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CSII in children with diabetes

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Although more than 40% of the participants in the intensive treatment group of the Diabetes Control and Complications Trial (DCCT) employed insulin pumps, in many countries the use of continuous subcutaneous insulin infusion (CSII) is not widespread outside research centres. In 1999, 7.5% (382 of 5065) Swedish children and adolescents (under 20 years of age) with diabetes were using CSII. This figure is now approaching 20% (1). Today very few paediatric centres in Sweden do not use pumps.

Insulin pump therapy is more expensive than conventional syringe or pen therapy. Since insulin pumps are not subsidized in most countries they may be a financial burden. In Sweden the cost of pumps and pump accessories has been reimbursed since 1997.

Indications for insulin pump therapy

Possible indications for the use of CSII are given in table 1.

Lack of insulin due to missing injections is one of the most common reasons for a high HbA_{1c} in a teenager. The question is how we can break the vicious cycle. An adolescent who 'forgets' many or most of their injections will do much better on a pump that at least supplies the basal insulin regularly (2). Non-compliance is very seldom the same as opposition, i.e. intentionally not taking the insulin (unless a desire for weight reduction is the reason for missing insulin).

Table 1. Possible indications for using an insulin pump

- High HbA_{1c}
- Problems with severe hypoglycemia
- High blood glucose during the night or in the morning
- Unstable blood glucose
- Multiple injections too demanding
- Missed injections
- Pain from insulin or needle
- Possibility of sleeping in
- Life quality benefits
- Patient's desire to try a pump?
- Pump from the onset of diabetes in pre-school children?

Clinical benefits and risks of CSII

Glycaemic control often improves, resulting in a lower HbA_{1c} after initiating insulin pump treatment (3, 4). Some patients will gain weight when they start using an insulin pump if they do not cut down their food intake as their glycaemic control improves (3, 4). Prospective and ongoing counselling can prevent an excessive weight gain after the initiation of pump therapy (5). The risk of severe hypoglycaemia usually decreases with pump treatment (4-6), even when it is used in children under the age of 6 years (7). Some parents of younger children feel that the pump needs more parental supervision than pen injector therapy during the day. For them nighttime pump is a feasible alternative. Nighttime pump use with daytime NPH plus lispro therapy led to improved fructosamine levels and better nighttime glycaemia in a 4 week cross-over trial in 7 to 10-year old children (8). Pump from the onset of diabetes has been successfully used in a clini-

cal trial when comparing with conventional therapy (9). A randomized trial comparing multiple injections of rapid-acting insulin with twice daily NPH-insulin and CSII in the age groups 7-17 years is now ongoing in Sweden. From experience we know that pre-school children often have labile blood glucose profiles and we have recently started several young children (aged 2-4 years) on pumps within 2 weeks of their diabetes.

The risk of ketoacidosis (DKA) may increase, according to some studies (10), or decrease, as in others (7). Ketoacidotic episodes are more common and occur soon after initiating pump therapy, when the patient is new to the method (6). Some teenagers are frequently hospitalized due to DKA caused by interrupted insulin supply. Such episodes can drastically be reduced with an insulin pump that makes a continuous insulin supply possible (11). In a study by Steindel et al the number of hospitalizations for DKA decreased by 50% while HbA_1c remained unchanged (2).

To prevent ketoacidosis, we readmit the child or adolescent to the day care ward after a couple of weeks of pump therapy for a 6-8 hour 'pump stop' to make the patient familiar with the symptoms and which measures should be taken. Some individuals have become slightly nauseous but none has vomited. They have had ketonuria but pH has not been affected. The patient/family can then practice taking an extra bolus dose of 0.1 IU/kg with a pen or syringe and restart the pump.

Pump initiation

Younger children are admitted to the hospital for 1-2 nights for pump initiation, and are then followed up at the day care unit. Older children and teenagers attend the day care unit for 3-4 days without hospitalization. During the initial phase we require blood glucose measurements before and 1.5-2 hours after each meal, plus 1-2 night-time tests. Our instructions to patients on pumps are to take at least 2-3, but preferably 4-5, blood glucose tests per day.

Some teenagers, however, find it difficult to achieve this; in fact, a small number of them take very few tests at all. As long as they do not have complications with recurrent severe hypoglycaemia or ketoacidosis we usually let them keep the pump. In this patient group we find many of the higher HbA_1c values, which without a pump would be even higher.

The use of rapid-acting insulin analogues in insulin pumps has been very successful and is steadily increasing. Today we start all pumps on rapid-acting insulin. The total insulin requirement per 24 hours usually decreases 15-20% after starting with insulin pump treatment (2, 6). Approximately 40-50% of the daily insulin requirement is given as basal rate but some patients may need up to 60%. The remainder is given as pre-meal bolus doses. In a pediatric study the pre-pubertal children had little change while the pubertal patients decreased in average 0.3 U/kg/24 hours (12). We found that the basal insulin dose when starting with the insulin pump can be reduced by approximately 20% (13). The bolus doses were reduced by 25-30% when the indication was high HbA1c and by ~15% in the other cases. The use of insulin pumps in toddlers has been found to be successful (14) and we now start children aged 4-5 years or younger at pumps from the onset of diabetes. We use 40 or 50U/ml in younger children if the basal rate is <0.3-0.4 U/h.

We usually start the patient on 5 separate basal rate profiles, one in the early night, one in the late night/morning and one for each main meal. It is important to inform that after a change in the basal rate it will take 2-3 hours before the amount of (short-acting) insulin absorbed into the blood stream is affected (15). With rapid-acting insulin this time span is shorter, presumably 1-2 hours.

The insulin requirement in adults is about 20% lower 1.00-3.00 a.m. compared with 5.00-7.00 a.m. (16). However, prepubertal children may need a higher basal rate late in the evening (12, 13) and it is not uncommon for the basal rate requirement to be higher earlier in the night (midnight to 3.00 a.m) than later on (3.00-7.00 a.m) (17). On most pumps you can make temporary changes to the basal rate for a number of hours. Standard advice is to decrease the basal rate during the night after physical exercise and to increase in case of intercurrent illness with a raise in blood glucose levels.

Testing for ketones is mandatory if blood glucose is >15 mmol/l for more than a couple of hours, the patient is ill or is nauseous/vomiting. Urine ketones are

good for screening but blood ketone measuring (Medisense Precision Xtra®) is far superior for follow-up of an episode of hyperglycaemia with ketosis.

Needle routine

The needle should be replaced every 3-4 days (1-2 days if using a metal needle). A disinfectant should be used before insertion. Remove the old needle after inserting the new one to avoid risk of contamination of the new site. It is best to replace the needle before a bolus dose, since the needle tip will be flushed by insulin when taking the dose. Avoid replacing the needle after the last meal in the evening: since the basal rate is usually low in the night, an occlusion will not give rise to an alarm until after many hours.

Conclusion

In conclusion, treatment with insulin pumps in children and adolescents is certainly feasible and can be safely managed.

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