

Chapter 7

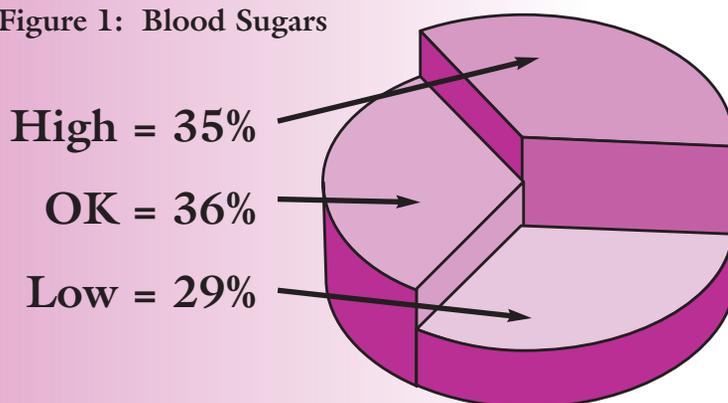
Blood Sugar
(Glucose)
Testing

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MEASURING BLOOD SUGARS

The ability of people (or families) with diabetes to check blood sugar levels quickly and accurately has changed diabetes management more than anything else in the past 20 years. Prior to this, diabetes was primarily managed by measuring urine sugars, which were very unreliable. The people in the intensive treatment group of the Diabetes Control and Complications Trial (DCCT) did at least four blood sugars every day (see

Figure 1: Blood Sugars



Graphs can be obtained from some of the blood sugar meters when they are brought to the clinic. This young man had a HbA_{1c} (see Chapter 14) of 7.1 percent, but was having too many lows. We like no more than 14 percent of values to be low and for at least 50 percent of values to be below the upper range level (see suggested ranges for different ages in Table 2).

TEACHING OBJECTIVES:

1. Present blood sugar (glucose) testing concepts (rationale, testing times, frequency and desired ranges for the individual).
2. Provide instruction for the meter of choice.
3. Discuss how to trouble shoot problems with their meter.
4. Introduce the concept of recording blood sugars and observing trends.

LEARNING OBJECTIVES:

Learners (parents, child, relative or self) will be able to:

1. Describe rationale for blood sugar testing and list testing times, frequency and their desired ranges.
2. Demonstrate use of meter including setting time and code when necessary.
3. Locate and state the 1-800 number listed on the meter to call for problems.
4. Choose and apply a method for recording blood sugars and recognizing trends.

Chapter 14). They were able to achieve excellent diabetes control as a result of frequent blood sugar testing, more frequent dosages of insulin and following a dietary plan. The improved glucose control was shown to significantly reduce the risk for eye, kidney and nerve complications of diabetes. Clearly, for people who are able to check blood sugars more frequently, improved sugar control is now possible. The Standards of Diabetes Care (see Chapter 20) recommends “frequent blood-glucose monitoring” (at least 3-4 times per day). This is a reasonable goal for all people with diabetes.

WHY DO BLOOD-SUGAR (GLUCOSE) MONITORING?

There are many reasons why measuring blood sugars at home has become a “cornerstone” of diabetes care. A few of these will be discussed here (and are listed in Table 1):

-  **Safety:** A big reason for the use of blood sugar testing relates to safety. Almost no one feels all the low blood sugars that occur (and very young children may not report feeling any lows). Checking the blood sugar before the bedtime snack may help in choosing ways to prevent low blood sugars during the night.
-  **Improving sugar control:** Studies have clearly shown that testing a minimum of four blood sugars daily and using the results wisely can result in improved sugar control. This results in a reduced risk for diabetic eye, kidney and nerve complications. Better sugar control also reduces the risk for heart attacks in later life!
-  **Adjusting the insulin dosage:** If blood sugars are checked regularly, and the results are recorded to look for patterns of lows or highs, the insulin dosage can be adjusted as needed. People who take a rapid-acting insulin (Humalog/NovoLog/Apidra) before meals should use the blood sugar level (along with the amount of food and planned exercise) to decide how much insulin to take.

Table 1 Reasons for Blood Sugar (Glucose) Testing

-  Safety
 -  Improve sugar control
 -  Adjust the insulin dosage
 -  Manage illnesses
 -  Understand the effects of various foods, insulin doses, exercise or stress
 -  Discriminate a rapid fall in blood sugar from a truly low blood sugar value
 -  Know the blood sugar level immediately
 -  Sense of control
 -  Indicate a need to test for urine or blood ketones
-
-  **Managing illness:** Being able to check blood sugars at home when a person is sick (or before or after surgery) allows for safe management at home. In the past, people with diabetes were sometimes kept in the hospital because accurate blood sugars could not be done at home. People who do not test their blood sugar frequently during illness are more likely to become seriously ill and be admitted to the hospital.
 -  **To understand the effects of various foods, exercise or stress:** By checking a blood sugar two hours after eating a certain food or doing a certain amount of exercise, one can better plan the insulin dose the next time. Pizza, for example, tends to raise blood sugars more than other foods for some people. If this is found to be true,

extra rapid-acting insulin can be considered for the next time it is to be eaten. Similarly, some people lower or raise their blood sugar with a certain exercise, whereas others do not. Knowing the blood sugar value after doing the exercise a few times will help in future planning.

