

# Continuous subcutaneous insulin infusion: practical issues

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### ABSTRACT

The growing number of individuals with diabetes mellitus has prompted new way of treating these patients, continuous subcutaneous insulin infusion (CSII) or insulin pump therapy is an increasingly form of intensive insulin therapy. An increasing number of individuals with diabetes mellitus individuals of all ages have started using insulin pump therapy. Not everyone is a good candidate for insulin pump therapy, and the clinician needs to be able to determine which patients are able to master the techniques required and to watch for the adverse reactions that may develop. Insulin pump increases quality of life of patient with diabetes mellitus with increasing satisfaction with treatment and decrease impact of diabetes mellitus. Manual errors by insulin pump users may lead to hypo or hyperglycemia, resulting into diabetic ketoacidosis (DKA) sometimes. Some of practical aspect is associated with insulin pump therapy such as selection of candidates, handling of pump and selection of site, and pump setting, henceforth this review is prepared to explore and solve the practical problems or issues associated with pump therapy.

**Key words:** CSII, diabetes mellitus, insulin pump

## INTRODUCTION

Technological advances in medicine are highly anticipated and valued. As these advances gain recognition, they frequently change perspectives about appropriate treatments and may affect the information that physicians provide to families when discussing treatment options. However, it is imperative that newer treatments are evaluated to accurately identify treatment efficacy as well as possible psychosocial effects of treatment.

Continuous subcutaneous insulin infusion (CSII) was first introduced as a management strategy for both adult<sup>[1]</sup> and pediatric<sup>[2]</sup> patients with type 1 diabetes mellitus (T1DM) in the late 1970s. However, it was not until the Diabetes Control

and Complications Trial<sup>[3,4]</sup> and epidemiology of Diabetes Interventions and Complications<sup>[5]</sup> studies confirmed and re-affirmed the pre-eminent role of glycemic control in the pathogenesis of microvascular complications that use of insulin pump therapy as “intensive therapy” in young people with diabetes has become increasingly widespread.

Continuous subcutaneous insulin infusion (CSII) with a portable pump is an insulin therapy system first built in 1976 by Pickup and Keen for research purposes.<sup>[1,6]</sup> At that time, the size of the pump was equal to that of a back bag. Nowadays, the size of an insulin pump is no bigger than a cell phone or a credit card. More than three lakhs patients around the world use a continuous subcutaneous insulin infusion (CSII) system today, and the number of “pumpers” is expected to increase dramatically in the next decade.<sup>[7]</sup> The potential benefits of CSII became clear after the Diabetes Control and Complications Trial (DCCT) Research Group published a report in 1993.<sup>[8]</sup> Although the basic principles remain the same, several technological improvements have occurred in the previous 15 years, making insulin pumps safer, easier, and more flexible. Although CSII or pumps are the best method of insulin delivery for patients with type 1 diabetic and type 2 diabetic

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on MDI who are motivated, technologically savvy, and have the means to pay for the technology.<sup>[9]</sup>

## OPERATING INSULIN PUMP

When pump is on, it will show various icons. First, it will show a countdown, after which the screen goes dark, and then the version of the particular pump will appear on the screen. Then, a dark circle, a battery sign, and a syringe sign will appear on the screen. Generally, the battery work up to 10-12 days, and if there is a low battery alarm, then the battery should be immediately changed; some patient are commonly doing mistake in operating insulin pump by proper way; therefore, before starting pump therapy, patient or parents has to understand the basic operating function of pump.<sup>[10]</sup>

## PROPER SELECTION OF SITE AND ROTATION

Patients need to change the infusion set site every 2-3 days and should always rotate to a new site. Some pump users may need to change the site more often if they notice their blood glucose is less stable over time. The abdominal area is the most common site for set insertions. The abdomen allows for more rapid and consistent insulin absorption than from other sites, especially after exercise. When using the abdomen, help the pumper to identify a variety of abdominal sites for adequate rotation. Imagining a clock drawn on the abdomen can be helpful. Ask the patient to rotate the site in clockwise position from 12 o'clock to 3 o'clock and so on, and make sure the site is convenient to insert the cannula.

