CHAPTER 7:

BLOOD SUGAR (GLUCOSE) MONITORING

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Blood sugar monitoring is an essential component of diabetes management. It is perhaps even more important when using an insulin pump to manage diabetes.

For purposes of this book, we are referring to glucose meter readings as "blood sugar levels." Continuous Glucose Monitor (CGM) readings are being referred to as "subcutaneous glucose levels." Some of the reasons for doing blood sugar checks are listed in Table 1.

TABLE 1:

SOME OF THE REASONS FOR BLOOD SUGAR MONITORING

- **Prevention and early detection of blood sugar excursions**
- **Improved blood sugar control**
- **Informed adjustment of insulin dosages**
- **Management of illnesses**
- **Understanding the effects of various foods, insulin doses, exercise or stress**
- **Discrimination of a rapid fall in blood sugar from a truly low blood sugar value**
- **Immediate knowledge of blood sugar level**
- **Sense of control**
- **Indication of a need to check urine or blood for ketones**

Blood sugar checking represents the **"Second Era"** of diabetes management (urine sugar checking being the **"First Era"**). Unfortunately, with blood sugar checking, the sugar level is known for only a few seconds out of the 86,400 seconds in each day. As a result, many people are now moving to the **"Third Era,"** which is continuous glucose monitoring (CGM) (see Chapters 15-18). Some people start CGM prior to beginning pump therapy to make the transition easier. Others get used to wearing the pump and then consider CGM. It is difficult to try to begin both at the same time. There will always be a need for blood sugar checking, both to calibrate the CGM systems and to check values when the CGM values do not seem quite right. Many people who use a CGM also check blood sugar levels when the CGM level is high, low, or when "pending low" CGM alarms occur. It is wise to check a blood sugar level if feeling low – even if the CGM value does not concur. The FDA has not approved making treatment decisions based on CGM results. Blood sugar values continue to be the gold standard for diabetes management.

DESIRABLE BLOOD SUGAR LEVELS

Table 2 gives suggested blood sugar ranges for people of different ages. Most diabetes care providers recommend higher blood sugar target values for very young children than for adolescents or adults. Young children's brains are still developing and are sensitive to low sugar levels. In addition, as young children may not always recognize low blood sugar symptoms, higher target ranges are usually suggested.

Some people are able to safely aim for lower blood sugar ranges without having severe hypoglycemia. Others who have difficulty recognizing low blood sugar symptoms, or who have had severe hypoglycemia may need to aim for higher ranges.

If blood sugar values (for age) are consistently above or below the upper or lower level at a given time of the day, the insulin working at that time needs to be adjusted. The pump user/family can discuss with the diabetes care provider if the basal and/or bolus dosages need to be altered.

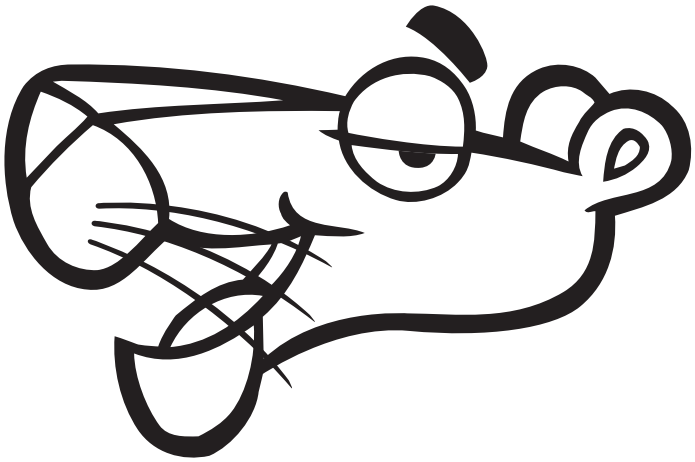
TABLE 2:

SUGGESTED BLOOD SUGAR LEVELS

	Fasting (a.m.) or no food for at least 2 hours		Bedtime (before bedtime snack or during the night)	
Age (years)	**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 blood sugar level should be rechecked 10-30 minutes after eating the recommended carbohydrate snack to make certain the blood sugar has come back up. If this happens more than once within a week, a reduction in either the dinner insulin to carbohydrate ratio or the evening basal rate may be needed. The pump user/family should call the diabetes care provider for advice.



WHEN TO CHECK

Frequent blood sugar monitoring is required in the first week or two after initiating pump therapy to help set the correct basal rates and bolus doses. The times to do checks include (at a minimum):

- prior to each meal
- before the bedtime snack
- two hours after eating (to help adjust bolus doses)
- once during the night (at midnight the first night, at 1 a.m. the second night, at 2 a.m. the third night, etc.)
- two hours after a correction dose is given (to determine if the dose is correct)
- before driving a car (safety issue to make sure the blood sugar is not low)
- anytime the person has symptoms of a low blood sugar
- anytime the person has symptoms of a high blood sugar
- anytime a pump insertion comes out or if an alarm for no insulin delivery occurs
- if a CGM is being used, anytime there are alarms for high, low or pending low glucose levels

This amounts to a minimum of seven or eight checks per day in the first week. This number may be reduced in the second or third week to a minimum of four or five per day. It is obvious that parents or a significant other are extremely helpful at this time to assist with checking. The minimum will eventually be four checks daily with occasional checks during the night. However, when striving for safe "tight" control, more than four blood sugar checks a day are usually needed.