 **To discriminate a rapid fall in blood sugar from a truly low blood sugar value:**

Some people report frequent symptoms of an insulin reaction (see Chapter 6). This occurs when the blood sugar falls rapidly (for example from 300 to 150 mg/dl [16.7 to 8.3 mmol/L]) or when a low blood sugar truly occurs. A blood sugar test at the time of a reaction will help determine whether the symptoms are due to a rapid fall (**false reaction**) or a seriously low blood sugar. We consider a truly low blood sugar to be below **60 mg/dl (3.3 mmol/L)** or in a preschooler, **below 70 mg/dl (3.9 mmol/L)**. Sugar can be given if the level is low, but it is not needed if the symptoms are just due to a rapid fall in sugar. If the level is between 60 and 100 mg/dl (3.3 and 5.5 mmol/L), it is often helpful to eat food that is not high in sugar. These differences will not be known unless a blood sugar level is tested at the time of the insulin reactions.

 **To know the blood sugar level immediately:** A blood sugar test will give immediate results when the value is important to know. For example, a child may be irritable and the cause may be unknown. A blood sugar test will quickly help the parent decide if the irritability is due to a low blood sugar level or another cause. Another person may have an important event and just want to know the blood sugar prior to the event.

 **Blood sugar testing gives people a “sense of control” over their diabetes:** Many people feel better knowing how their blood sugars are running. However, it is important to remember that there may not always be an exact relationship between the blood sugar level and what one expects it to

be. There are always unknown factors that result in occasional high or low levels. This can be very upsetting for the person who expects blood sugars to always be in the target range. It is important not to become discouraged when blood sugars do not always match the expected results.

Questions or concerns about the blood sugar tests should be discussed with the diabetes team.

 **As an indicator to do a urine or blood ketone test:** A fasting blood sugar above 240 mg/dl (13.3 mmol/L) or a value above 300 mg/dl (16.7 mmol/L) during the rest of the day should indicate a need for a blood or urine ketone test. (Some meters now even flash this advice.) Testing for blood or urine ketones when the blood sugar is high may help to prevent an episode of ketoacidosis (see Chapter 15).

WHEN TO DO BLOOD SUGAR TESTS

We now encourage people to do at least four blood sugar tests every day. When four blood sugar tests are done each day, they are often scheduled before breakfast, before lunch, before the afternoon snack or before dinner, and before the bedtime snack. Occasional values should also be done two hours after meals and during the night. The blood sugar goals for before meals and two hours after meals are shown in Figure 2 and Table 2. Suggested bedtime and nighttime values are given in Table 2.

1. Pre-breakfast

The morning blood sugar test reflects the values during the night and is probably the most important blood sugar related to diabetes control. It directly reflects the dose of Lantus insulin (no matter when it's given during the day). As shown in the figure at the beginning of Chapter 2, this value reflects the “turning off” of internal sugar production by the liver. The rapid-acting insulin dose at breakfast is also usually based, at least in part, on the blood sugar result. Using Lantus insulin or an insulin

pump, it is now usually possible to get the majority of fasting blood sugars “in range” (see Table 2).

2. Pre-lunch

A blood sugar test before lunch helps to decide if the morning rapid-acting insulin and/or Regular insulin dosage is correct. For people using morning NPH insulin, it may also be having an effect at this time. Most families now routinely request that a test be done prior to eating lunch. For most children (and schools), this is not a problem and can be done without interfering with the child’s normal school life. Other families (or children) prefer to do blood sugars at school only if the child is feeling “low.” This is discussed in more detail in Chapter 23, The School and Diabetes.

3. Pre-dinner

The test before dinner reflects the dose of morning NPH insulin (if taken) and the dose of rapid-acting insulin given at lunch and/or for the afternoon snack. It may also reflect afternoon sports activities and the food eaten for an afternoon snack. A test should not be done unless it has been at least two hours since food was last eaten. Otherwise, the result will be high from the food eaten in the previous two hours. If it is time for dinner and the person had an afternoon snack one hour earlier, it may be best to just wait and do the test prior to the bedtime snack. If this is a common occurrence, change to doing the blood sugar tests BEFORE the afternoon snack. Some youth, who like a large afternoon snack, will now routinely use Humalog/NovoLog/Apidra to cover the rise in blood sugar. The dinner value will then tell if the dose given was correct.

4. Bedtime

The blood sugar test prior to the bedtime snack is important for all people with diabetes. It is particularly important for:

-  people who tend to have reactions during the night
-  children who play outside after dinner or who have had heavy exercise that day

-  anyone who did not eat well at dinner
-  knowing if the rapid-acting insulin dose given at dinner is correct

As can be seen in Table 2, suggested bedtime blood sugar values are given for the different ages. **If the values are below the values in brackets (two stars), doing a follow-up blood sugar check during the night is wise.** These values may be different for a given person.

