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Assessment of insulin dose changes in pediatric patients with type 1 diabetes mellitus starting on continuous subcutaneous insulin infusion

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ABSTRACT

Objective: To assess change in total daily dose (TDD) of insulin following a switch from subcutaneous (SC) injections to continuous subcutaneous insulin infusion (CSII) in pediatric patients with type 1 diabetes (T1D). Secondary objectives were to determine the change in %basal insulin, insulin to carbohydrate (I:C) ratios, insulin sensitivity factor (ISF), and HbA1c/IDAA1c.

Methods: A retrospective chart review of patients < 18 years of age who transitioned from SC to CSII at the Alberta Children's Hospital (Calgary, Alberta, Canada) between January 2019 and March 2022.

Results: There was an increase of 0.04 units/kg/day in TDD from baseline vs 1–3 months later ($p = 0.04$, 95 % confidence interval (CI) [0.002, 0.072]). When stratified by age, a similar increase in TDD was observed in age 5–12 years only ($p = 0.05$, 95 % CI [0.0006, 0.8236]). There was a decrease in overall %basal insulin by 3 (44 % of TDD at baseline vs 41 % of TDD on CSII). ($p = 0.02$, 95 % CI [−5.5, −0.4]). No strengthening was seen in I:C ratios from baseline vs 1–3 months later. There was a significant strengthening of I:C ratios at all meals in the basal bolus group from 1–3 weeks to 1–3 months post-CSII; overall strengthening of ISF at both time points; and an overall HbA1c decrease −0.30 ($p < 0.0001$, CI [−0.45, −0.15]). Each extra year with diabetes was associated with a decrease in HbA1c by 0.07 % ($p = 0.006$).

Conclusions: TDD of insulin was not found to be decreased post CSII initiation and patient characteristics should be considered when changing from SC to CSII. HbA1c was significantly improved post CSII.

Introduction

Type 1 diabetes (T1D) is one of the most common chronic diseases in children. It is defined as hyperglycemia due to insulin deficiency as a result of autoimmune pancreatic beta cell destruction [1]. Insulin, administered subcutaneously, is the only treatment for T1D. For decades, subcutaneous injections were the only method of administering insulin, with patients requiring 4 or more injections per day. Insulin pumps, which administer insulin in a continuous infusion subcutaneously, were first tried in children in the 1970s [2], but have only become widely used in the last two decades [3]. Today, continuous subcutaneous insulin infusion (CSII) via insulin pump is considered the most physiologic method of insulin administration [4], and CSII is supported as safe and effective for children [5]. Other advantages of the pump include the flexibility of basal and bolus insulin delivery, more precise insulin dosing, the portable nature of the pump, and fewer needle insertions [6]. Hybrid closed loop insulin pump systems are also available that use continuous glucose monitors and an algorithm to automatically adjust insulin doses being delivered by the pump.

When patients with T1D are switched from insulin injections to CSII, recommendations exist to decrease the total daily dose (TDD) [4]. Previous studies are extremely limited and have found that the decrease in TDD depends greatly on multiple factors including age/pubertal status, previous diabetes control, and previous insulin type [7–9]. When prescribing initial insulin doses for CSII, the goal to is to start a set of parameters that are safe and match the child's current needs, while avoiding hypoglycemia and hyperglycemia. The primary objective of this study was to determine the change in TDD of insulin following a switch from subcutaneous injections to CSII in pediatric patients with T1D and to see if this change in TDD varies by age. In addition, secondary objectives of this study were to assess the change in percent basal insulin dose, insulin to carbohydrate (I:C) ratio, insulin sensitivity factor

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(ISF), hemoglobin A1c (HbA1c) and insulin dose-adjusted A1c (IDAA1c) post CSII initiation. The IDAA1c was used to assess for possible improved insulin sensitivity post CSII initiation and has been used for assessing for partial clinical remission and honeymoon in patients with T1D [10].

Methods

Study design

This study is a retrospective chart review of patients who transitioned from subcutaneous insulin injections to CSII at the Alberta Children's Hospital (Calgary, Alberta, Canada) between January 2019 and March 2022.

Study participants

Only patients under the age of 18 years at the time of transition from injections to CSII were included. Patients were excluded if their CSII start was not done locally (i.e. if CSII was started at an outlying center where charts were not available to review).