Recording blood sugar results is essential. A specific form for reporting (via fax or email) blood sugar results is shown in Table 3 and may be copied as often as desired. It can also be found on our website (www.BarbaraDavisCenter.org). The basal rates can be entered on the first day of the chart and then re-entered only when a change is made.

If a person does not recognize signs and symptoms of hypoglycemia, it is even more critical to continue frequent blood sugar monitoring. A CGM may be helpful, but it cannot take the place of frequent blood sugar checking for this condition (often called "hypoglycemia unawareness").

To help control high post-meal blood sugars, do more checks in the periods after meals. This is the period when food is being absorbed and the blood sugar levels are the highest. The ADA recommends that blood sugar levels not exceed 180 mg/dl (10 mmol/L) at any time after the meal. The peak blood sugar level usually occurs 60 minutes after a meal. This is in contrast to the peak in activity for any of the three rapid-acting insulins (Humalog, NovoLog, Apidra), which occurs after 100 minutes. A blood sugar reminder or other alarm feature is built into many pumps. This feature can be set to remind the person to check their blood sugar after a meal. With checking after meals, it soon becomes obvious that the best way to prevent high blood sugar values after meals is to give a pre-meal bolus 15 to 30 minutes prior to eating (see Chapter 6).

NUMBER OF CHECKS PER DAY

Most diabetes clinics require pump candidates to be checking their blood sugar at least four times per day. Pump users are thus a pre-selected group. One study found that people who were most likely to discontinue using the pump were those doing only one or two checks per day. (2) Many studies have shown an association between doing more daily blood sugars and lower HbA1c levels, which reduces the risk for diabetes-related eye, kidney, nerve and heart problems. It is generally not possible to fine tune pump therapy unless multiple blood sugar checks are done each day. As noted above, a minimum of seven or eight blood sugar checks per day is required in the first week or two on

the pump. Many of the people with the best HbA1c values continue to do this number of checks each day. **The number of blood sugar checks should never decrease to fewer than four a day.**

KEEPING AND SHARING RECORDS

A pet peeve of most diabetes care providers is a person/family showing up at clinic with no blood sugar records or meters to download. The clinic visit usually results in wasted time for all. If the blood sugar checks are done using the CoZmonitor (Deltec Cozmo pump) or on a meter that relays the values to the pump, the blood sugar results will be included in the pump download. When blood sugar results have to be manually entered into the pump, some values are usually not entered (or are entered erroneously).

Some pump users download their meters and email the values. Others use the form shown in Table 3. Good communication on a daily basis between the pump user/family and the diabetes care provider in the early period is essential. After the initial basal and bolus doses are established and the blood sugar values are mostly (>50%) in the acceptable range, faxes or emails on a monthly basis are helpful. If the HbA1c is not in the desired range at a clinic visit, more frequent blood sugar checking and regular communication is usually advised.

SUMMARY

Frequent blood sugar monitoring is extremely important in attaining optimal diabetes management for pump users (and those on other insulin regimens). It is essential for safety as well as for determining correct basal and bolus insulin dosages. The more often you check, the more you and the Team will know how well your treatment is keeping your blood sugars within the acceptable target range. The pump user/family and diabetes providers must work together in using the data to achieve the maximum benefit from insulin pump therapy.

DEFINITIONS

Continuous Glucose Monitor (CGM): A device (sensor, transmitter and receiver) that measures subcutaneous glucose levels every one to five minutes (see Chapters 15-18).

FDA: The Food and Drug Administration. They approve and monitor medicines and devices for our safety.

