

CHAPTER 2:

ADVANTAGES AND DISADVANTAGES OF INSULIN PUMPS



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Much of what is written on insulin pump use is biased in favor of insulin pump manufacturers. There are many people who are able to control all aspects of their diabetes without using insulin pumps. This chapter objectively discusses advantages and disadvantages of insulin pump use.

TABLE 1:

Advantages

1. Improved blood sugar control
2. Availability and convenience of insulin delivery
3. Reduction of hypoglycemia
4. Flexibility and freedom
5. Control of post-meal blood sugar levels and correction of hyperglycemia
6. Ease of adjusting insulin doses with exercise

Disadvantages

1. Remembering to give insulin boluses with food intake
2. Ketonuria or ketoacidosis
3. Psychological factors
4. Expense
5. Weight gain
6. Skin infections
7. Insulin unavailability and instability
8. Infusion site locations and set changes every three days
9. Physical/logistical considerations

ADVANTAGES OF INSULIN PUMPS

The main advantage of a pump is in the eye of the beholder. A youth who takes six or eight insulin injections a day would probably say the main advantage is “reducing the number of shots.” In contrast, a parent who has been doing most of the diabetes management tasks might think insulin pump use would get the youth more involved in the diabetes management. Many diabetes team members believe the main advantage of pump therapy is improved blood sugar control (and thus reduced risk of diabetes

complications). All of these reasons are correct to some degree.

1. Improved blood sugar control

The Diabetes Control and Complications Trial (DCCT) (4) showed that improved glucose control lessened the likelihood of the eye, kidney, nerve and heart complications of type 1 diabetes. Sugar control is measured by doing daily blood sugar checking and obtaining an HbA1c value every three months. Many people who use pump therapy achieve lower HbA1c values and thus decrease their risk for

complications. People who are unable to achieve good blood sugar control on multiple daily injections of insulin may do better with insulin pump therapy. If insulin boluses for food or high blood sugar levels are not given, however, sugar control will **NOT** improve and may even worsen.

We have collected up to nine years of data on pump therapy in youth. All youth were followed in a general pediatric diabetes clinic. They were not in a research study with extra funding for increased medical attention. HbA1c values decreased by an average of 0.5% (for any given year of pump therapy) when compared to pre-pump values. (5) The decrease in HbA1c values was greatest for youth with a high pre-pump HbA1c (e.g., 8% to 9%). Youth whose pre-pump HbA1c values were lower (e.g., 7% to 8%) had less of a decrease in HbA1c values. An article published in 2002 summarized 11 research papers that compared insulin pump therapy to multiple daily insulin injections. The authors also reported an average decrease in HbA1c values of 0.5% in the insulin pump group. (6)

2. Availability and convenience of insulin delivery

One of the big advantages of using a pump is that the insulin is readily available. If the pump user is going to share a meal or snack with friends, it is relatively easy to push a few buttons to take extra insulin. The pump does offer unique opportunities that insulin shots do not offer — such as the ability to temporarily decrease or discontinue the insulin. In contrast, there is no way to discontinue insulin activity from a shot of NPH, Lente or Lantus insulin given a few hours earlier.

Insulin does not need to be drawn from a vial and injected. Youth who do not like to take multiple shots may be more likely to take insulin for random food intake with an insulin pump.

3. Reduction of hypoglycemia (low blood sugars)

At our Center, youth using insulin pumps have had significantly fewer episodes of severe hypoglycemia, compared to their pre-pump years. (5) This decrease in severe hypoglycemia is dependent on thinking ahead, doing frequent blood sugar checks, decreasing basal insulin infusion rates during and after heavy exercise, checking basal rate and bolus accuracies and eating meals and snacks appropriately.

In addition, current “smart” insulin pumps will fine-tune the correction bolus dosage by adjusting for insulin that could still be active in a person’s body. This reduces the chance of a low blood sugar. In summary, insulin pumps can help prevent hypoglycemia if used correctly.

