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Technology and Glucose Metabolic Control in Children and Adolescents with Type 1 Diabetes

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Academic dissertation

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Abstract

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Background: There has been a rapid technological development during the last decade concerning insulin pumps and continuous glucose monitoring (CGM) for children and adolescents with type 1 diabetes. Few studies have been performed on real-life data from children with type 1 diabetes to investigate the effects of such technological devices on glucose metabolic control and partial clinical remission.

Aim: The aim of this thesis was to expand the understanding of what methods of insulin administration and glucose monitoring give the best opportunity to achieve good glucose metabolic control in children and adolescents with type 1 diabetes, and to explore the experiences of youths and parents using technological devices such as insulin pumps and CGM, the glucose target and the support from healthcare.

Methods: Three of the studies were prospective, longitudinal, observational research with quantitative data from the Swedish National Diabetes Register (NDR-Swediabkids), and the Better Diabetes Diagnosis Study (BDD), where two include cross-sectional comparisons or cohort analysis (Papers I and II), and one is cross-linked with the BDD-register (Paper III). Papers I-III covered different time periods, i.e., Paper I 2011-2016, Paper II 2016-2023 and paper III 2007-2020. The fourth paper was an interview study with qualitative content analysis (Paper IV).

Results: Overall, the use of insulin pumps and CGM-meters became increasingly common, where practically all children and adolescents with type 1 diabetes used CGM, most often in combination with an insulin pump by the end of the study period. In Paper I, we showed a small decrease of mean HbA1c (0.7-1.5 mmol/mol) without effects on the prevalence of reported hypoglycaemic events with insulin pump treatment compared to multiple daily injections. Insulin pump treatment was associated with female sex (OR: 1.30, 95% CI 1.16-1.45), higher BMI-SDS (OR: 1.13, 95% CI 1.07-1.19) and longer diabetes duration (OR: 1.16, 95% CI 1.14-1.18). In Paper II, the group with CGM and insulin pump had lower mean HbA1c compared with MDI treatment, 59.4 mmol/mol vs. 61.0 mmol/mol, $p<0.001$, but patients with rtCGM and MDI had the relatively largest reduction in HbA1c over time. There were associations between higher BMI and insulin pump use. In Paper III, we found that partial clinical remission was associated with insulin pump treatment (OR: 1.39, 95% CI 1.13-1.71), shorter diabetes duration (OR: 0.80, 95% CI 0.76- 0.84), and male sex (OR: 1.23, 95% CI 1.04-1.46). In Paper IV, the youths described increased satisfaction, security, freedom, and strengthened independence. The parents described improved sleep at night leading to increased quality of life. The opportunity for parents to follow their youth's glucose values from a distance does not seem to be a problem for neither youths nor parents, and the lowering of the glucose target was not anything they had considered a problem. Both youths and parents had positive experiences of the diabetes teams, and parents emphasized the need of technical support and to stay connected during the transition period from childhood into adult life.

Conclusions: New technologies facilitate life with type 1 diabetes for both youths and their parents, and CGM and insulin pump treatment improve glycaemic control, without substantial side-effects and seem to contribute to a longer period of partial remission. There are concerns regarding BMI-trajectories tied to the use of insulin pumps, particularly among teenagers, but from a user perspective, these devices confer improvements in quality of life, both for the adolescents using them and their parents. With the devices now being almost ubiquitous among paediatric patients, the diabetes teams will have to keep up with the rapid technological development to support the patients and their families as well as being vigilant to possible negative consequences of their use.

Keywords: Children and adolescents, type 1 diabetes, continuous subcutaneous insulin infusion, multiple daily injections, continuous glucose monitoring, glycaemic control, partial clinical remission, C-peptide

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