Some pumpers use the thigh or hip area; it is also possible to use areas higher on the abdomen that may have previously been used with injected insulin. Many prefer the hip area because it is "out of sight." If these sites are used, make sure that cannula placement is subcutaneous, not intramuscular.

Make sure that your patients understand that the insulin pump will alarm only if insulin delivery is interrupted. Reinforce that the pump cannot detect and will not alarm for certain problems at the infusion site. Explain that occasionally an infusion site may temporarily cease to absorb insulin properly, resulting in hyperglycemia.

## CONSIDERATION OF CANDIDATE FOR INSULIN PUMP THERAPY

Patients should be considered for insulin pump therapy when intermittent insulin injections are not meeting treatment goals and outcome measures are sub-optimal, including, but not limited to:<sup>[11]</sup>

- A1C > 7.0-7.5%, accompanied by frequent severe hypoglycemia (<70 mg/dL)
- Hypoglycemic events requiring third party assistance or interfering with work, school, or family obligations
- Frequent and unpredictable fluctuations in blood glucose levels
- Patient perception that diabetes management impedes the pursuit of personal or professional goals

Prospective pump users or their care givers must be able to change infusion sets, fill pump cartridges and program the pump, and must demonstrate willingness to collaborate with healthcare providers in achieving the goals of diabetes therapy.<sup>[11,12]</sup> In general, patients likely to succeed on insulin pump therapy will have had sufficient education and support while using other forms of insulin therapy so that they are already competent in assessing the nutritional value of meals and monitoring blood glucose levels frequently (minimum four times a day, preferably 6-8 times) and checking ketone levels when appropriate.<sup>[13]</sup> Insulin pump therapy is contraindicated in patients lacking the commitment or competence to perform basic diabetes self-management behaviors;<sup>[6]</sup> however, many of recent research has shown that such patients can see positive results from using a pump.<sup>[11,14]</sup>

Insulin pump users have the option of skipping or delaying meals and flexing the amount of carbohydrates consumed at one time. While taking insulin injections, patients must consume a pre-determined amount of food at specific times to prevent hypoglycemia from the onset and peak of the insulin injection.<sup>[15]</sup> With a pump, mealtime insulin is delivered more physiologically, based on the use of rapid acting insulin.

## PROBLEM ASSOCIATED WITH INSULIN PUMP THERAPY

### Discomfort

Although the insertion devices make insertion virtually painless, a small percentage of pumpers will experience discomfort when first inserting the infusion set.

### Skin problem

Clean technique, good hygiene, and changing the site as recommended are the best protection against skin infections. Careful attention to site preparation and daily checks of the site will prevent most infections. However, serious consequences can occur if insertion site irritation and infections are ignored. Suggestions for avoiding skin infections at insertion sites are:

- Always wash hands thoroughly with soap and water prior to removing a used infusion set and then again before preparing a new set.
- Change the infusion set every 2-3 days, preferably, after a bath or shower.
- Prepare the new infusion set on a clean surface such as on a clean paper towel.
- Always remove an infusion set at the first sign of abnormal discomfort at the insertion site and place a new infusion set in a fresh site, away from the original area.
- At the first sign of an infection, instruct the patient to call the doctor if any of the following are present:
  - Redness/hardness and tenderness/soreness around the site
  - Oozing from the cannula site
  - Area warm to the touch
  - If an infection occurs:
    - It is usually staphylococcal in nature and typically requires oral antibiotic treatment
    - If infection are recurrent, recommend patient to cleanse the area followed by alcohol prior to needle insertion
    - If abscess occur, perform an incision, drain the area, and culture the fluid
  - Rule out the methicillin-resistant staphylococcus
  - Consider using antibacterial in nares weekly to minimize recurrent infections

### Lipohypertrophy and lipodystrophy

Placing the infusion set frequently in the same region can lead to tissue hypertrophy and lipodystrophy. Although these lesions are benign, they can have significant cosmetic effects for patients. Patients should be instructed to frequently rotate the site of infusion set placement to avoid lipodystrophy. Patients should wait 3 to 4 weeks before using the same area to allow appropriate healing time.<sup>[16]</sup>

### Hypoglycemia

Hypoglycemia occurs in some patient due to following reason or issues (common mistakes):

- The most frequent cause is incorrect basal and bolus insulin dosage
- A second cause is excessive insulin administration and overlapping of bolus doses
- A third cause is not accurately estimating the amount of carbohydrates to be eaten
- Forth cause is due to mistake in setting of pump
- Another cause is that pump user sometime worry about is a pump malfunction, in which pump gives too much insulin. This rarely happen. The pumps have maximum dosage settings for both basal and bolus doses. These are set by the pump trainer at the pump start visit.