Patients were switched to CSII based on multiple factors including patient preference and diabetes team recommendation. Patients and/or their caregivers had to demonstrate appropriate diabetes control and proficiency in diabetes management (e.g. carbohydrate counting, monitoring of blood glucose, etc.) prior to starting CSII. All patients and their caregivers were required to attend a pump education class. Pump initiation doses were prescribed by a pediatric endocrinologist or a pediatric diabetes educator using a pre-set algorithm which included a decrease in TDD of 10 % to 30 % depending on history of low blood glucose and current insulin injection regimen. Clinicians also had the liberty to use clinical judgement to adjust the doses as they felt appropriate based on the clinical situation.

Once patients started on CSII, patients were able to contact a member of the diabetes team at any time if needed and had frequent contact with the diabetes educators to review blood glucose levels (typically daily contact for 1–3 weeks post pump start). Insulin doses were titrated to target blood glucose levels of approximately 4–10 mmol/L, primarily by diabetes educators, but also by patients and their families if they felt comfortable. All patients had insulin doses documented by the diabetes educators after 1–3 weeks of starting CSII. Patients were seen in clinic approximately 1–3 months following the CSII start with insulin doses documented again at that time.

Measures and procedures

Data was collected using Soprano, an electronic medical record system used for all patients with T1D at Alberta Children's Hospital during the study period. Data collected at baseline included patient's sex at birth, age, weight, and duration of diabetes. Baseline information included insulin regimen (i.e. TID [insulin three times daily] vs basal bolus vs BID [insulin twice daily]), insulin type (i.e. NPH vs glargine vs degludec vs detemir), TDD of insulin, percent basal of TDD, I:C ratio for each meal, ISF, HbA1c, and IDAA1c (calculated using the formula IDAA1c = HbA1c (%) + 4[insulin dose (units/kg/day)] [10]. TDD for patients on basal bolus was based on parent or patient estimation of the past 2 weeks at the last clinic visit. Patients on TID or BID insulin would have used carbohydrate ratios for breakfast and supper and have fixed carbohydrate at lunch time.

CSII data included pump type (i.e. open loop pumps available with government funding at our clinic were Omnipod and Medtronic, while the only closed loop pump available was Tandem which was not government funded at the time of this study), insulin used in the pump, and pump orders (TDD, basal rates, percent basal of TDD, I:C, ISF).

Post-CSII start data included insulin doses 1–3 weeks post pump start (TDD, basal rates, percent basal of TDD, I:C, ISF), first clinic visit 1–3 months post-CSII insulin doses (TDD, basal rates, percent basal of TDD, I:C, ISF), and HbA1c at first clinic visit post pump start. Following data collection, available variables were compared at the following three time points: baseline, 1–3 weeks post-CSII start, and first clinic visit 1–3 months post-CSII. Variables were also compared by age group, which were split into < 5 years, 5–12 years, and > 12 years to compare toddlers, school age children, and pubertal children.

Table 1
Baseline patient characteristics.

Characteristic	Total (n = 152)	
Age at pump start – years, mean (SD)	10.4 (3.8)	
< 5 years, no. (%)	19 (13 %)	
5–12 years, no. (%)	78 (51 %)	
> 12 years, no. (%)	55 (36 %)	
Sex at birth, no (%)		
Female	72 (47)	
Male	80 (53)	
Duration of diabetes at pump start – years, median (SD)	1.7 (2.9)	
Insulin regimen, no. (%)		
Basal bolus	110 (72)	
TID/BID	42 (28)	
HbA1c, mean (SD)	8.0 (1.2)	
TDD – units/kg/day, mean (SD)	0.73 (0.25)	
Percent basal (in basal bolus group), mean (SD)	43.93 (13.63)	
Glucose monitoring, no. (%)	Prior	1–3 months post CSII
Glucometer	24 (16)	17 (11)
Continuous glucose monitor	68 (45)	84 (55)
Flash glucose monitor	60 (39)	51 (34)
Pump type, no. (%)		
Omnipod	112 (74)	
Medtronic	24 (16)	
Tandem (Hybrid closed loop)	16 (10)	
Insulin type in pump, no. (%)		
Humalog (insulin lispro)	92 (60)	
Novorapid (insulin aspart)	56 (37)	
Fiasp (insulin aspart)	3 (2)	
Apidra (insulin glulisine)	1 (1)	

Statistical analysis

Statistical analysis was done using R version 4.2.2. (Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/). Summary statistics were reported as mean (standard deviation) or median (minimum − maximum) for interval data if they failed to pass Shapiro-Wilk normality test, and count (percentage) for categorical data. A paired T-test was used for paired/matched interval data at pre-CSII vs 1–3 month post-CSII and 1–3 week post-CSII vs 1–3 month post-CSII comparison, if the normality assumption was met. Otherwise, a Wilcoxon signed-rank test was used. A linear regression model was used to assess the effects of age at T1D diagnosis and/or duration of T1D on HbA1c and IDAA1c. Result of parameter estimate along with its 95 % confidence interval (95 % CI) from a statistical test, or standard error (SE) from a regression model will be reported. A p-value < 0.05 is considered statistically significant in all tests.