4. Flexibility and freedom

Some people enjoy more flexibility and freedom with insulin pump therapy. They enjoy:

- Being able to sleep late in the morning
- Being able to vary the time or size of meals or exercise
- Being able to take extra insulin to correct high blood sugar levels or ketones

It is possible to use Lantus or Levemir insulin instead of pump therapy during extreme sports or extended water activity. This is done by converting the total 24-hour basal insulin dose to a dose of Lantus or Levemir insulin. However, the pump basal insulins must not be restarted until 24 hours after giving the basal insulin injection.

5. Control of post-meal blood sugar levels and correction of hyperglycemia (high blood sugars)

The rapid-acting insulin in the pump begins to work in 10 minutes, peaks in 100 minutes and lasts three to four hours. As carbohydrates can increase blood sugar levels 10 minutes after being consumed and cause a peak in blood sugar levels in 60 minutes, the insulin bolus is ideally given 15 to 30 minutes before the first bite of food. Special bolus settings (Square Wave or

Extended, or Dual Wave or Combination) are available (see Chapter 6) to manage the delayed absorption of high-fat and high-carbohydrate meals (e.g., pizza). Using the pump bolus features correctly can prevent post-meal hyperglycemia. In addition, extra boluses can be administered easily to correct hyperglycemia between meals. People are often more willing to do this since it does not require an additional shot.

6. Ease of adjusting insulin doses with exercise (see Chapter 9)

It is easy to discontinue insulin delivery or to use a temporary basal for extended periods of exercise. Some people decrease insulin 30 or 60 minutes before exercise, during the exercise, and/or for three to seven hours after exercise to prevent lows during exercise and/or delayed hypoglycemia. Similar individualized alterations are more difficult with injected insulin regimens.

DISADVANTAGES OF INSULIN PUMPS

1. Remembering to give insulin boluses with food intake

Some people have difficulty remembering to give an insulin bolus for a meal or snack that contains greater than five grams of carbohydrate. This also occurs with people taking multiple daily injections. HbA1c values will not improve (and in fact may increase) if boluses are forgotten. Basal insulin doses turn off the body's internal sugar production, but basal insulin does not manage the carbohydrate content of food or beverages. If the bolus is forgotten, the post-meal blood sugar level will increase. Forgetting bolus doses is the major reason for lack of improved HbA1c values with insulin pump therapy. The HbA1c value may increase by 0.5% if two meal boluses per week are missed for three months and by 1% if four meal boluses per week are missed for three months. (7) Pump alarms, alarms in blood sugar meters, or watch alarms can help some people to remember to give boluses. Receiving verbal reminders from other people can also help.

2. Ketonuria or ketoacidosis

When an insulin pump malfunctions, insulin delivery is interrupted. Ketones can develop within three to four hours, which is the duration of action of the last dose of rapid-acting insulin infused. The pump may alarm if the infusion cannula or plastic tubing is plugged or if the pump reservoir is low on insulin. It is possible for the plastic tubing to develop a kink that decreases the insulin delivery. If the infusion cannula slips out from under the skin, the person may smell or feel the wetness of the insulin. Insulin exposed to extreme temperatures can lose potency. When the pump user experiences unexplained high blood sugar or notes increased thirst and urination, he or she must do a urine or blood ketone check and administer a correction insulin dose by injection (syringe). The infusion set, tubing and insulin reservoir must then be changed. Correction insulin doses must continue to be given by syringe (or pen) until the blood sugar level normalizes and ketones resolve.

If blood sugar control has been good for a period of time, ketones will generally not form as rapidly and/or can be cleared more easily. In contrast, if sugar control has been poor, the ketones will develop more rapidly and build up. Our pump users are routinely taught to use a blood ketone meter to know the exact ketone status at that moment. The blood ketone strips are now available in all Wal-Mart pharmacies. However, they are expensive (\$4.00 USD per strip) and are often not covered by health insurance.

