decreases its production of insulin).
 - Glucagon notifies the liver to release stored glucose back into the bloodstream, thus raising glucose levels.
- The liver stores glucose when the pancreas produces insulin, and releases stored glucose back into the bloodstream when the pancreas produces glucagon.
- Therefore, it is important for you to know that:
 - If you have a low blood sugar because you have taken too much insulin, (either by injection or a pump), your liver cannot release stored glucose back into your blood stream.
 - You must eat or drink to raise your blood glucose levels. (Remember, insulin notifies the liver to store glucose – not release it.)

Review Questions

(Circle the best answer)

- 1. The pancreas makes two hormones that help control blood glucose levels. One hormone is insulin and the other is:**
 - a) estrogen
 - b) glucagon
 - c) growth
- 2. Insulin helps to _____ glucose levels.**
 - a) raise
 - b) lower
- 3. Glucagon helps to _____ glucose levels.**
 - a) raise
 - b) lower
- 4. Glucagon signals the liver to release stored glucose.**
 - a) true
 - b) false

Balancing Glucose and Insulin

Section 4:

Insulin Pumps Deliver Insulin Similar to a Pancreas

When a person has diabetes, it is best to take insulin as close to the way the pancreas delivers it as possible. An insulin pump comes closer to delivering insulin the way a pancreas does than any other delivery method.

Insulin pump therapy is considered the “gold standard” in diabetes management because it provides the best glucose control. There are two basic reasons pump therapy provides better control:

- 1) The pump only uses rapid-acting insulin (U100).
- 2) The pump delivers rapid-acting insulin similar to the way the human pancreas delivers insulin. It delivers both basal and bolus insulin in very precise amounts.



An insulin pump delivers basal and bolus insulin similar to a pancreas.

Rapid-acting Insulin

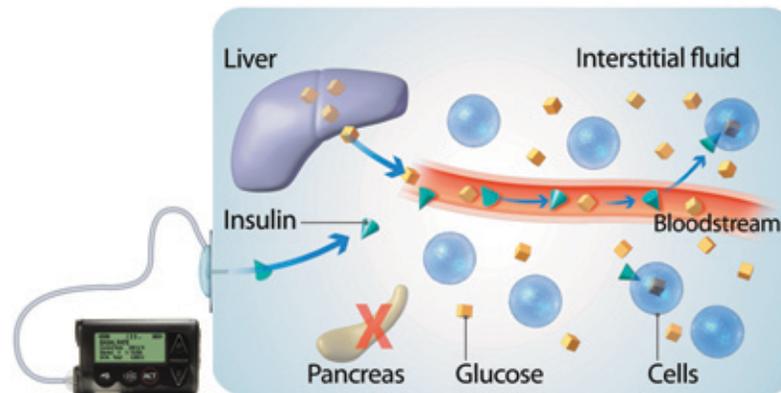
Rapid-acting insulin is the fastest acting insulin available. It acts much like insulin made by the pancreas. Clinical studies show that rapid-acting insulin lowers glucose levels in a very consistent manner. It is reliable in how it is absorbed and used by your body. This means that when you deliver a dose of rapid-acting insulin, you can have confidence that it will perform similarly to doses you have taken before. When rapid-acting insulin is given, it:

- Enters the bloodstream within 10 to 15 minutes after it is taken.
- Has its strongest glucose lowering effect 1 to 1½ hours after it is given.
- Stops lowering glucose levels within 5 to 6 hours after it is delivered.

Balancing Glucose and Insulin

Basal Insulin

The pump delivers small amounts of basal insulin 24 hours a day. Basal insulin covers your insulin needs between meals and through the night. The amount of basal insulin the pump delivers can be adjusted to match your body's varying insulin requirements throughout the day. For example, if you need less basal insulin during the night than during the day or more insulin during the early morning hours than the afternoon, your pump can be programmed to deliver basal insulin at different rates and times to match your needs. Once basal rates are set, the pump will continue to deliver the same basal rate profile every day until you program it to deliver different basal rates.



The pump delivers basal insulin 24 hours a day, and can be programmed to match your body's insulin needs.

Bolus Insulin

The pump can also deliver boluses (large single doses) of insulin. A bolus is given when you eat food that contains carbohydrate, or when you have a high blood glucose (BG) level. You control the amount and time each bolus is given. The amount of each bolus is determined by your current BG reading, the number of grams of carbohydrate you plan to eat, and other settings (such as your target glucose range) that are programmed into your pump. (You will learn more about programming your personal pump settings later.)

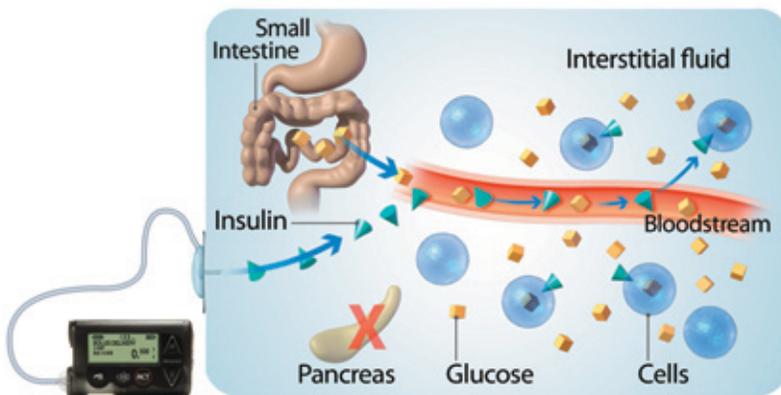
Once your settings are programmed, all you will need to do is enter your BG reading and the amount of food you are planning to eat. Your pump will calculate and recommend the amount of bolus insulin to deliver.

If you agree with the suggested bolus amount, simply confirm the bolus recommendation by pressing the activate button on the pump. Once the bolus is confirmed, the pump delivers the bolus of insulin.



DID YOU KNOW?

The Bolus Wizard® feature found in your pump will help you calculate exactly how much insulin you need for food and/or to correct high blood sugars.



You program the pump to deliver a bolus of insulin when you eat or need to correct a high BG.

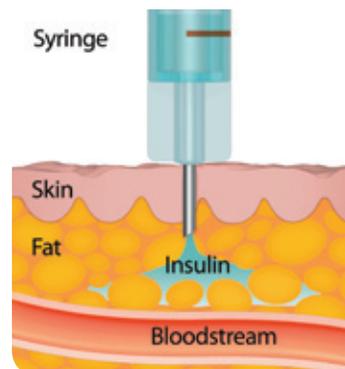
Balancing Glucose and Insulin

Injection Therapy

The types of insulin used with injection therapy and the type of insulin used with pump therapy are different.

Injection therapy uses intermediate or long-acting insulin to cover basal insulin requirements. When intermediate or long-acting insulin is injected, it deposits or “pools” under the skin where it remains until it is absorbed into the bloodstream. Depending on the type of insulin used, it will take somewhere between 12 to 24 hours to completely absorb. This means the body has some background insulin available for that period of time. However, exactly how much and when the background insulin is available is not clear and can vary from one day to the next.

The variability in absorption of intermediate and long-acting insulin makes it difficult to keep glucose levels within a reasonable range and contributes to many of the unexplained high and low blood sugars that occur when a person takes insulin by injection.



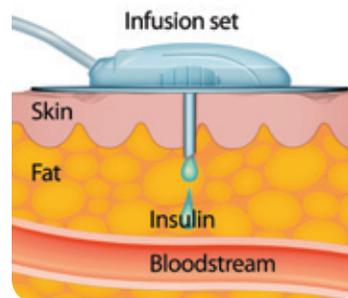
Intermediate and long-acting insulin “pool” under the skin.

Intermediate and long-acting insulins are injected in large amounts once or twice a day. After intermediate and long-acting insulin is injected you:

- Cannot control when it will be absorbed into your body.
- Cannot increase or decrease it to match your varying basal needs.
- Cannot adjust it for last minute changes in your daily routine.

Insulin Pump Therapy

Pump therapy, on the other hand, uses rapid-acting insulin which provides improved glucose control not possible with injections. This improved control occurs because the pump delivers tiny amounts of rapid-acting insulin each hour. Rapid-acting insulin is reliable and consistent in the way it is absorbed and used by your body. Basal insulin is programmed to match your body's hourly insulin needs, and can easily be adjusted.



The pump delivers tiny amounts of insulin each hour.



DID YOU KNOW?

