

INSULIN-PUMP THERAPY

What is an insulin pump?

An insulin pump is a small electronic device that delivers customizable rapid insulin dosing throughout the day and night. This constant infusion of rapid insulin provides the background (basal) insulin supply that would otherwise be provided by an injectable long-acting basal insulin.

Bolus insulin is then given at mealtime, with a dose calculated using predetermined insulin-to-carbohydrate ratios (I:C ratio). This calculation involves matching 1 unit of rapid-acting insulin to an estimated number of carbohydrate grams to help control glucose rise after eating. By estimating the grams of carbohydrates to be consumed at any meal, a premeal dose can be determined, which should keep postprandial blood-glucose levels on target.

Bolus insulin is also further adjusted to correct for blood-glucose values that are above the individual targeted goal before the meal. This sensitivity or correction factor is a ratio that provides a specific decrease in blood glucose per unit of insulin. An insulin pump uses a built-in calculator to determine bolus doses that have been preprogrammed with the guidance of a health care provider. A specific blood-glucose target is determined for each individual pump user, along with the length of time that an insulin bolus dose is active in that person's system. This active insulin time or insulin on board is a calculation that reflects how much insulin remains active in the body from a prior insulin bolus injection. This timed calculation helps a user determine how frequently and how much insulin is recommended, and reminds patients that injecting more insulin too soon or "stacking" can cause hypoglycemia.

Some of the available insulin pumps use a thin plastic tubing (infusion set) with a small insertion needle or plastic cannula placed under the skin. The infusion set is connected on the other end to a mechanical pump which houses the insulin reservoir. Another model, a tubeless insulin-filled "pod," is adhered directly to the skin and insulin is infused through a small cannula under the skin. These "pod" pumps are managed by a remote handheld device. Pump site changes must be performed every 2-3 days to prevent hypertrophy, site irritations, or infections.

Pumps can be used with a blood-glucose meter or a continuous glucose monitor (CGM) system to provide data on blood-glucose values. When bolus doses are to be given, the pump user inputs the blood-glucose value, as well as the carbohydrates consumed at that meal. The pump then calculates the bolus dose based on the I:C ratio and correction factor.

Some pumps are sensor augmented, whereby the blood-glucose value from a CGM is communicated continuously to the pump. These pumps, referred to as "hybrid closed-loop systems," make adjustments to the background basal insulin delivery or temporarily suspend that delivery based on glucose data obtained from the CGM. In the future, more pumps will feature this system. An estimate of the number of grams of carbohydrates consumed must still be entered by the pump user at mealtime, so the appropriate bolus insulin is given to keep postprandial glucose levels at target.

The advantages of insulin pumps for your patients include fewer injections (only 1 injection every 2-3 days with the placement of the infusion set), insulin delivery that more precisely mimics natural insulin secretory patterns, and more convenience and flexibility. An insulin pump can be programmed to deliver a temporary basal, either increasing or decreasing the current basal for times of illness or hypoglycemia. Hybrid closed-loop system pumps will decrease basal rates automatically based on CGM blood-glucose data and targets. Pumps can also deliver mealtime insulin boluses over an extended period of time, which is extremely useful for someone with gastroparesis or when eating a high-fat meal that may be absorbed slower than usual.

It is important to emphasize to patients that poorly controlled diabetes on multidose injections will not magically and dramatically improve if they change to insulin-pump therapy. Still, a person who manages his or her diabetes well on injections will likely do well or better when pumping due to the additional features and flexibility that pumps offer. That improvement in control is often reflected in a greater glucose time in range (70-180mg d/L) and lower A1C, along with a decreased incidence of hypoglycemia.

Since it is a mechanical device, the possibility of a pump malfunction or an occlusion in the infusion set or cannula is a potential risk. There could also be an increased risk of diabetic ketoacidosis (DKA) if the pump user does not respond appropriately to high blood glucoses. When pumping, since there is no long-acting insulin present to provide some insulin coverage over an extended period of time and the basal insulin is supplied by the infusion of rapid-acting insulin from the pump, high glucose levels or even DKA can quickly ensue if the pump delivery is compromised. Having available ketone test strips is a necessity for insulin-pump users.

Who should use an insulin pump?

Insulin pumps can be used by persons with type 1 or type 2 diabetes if requiring multiple daily insulin injections. A potential pump candidate must have the desire and skills necessary to operate a pump. There needs to be commitment to checking blood sugars regularly or to wearing a CGM.

A pump user must be willing to engage in training sessions with the diabetes team to fully understand the functionality and technical aspects of a pump to prevent acute complications. Users must be prepared to problem-solve different scenarios, such as sick days, hyperglycemia, presence of ketones, or hypoglycemia, as well as recognize technical malfunctions and respond appropriately to alarms.

A person with an active lifestyle, one prone to frequent hypoglycemia, or someone with delayed food absorption (gastroparesis) would all be candidates for insulin-pump therapy. The ongoing evolution of the hybrid closed loop pumps will further enhance the efficacy of these devices. However, it is important to recognize that all these devices require user attention and involvement, and all patients must be dissuaded of any impression that you just “plug these in and forget them.” That is not the case.

If your patient with type 1 or multi-insulin-injection-requiring type 2 diabetes expresses a desire to use an insulin pump, a referral to a diabetes care team would be a good place to begin.

For more information, visit these insulin-pump websites:

www.tandemdiabetes.com

www.omnipod.com

www.metronicdiabetes.com

Reference: American Diabetes Association. Diabetes technology: Standards of medical care in diabetes – 2020. Diabetes Care. 2020;43(Supplement 1):S77-S88