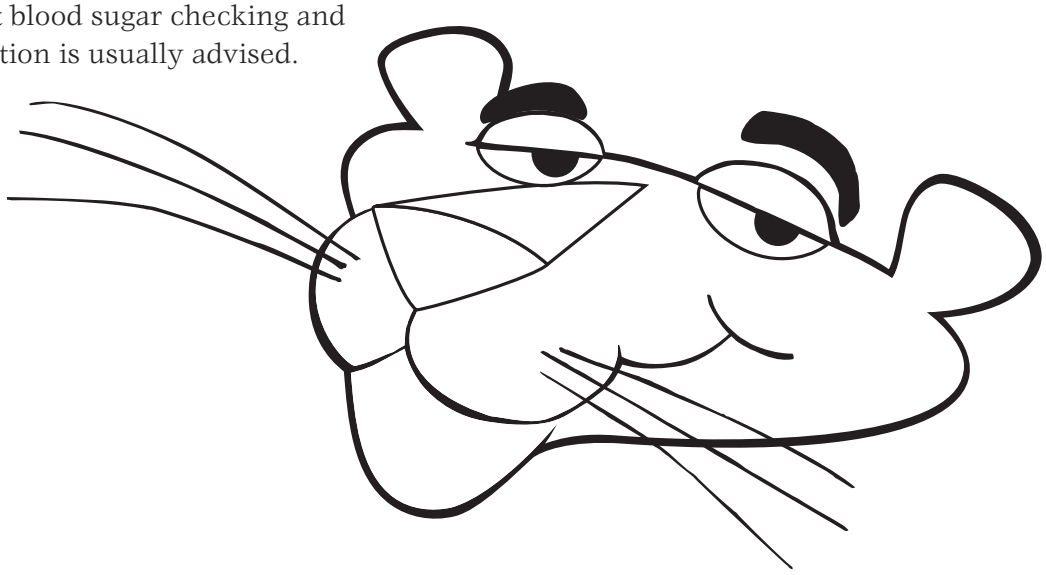


TABLE 3: Weekly Insulin Pump Management Record

Name ______________________ Week of ______________________

		12M	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12N	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P	Notes
Day/	BG																									
Date	Carbs																									
	Basal																									
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Target Range: ______________________

Correction: ______________________

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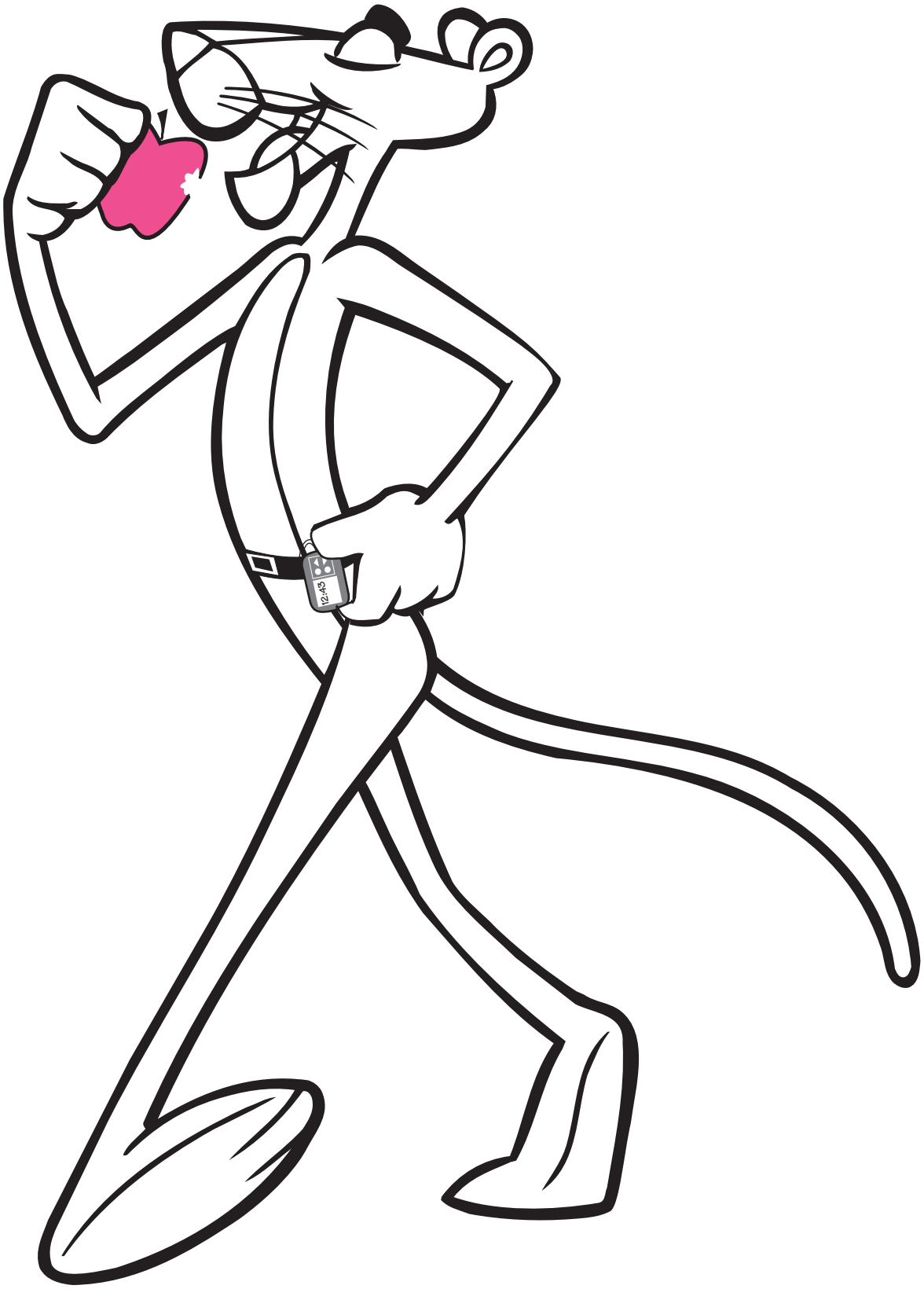
I/C Ratio

I/C Ratio

* Correction bolus

This table may be copied as often as desired.



FOOD IN MOUTH, HAND ON PUMP!