Your insulin pump also has a feature called a temporary basal rate that can be set to accommodate temporary changes in basal insulin needs. For example, the basal rate can be decreased for exercise or increased during illness.

Balancing Glucose and Insulin



IMPORTANT Please Read and Remember:

It is recommended that you never stop or suspend your basal insulin delivery for more than an hour without checking your BG levels because:

- Insulin pumps deliver tiny amounts of rapid-acting insulin each hour that cover your basal insulin needs.
- Delivering rapid-acting insulin in this manner provides improved glucose control not possible with injection therapy.
- However, the tiny amount of basal insulin is quickly used by your body. This means you have very little background insulin available. If basal insulin is stopped or if your infusion set pulls loose without your realizing it, your glucose levels will rise quickly.

NOTE: This is one of the reasons why you should:

- 1) Check glucose levels a minimum of 4 times a day.
- 2) Never ignore a high glucose reading.
- 3) Check for ketones if you have an unexplained high glucose reading greater than 250 mg/dL.

Following these guidelines will help you maintain reasonable glucose levels and prevent unnecessary problems from developing.



KEY LEARNING POINTS

- It is best to take insulin as close to the way the pancreas delivers it as possible.
- Insulin pumps deliver insulin closer to the way the pancreas produces it.
- Insulin pumps use only rapid-acting insulin (U100).
- Rapid-acting insulin is reliable in how it is absorbed and used by your body. You can count on it to:
 - 1) Enter into the bloodstream within 10 to 15 minutes after it is given.
 - 2) Have its strongest glucose lowering effect 1 to 1½ hours after it is delivered.
 - 3) Stop lowering glucose levels approximately 5 to 6 hours after it is given.
- Insulin pumps deliver basal and bolus insulin much like a healthy pancreas.
- The pump delivers basal insulin in tiny amounts each hour.
- Basal insulin can be programmed to deliver at different rates.
- A bolus of insulin is given for two reasons:
 - 1) To cover foods that contain carbohydrate.
 - 2) To correct high glucose levels.
- Injection therapy uses intermediate or long-acting insulin for basal insulin needs.
- The irregular absorption and action of intermediate and long-acting insulin contributes to many unexplained high and low BGs.
- When using pump therapy, it is important to remember: The tiny amounts of basal insulin delivered each hour are used quickly by your body. You should never interrupt insulin delivery for more than an hour without checking your BG. BG levels will rise quickly if insulin delivery is interrupted or if the infusion set pulls out.

Balancing Glucose and Insulin

Review Questions

(Circle the best answer)

- 1. Injection therapy uses intermediate or long-acting insulin to cover the body's:**
 - a) basal insulin needs
 - b) bolus insulin needs

- 2. Intermediate or long-acting insulin is unpredictable in its action and absorption time which contributes to:**
 - a) better glucose control
 - b) erratic glucose control and many unexplained lows and highs

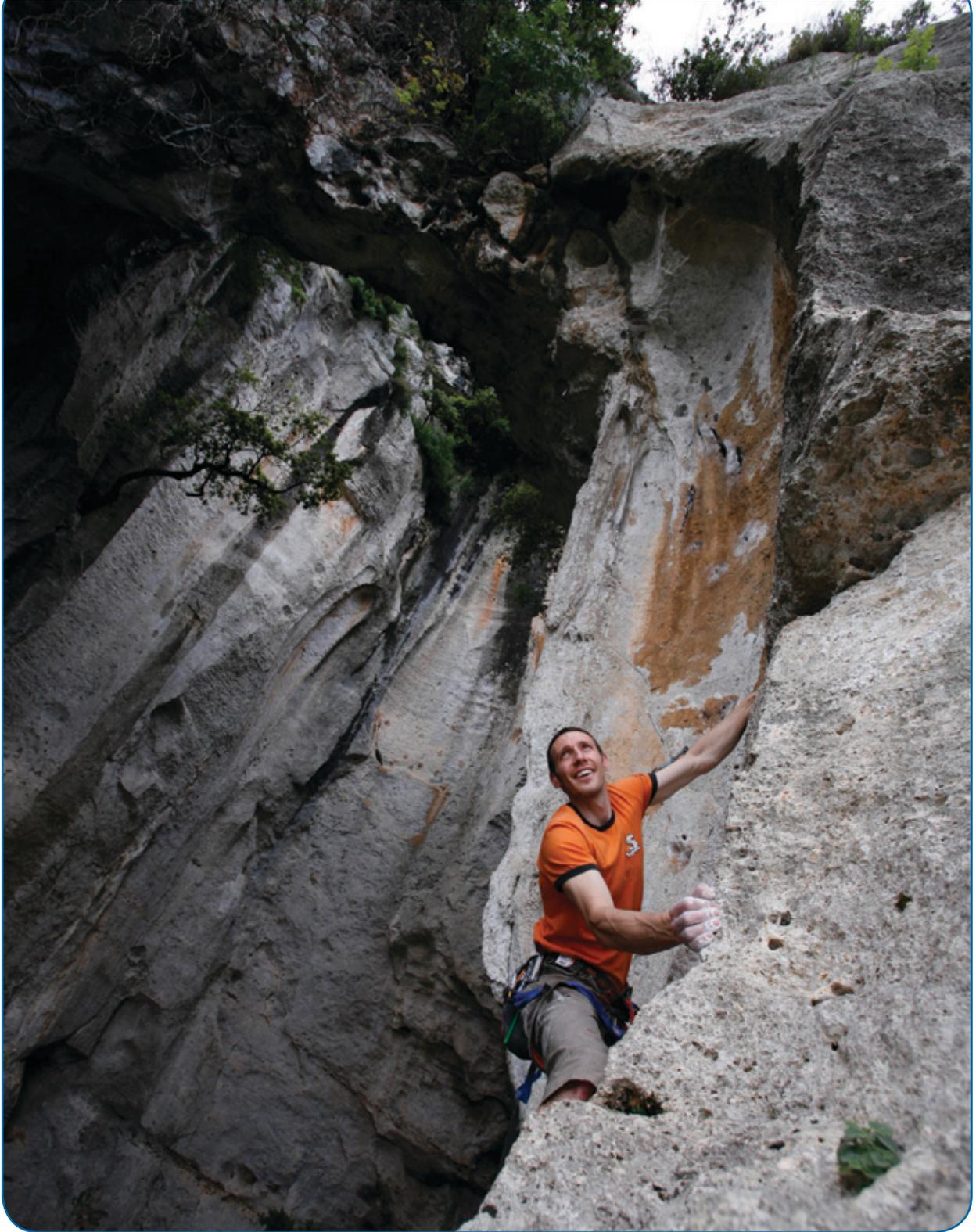
- 3. What type of insulin is used for insulin pump therapy?**
 - a) long-acting insulin
 - b) rapid-acting (U100) insulin
 - c) basal insulin

- 4. Rapid-acting insulin enters the blood and begins to work within 10 to 15 minutes after given.**
 - a) true
 - b) false

- 5. Rapid-acting insulin's strongest effect is 1 to 1½ hours after it is given.**
 - a) true
 - b) false

6. **Rapid-acting insulin's ability to lower glucose levels is gone after how many hours?**
- a) 9 to 10 hours
 - b) 5 to 6 hours
7. **The pump can be programmed to deliver insulin similar to a healthy pancreas. Basal insulin can be programmed to deliver at different rates to meet your varying insulin needs.**
- a) true
 - b) false
8. **An insulin pump can be programmed to deliver a bolus:**
- a) to cover food or a high BG
 - b) to cover exercise or treat low blood sugar
 - c) to cover exercise or treat high blood sugar
9. **When using an insulin pump, you should not disconnect from your pump or suspend your insulin delivery for more than an hour without checking your BG.**
- a) true
 - b) false

Managing Pump Therapy



Chapter 2:

Managing Pump Therapy

When you use an insulin pump, it is important for you to recognize and handle small issues as they arise. Handling small issues when they occur, will help prevent unnecessary problems from developing.

This chapter introduces some basic safety practices, such as:

- Checking your blood glucose (BG) levels a minimum of 4 times a day.
- Always keeping food or drink with you to treat lows.
- Never ignoring an unexplained high BG reading.
- Checking for ketones if your BG is higher than 250 mg/dL.
- Rechecking your BG after treating a high to make sure it is coming down.

Including these practices in your daily diabetes management will help you keep your glucose levels within your target range and ensure your safety and success with insulin pump therapy.