Ethics

Ethics was obtained from the Conjoint Health Research Ethics (CHREB) at the University of Calgary (Calgary, Alberta, Canada). Administrative approval to access the electronic health records was obtained through Alberta Health Services.

Results

Overall, 202 patient charts were accessed for this study. Patients were excluded from the study if there was missing information, which was generally due to the pump being started at a site other than Alberta Children's Hospital. Following the exclusion of those patients, a total of 152 patients were included in the analysis. Baseline characteristics are described in Table 1. Fig. 1 shows the distribution of age at pump start.

Table 2 describes the changes in insulin doses from baseline to post CSII start. In all age groups combined, there was a significant median increase in TDD of 0.04 units/kg/day (p = 0.04, 95 % CI [0.002, 0.072]). There was a decrease in overall %basal insulin in all age groups combined by 3 (44 % of TDD at baseline vs 41 % of TDD on CSII). For patients that were on a basal bolus regimen prior to CSII, there was a weakening (indicated by an increase in percentage change) of the breakfast ratio overall and no significant changes with the lunch or supper ratios. Only those aged 5 to 12 years had a significant strengthening (indicated by a decrease in percentage change) of the day and night ISF post CSII start.

When comparing 1–3 weeks post-CSII with the 1–3 months post-CSII for those on basal bolus insulin, there was a significant reduction (strengthening) of the breakfast, lunch and supper ratio overall with reductions of −2.00 (p = 0.0001, 95 % CI [−3.00, −1.00]), −2.00 (p <

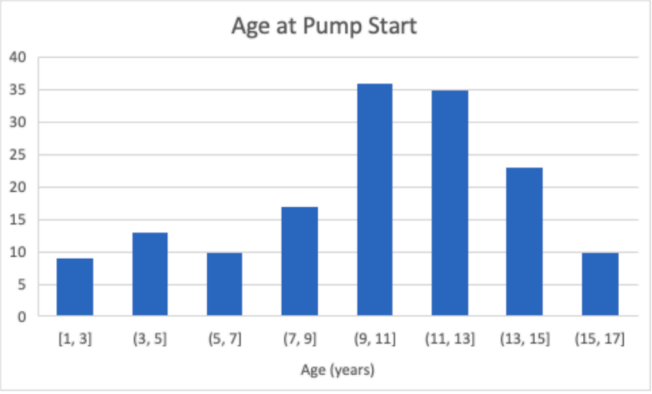

Fig. 1. Distribution of age (years) at pump start.

Table 2
Change from baseline to post CSII start (1–3 months).