3. Psychological factors

Wearing a pump, even though it is about the size of a cell phone, is difficult for some people. We have heard the comment, "Starting the insulin pump was like getting diabetes all over again. People who had not known that I had diabetes now ask me what the pump is." A considerable amount of learning about the pump is necessary. Other people comment, "Wearing an insulin pump is like constantly being hooked up to an instrument."

TABLE 2:

COSTS: PUMP VS. INJECTION THERAPY FOR TYPE 1 DIABETES
Out-of-pocket monthly costs (without insurance, as of 8/07)

INJECTION THERAPY		PUMP THERAPY	
<ul style="list-style-type: none"> • Insulin: Humalog (\$92), Apidra (\$92) NovoLog (\$99), Lantus (\$90) Average use ~3 vials x ~\$95/vial = • Blood sugar checking strips: 100 strips/box, ~\$95/box x 2 = • Syringes: 100/box ~\$35/box • Ketostix: 20/box ~\$10/box • Lancets: 100/box ~\$12/box • Glucagon Emergency Kit: (1-2/year ~\$117 each) 	<p>\$285</p> <p>\$190</p> <p>\$35</p> <p>\$10</p> <p>\$12</p> <p>\$117</p>	<ul style="list-style-type: none"> • Initial cost of an insulin pump = \$6000** • Monthly cost of an insulin pump • Insulin for pump: Humalog, NovoLog, Apidra ~\$95/vial x 3= • Blood sugar checking strips: 100 strips/box, ~\$95/box x2 = • Sets, tubing and cartridges • Ketostix: 20/box ~\$10/box • Lancets: 100/box ~\$12/box • Glucagon Emergency Kit: 1-2/year ~\$117 each) 	<p>\$125</p> <p>\$285</p> <p>\$190</p> <p>\$200</p> <p>\$10</p> <p>\$12</p> <p>\$117</p>
Total Monthly:	\$649	Total Monthly (incl 1/48 of pump cost)***:	\$939
Total Monthly w/out glucagon*:	\$532	Total Monthly w/out glucagon*:	\$822
MD visits every 3 months ~ \$193/visit + labs			

* add \$90 for an extra vial of insulin for teens

** Payment plans are available through most pump companies. Many offer refurbished pumps (which carry the same four year warranty) for about half price (~\$3,000). Some companies also offer financial assistance of up to ~\$1,000 for new pumps and ~\$600 for refurbished as well as cash discounts (~20%).

*** Most pump warranties last for four years (48 months).

4. Expense (see Table 2)

Pumps are expensive but most insurance companies pay for at least a portion of the cost. Initial expenses include buying the pump (~\$6,000 USD), initiating pump therapy (\$1,500-\$10,000 USD, depending on whether the pump start is done as an outpatient or in the hospital) and yearly pump supplies (~\$2,000 USD). Although this may seem like a lot of money, if blood sugar control improves, the cost savings in the prevention of diabetic complications offsets these expenses.

5. Weight gain

People who achieve better sugar control with

insulin pump therapy may gain weight. This is because sugar is used for energy rather than being spilled into the urine. In addition, some people tend to snack more as it is easier to push buttons to give an extra bolus of insulin than it was to give an injection. Working with a dietitian before and after starting pump therapy can help prevent weight gain. Excessive weight gain has not been a problem among the Barbara Davis Center insulin pump users. (5)

6. Skin infections

Infections can occur at the infusion sites, particularly if the infusion sets are left in for longer than three days. However, if proper

cleaning techniques are followed, and the infusion set is changed every two or three days, infections are not common.

7. Insulin unavailability and instability

One must remember to routinely fill the insulin reservoir (syringe) in the pump so that the pump does not run out of insulin. If using the OmniPod, after the warning at 72 hours of wear, the pump will shut down in 8 hours, regardless of the insulin remaining. Insulin spoils if it freezes or reaches temperatures above 90°F. One of our youth “cooked” her insulin by wearing her waterproof pump in a hot tub. Others have frozen insulin by exposing tubing while skiing. This can be prevented by keeping the tubing close to the body. Whenever the pump is subjected to temperature extremes or direct sunlight, the insulin action may be compromised.