NOTE Because insulin pump therapy only uses rapid-acting (U100) insulin, the guidelines for treating lows and highs may be different than the guidelines you use with intermediate or long-acting insulin.

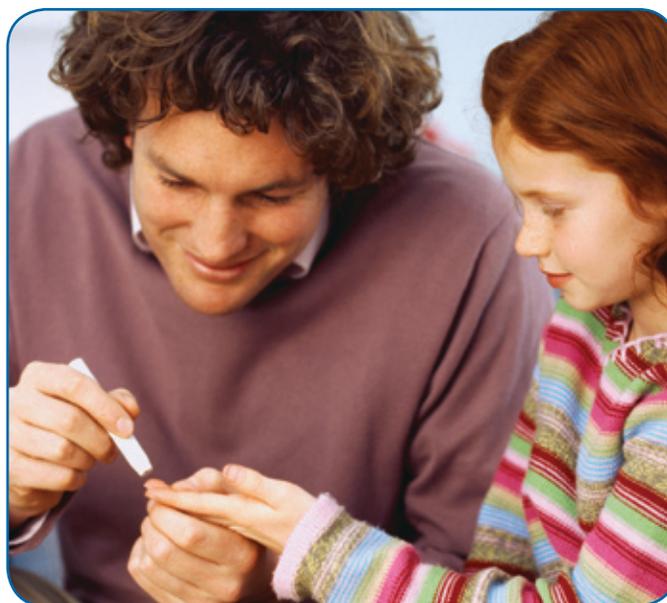
Managing Pump Therapy

Section 1:

Blood Glucose Monitoring

Checking glucose readings regularly and responding to those readings appropriately are the two most important things you can do to ensure your success and safety with insulin pump therapy.

For the first week or two after you start on your pump, you will need to check your BG frequently — 8 to 10 times a day. These BG readings will provide the information needed to adjust the settings on your pump so they can be “fine-tuned” specifically for you. Settings that may need to be adjusted include your basal rate, insulin to carbohydrate ratio, sensitivity factor, target ranges, and active insulin time.



Below is a sample of the BG monitoring schedule you will most likely use when you start on your pump. Your healthcare provider will tell you how often and at what times you should check your BG once you start on your pump.

“Pump Start” BG Monitoring Schedule

Check BG:	Why?
Before each meal (breakfast, lunch, and dinner)	Comparing your pre-meal BG level to your post-meal BG level allows you to determine if your insulin to carbohydrate ratio is set correctly.
2 hours after each meal (breakfast, lunch, and dinner)	
Bedtime	Comparing your BG level during your sleep schedule allows you to determine if your overnight basal rates are set correctly.
Mid-sleep (or every 3 to 4 hours during sleep)	
When you awake	

Managing Pump Therapy

Although your glucose readings may not always be 100% within your target range, when you learn to use your pump correctly and the settings on your pump are properly adjusted, your BG readings should remain within your glucose target range most of the time.

Once your pump settings are correct, and your glucose levels are stable, you should establish a routine of checking your BG 4 to 6 times each day.

Routine Daily BG Monitoring Schedule

Check BG:	Why?
When you awake	Determines if fasting BGs are high or low
Before each meal (breakfast, lunch, and dinner)	Determines if you need to take additional insulin for a BG that is above your target or less insulin if your BG is below your target range
Bedtime	Provides information to help you prevent low or high BGs during sleep
Occasionally mid-sleep	Allows you to see if your BG levels are stable through the night and if your nighttime basal rates are set correctly



IMPORTANT If you begin to notice that your BG levels are frequently above or below your target range, this typically indicates that your insulin needs have changed and the settings on your pump may need to be adjusted.

To accurately determine which settings need to be adjusted, return to checking your BG as outlined on the “Pump Start” monitoring schedule (8 to 10 times a day). BG readings, along with the carbohydrates you eat and the amount of insulin you take provide the information that is required to determine which settings should be adjusted. Instructions on how to adjust your pump settings will be covered in your continuing education classes.

Date	Overnight	Pre-Brkfst	Post-Brkfst	Pre-Lunch	Post-Lunch	Pre-Dinner	Post-Dinner	Bedtime
Time		7:00		12:30		6:15		10:45
Blood Glucose		88		92		88		124
Carb Grams		60		54		75		
Food Dose		5.0		4.5		6.2		---
Correction Dose		-0.2		-0.2		-0.4		
Total Bolus		4.8		4.3		5.8		

Date	Overnight	Pre-Brkfst	Post-Brkfst	Pre-Lunch	Post-Lunch	Pre-Dinner	Post-Dinner	Bedtime
Time	3:10	7:20		12:22		6:30		11:00
Blood Glucose	102	82		83		96		118
Carb Grams		66		60		88		
Food Dose		5.5		5.0		7.1		
Correction Dose		-0.3		-0.3		0		
Total Bolus		5.2		4.7		7.1		

Monitoring and recording your BG, the grams of carb you eat, and the amount of insulin you take provides the information needed for adjusting pump settings.

Managing Pump Therapy



KEY LEARNING POINTS

- Checking your glucose readings and responding appropriately to your glucose readings are the two most important things you can do to ensure your safety and success on insulin pump therapy.
- When you first start on your pump, you will need to check your BG 8 to 10 times a day.
 - When you awake in the morning
 - Before each meal
 - 2 hours after each meal
 - Bedtime
 - Mid-sleep (or every 3 to 4 hours during sleep)
- Checking your BG 8 to 10 times a day provides the information needed to adjust and fine-tune your pump settings (basal rate, insulin to carbohydrate ratio, sensitivity factor, target range, active insulin time).
- Although your glucose readings may not always be 100% within your target range, when you learn to use your pump correctly and the settings on your pump are properly adjusted, your BG readings should remain within your glucose target range most of the time.
- When your pump settings are correct, and your glucose levels are stable, you should establish a routine that includes checking your BG 4 to 6 times each day or according to your healthcare provider's instruction.
 - When you awake
 - Before each meal
 - Bedtime
 - Occasionally mid-sleep

- If you begin to notice that your glucose readings are frequently above or below your target range, this usually indicates your insulin needs have changed and your pump setting(s) need to be adjusted.
 - To accurately determine which setting(s) needs to be adjusted, return to monitoring your BG as outlined on the “Pump Start” BG monitoring schedule (8 to 10 times each day). The additional BG readings will help provide the information necessary to determine which setting(s) needs to be adjusted.

Managing Pump Therapy

Review Questions

(Circle the best answer)

- 1. Checking your BG regularly and responding appropriately to those BG readings are the two most important things you can do to ensure your safety and success on insulin pump therapy.**
 - a) true
 - b) false
- 2. When you first start on your pump you will need to check your BG _____ times a day to adjust and “fine-tune” the settings.**
 - a) 4 to 6
 - b) 6 to 8
 - c) 8 to 10
 - d) 10 to 12
- 3. Once the settings on your pump are correct, you should continue to routinely check your BG a minimum of _____ times a day.**
 - a) 4 to 6
 - b) 6 to 8
 - c) 8 to 10
 - d) 10 to 12
- 4. Checking your BG before meals allows you to determine if you need to take additional insulin for a BG level that is above your pre-meal target range or less insulin if your BG is below your target range.**
 - a) true
 - b) false

5. **Checking your BG before going to sleep can help provide the information you need to prevent highs or lows while sleeping.**
 - a) true
 - b) false

6. **You should check your BG level mid-sleep to determine if your glucose levels are staying within your target range while you rest.**
 - a) true
 - b) false

Managing Pump Therapy

Section 2:

Treating Low Blood Glucose



DID YOU KNOW?

One of the main goals of insulin pump therapy is to improve glucose control without increasing the frequency or severity of low blood sugars.

While low blood glucose levels cannot be completely avoided on pump therapy, most people find that they occur less often and are less severe than with insulin injections. In fact, clinical studies show that lows can be reduced by as much as 50% when using pump therapy.

What Causes Low Blood Glucose?

TOO MUCH INSULIN!

Low BGs occur when there is too much insulin in your body. The excess insulin moves most of the glucose from your bloodstream and interstitial fluid into your cells. Once your cells use the glucose, there is not enough left to provide the energy your body needs to function well or for your brain to think clearly.

Common causes of low BGs on an insulin pump include:

- Having the basal rate set too high for your background insulin needs.
- Taking more insulin than needed for food or to correct a high BG.
- Exercising without setting a lower temporary basal rate.
- Drinking alcoholic beverages without eating carbohydrate containing foods.