5. After meals

In recent years, more emphasis has been placed on doing a blood sugar two hours after eating a meal. The highest blood sugars of the day occur after meals and these values add to the HbA_{1c} value (Chapter 14). More people are now using carbohydrate counting. They may inject insulin prior to meals based on their expected carbohydrate intake (Chapter 12). The blood sugar two hours after the meal tells if the **Insulin to Carbohydrate ratio (I/C ratio – Chapter 12)** and estimated carbohydrates are correct. **The sugar values listed in Table 2 by age can also be the goals for two hours after meals.** Others just aim for values below 140 mg/dl (7.8 mmol/L) two hours after meals. We would recommend that families try to check blood sugar two hours after each meal at least once or twice weekly. Values obtained two hours after meals can perhaps be flagged by a symbol such as a star.

6. Nighttime

It may be necessary to occasionally do blood sugar tests in the middle of the night (see Chapter 6 on Low Blood Sugar) to make sure the value is not getting too low. This is particularly true if it has been a heavy exercise day. The diabetes care provider may suggest this if very erratic results are noted for the morning blood sugars.

A nighttime blood sugar test is particularly important for people who tend to have reactions (low blood sugars) during the night. More than half of the severe low sugars occur during the nighttime hours. Many families will

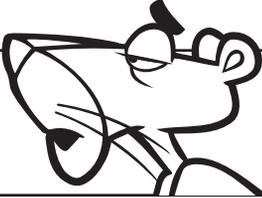
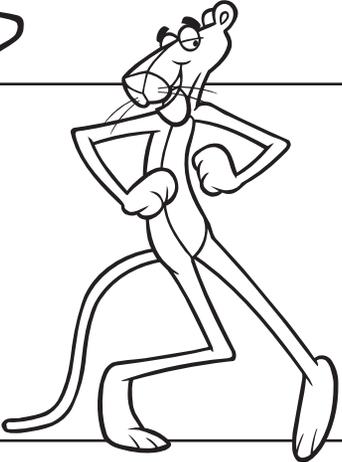
routinely do a test during the night. Others choose to do a test once weekly. **IT IS IMPORTANT TO TEST ON NIGHTS WHEN THERE HAS BEEN EXTRA PHYSICAL ACTIVITY.** The extra activity might be a basketball game in the evening. For a younger child, it might be playing hard outside on a nice summer evening. The best time to do a check varies with each person. For some, between midnight and 2 a.m. is the best. For others, the early morning hours are the

most valuable – perhaps when a parent is getting ready for work. Table 2 also gives suggested values for during the night.

7. With low blood sugar

As noted above, doing a blood sugar when feeling low helps to separate a rapid fall in blood sugar from a “true-low” (< 60 mg/dl [or < 3.3 mmol/L]). A food with sugar must be given for a “true-low” whereas other food may be given (e.g., cheese, peanut butter) for a “false-low.”

Figure 2
Blood Sugar Level in mg/dl (mmol/L)

VERY HIGH 400-800 (22.2-44.4)				Stomachache Difficulty Breathing
HIGH 200-400 (11.1-22.2)				Low Energy
GOALS 80-200 (4.5-11.1)	Under 5 years			Fine
70-180 (3.9-10.0)	5-11 years			
70-150 (3.9-8.3)	12 years and up			
LOW below 60 (below 3.3)	True-Low			Sweating Hunger Shakiness
NON-DIABETIC NORMAL VALUES FOR CHILDREN*				
70-100 (3.9-5.5)	Normal (fasting)*			
70-130 (3.9-7.3)	Normal (random)*			

*The DirecNet Study Group showed that approximately 95 percent of values for non-diabetic children are in this range. However, occasional values down to 60 mg/dl (3.3 mmol/L) and, for random values, up to 144 mg/dl (8.0 mmol/L) are still normal.

Table 2
Suggested Blood Sugar Levels

Age (years)	Fasting (a.m.) or no food for 2 hours		Bedtime (before bedtime snack or during the night)	
	mg/dl	mmol/L	mg/dl	mmol/L
Below 5	80-200	4.5-11.1	Above 150* [80**]	above 8.3* [4.5**]
5-11	70-180	3.9-10.0	Above 130* [70**]	above 7.3* [3.9**]
12 and above	70-150	3.9-8.3	Above 130* [60**]	above 7.3* [3.3**]

*If values are below these levels, milk or other food might be added to the solid protein and carbohydrate bedtime snack.

**If values are below these levels, the test should be rechecked 10-30 minutes later to make certain it has come back up. If this happens more than once within a week, either reduce the dinner rapid-acting or Regular insulin or call the diabetes care provider for advice.

Note: The ADA recommended sugar levels for children of different ages vary somewhat from our suggestions. The levels for before meals and during the night recommended by the ADA can be found in Table 1 of Chapter 14.

HOW TO DO SELF BLOOD SUGAR TESTS

Finger-poking

A finger-poking (lancing) device is used to get the drop of blood. There are many good devices on the market, and these can now often be set at different depths for different people. The adjustable pokers are particularly good for young children who have tender skin and may not need much lancing depth.

The hands should be washed with warm water (to increase blood flow and to make sure they are clean). Any trace of sugar on the finger may give a false elevated reading. We do not recommend routinely wiping with alcohol because any trace of alcohol left on the skin will interfere with the chemical reaction for the blood sugar test (Table 3). Alcohol also dries and toughens the skin. Occasionally, when away from home (e.g., camping, picnics), it is necessary to use alcohol-free travel wipes to cleanse the finger. Air dry the finger before doing the blood sugar check.