8. Infusion site locations

It is important that all possible site locations be used, even the ones that are not the “favorites.” A pump set can be inserted anywhere an insulin injection can be given. Following a pattern of rotation and using an infusion site template (see Chapter 12) allow maximum healing time before a site is re-used. This helps to prevent swelling (hypertrophy) which may alter the timing of insulin activity.

9. Physical/logistical considerations

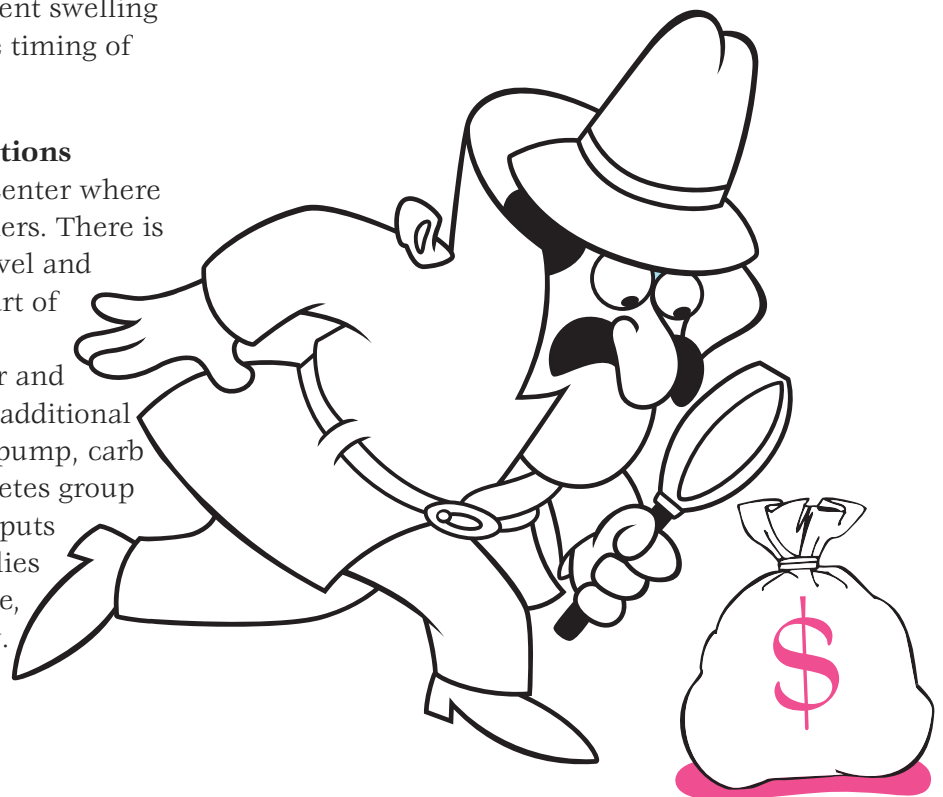
Some families live further from a center where training can take place than do others. There is then the added burden of time, travel and expense. Sometimes families do part of their training (e.g., learning pump features) from a local pump trainer and then travel to a diabetes clinic for additional help (e.g., initiating insulin in the pump, carb counting). The Children with Diabetes group (www.ChildrenwithDiabetes.com) puts on a course to help introduce families to pump therapy. In our experience, where there is a will there is a way.