Whether you take insulin by injection or with an insulin pump, it is important to always keep food or drink with you to treat a low BG. Establishing a routine to follow when you have a low BG will help you to be prepared and ensure that you do not over treat low blood sugars.



IMPORTANT You should always check your BG at bedtime. Make sure your BG is above 100 mg/dL before going to sleep.

To ensure your safety and that of others on the road, you should always check your BG and make sure it is above 100 mg/dL before driving.



DID YOU KNOW?

High fat foods, like chocolate, should not be used to treat lows.

High fat foods take longer to digest and longer for the glucose to move into the bloodstream.

When a person takes insulin, hypoglycemia (low BGs) can be mild or severe. Treatment of a low blood sugar depends on whether the low is mild or severe.

Managing Pump Therapy



DID YOU KNOW?

Over-treating lows is a common mistake that is made by many people. Often, a person wants to continue eating or drinking until they feel better. Keep in mind, it takes 10 to 15 minutes for carbohydrates to move from the digestive tract into the bloodstream and raise glucose levels. If you are not careful you will eat more than 15 grams in 15 minutes!

Over-treating a low BG results in having a very high BG later. This low-high “yo-yo” effect is very hard on your body.

Mild Hypoglycemia

Mild hypoglycemia is a low BG that is recognized and managed by you. With mild hypoglycemia, you realize your BG is low, and eat or drink to correct it.

Protocol for Treating a Low BG

15-15 rule

If your BG drops below 70 mg/dL:

1. Eat 15 grams of fast-acting carbohydrate,
 2. Recheck your BG in 15 minutes, and
 3. If your BG is still below 70 mg/dL, repeat steps 1 and 2 every 15 minutes until your BG returns to your target range.
-

If BG is less than 50 mg/dL, start treatment with 20 to 25 grams of carb.

Recommended Items for Treating Lows

Items that contain 15 grams of fast-acting carbohydrate

- 3 to 4 glucose tablets
 - 5 jelly beans or gum drops
 - 1/2 glass (4 oz) of juice
 - 1 tablespoon of sugar
 - 4 ounces of soda (not diet)
 - 8 ounces of milk (low or non-fat)
 - 1 tablespoon of honey
-

A low BG should be treated as soon as it is noticed. Treating mild lows promptly, helps prevent more serious lows from occurring.

Severe Hypoglycemia

Severe hypoglycemia is a low BG that you do not recognize. Another person realizes that your BG is low and assists you in treating the low. Severe hypoglycemia may involve mental confusion or unconsciousness.

Treating Severe Lows With a Glucagon Emergency Kit

Severe lows rarely occur when using insulin pump therapy. However, it is recommended that everyone who takes insulin (whether by injection or an insulin pump) keep a glucagon emergency kit on hand. Glucagon can be given by injection to help raise blood glucose levels if you are not able to eat, drink or if you are unconscious. Glucagon raises glucose levels by signaling the liver to release stored glucose.



DID YOU KNOW?

The number one goal for treating low blood sugar is to prevent severe hypoglycemia.



NOTE Ask your healthcare provider for a prescription for a glucagon emergency kit. Make sure you purchase a new kit every year when it expires. A family member, friend or colleague should be instructed on how to properly give glucagon.

Managing Pump Therapy



KEY LEARNING POINTS

- Low BG levels occur when there is more insulin in the blood than needed.
- Mild hypoglycemia: A low BG that is recognized and managed by you. You eat or drink to correct the low.
- Use the 15/15 rule to treat a low BG. If your BG drops below 70 mg/dL you should:
 - Eat 15 grams of fast-acting carbohydrate,
 - Recheck your BG in 15 minutes, and
 - If your BG is still below 70 mg/dL, repeat the above two steps every 15 minutes until your BG is back within your target range.
- Severe hypoglycemia: A low BG that requires the assistance of another person to treat the low glucose. You may experience mental confusion or unconsciousness.
- If a severe low occurs, glucagon can be given by injection to help raise glucose levels.
- Everyone who takes insulin, whether by injection or insulin pump, should keep a glucagon emergency kit on hand in case a severe low occurs.
- A family member, friend, or colleague should be instructed on how to properly administer glucagon.

Review Questions

(Circle the best answer)

- 1. How should most mild low BGs be treated?**
 - a) use the 15-15 rule
 - b) eat as much as you can until you feel better
 - c) take more insulin
- 2. What is the 15/15 rule?**
 - a) eat 15 grams of fast-acting carbohydrate
 - b) re-check BG in 15 minutes
 - c) if BG is still below 70 mg/dL, repeat the process every 15 minutes until your BG returns to normal
 - d) all of the above
- 3. Which of the following items is recommended for treating a low BG?**
 - a) 3 to 4 glucose tablets
 - b) 5 jelly beans or gum drops
 - c) 1/2 glass (4 oz) of juice
 - d) a tablespoon of table sugar
 - e) all of the above
- 4. Everyone who takes insulin (by injection or an insulin pump) should keep a glucagon emergency kit on hand in case a severe low occurs.**
 - a) true
 - b) false
- 5. Glucagon can be given by injection to help raise glucose levels if a severe low occurs.**
 - a) true
 - b) false

Managing Pump Therapy

Section 3:

Treating High Blood Glucose Levels

Hyperglycemia (also known as high blood sugar or high blood glucose) means there is too much glucose in the blood. High blood sugars occur when there is not enough insulin available to cover the amount of glucose that is in your body. A major goal of managing diabetes is to avoid high BGs and to properly treat a high as soon as it is noticed because:

- Exposure to high glucose levels over time can cause diabetes related complications (such as eye, kidney, and nerve damage).
- Under certain circumstances, high BGs that occur due to a lack of insulin can develop into a serious complication known as diabetic ketoacidosis (DKA).



NOTE Keeping glucose levels within your target range reduces your risk of developing complications.

Causes of Hyperglycemia

Glucose levels can rise too high for many reasons.

Food	Food can cause BG levels to rise too high if you do not take enough insulin to cover your food (especially if carbohydrate grams are not counted correctly, or if a food bolus is missed).
Illness or infection	Illness or infection (such as cold, flu, or stomach virus) can cause BG levels to run higher than usual. Using a temporary basal rate to cover increased basal insulin needs can help you keep your BG levels in better control during an illness.
Stress	Stress (emotional or physical) can cause your BG level to run high.
Medications	Medications (prescription and over-the-counter) can affect your BG. Consult with your healthcare provider to determine if your medication could be affecting your BG control.
Weak insulin	Weak insulin can cause high BGs. Insulin can lose its strength if it is exposed to extreme heat or cold, if it has expired or if it has been used too long (not changing insulin reservoir).
Not receiving insulin	Not receiving insulin because an infusion set has become dislodged, kinked or is leaking. Although this rarely occurs, it can happen. Always check to see if this could be the cause of an unexplained high BG level, especially if your BG level is not decreasing in response to a correction bolus.

Managing Pump Therapy

Treating High BGs Lower than 250 mg/dL

Keep in mind that most high BGs occur either because you have underestimated your food intake, you feel stressed, you are ill or your activity level is lower than usual. When using pump therapy, these highs can usually be corrected simply by giving a correction bolus.

Below are some guidelines you should follow when correcting BG readings that are high but less than 250mg/dl.

Protocol for treating a high BG lower than 250 mg/dL

1. Enter the BG reading into your pump.
 2. Allow the Bolus Wizard® feature to calculate the amount of correction insulin you need.
 3. Press the activate button and allow the pump to deliver the correction bolus.
 4. Recheck your BG in an hour to make sure your BG is coming down.
-



NOTE If the Bolus Wizard calculator recommends that you give a reduced amount of correction insulin or no correction insulin it is because you have active insulin remaining from a previous bolus. It is usually best to follow the Bolus Wizard calculator recommendation to avoid over correcting a high BG.

Treating BGs Higher than 250 mg/dL

One big key to success with pump therapy is to know that an unexplained high BG that is above 250 mg/dL, should never be ignored and could indicate a potential problem with your infusion set. Remember, insulin pumps only deliver small amounts of rapid acting insulin each hour. If your infusion set comes loose without your realizing it, your BGs could rise very quickly.

It is a good idea to always investigate unexplained high BGs and identify the cause of the high glucose level. Make sure you estimated your carbohydrate intake correctly, check to see if you gave your last bolus, check your infusion site, make sure the infusion set is connected and properly inserted, and check to see if you have ketones in your blood or urine. Always follow-up an unexplained high by rechecking your BG an hour or two later to make sure your glucose levels are not going higher and that they are beginning to come down.