It is often helpful to place the finger to be used on a table top (to prevent the natural reflex of withdrawing the finger and not getting an adequate poke). The side of the finger should be used rather than the fleshy pad on the fingertip, which is more painful. If the drop is not coming easily, hold the hand down to the side of the body to increase the blood in the finger. **IT IS IMPORTANT TO ROTATE FINGERS SO THAT ONE FINGER DOES**

NOT BECOME TOO “ABUSED.” If the fingers become sore, the toes or the ball at the base of the thumb may be used.

Alternate Testing Sites

Many children are now poking sites other than the fingers or toes. These sites are used as they may not hurt as much. The piker may need to be ‘dialed’ to the maximum depth to get enough blood. The most common site is the forearm. Meters approved for the arm include The FreeStyle™, The FreeStyle Flash™ and the One Touch Ultra®. The FreeStyle is also approved for use on the fleshy pad at the base of the thumb, the upper arm and the thigh and calf. The main problem has been that the blood flow through the arm is slower than through the fingertips. The slower blood flow means the blood sugar value from the arm may be 10 minutes or more **behind** the fingertip. It is important to rub the site to be used on the arm prior to doing the stick. The rubbing will increase the blood flow in the area. The person may feel low or have a low value from a fingerstick, but the arm level will not be low. We advise families to use the fingertip if the child is feeling low. Also, people who do not feel their lows (hypoglycemic unawareness; Chapter 6) should always use their fingertips for blood sugars. **Remember** to change the lancet everyday. A sharp lancet will lessen injury to the site and help prevent an infection.

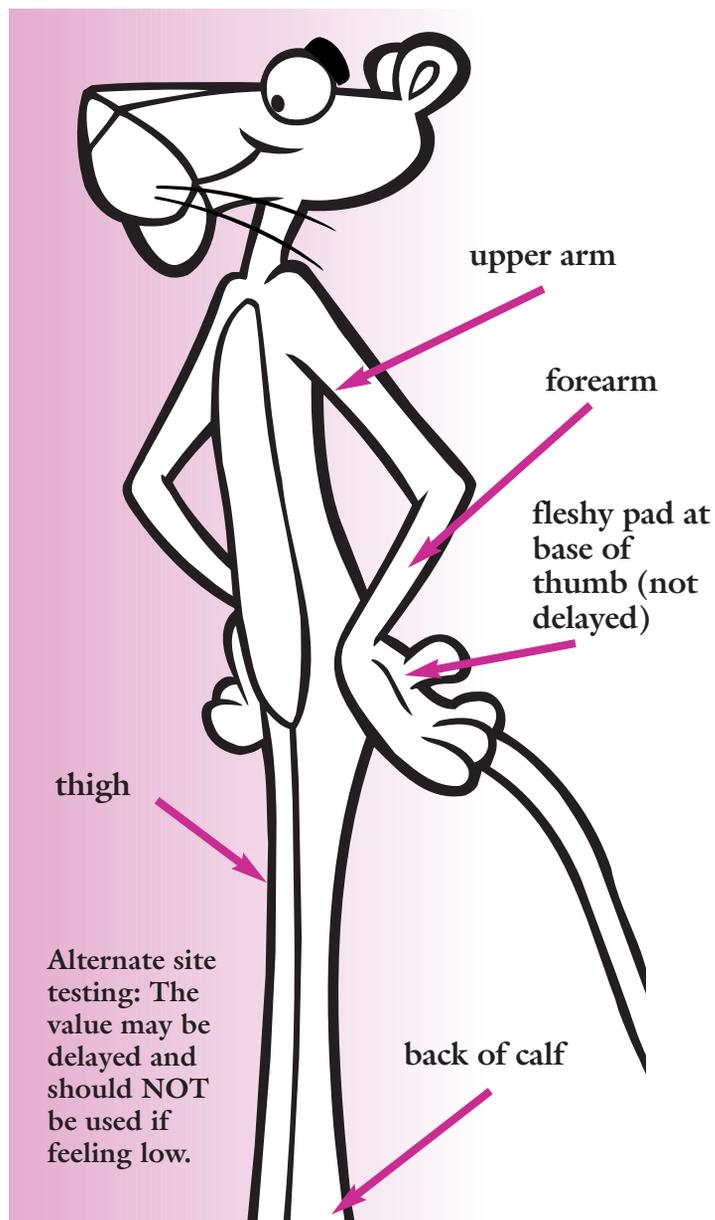


Table 3

Common Problems Causing Inaccurate Blood Sugar Test Results

-  Finger is not clean and dry (sugar on finger will raise result; alcohol or water will interfere)
-  Adding more blood after the first drop has been put on pad (now ok for some meters)
-  Meter parts are dirty (e.g., with dried blood)
-  Codes on strips and meters are not matched (some meters now read the codes automatically)
-  Too small a drop of blood on pad
-  Strips have expired
-  Strips have been exposed to heat (> 90°, e.g., left in hot car) or frozen (e.g., left in cold car)