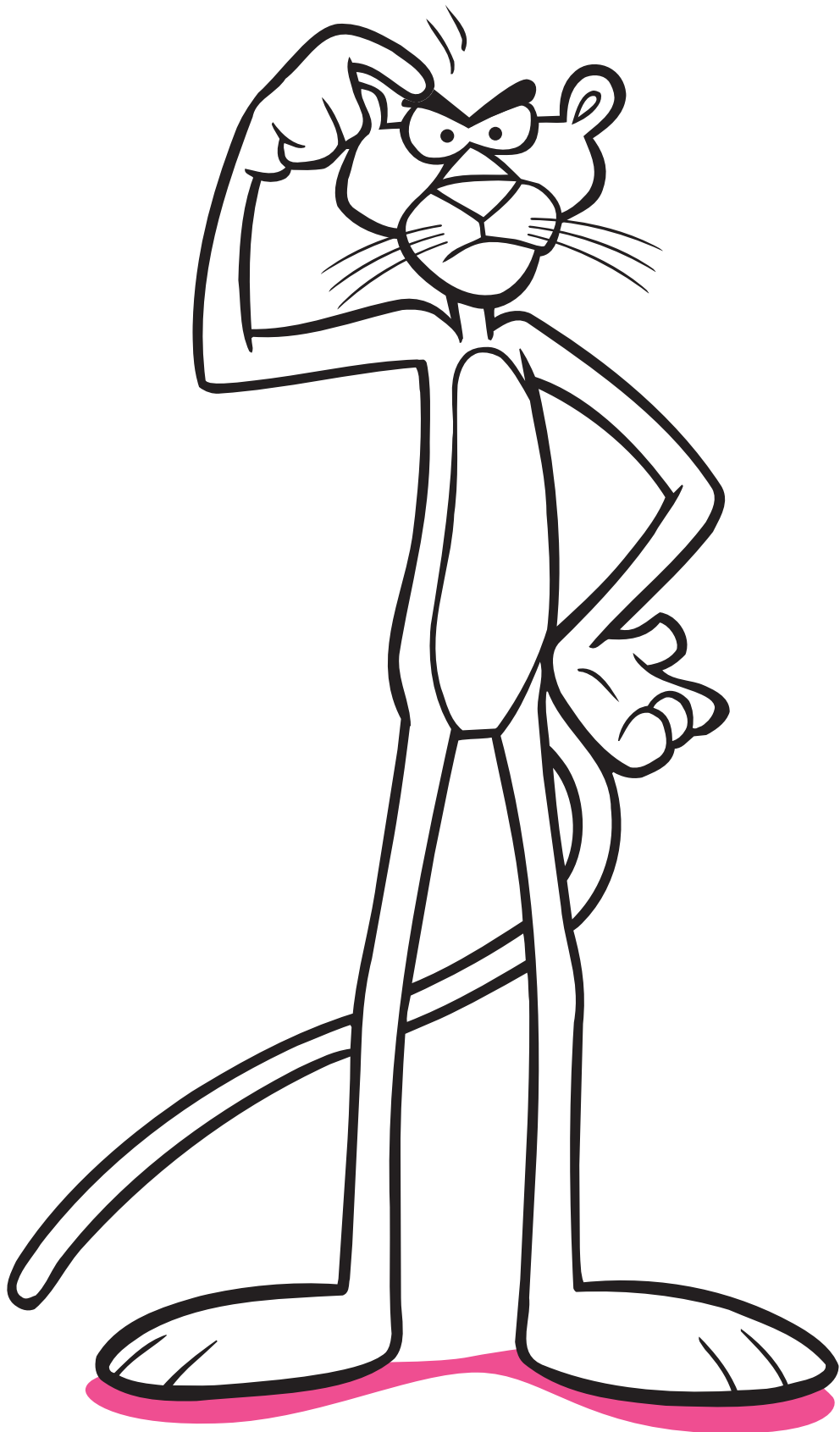
SUMMARY

There are many advantages and disadvantages to weigh when considering insulin pump therapy. Each family must discuss these issues and decide if it is time to proceed with the next step. If the answer is YES, Chapter 3 outlines the process of starting insulin pump therapy.

REFERENCES

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7. Burdick, J., Chase, HP, et al, *Pediatrics* 113; e221, 2004.





WHEN TO START?