On the next page, there are some important guidelines for you to follow when your glucose levels are above 250mg/dL.



NOTE The most common cause of unexplained hyperglycemia that does not respond to a correction bolus is a dislodged or kinked infusion set or a weak vial of insulin.

Managing Pump Therapy



DID YOU KNOW?

Positive ketones indicate that you do not have enough insulin in your body, and that you are using fat for energy.

Protocol for treating a high BG higher than 250 mg/dL

CHECK for KETONES

If KETONES are NEGATIVE

1. Take a correction bolus of insulin (you can use your pump).
 2. Re-check your BG in one hour. If your BG has started to decrease, continue to monitor your BG until it is normal.
 3. If your BG has not started to decrease 1 hour after the first correction dose, take a correction dose of insulin using a syringe. Change your infusion set, reservoir, and insulin. Continue to check your BG until normal.
-

If KETONES are POSITIVE

1. Take a correction dose of insulin using a syringe.
 2. Change your infusion site, infusion set, reservoir, and insulin.
 3. Follow the “Not Responding to a Correction Bolus? Try These...” guidelines (found in the Appendix) to see if there is a problem with your pump or infusion set.
 4. Check your BG every 1 to 2 hours and continue to take insulin (as needed) using a syringe until glucose levels are normal.
 5. Drink plenty of water or non-carbohydrate fluids.
 6. If your BG continues to rise or if you have moderate to high ketones, nausea, vomiting, or difficulty breathing, notify your healthcare provider or go to the nearest emergency room.
-

Following this protocol will help you prevent complications and DKA.

How to Check for Ketones

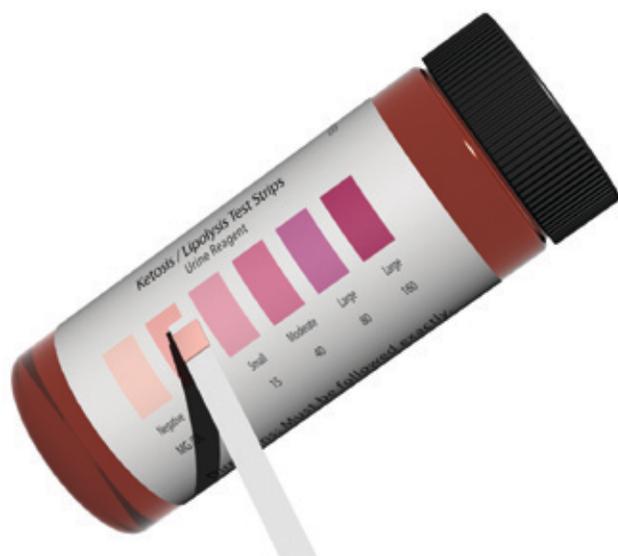
Checking for urine ketones is easy and inexpensive. All you need are ketone strips (purchased from pharmacy) and a sample of your urine.

Dip the end of the ketone strip into the urine sample and read the results according to the instructions found on the ketone strip bottle.

Ketones can also be tested with a drop of blood. Ask your healthcare provider which method is best for you.



IMPORTANT Notify your healthcare provider if ketones are moderate to high, you have nausea or vomiting, or you have difficulty breathing.



Checking for ketones is an important step in preventing the development of DKA.



NOTE Ketones are not usually present unless you have had no insulin or inadequate amounts of insulin over a period of time, or you are ill.

Managing Pump Therapy



KEY LEARNING POINTS

- High BGs occur when there is too much glucose and not enough insulin in the body.
- Most high BGs occur when some insulin is in the body but not enough to keep glucose levels within your target range. These highs can usually be lowered by giving a correction bolus of insulin.
- If your BG is high, but lower than 250 mg/dL, follow the guidelines below:
 - 1) Enter the BG reading into your pump,
 - 2) Allow the Bolus Wizard® feature to calculate the dose needed to correct the high, and
 - 3) Confirm the suggested bolus amount, press the activate button and allow the pump to deliver the bolus.
- You should never ignore a high BG reading. Always consult the Bolus Wizard feature to see if a correction bolus should be taken. Recheck your BG in about an hour after giving a correction bolus to make sure the high BG is starting to come down.
- If your BG is higher than 250 mg/dL, check for ketones.
- If your ketone test is negative:
 - 1) Consult the Bolus Wizard feature to see if you need a correction dose of insulin (you can use your pump if you do not have ketones)
 - 2) Re-check your glucose level in one hour
 - If your BG has started to decrease, continue to monitor your BG until it is normal.

- 3) If your BG has not started to decrease 1 hour after the correction dose:
 - Take a correction dose of insulin using a syringe
 - Change your infusion set, reservoir, and insulin
 - Continue to check your BG until it returns to normal
- If your ketone test is positive, you do not have enough insulin in your body and you are using fat for fuel.
 - 1) Take an insulin correction dose using a syringe.
 - 2) Change your infusion site, infusion set, reservoir, and insulin.
 - 3) Use the “Not Responding to a Correction Bolus? Try These...” guidelines (found in the Appendix) to see if there is a problem with your pump or infusion set.
 - 4) Check your BG every 1 to 2 hours. Give correction boluses as needed.
 - 5) Drink non-carbohydrate fluids.
 - 6) If your BG continues to rise or if you have moderate to high ketones, nausea, vomiting, or difficulty breathing, notify your healthcare provider or go to the nearest emergency room.

Managing Pump Therapy

Review Questions

(Circle the best answer)

1. Causes of hyperglycemia include:

- a) stress
- b) illness and infection
- c) medications
- d) food
- e) not receiving insulin due to a site or infusion set problem
- f) weak or expired insulin
- g) all of the above

2. If you have a BG that is high but less than 250 mg/dL you should:

- a) enter the BG reading into the pump
- b) allow the Bolus Wizard® feature to calculate the correction dose of insulin you need
- c) accept and confirm the amount and let the pump deliver the correction bolus
- d) all of the above
- e) none of the above

3. If your BG is higher than 250 mg/dL you should:

- a) eat and drink something
- b) check for ketones
- c) call your doctor

4. If the ketone test is negative you should:

- a) enter your BG into your pump and allow the Bolus Wizard feature to calculate your correction dose and deliver the bolus
- b) eat a lot of food
- c) take insulin by mouth
- d) ignore the high BG

5. If the ketone strip indicates that you have positive ketones you should:

- a) immediately take a correction dose of insulin by syringe
- b) change your infusion site, infusion set, reservoir, and insulin
- c) start drinking plenty of non-carbohydrate fluids
- d) notify your healthcare provider if your BG continues to rise, you have moderate or high ketones, if you have nausea or vomiting, or if you have difficulty breathing
- e) all of the above

Managing Pump Therapy

Section 4:

Preventing Diabetic Ketoacidosis (DKA)

DKA is caused from a lack of insulin. When the body does not receive any insulin or receives too little insulin, glucose levels rise. After a period of time, the body is forced to burn fat for energy. When fat is used as the main source of energy, ketones (a waste product of fat) are produced in large amounts and accumulate in the blood. If your body does not receive insulin, DKA can develop. The length of time it takes and how high the glucose levels rise varies, however DKA can occur within a few hours.

Although DKA rarely occurs when using an insulin pump, it is serious and can be life-threatening if not handled correctly. Checking your BG regularly (4 to 6 times each day), testing more frequently when you are ill, and recognizing and responding appropriately to high glucose levels will almost always prevent DKA.

The good news is that DKA does not occur without warning signs and can almost always be avoided if you pay attention and take action when warning signs appear.

Warning Signs and Symptoms of DKA

- High BG levels
- Ketones (in blood and urine)
- Nausea, vomiting, and abdominal pain (cramps)
- Confusion
- Lethargy (tired, sluggish, or weak)
- Difficulty breathing
- Unconsciousness

Keep in mind that your insulin pump uses rapid-acting insulin

- If your insulin infusion is interrupted, you can expect to see a fast rise in your glucose levels (usually within a couple of hours).
 - Insulin infusion should not be stopped or suspended for more than about an hour without checking your blood glucose.
-



It is important to check BGs regularly.



IMPORTANT The warning signs of DKA are similar to the symptoms experienced with flu or a stomach virus (nausea, vomiting, and stomach pain). Therefore, anytime you have nausea or vomiting, you should monitor your BG closely and check for ketones regularly. The signs and symptoms of DKA will always include high BG levels and ketones. Testing for ketones will tell you if DKA may be developing and if you need to take corrective action to prevent it.