Table 4

Desired Features of Blood Glucose Meters

- 🐾 Accurate (in environment where it is to be used)
- 🐾 Storage of at least the last 100 values
- 🐾 Able to be downloaded at clinic and/or at home
- 🐾 Small in size
- 🐾 Short determination time
- 🐾 Small drop of blood (capillary action of strip)
- 🐾 Blood is applied to the end of the strip and does not get into the meter
- 🐾 Cleaning is easy or not necessary
- 🐾 A control solution or strip can be used to check for accuracy
- 🐾 Strips are paid for by the family's insurance

🐾 Blood Sugar (Glucose) Meters

Some of the desirable features in selecting a meter are listed in Table 4. The meter chosen should meet the person's needs. Some people leave a meter at school or at work. If testing is done on more than one meter, try to use no more than two different brands. Families tend to prefer small meters that are easy to slip into a pocket. They also prefer meters that take a short time for the glucose determination.

Particularly for younger children, the need for only a small amount of blood is helpful. Most of the strips now have a capillary action to pull the blood into the strip. This may be helpful for a small child who has difficulty holding still. For some people, accuracy in cold, heat, high humidity or high altitude is important. If a strip has been in a cooler or refrigerator (most

strips spoil at above 90° or if they freeze), they should always be brought to room temperature before using.

Often the main reason one meter is selected over another in the U.S. is that the family's health insurance will pay for that meter and its strips. The glucose strips usually add up to a cost of \$3-4 (U.S.) per day, and so insurance coverage is important. The cost of strips is usually a more important factor than the cost of the meter.

It is important with most meters to test a control strip or solution at regular intervals to make sure reliable results are being obtained. Some clinics with a more accurate meter may wish to intermittently check the family's meter with the clinic's. Some common problems causing inaccurate blood sugar test results are shown in Table 3.

We do request that families choose a meter with a memory for at least the last 100 glucose values. **The meter(s) must always be brought to the clinic visit** so that it can be downloaded. The values as well as graphs, such as the pie-chart (Figure 1), can be printed. Some families like to download their blood glucose results in their homes. Research from our Center showed that if at least half of the blood sugar values are below the upper limit of the goal for the age (see Figure 2 and Table 2), the HbA_{1c} values will usually be in the desired range for the age (see Chapter 14). During the "honeymoon" phase (Chapter 2), or when one still makes much of one's own insulin, most of the blood sugars will be in the desired range for age. For other people with diabetes, it is a reasonable goal to try to get half of the blood sugar values at any time of day within range for that person's age.

Most meters read within 10 percent of a hospital laboratory determined value. Most of the meters currently on the market read the sugar in the plasma (the clear part of the blood). Research done by the DirecNet study group has confirmed that two meters, the One-Touch Ultra and the FreeStyle (or Flash), read with a high degree of accuracy.

Record Keeping

Examples of daily record sheets are included in this chapter. The pages record either the last one week or the last two weeks of blood sugars. Many families will now fax the page to their diabetes care provider at regular intervals. If this is done, make sure the insulin dosages and instructions for return fax or phone contact are included. These sheets may be copied and stored in a notebook to bring along to clinic visits. Keeping good records to look for patterns in blood sugar fluctuations is essential. It is wise to keep written records even if your meter is able to store results (these may be lost if the meter malfunctions). **Patterns of high or low blood sugars will be missed if results are not recorded.** It is important to note all reactions and possible causes. Some people also circle or highlight all values below 60 mg/dl (3.25 mmol/L) or put a star on days of reactions so that these can be easily noted by the diabetes care providers. If times of heavy exercise are recorded, it may be possible to see the effects of exercise on blood sugars. Illnesses, stress and menstrual periods may increase the blood sugar and should be noted. It may be helpful to record what was eaten for the bedtime snack or if there has been heavy exercise to see if these are related to morning blood sugars. Hopefully, occasional tests will also be done at the time(s) when routine tests are not usually done. Also included is a place to record urine or blood ketone checks, as newly diagnosed people must check their ketones frequently. Ketone checks are essential with any illness or anytime the blood sugar level is above 240 mg/dl (13.3 mmol/L) fasting or over 300 mg/dl (16.7 mmol/L) during the day.

The insulin dose can be recorded with the units of rapid-acting insulin on top (e.g., 5H or 5NL) and the units of intermediate-acting insulin on the bottom (e.g., 15N).

Good record keeping and bringing the results to clinic visits allow the family and diabetes team to work together most effectively to achieve good diabetes management. Complacency and not

recording values often results in missing patterns of high blood sugars and a resultant high HbA_{1c} value (see Chapter 14).

