

Insulin pump complications among children with diabetes

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Abstract

Question Several children with diabetes in our clinic use continuous subcutaneous insulin infusion therapy. Recently a 5-year-old presented with a dysfunctional pump, and it took 2 days to identify the problem and resolve it. What are the potential pitfalls of insulin pumps in children and how can these be prevented?

Answer The use of continuous subcutaneous insulin infusion pumps has increased considerably during the past decade. Adverse events can range from mild events that can be resolved by troubleshooting at home, to severe incidents that necessitate admission to the hospital. Adverse events include technical issues, skin complications that can lead to infection, and metabolic imbalances that can lead to hospitalization. Long-term monitoring and targeted education are needed for children and their families to ensure early identification of problems with the pump and to avoid diabetic ketoacidosis or hypoglycemia.

Complications de la pompe à insuline chez les enfants diabétiques

Résumé

Question Plusieurs enfants diabétiques à notre clinique suivent une insulinothérapie par pompe de perfusion sous-cutanée continue. Récemment, un enfant de 5 ans s'est présenté avec une pompe dysfonctionnelle et il a fallu 2 jours pour déterminer le problème et le régler. Quels sont les problèmes potentiels des pompes à insuline chez les enfants et comment peut-on les prévenir?

Réponse L'utilisation des pompes à perfusion sous-cutanée continue d'insuline a augmenté considérablement au cours des dernières décennies. Les événements indésirables peuvent aller d'un incident mineur qu'il est possible de corriger par dépannage à domicile jusqu'à des événements graves qui exigent une hospitalisation. Parmi les événements indésirables, on peut mentionner des problèmes techniques, des complications dermatologiques susceptibles de causer une infection et des déséquilibres métaboliques menant à une admission à l'hôpital. Il faut une surveillance à long terme et une éducation ciblée pour les enfants et leur famille afin de détecter rapidement les problèmes liés à la pompe et d'éviter une acidocétose diabétique ou l'hypoglycémie.

Insulin pumps, also known as continuous subcutaneous insulin infusion (CSII) therapy, are a popular treatment option for people living with diabetes who require insulin therapy. Most patients using CSII therapy have type 1 diabetes, with a growing number of patients with type 2 diabetes using it. In Canada, 1 in 300 children and youth younger than 19 years live with diabetes, with type 1 diabetes typically developing in childhood.¹

Continuous subcutaneous insulin infusion involves delivery of insulin via an infusion pump connected to a catheter that sits in the subcutaneous tissue; it dispenses a continuous adjustable basal infusion, with the ability to manually administer additional prandial bolus doses. Continuous subcutaneous insulin infusion is an alternative to multiple daily injections of insulin administered by patients or their caregivers. It can be offered to children of all ages when optimized by a diabetes care team.² In a consensus statement from the International Society for Pediatric and Adolescent Diabetes and other societies, existing research associates CSII use with improved glycemic control and quality of life for pediatric patients.² In a cohort of 161 youth in the United States, patients who

used CSII sustained lower hemoglobin A_{1c} levels after 1 year of use compared with those who resumed injection therapy (mean [SD] 8.0% [1.3%] vs 8.6% [1.3%]; $P=.04$).³ In a meta-analysis, pooled quality-of-life measures in youth were significantly better with CSII than with injections ($P=.002$).⁴

Insulin pump-associated adverse events

Insulin pump-associated adverse events can be broadly defined to include "any untoward medical occurrence in a patient using an insulin pump, specifically those directly stemming from the pump intervention and its use, as opposed to the diabetes itself."⁵ These can range from mild events that patients can comfortably resolve at home to severe events that require hospitalization. Studies with various cohorts of children found that all reported adverse events ranged from 0.5 to 5 per person-year and rarely required hospitalization.⁶⁻¹⁰ This variability can be attributed to differences in study participant demographic characteristics and in thresholds of adverse event reporting used in participant recruitment protocols. Studies have not found associations

between adverse events and sex, diabetes duration, glycemic control, or socioeconomic status.^{8,9} Adverse events include technical faults, skin-related complications, and metabolic adverse events.