Managing Pump Therapy



KEY LEARNING POINTS

- Diabetic ketoacidosis (DKA) is a serious condition.
- DKA can develop if there is not enough insulin available for the body to use glucose as its main source of fuel.
 - If there is no insulin or not enough insulin in the blood, glucose levels rise and the body is forced to burn fat for fuel.
 - When fat is used as the body's main source of energy, ketones are produced and accumulate in the body.
 - If insulin is not provided, DKA can develop.
- DKA is always preceded by warning signs that include high glucose levels and ketones. Other signs and symptoms of DKA may include nausea, vomiting, stomach pain, difficulty breathing, or unconsciousness.
- Because the warning signs of DKA are similar to the symptoms you experience with the flu or a stomach virus, anytime you have nausea or vomiting you should check your BG and check for ketones.
- Insulin pump therapy uses rapid-acting insulin. Therefore you can expect glucose levels to increase quickly if insulin delivery is interrupted.
- You should not suspend your insulin delivery or disconnect from your pump for more than about an hour without checking your BG.

Review Questions

(Circle the best answer)

1. What causes DKA?

- a) a combination of not enough insulin, high blood sugars, and ketones
- b) too much protein in the diet
- c) neither

2. The warning signs of DKA always include:

- a) high glucose levels and ketones
- b) chills
- c) fever
- e) none of the above

3. The warning signs of DKA are similar to the flu or a stomach virus therefore anytime you have nausea or vomiting you should:

- a) monitor your glucose levels closely and check for ketones
- b) eat a lot
- c) go to bed and sleep
- d) none of the above

4. It is important to check your BG a minimum of 4 times a day and never ignore a high BG reading. The pump uses rapid-acting insulin and glucose levels will rise quickly if your infusion set has pulled out without you realizing it.

- a) true
- b) false

5. DKA rarely develops when using an insulin pump. It can almost always be avoided if you pay attention to the warning signs.

- a) true
- b) false

ANSWERS: 1.a 2.a 3.a 4.a 5.a

Managing Pump Therapy

Section 5:

Guidelines for When You Are Sick

Illness and infections typically cause glucose levels to run high. Because illness causes glucose levels to increase, the risk of developing DKA is higher. When you are sick, you should check your BG levels and monitor for ketones frequently.

The importance of checking your BG and monitoring for ketones frequently when you are ill cannot be over emphasized.



Sick Day Guidelines

- Check BG every 2 hours
- Check urine for ketones each time you urinate
- Drink plenty of clear, non-carbohydrate fluids to prevent dehydration

Notify your healthcare provider if you have moderate or high ketones, nausea, or vomiting, or if your glucose levels remain high.



IMPORTANT Your body must have basal insulin even when you are not able to eat. You should NEVER stop the delivery of your basal insulin when you are ill, unless you are specifically instructed to do so by your healthcare provider.

Keep a few supplies on hand in case you become sick. Recommended items include:

- Sugar-free liquids, such as diet drinks, bouillon, and chicken broth, can be used to replace lost fluids and prevent dehydration
- Fluids that contain sugar, such as regular soda, popsicles, and jello, can be used to replace needed calories if you are not able to eat
- Extra glucose meter strips
- Ketone strips
- Medications (sugar-free) for cough, congestion, nausea or vomiting, and fever



IMPORTANT Glucose levels and ketones must be checked frequently during illness. Please check with your healthcare provider for additional guidelines that you should follow when you are ill.

Managing Pump Therapy



KEY LEARNING POINTS

- Illness and infections of any type can cause glucose levels to run high.
- The risk of developing DKA increases when you are sick because illness causes blood sugars to run high.
- Monitoring your glucose and checking for ketones during illness is extremely important.
- When you are ill you should check your BG every 2 hours and check for ketones every time you urinate.
- Follow sick day instructions and keep sick day supplies on hand to help avoid complications.
- Your body needs basal insulin even when you are not able to eat. You should never stop or interrupt your basal insulin delivery during illness unless you are specifically instructed to do so by your healthcare provider.

Review Questions

(Circle the best answer)

- 1. Illness and infections typically cause:**
 - a) glucose levels to run higher than normal
 - b) greater risk for DKA
 - c) both a and b
 - d) none of the above
- 2. When you are sick it is important to monitor glucose levels and ketones.**
 - a) true
 - b) false
- 3. During illness you should check for ketones:**
 - a) every 2 hours
 - b) every 4 hours
 - c) every time you urinate
- 4. Notify your healthcare provider if:**
 - a) you have nausea, vomiting, or stomach pain
 - b) your glucose levels remain high
 - c) you have moderate or high ketones
 - d) all of the above
 - e) none of the above
- 5. What supplies should you keep on hand in case of illness?**
 - a) sugar free liquids
 - b) fluids that contain sugar
 - c) extra glucose meter strips and ketone strips
 - d) thermometer
 - e) sugar-free medications for fever, cough, congestion, and nausea or vomiting
 - f) all of the above

Calculating Boluses



Chapter 3

Calculating Boluses

The Importance of Counting Grams of Carbohydrate When Using an Insulin Pump

Carbohydrate (carb) counting is an important part of diabetes management because it allows flexibility in food choices and the best possible glucose control after eating.

Although pump therapy provides many benefits even for individuals who do not count carbs, the total benefit of pump therapy can only be realized when carb counting is used along with the Bolus Wizard feature.

Counting grams of carbohydrate is easy to learn and simple to use.

If you need training on carbohydrate counting, there are many classes and teaching aids available. Please contact your Medtronic representative or healthcare provider to ask for the location of a class near you.

Calculating Boluses

Learning to count grams of carbohydrate is the first step in making sure that you give the right amount of insulin for the food you eat. The second step involves determining the correct amount of insulin to take for the grams of carbohydrate you eat.

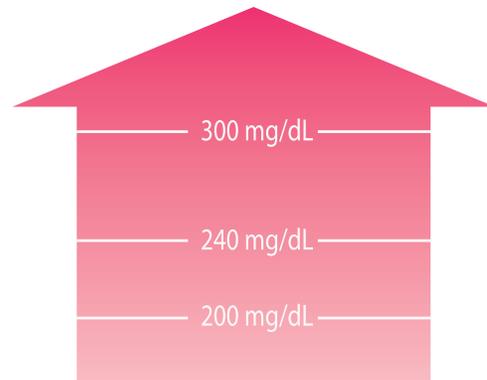
When using an insulin pump, there are two reasons a bolus of insulin needs to be given. One is to cover food or drink that contains carbohydrate. This is called a food bolus. The other is to give insulin to correct a high BG level. This type of bolus is referred to as a correction bolus.

Food bolus: Insulin given to cover the rise in glucose levels that occur after eating or drinking foods containing carbohydrate.

Correction bolus: Insulin given to correct a BG level that is out of your target range.



A food bolus is given to cover meals and snacks.



A correction bolus is given to correct a high BG.

You will rarely need to determine the amount of insulin needed for a bolus because the Bolus Wizard® feature will “do the math” for you. The Bolus Wizard feature will calculate the amount of insulin needed for a food bolus or a correction bolus separately, or it can do both at the same time.

We recommend that you always use the Bolus Wizard feature to calculate your boluses when giving insulin.

Although you do not need to “do the math”, it is important for you to know how the Bolus Wizard feature determines the amount of each bolus. This will reinforce your confidence that the amount suggested by the Bolus Wizard feature is correct.

Section 1 of this chapter explains how a food bolus is calculated. Section 2 explains how a correction bolus is calculated. The exercises in this chapter provide an opportunity for you to practice these calculations. *Let’s get started!*



The Bolus Wizard feature will calculate your insulin needs based on your current BG level and carbohydrate grams.



DID YOU KNOW?

The Bolus Wizard feature tracks and records the amount of insulin you take, records the number of grams of carbohydrate you eat, and keeps a record of your BG readings. This information can easily be reviewed in the Bolus History on your pump. In addition, all of your bolus information can be uploaded to a computer and organized into easy-to-read reports.

Calculating Boluses

Section 1:

Calculating Food Boluses

To calculate a food bolus, the Bolus Wizard® feature uses the number of grams of carbohydrate (carb) you eat and your insulin-to-carbohydrate ratio (ICR).