Continuous Glucose Monitor (CGM)

It had been expected that CGMs would be developed more rapidly than has happened. Accurate CGMs will be essential in the development of the “closed-loop” insulin pump (an insulin pump automatically regulated by sugar levels as measured by CGMs). Unfortunately, the CGMs have not measured the sugar levels with adequate accuracy (particularly at low glucose [sugar] levels) to permit the closed-loop pump. In the meantime, CGMs can be useful in improving glucose control. They have been most helpful for:

- ✓ detection of high sugar levels after meals
- ✓ detecting low sugar levels and for people who have trouble telling when they are low (hypoglycemic unawareness)
- ✓ measuring sugar levels during hospitalizations (when better sugar control may result in a better outcome)
- ✓ during pregnancy (when better sugar control may result in a better outcome)

Continuous Glucose Monitors (CGMs)

1. **The Guardian® RT Continuous Glucose Monitoring System (CGMS)**, made by Medtronic MiniMed, is a home-use device with alarms for high and low glucose levels, which displays glucose values every five minutes. It was approved by the FDA for use in adults, 18 and older, in August, 2005. The small flexible wire is inserted under the skin with a needle that is then removed. The sensor then transmits the glucose levels to the receiver box (about the size of an insulin pump). The receiver is not attached to the sensor and people can shower while wearing the sensor. The accuracy of the Guardian (particularly for low sugar levels during the night) has not yet been tested by an independent group. We have found past CGM devices to be

more accurate at high sugar levels than at low sugar levels. They are thus best utilized in showing how high the blood sugar levels go following meals. The Guardian requires two blood sugar values per day (every 12 hours) to be obtained by finger poke for calibration purposes.

2. **The DexCom STS™** was approved by the FDA for use in adults in April, 2006. A small wire is inserted under the skin using an automatic inserter. Subcutaneous fluid glucose readings are obtained every 5 minutes after the initial two hour warm-up period. It can be set to vibrate at the desired high and low glucose settings. Its accuracy has not yet been checked by an independent group.
3. **The Navigator®**, made by Therasense/Abbott Diabetes Products, is being considered by the FDA for approval. As with the Guardian and DexCom STS, the sensor is not connected to the receiver, but communicates by radio waves (showing is thus possible). The sensor is inserted under the skin using an automatic injection device. Two glucose levels (done by the FreeStyle meter built into the receiver) must be entered into the Navigator in the first 24 hours and then one test daily. The company hopes to be allowed to state that further routine sugar testing by finger-poke will not be necessary (for 3-5 days). Our recommendation is to do a finger-poke blood glucose level if the high glucose alarm sounds (and more insulin is to be given), or if the low glucose alarm sounds (for safety). Arrows on the face of the receiver can point straight up or down, meaning that the blood sugar is changing by > 2 mg/dl/min. In this case we recommend approximately a 20 percent change in correction and food bolus (compared to what would usually be

given). The change should be in the same direction as the arrow. For example, if the arrow is straight up and the planned correction bolus is 4 units and the planned food bolus is 4 units (total bolus = 8 units), the new bolus amount should be 9.6 units (20% of 8 is 1.6). If the arrow were straight down one would subtract the 1.6 units ($8 - 1.6 = 6.4$ units). If the arrow is either up or down at 45 degrees, then the correction and food insulin dose change is also up or down by 10 percent (compared to what would usually be given). If the arrow is horizontal, the standard bolus is taken. The Navigator has been found to be reasonably accurate by our DirecNet study group.

DEFINITIONS

DCCT: Diabetes Control and Complications Trial. This trial was completed in June 1993 and clearly showed that eye, kidney and nerve complications of diabetes were related to glucose control. More recently (June, 2005), the likelihood of later heart attacks was also shown to be reduced by the earlier better glucose control.

Glucose: The scientific name for the sugar in the blood or urine.

Insulin reaction (hypoglycemia): Another term for a blood sugar level that is too low. See Chapter 6.

Monitoring: As used in this chapter, keeping track of and following blood sugar levels at home and writing them down in a record book.

Self blood-glucose monitoring: Checking one's own blood sugar rather than going into a clinic or hospital to have the tests done.

Subcutaneous: Under the skin (but not in a blood vessel).

QUESTIONS AND ANSWERS FROM NEWSNOTES

Q What is the best range for my blood sugars?

A This is not an easy question to answer. It depends on the individual person and family as well as the age of the person with diabetes. Most textbooks list a normal fasting level (or when no food is taken for two or more hours) as 70-100 mg/dl (3.9-5.5 mmol/L). It is unrealistic for most people with diabetes to aim for normal non-diabetic sugar levels. *“Understanding Diabetes”* (the Pink Panther book) suggests ranges by ages:

Under five years old:

80-200 mg/dl (4.5-11.1 mmol/L)

5-11 years old:

70-180 mg/dl (3.9-10.0 mmol/L)

12 years old and above:

70-150 mg/dl (3.9-8.3 mmol/L)

However, these are “generally suggested ranges” for fasting or if there is no food intake for at least two hours, and they do not take individuals or families into account. For example, a 10 to 11-year-old who does blood sugar testing regularly so that the chances of unrecognized low blood sugars occurring are unlikely, and who does not have severe insulin reactions (e.g., unconscious episodes), can probably safely aim for a level of 70-150 mg/dl (3.9-8.3 mmol/L). The reason for aiming for the lower level would be so that the glycohemoglobin (HbA_{1c}) levels may be lower with a reduced long-term likelihood of complications.

On the other hand, an adult who has severe episodes of unrecognized hypoglycemia might be wiser to try to achieve the middle range of 70-180 mg/dl (3.9-10.0 mmol/L). This might help to reduce the severe insulin reactions.

It is generally wise to discuss the level of blood sugar to aim for with your physician at each clinic visit.