Technical faults usually result in the pump no longer delivering insulin and include hardware failure, battery failure, and software failure. Technical faults can be caused by excessive water exposure, improper use, damage from being dropped, sports-related damage, or damage from unknown causes.¹¹ Faults either are troubleshooted at home, where patients are often notified via error or alert messages, or require pump replacement. Other technical issues occur at the catheter or infusion site and interrupt insulin delivery, such as catheter occlusion, dislodged cannulas, insulin leakage, air bubbles in the tubing, and tube kinks.⁵ Catheter events rarely lead to complications requiring hospitalization, as patients are educated on how to change infusion sets to address warning messages.^{2,12}

Skin-related adverse events include scarring, erythema, nodules, lipohypertrophy, and infections.¹³ In a prospective study from Italy with 1046 children and adolescents, 0.3 infection events were reported per person-year, with cellulitis being the most common.¹⁰ These events may disrupt insulin absorption and more research is needed to understand and prevent their interference.⁵

Metabolic adverse events occur when there are interruptions in insulin delivery, leading to hospitalization. Events include diabetic ketoacidosis (DKA) and hypoglycemia. Diabetic ketoacidosis occurs when insulin delivery interruption is not addressed, either because the pump software fails to provide a warning or because an insulin correction bolus is not delivered. Hypoglycemia occurs due to incorrectly timed changing of infusion sets or incorrectly administered insulin boluses, leading to excess insulin.⁸ In a 2006 literature review, 2.7 to 9 episodes of DKA per 100 participants per year were reported in youth,¹⁴ but more recent studies have shown a lower rate, likely due to improved DKA prevention guidelines.² Wheeler et al recorded 3 severe hypoglycemic events requiring hospitalization during a 16-week prospective period in a hospital serving approximately 850 children with type 1 diabetes in Australia.⁸ In a retrospective review of 1 year of data, Rabbone et al from Italy found 1 severe hypoglycemic episode (0.3 episodes per 100 participants per year) and 7 episodes of DKA (2.1 episodes per 100 participants per year) in 11,311 children with type 1 diabetes.⁷ Overall, DKA and hypoglycemia are now uncommon with CSII therapy, but they still present as challenging medical events for children and their families.^{7,8}

Overall, young children had a higher incidence of air bubble interference, unexplained hyperglycemia, lipohypertrophy, bleeding, and tube kinking, whereas adolescents had a higher incidence of dislodged infusion sets, tunneling (due to their larger muscle mass), and pump blockages.¹⁰

Prevention

Primary care providers have an important role to play in maintaining patients' confidence in operating their infusion pumps, as well as in providing support for delivery of insulin in the event of pump failure.

Patients who report a lack of trust in infusion pump technology or in their own abilities have a higher incidence of impaired metabolic control due to pump failure.¹⁵ In the event of permanent pump failure, observational studies have found that it takes an average of about 2 days for patients to be able to replace their pumps,^{6,8} requiring the use of injections with both short-acting and long-acting insulin to bridge the gap. Educating patients about what to do in the event of insulin pump failure and developing insulin pump discontinuation plans are important education components required with initiation of CSII therapy. Qualitative studies with families of young patients using CSII therapy suggest that primary care providers may revisit these concepts, in addition to the education provided as part of diabetes care, to increase confidence and decrease anxiety in CSII management.¹⁶ Families have reported that increased confidence in self-managing pump failure and awareness of danger signs would reduce hospital admissions or emergency department visits.⁶

Conclusion

Continuous subcutaneous insulin infusion therapy is a popular and effective method of treatment for children with insulin-dependent diabetes. Adverse events include technical issues, skin complications that can lead to infection, and metabolic imbalances that can lead to hospitalization. Continuous subcutaneous insulin infusion therapy requires long-term monitoring and targeted education based on history of adverse events and response to therapy. It is important for primary care providers to enhance education of the patient and family and monitoring carried out by the diabetes team with additional support for insulin pump action plans and identification of adverse events relevant to patients. 🌟

Competing interests

None declared

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