An ICR indicates the number of grams of carb that are covered by 1 unit of insulin. For example, if you need 1 unit of insulin to cover 10 grams of carb, your ICR is 10. If your ICR is 10, and you ate 20 grams, you would take 2 units of insulin to cover the 20 grams of carb.

The chart below shows examples of different insulin-to-carb ratios and what each ratio means.

If your ICR is...	this means you need...
ICR = 8	1 unit of insulin for every 8 grams of carb
ICR = 10	1 unit of insulin for every 10 grams of carb
ICR = 15	1 unit of insulin for every 15 grams of carb
ICR = 30	1 unit of insulin for every 30 grams of carb

Your healthcare provider will determine the ICR that is best for you to use when you start on the pump.

Calculating the Food Bolus Amount

To determine the amount of insulin needed to cover a meal or snack, divide the number of grams of carbohydrate you plan to eat by your ICR.

Food Bolus Formula

Carb Grams ÷ ICR = Units of Insulin

Carb Grams: Total number of carb grams

ICR: Insulin-to-carbohydrate ratio

Units of Insulin: Number of units needed to cover the total carb grams

Example: Total grams of carb = **30** and ICR = **10**

$$30 \text{ (grams)} \div 10 \text{ (ICR)} = 3 \text{ (units of insulin)}$$

Therefore, 3 units of insulin are needed to cover 30 grams of carbohydrate.

Calculating Boluses

Practice Exercises

For practice, see if you can calculate the number of insulin units needed to cover the total grams of carb in these examples:

Exercise 1: Total grams of carb = **40** and ICR = **10**

$$\frac{\text{_____}}{\text{Grams}} \div \frac{\text{_____}}{\text{ICR}} = \frac{\text{_____}}{\text{Insulin}} \text{ units}$$

Exercise 2: Total grams of carb = **45** and ICR = **15**

$$\frac{\text{_____}}{\text{Grams}} \div \frac{\text{_____}}{\text{ICR}} = \frac{\text{_____}}{\text{Insulin}} \text{ units}$$

Exercise 3: Total grams of carb = **40** and ICR = **20**

$$\frac{\text{_____}}{\text{Grams}} \div \frac{\text{_____}}{\text{ICR}} = \frac{\text{_____}}{\text{Insulin}} \text{ units}$$

If you worked these practice problems correctly, you will have no problem calculating bolus doses using any ICR for the amount of carbohydrate you eat.

ANSWERS: 1. 4.0 units 2. 3.0 units 3. 2.0 units

Your pump allows you to deliver insulin boluses in very precise amounts and can even deliver boluses in doses smaller than 1-unit amounts. Let's look at how the pump calculates these small amounts.

Example

Dora eats 36 grams of carbohydrate and her ICR is 10. She divides 36 by 10 and determines that she needs to take 3.6 units of insulin for her meal.

$$36 \text{ (grams)} \div 10 \text{ (ICR)} = 3.6 \text{ units (insulin)}$$

The Bolus Wizard® feature uses your ICR to calculate the exact amount of insulin needed, and your pump delivers precisely that amount! Before we practice calculating boluses in less than 1-unit amounts, let's learn one more new concept. Then you can practice both of these at the same time.

Using Different ICRs for Different Times of the Day

Many people need different ICRs for different mealtimes. For example, you may find that you need one ICR for breakfast and another for your lunch and dinner.

The Bolus Wizard feature can be programmed with more than one ICR. It can calculate the exact amount of insulin you need for each meal using the correct ICR for that time of day. You will learn how to program the Bolus Wizard feature in your Pump Start Training class.



Many people need different ICRs for different mealtimes.

Calculating Boluses

Practice Exercise:

Calculating Food Boluses Using Different ICRs

Complete these practice exercises. Your goal is to find the same answer as the Bolus Wizard® feature.

How much insulin is needed for the following meals?
(You may need a calculator).

Exercise 1: Breakfast	Exercise 2: Lunch
2 slices of toast 30 g	½ turkey sandwich 15 g
1 egg 0 g	1 small salad 5 g
½ glass orange juice 15 g	1 cup vegetable soup 15 g
1 slice bacon 0 g	1 small apple 15 g
2 tbsp jelly 30 g	
Total grams _____ g	Total grams _____ g
ICR = 10	ICR = 15
_____ ÷ _____ = _____ units Grams ICR Insulin	_____ ÷ _____ = _____ units Grams ICR Insulin

ANSWERS: 1. 7.5 grams/7.5 units 2. 50 grams/3.3 units



NOTE Keep in mind that the Bolus Wizard® calculator recommends bolus amounts for you. You are only practicing to ensure that you fully understand how the Bolus Wizard feature calculates your boluses.

Exercise 3: Dinner	Exercise 4: Snack
4 oz chicken breast 0 g	1 pack of crackers 35 g
1 small baked potato 30 g	1 diet soda 0 g
1 cup green beans 5 g	
1 small roll 15 g	
½ glass juice 15 g	
 Total grams _____ g	 Total grams _____ g
ICR = 15	ICR = 12
 _____ ÷ _____ = _____ units Grams ICR Insulin	 _____ ÷ _____ = _____ units Grams ICR Insulin

ANSWERS: 1.65 grams/4.3 units 2.35 grams/2.9 units

Calculating Boluses

Section 2:

Calculating Correction Boluses

The second reason a bolus is given is to correct a high BG. Anytime your BG is above your target, the Bolus Wizard® feature can calculate a correction bolus and determine if you need insulin to correct the high.

Four factors calculate your correction bolus:

1. **Current BG:** Your current blood glucose reading
 - You enter your current BG reading each time you give a correction bolus.
2. **Target BG:** The glucose value you are trying to achieve when you correct a glucose level that is above or below your target range.
 - Your healthcare provider will help you determine your target BG.
 - Your target BG is programmed into the Bolus Wizard feature.
 - The target BG is used by the Bolus Wizard feature each time a correction bolus is calculated.
3. **Insulin sensitivity factor (ISF):** The number of points (or mg/dL) 1 unit of insulin lowers your BG level
 - Your healthcare provider will help you determine your ISF.
 - Your ISF is programmed into the Bolus Wizard feature.
 - The ISF is used by the Bolus Wizard feature each time a correction bolus is calculated.
4. **Active insulin:** The amount of insulin that is still active in your body from previous boluses and that could continue to lower your BG. (Active insulin will be discussed in detail during your Pump Start Training class.)
 - The Bolus Wizard feature always checks the amount of active insulin in your body before it suggests the amount of insulin for a correction bolus

More About Insulin Sensitivity Factors

An ISF indicates how sensitive your body is to insulin. For example, an ISF of 50 indicates that 1 unit of insulin lowers your BG level by approximately 50 mg/dL (or 50 “points”). Your healthcare provider will determine the insulin sensitivity factor that is best for you to use when you start on the pump.

Knowing the amount 1 unit of insulin lowers your BG level helps determine the amount of insulin you should take to correct a high BG.

The Bolus Wizard feature uses your ISF in the following formula to calculate each correction bolus.

Correction Bolus Formula

$$(\text{Current BG} - \text{Target BG}) \div \text{ISF} = \text{Units of Insulin}$$

(Current BG - Target BG): Amount BG needs to be lowered

ISF: The amount 1 unit of insulin lowers your BG

Units of Insulin: Number of units needed to correct the BG

Calculating Boluses

Example

Correction Bolus Formula:

$$(\text{Current BG} - \text{Target BG}) \div \text{ISF} = \text{Units of Insulin}$$

Current BG = 250 mg/dL

Target BG = 100 mg/dL

ISF = 50

$$(250 \text{ mg/dL} - 100 \text{ mg/dL}) \div 50 = 3.0 \text{ units}$$

This means:

- It will take 3 units of insulin to lower this individual's BG level from 250 mg/dL to 100 mg/dL.

In other words:

- 3 units of insulin lowers this individual's BG level approximately 150 mg/dL.

Practice Exercise

Now it's your turn. Calculate the correction bolus in the following exercise.

Current BG = 200 mg/dL

Target BG = 100 mg/dL

ISF = 50

$$\left(\frac{\text{Current BG} - \text{Target BG}}{\text{ISF}} \right) = \text{Insulin units}$$

ANSWER: 2.0 units

Calculating Boluses

Section 3:

Calculating the Total Bolus

There will be times when you only take a food bolus and times when you take only a correction bolus. But most of the time (before eating), you will take a food and a correction bolus together.

The Bolus Wizard® feature calculates the food and correction bolus separately and then adds them together to determine your total bolus.