Q Should bedtime blood sugar values be in the same range as morning blood sugars?

A No!

Table 2 in this chapter lists suggested blood sugar levels for the morning and bedtime. We ask that values be 60-70 mg/dl (3.3-3.9 mmol/L) higher at bedtime for the three age groups in comparison to the morning values.

This is particularly important for the spring and early summer. As the good weather comes and children play outside in the evening, it is important to reduce the pre-dinner rapid-acting insulin and to check the blood sugar before the bedtime snack. If the blood sugar value is below the suggested lower limit for the age, an additional snack should be given (and the insulin dose further reduced the next day). Levels are also suggested in Table 2 for when it would be wise to check another blood sugar during the night. It is only by constant monitoring that some families are able to prevent severe insulin reactions in their children.

Q With the data from the DCCT being in everything we read about diabetes, what can we do to improve glucose control for our 17-year-old son? His morning blood sugars are fine, but he is extremely variable (60-340 mg/dl or 3.3-18.9 mmol/L) before dinner.

A Blood sugars before dinner are influenced by lots of factors.

For example:

-  The size and sugar content of the afternoon snack
-  If it has been at least two hours without food intake when the blood sugar is done
-  Exercise, which makes some people’s blood sugar higher (due to adrenaline [epinephrine] output) while causing other people’s to become lower

One helpful practice is to do a blood sugar before the afternoon snack. If the value is high, the snack can be limited to low carbohydrate foods such as diet pop, popcorn, string cheese, carrots, celery, etc. Then see if the value is down by dinner. Obviously, if the value is low, calories are needed. Each family has to decide (on the basis of exercise, school lunch, stress, etc.) what a low value is at that time of day for their child.

Another alternative might also be considered. I know a 17-year-old (whose father asked this question) whom I would guess is going to eat regardless of the blood sugar level! He might take some rapid-acting insulin if the value is above a certain level to hold him until dinner. In this boy's case, I suggested he take four units of rapid-acting insulin if the blood sugar is 150-200 mg/dl (8.3-11.1 mmol/L) and six units if greater than 200 mg/dl (11.1 mmol/L). The dose would vary for different sized people and different sized appetites.

A third alternative which works for many people is to exercise for 30 or more minutes (shooting baskets, riding an exercise bike or doing other activities). This brings the sugar down for many people, and the exercise is obviously important for many other reasons.

I should also stress that with the DCCT data and the push for better control, more frequent blood sugar monitoring and extra insulin when the value is high may be the key for many people. Sometimes the extra shot may be in the afternoon or at lunch. This adds extra pressure to families, but the results will be rewarding in the long run.

Q Do I need to test my child's blood sugar every morning at 2:00 a.m.?

A For most children, this is NOT necessary. Occasional checks during the night (e.g., once every one or two weeks) are helpful. *Special circumstances that make nighttime checks important are:*

An illness. A sick child who may not have eaten well during the day, or who had urine ketones and/or extra (or less) insulin secondary to the illness.

A low pre-bedtime snack blood sugar. If values are below 80 mg/dl (4.5 mmol/L) in a preschooler, below 70 mg/dl (3.9 mmol/L) in a 5- to 12-year-old, or below 60 mg/dl (3.2 mmol/L) in a person age 12 or above, the blood sugar should be checked later (when the parents go to bed or during the night) to make sure the value has risen. This is recommended in Table 2 in Chapter 6. It might also be good to give an extra snack (or a larger amount) at bedtime.

Variable morning blood sugar levels. When some morning blood sugar values are low (e.g., below 60 mg/dl [3.3 mmol/L]) and other values are high (e.g., above 200 mg/dl [11.1 mmol/L]), many care providers suggest doing a value during the night to make sure "rebounding" from low values is not causing the high values. Other care providers believe that rebounding is very unlikely and that the difference in morning values is due to other factors such as variability in insulin absorption.

Frequent low blood sugars during the night. If a child is awakening two or more times during the week with symptoms of low blood sugar, it may be wise to routinely do some middle-of-the-night blood sugars to make sure this is not happening more frequently. The physician caring for the child should also be called.

If blood sugars are fluctuating without explanation. A more intensive testing

schedule for a week or more, including early a.m., can often determine where the insulin dosage needs to be adjusted.

Q With all of the good glucose meters having memories of blood sugar values which can be printed out in clinic, do I still need to write down every blood sugar value?

A Unfortunately, the answer is YES. It is just as important to write values down now as it was when meters did not have memories. It is important to look for “trends” in blood sugar levels in order to know when to make changes in insulin dosages. If a person or family does not do this, they are not doing a good job of home diabetes management. One of my top “pet peeves” in diabetes care is to have a patient (or family) who does blood sugars and constantly has values that are too high or too low, but they don’t make changes between clinic visits or fax the values to a diabetes care provider who can make suggestions.