### Hyperglycemia

Some of pump users may suffer from hyperglycemia due to following reason:

- Due to pump catheter dislodged, blocked (partially or completely), or bent
- Due to incorrect basal rates programmed and delayed or dose not given bolus
- Sometime, pump is responsible due to pump malfunction such as dead battery/no power
- Reservoir/Cartridge (Pump Syringe): Leakage at infusion set and pump syringe, empty pump syringe
- Infusion Set: Set not primed, kinked tubing, blood in set, set in too long, set inserted at bedtime, air in set.
- Infusion Site: Irritated, red, inflamed tender, friction at site placement causing discomfort areas of hypertrophy
- Insulin: Cloudy, exposed to extreme temperatures (cold or heat)

### Diabetic ketoacidosis (DKA)

DKA is a serious medical condition that results from untreated hyperglycemia. DKA needs immediate treatment. Since insulin pump therapy uses only fast-acting insulin, DKA can occur rapidly because there is no longer-acting insulin in the body as back-up.

### Illness

Illness and infection put extra stress on the body, often causing a rise in blood glucose. If left untreated, hyperglycemia from illness can quickly lead to DKA. Hyperglycemia during illness is easily prevented by increasing oral fluid intake, adjustments to insulin pump doses, and more frequent blood glucose monitoring. Illness is manageable with diabetes if treatment guidelines are understood and necessary supplies are available. It is important to teach your patient to prepare for sick-days by having necessary supplies available at all times, especially when travelling.

### Mechanical problems

Mechanical problems and interruptions in insulin delivery often cause unexplained highs and can progress to ketoacidosis, if they are not promptly addressed. Possible causes for unexplained highs include infusion-site problems, displaced or clogged infusion set, inactivated insulin because of degradation, or pump malfunction. Troubleshooting should include an investigation of the pump, battery, reservoir, and infusion site to determine the potential causes for unexplained highs or lows.<sup>[16]</sup> Tunneling (insulin return on skin surface) is common when the subcutaneous tissue becomes inflamed and swollen around the infusion site. Blockage of the infusion pipe is also a common problem. Prolonged exposure to heat can cause insulin to coagulate within the infusion set, thereby

blocking delivery. Using unbuffered regular insulin increases the risk of infusion-line clogs.<sup>[17]</sup> Insulin leakage from the tubing or reservoir can also cause unexplainable high blood glucose levels. Although insulin leakage can be difficult to detect, patients can use observation and the distinct smell of insulin to locate the leak.<sup>[18]</sup> If a clog, leak, or infusion-related issue is suspected, the entire infusion set should be replaced or should be corrected. When the blood glucose rise up to 300 mg/dL or if two consecutive readings are more than 250 mg/dL, the patient should be instructed for ketones test.<sup>[16]</sup> In addition, a correction bolus dose of insulin should be administered. The blood glucose should be monitored every 2 hours, and, if ketones are present, the patient should rehydrate with an appropriate fluid until ketones have cleared and the blood glucose has stabilized.<sup>[16]</sup> Other reasons for unexplained hyperglycemia or DKA include mechanical problems, illness or infection, incorrect bolus dosing, and degraded insulin. When faced with mechanical problems, the patient may need to remove the insulin pump and correct the error.

## CONCLUSION

Insulin pump, also known as *In-vitro* pancreas and latest technological therapy, considered as standard care for type 1 diabetes mellitus and type 2 patients who developed severe beta cell failure or patients on multiple daily injections who need flexible quality of life. Some of practical issues are associated with pump therapy such as selection of candidates, site selection and rotation, setting of various pump parameters, and handling of pump in daily life. According to this review, it may conclude that for better outcome of insulin pump therapy, effective patient education is required to solve practical issues. Patient education for pump therapy should be delivered by diabetologist, diabetes educator, and pump technician.

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