Let's consider the following scenario.

Kathy's BG level is currently 200 mg/dL and she plans to eat 76 grams of carb. Her ICR, ISF and target BG range have been programmed into her pump.

The Bolus Wizard feature calculates her food bolus and her correction bolus and then adds them together to determine the total bolus amount to suggest.

First, calculate the food bolus.

Carb = 76 grams; ICR = 10

76 grams ÷ 10 (ICR) = 7.6 units (insulin)

Kathy needs 7.6 units of insulin to cover her food.

Second, calculate the correction bolus.

Current BG = 200 mg/dL; Target BG = 120 mg/dL; ISF = 40

(200 mg/dL - 120 mg/dL) ÷ 40 = 2.0 units

Kathy needs 2.0 units to correct her high BG level.

Add them together

7.6 units	+	2.0 units	=	9.6 units
Food bolus		Correction bolus		Total bolus amount

Practice Exercises

1. Food Bolus Calculation

Carb = 30 grams; ICR = 15

$$\frac{\text{Grams}}{\text{ICR}} = \text{Insulin units}$$

ANSWER: 2.0 units

2. Correction Bolus Calculation

Current BG = 220 mg/dL; Target BG = 100 mg/dL; ISF = 40

(Current BG – Target BG) ÷ ISF = Units of Insulin

$$\frac{(\text{Current BG} - \text{Target BG})}{\text{ISF}} = \text{Insulin units}$$

ANSWER: 3.0 units

3. Total Bolus Amount

Units for Food + Units for Correction = Total Bolus Amount

$$\text{Food bolus} + \text{Correction bolus} = \text{Total bolus amount units}$$

Hint: Use the Food Bolus amount you calculated for #1 and the Correction Bolus amount from #2 to find the Total Bolus amount.

ANSWER: 5.0 units

Calculating Boluses

Section 4:

Calculating a Negative Correction

There is one more situation to consider. What if your BG level is below your target range when you are ready to eat?

If your BG reading is below your target range before you eat, you should take less insulin for the food you are getting ready to eat.

Consider the following example:

Carb = **80** grams; ICR = **10**; Current BG = **75** mg/dL

Target BG = **100** mg/dL; ISF = **50**

Use the same formulas.

First, calculate the food bolus.

Carbs = **80** grams; ICR = **10**

$80 \div 10 = 8.0$ units of insulin

Normally, you would take 8 units of insulin to cover your food. But because your glucose reading is below your target range, you need to take less insulin.

How much less?

Use the correction formula to determine the amount.

Second, calculate the correction bolus.

Current BG = 75 mg/dL; Target BG = 100 mg/dL; ISF = 50

(Current BG – Target BG) ÷ ISF = Units of Insulin

(75 mg/dL - 100 mg/dL) ÷ 50 = **-0.5** units

This means that the food bolus should be decreased by **0.5** units.

8 units	–	0.5 units	=	7.5 units
Food Bolus		Negative Correction Bolus		Estimated Total Bolus Amount

Note: All negative numbers are shown in red

This individual would normally take 8.0 units of insulin for 80 grams of carbohydrate. But because their glucose is 75 mg/dL the Bolus Wizard® feature automatically subtracts 0.5 units of insulin from the food bolus to ensure that their post-meal BG level will return to their target range.



NOTE If this seems hard to understand, do not be concerned. It is a difficult concept for most people. All you need to understand is that when your BG level is below your target, the Bolus Wizard feature will subtract insulin from your food bolus for you.

Calculating Boluses

Practice Exercises

1. Food Bolus Calculation

Carb = 30 grams; ICR = 15

$$\frac{\text{Grams}}{\text{ICR}} \div \text{ICR} = \text{Insulin units}$$

ANSWER: 2.0 units

2. Correction Bolus Calculation

Current BG = 75 mg/dL; Target BG = 100 mg/dL; ISF = 50

(Current BG – Target BG) ÷ ISF = Units of Insulin

$$\frac{(\text{Current BG} - \text{Target BG})}{\text{ISF}} = \text{Insulin units}$$

ANSWER: -0.5 units

3. Total Bolus Amount

Units for Food + Units for Correction = Total Bolus Amount

$$\frac{\text{Food bolus}}{\text{Correction bolus}} + \frac{\text{Correction bolus}}{\text{Total bolus amount}} = \text{units}$$

Hint: Use the Food Bolus amount you calculated for #1 and the Correction Bolus amount from #2 to find the Total Bolus amount.

ANSWER: 1.5 units

Appendix



In this Appendix you will find:

Not Responding to a Correction Bolus? Try These.....	98
Hemoglobin A1C (Hb A1c)	99

Appendix

Section 1:

Not Responding to a Correction Bolus? Try These...

If you experience a high blood glucose (BG) that does not come down with a correction bolus, please follow the tips in this troubleshooting guide. The tips in this guide will help you determine if an issue exists with your infusion site, infusion set, pump or your insulin. If you determine that your infusion site, infusion set, pump and insulin are OK, continue to follow the protocol for treating a high BG and contact your healthcare provider.

Things to Examine	Questions to Ask	Solutions
Infusion site problem?	<ul style="list-style-type: none">• Is it red, irritated, or painful?	If yes, rotate and change the infusion site, infusion set, reservoir and insulin
Infusion set or tubing issue?	<ul style="list-style-type: none">• Are there bubbles, larger than champagne bubbles, in the tubing?• Is there blood in the tubing?	If yes, disconnect and then purge air bubbles from the tubing using the fill tubing feature. If yes, change the infusion set, reservoir and insulin
Reservoir and infusion set connection issue?	<ul style="list-style-type: none">• Are there leaks or breaks?• Is connection loose or easily moved?	If yes, change infusion set, reservoir and insulin if unable to correct the problem by tightening
Reservoir issue?	<ul style="list-style-type: none">• Is the reservoir empty?• Are there excessive bubbles?	If yes, change infusion set, reservoir and insulin
Pump Settings issue? <ul style="list-style-type: none">• Bolus Delivery• Basal Rates• Time	<ul style="list-style-type: none">• Was last meal bolus missed?• Are basal rates set correctly?• Are basal rate times correct?• Is time (AM/PM) set correctly?	If yes, give correction dose If not, set basal rates correctly If not, set basal rate times If not, set time correctly
Denatured or “bad” insulin?	<ul style="list-style-type: none">• Has insulin vial expired?• Has insulin been exposed to high temperatures or direct sunlight?	If yes, replace with a new vial of insulin
Insulin pump problem?	<ul style="list-style-type: none">• Is pump inoperable?• Not sure if pump has a problem?	Call the Medtronic Diabetes 24-Hour Helpline at 800.646.4633

Section 2:

Hemoglobin A1C (Hb A1c)

Blood Glucose Testing and Hemoglobin A1C

When you check your blood glucose (BG) using a meter, you measure the amount of glucose that is in your blood at the moment you perform the test.

The hemoglobin A1C (A1C) is a test that is performed by your healthcare provider. It provides a measure of your overall glucose control for the past 2-3 months. The A1C is reported as a percent (%) that can be compared to an estimated average glucose value in mg/dL. The chart below depicts A1C percentages from 6% through 10% and shows the estimated average glucose value for each one.

A1C %	eAG (estimated average glucose) ¹
6%	126 mg/dL
7%	154 mg/dL
8%	183 mg/dL
9%	212 mg/dL
10%	240 mg/dL

*The American Diabetes Association's (ADA) goal for A1C is <7%.

*The American Association of Clinical Endocrinologists (AACE) goal for A1C is <6.5%.

Clinical studies clearly indicate that lowering A1C by 1% decreases your risk of developing complications related to diabetes by as much as 37%²! Ask your healthcare provider for the results of your last A1C. Monitor your A1C three to four times a year with the goal of keeping your A1C at or below 7%, or at the target set by your healthcare provider.

The A1C reflects the average of every glucose level you experienced over the past 2-3 months. While an A1C is an easy way to estimate your average glucose, it does not reveal how often you were high or how often you were low. Nor does it show your highest BG or your lowest BG. In other words, it does not show the variability of your glucose control.

Some people have A1C levels that are within the acceptable range, and yet they have extreme glucose excursions. Using an insulin pump should help improve your glucose control and decrease glucose variability (how often you experience a high or low BG).

1. American Diabetes Association. "Standards of Medical Care in Diabetes - 2009." *Diabetes Care*. 2009;32:S19.

2. DCCT. *Diabetes* 995;44:968-83.

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