Our general rule of thumb is that if more than half of the values at any time of day are above the upper level (usually 180 for 5-11 years old or above 150 if 12 years or older), an increase in the insulin dose is needed. For example, if an 11-year-old has all morning values above 180 mg/dl (10.0 mmol/L) for a week, the Lantus insulin should be increased by one unit. Similarly, if the pre-dinner values are all above 180 mg/dl (10.0 mmol/L) for a week, the morning intermediate-lasting insulin dose should be increased by one or two units. If the values are not being recorded in such a way that values done at the same time of day can be easily compared, it is possible that these trends will be missed. The opposite is also true; if there are more than one or two values in a week below 60 mg/dl (3.24 mmol/L) at any time of the day, the insulin dose working at that time can be reduced. If there is a question whether doses should be changed, the fax page in this Chapter can be faxed to the healthcare

provider (most schools and work places now have fax machines). The faxing of the blood sugars saves valuable doctor/nurse time in having to sit at a phone and write down results. Our Center now averages over 20 patient faxes per day, and it is considered part of the service of the quarterly (every three months) clinic visits.

For the young child or teen who does not want to write values down, it is often acceptable for the parent to push the “M” (memory) button at the end of the day and record the values. This is a way for the parents to stay involved and most teenagers agree to accept this help. The parent is often the family member who does the faxing to the healthcare team as well.

Q Are blood sugar levels after meals important?

A Blood sugar levels after meals have previously been largely ignored by children’s doctors and families.

Yet, the highest blood sugars of the day occur in the 1-2 hours after meals. Recent data shows that these high values affect the HbA_{1c} and are thus important in relation to many of the later complications of diabetes. Thus, it is now recommended that you check the blood sugar two hours after each of the meals at least once weekly.

Part of the problem in the past was that there was not a-rapid acting insulin to help to lower the sugars after meals. Now Humalog/NovoLog/Apidra insulins fill the need. Many of our teens working for improved glucose control (a lower HbA_{1c} level) will now take a shot of rapid-acting insulin with lunch and/or with their afternoon snack. If this is done consistently, it can be just as effective as using an insulin pump. The insulin pens are easy to carry and often work effectively for this purpose (see Chapter 9).

continued on page 64

Daily Record Sheet

Name _____

Fax To _____ At _____

Bring these results to your clinic visit

	Breakfast		Lunch		Dinner		Bedtime		Comments: Reactions, exercise, illness, bedtime snack
	Results	Insulin Dose	Results	Insulin Dose	Results	Insulin Dose	Results	Insulin Dose	
Sun Time									
BG/Ket									
Mon Time									
BG/Ket									
Tues Time									
BG/Ket									
Wed Time									
BG/Ket									
Thurs Time									
BG/Ket									
Fri Time									
BG/Ket									
Sat Time									
BG/Ket									
Sun Time									
BG/Ket									
Mon Time									
BG/Ket									
Tues Time									
BG/Ket									
Wed Time									
BG/Ket									
Thurs Time									
BG/Ket									
Fri Time									
BG/Ket									
Sat Time									
BG/Ket									

- Reminder: 1. Make sure insulin doses are included under the Insulin Dose Heading.
 2. How to reach you: FAX _____ or Phone _____
 if by phone, best time to reach you: _____ (between 8 a.m.- 5 p.m.)
 3. Person to be reached: _____

Q Our family does everything by e-mail now. Is there a way I can get the blood glucose fax sheets from Chapter 7 of the Pink Panther book on my computer?

A Yes, this can now be easily done. Families wanting to use these forms to e-mail to their doctor or nurse, can get them from these links:

The Barbara Davis Center home page is at: www.barbaradaviscenter.org. Then go to Books Online, to Understanding Diabetes, and you can then e-mail them to your doctor

and nurse at your Center. The e-mail address at my clinic is:

It is essential for you to give phone numbers and the time to get back to you as it is often best to actively discuss the blood sugars and insulin doses.

Please note: depending on the resolution of your monitor, the lines on the sheets may not appear continuous. They will, however, print out accurately.

Appendix

Some Meters with Programs to Allow Downloading at Home

PROGRAM AND COST	VENDOR/ADDRESS PHONE/WEBSITE	METER SUPPORT
In OneTouch Diabetes Management Software is free with connecting cable; cable = \$29.99	LifeScan, Inc. 1000 Gibraltar Drive Milpitas, CA 95035 800-382-7226 www.lifescan.com	OneTouch Diabetes Management
Precision Link and Software: connecting cable = \$39.95 FreeStyle/Flash free software is available on the website	Abbot Diabetes Care 1360 South Loop Road Alameda, CA 94502 888-522-5226 www.abbottdiabetescare.com	Precision Xtra, FreeStyle, FreeStyle/Flash
Ascensia®WinGlucofacts®: software can be downloaded from website for free (www.bayercaresdiabetes.com) connecting cable = \$29.95 or \$49.95 if you purchase the cable and software	Bayer Corp. 7750 West Morris Street Indianapolis, IN 46231 800-348-8100 bayercaresdiabetes.com	Ascensia® Contour®, Ascensia® Breeze®, Ascensia® Dex® 2, Ascensia Elite®, Ascensia Elite® XL
Accu-Chek® Compass: software = \$29.95 connecting cable = \$30.00	Roche Diagnostics 9115 Hague Road P.O. Box 50457 Indianapolis, IN 46250-0457 800-858-8072 www.accu-chek.com	Accu-Chek Active System, Accu-Chek Advantage System, Accu-Chek Compact System, Accu-Chek Complete System