	Change from baseline to post CSII start	95 % Confidence interval	p-value
Total daily dose (units/kg/day)			
Baseline mean 0.73 units/kg/day (0.26 to 1.59)			
All ages	0.04 units/kg/day	0.002 to 0.072	0.04*
Less than 5 years	0.07 units/kg/day	−0.03 to 0.16	0.15
5–12 years	0.04 units/kg/day	0.0006 to 0.0824	0.05*
Greater than 12 years	0.03 units/kg/day	−0.08 to 0.09	0.48
Basal insulin (% of total daily dose) for basal bolus group			
Baseline mean 43.93 % (14.79 % to 85.71 %)			
All ages	−2.96	−5.50 to −0.41	0.02*
Less than 5 years	0.83	−4.62 to 6.27	0.75
5–12 years	−3.42	−7.94 to 0.14	0.06
Greater than 12 years	−2.77	−7.25 to 1.71	0.22
% Change in Insulin to Carbohydrate Ratio- Breakfast			
Baseline mean 1 unit per 11 g (1unit per 2 g to 1 unit per 40 g)			
All ages	14.29 %	5.00 to 22.50	0.001*
Less than 5 years	4.76 %	−15.52 to 25.03	0.63
5–12 years	21.43 %	8.93 to 31.43	0.001*
Greater than 12 years	7.96 %	−4.72 to 20.63	0.21
% Change in Insulin to Carbohydrate Ratio- Lunch			
Baseline mean 1 unit per 14 g (1 unit per 2 g to 1 unit per 80 g)			
All ages	4.09 %	−2.25 to 10.43	0.20
Less than 5 years	2.01 %	−12.91 to 16.94	0.78
5–12 years	9.82 %	−0.20 to 19.84	0.05
Greater than 12 years	−2.06 %	−12.17 to 8.04	0.68
% Change in Insulin to Carbohydrate Ratio- Supper			
Baseline mean 1 unit per 14 g (1 unit per 3 g to 1 unit per 40 g)			
All ages	−0.71 %	−8.50 to 6.67	0.84
Less than 5 years	−8.28 %	−27.08 to 23.12	0.49
5–12 years	5.00 %	−6.67 to 17.78	0.31
Greater than 12 years	−7.45 %	−19.38 to 5.00	0.25
% Change in Insulin Sensitivity Factor- Day			
Baseline mean 5.65 (0.90 to 24.0)			
All ages	−7.50 %	−15.83 to 1.67	0.11
Less than 5 years	−6.30 %	–23.43 to 10.82	0.45
5–12 years	−16.30 %	−25.00 to −3.57	0.01*
Greater than 12 years	4.17 %	−8.33 to 20.33	0.46
% Change in Insulin Sensitivity Factor- Night			
Baseline mean 5.83 (3.0 to 36.0)			
All ages	−8.33 %	−17.50 to 1.67	0.09
Less than 5 years	−14.00 %	−35.00 to 40.00	0.43
5–12 years	−16.07 %	−26.67 to −1.11	0.03*
Greater than 12 years	4.80 %	−7.20 to 16.81	0.43
Change in Hemoglobin A1c (%) by Age Groups			
Baseline mean 8.0 (5.4 % to 11.70 %)			
All ages	−0.30	−0.45 to −0.15	<0.0001*
Less than 5 years	−0.67	−1.0 to −0.35	0.0004*
5–12 years	−0.22	−0.42 to −0.02	0.03*
Greater than 12 years	−0.25	−0.55 to 0.0003	0.04*
Change in Hemoglobin A1c (%) by Glucose Monitoring			
Glucometer	−0.11	−0.53 to 0.32	0.61
Continuous glucose monitor	−0.45	−0.65 to −0.25	<0.0001*
Flash glucose monitor	−0.16	−0.41 to 0.08	0.19

* Insulin Sensitivity Factor values are based on glucose measurements in mmol/L.

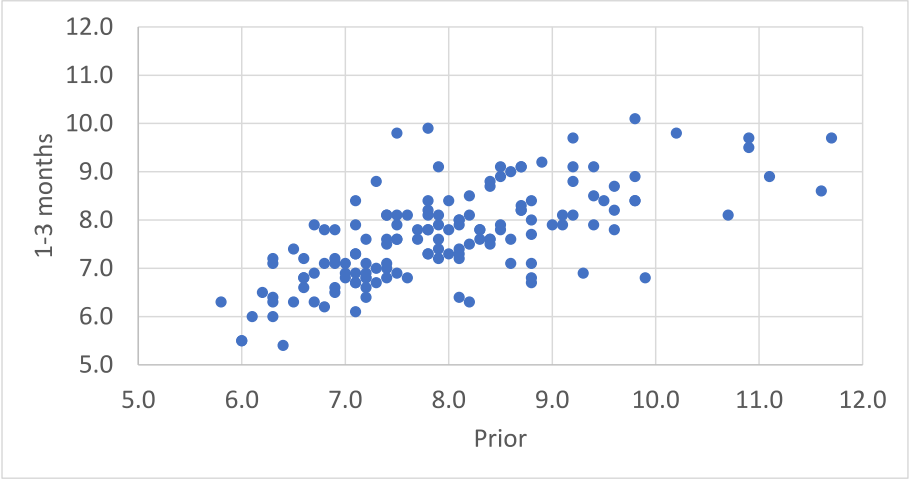

Fig. 2. Scatter plot of HbA1c prior vs. 1–3 months after starting the pump.

0.0001, 95 % CI [−3.00, −1.50]), and −2.50 ($p < 0.0001$, 95 % CI [−3.50, −1.50]) respectively. For those that were on a TID or BID regimen at baseline, there was a significant reduction (strengthening) noted in the breakfast ratio −2.00 ($p = 0.01$, 95 % CI [−3.00, −1.00]) but no significant difference in the supper ratio. ISF also showed a significant decrease (strengthening) at daytime and nighttime with a median decrease of −1.0 ($p < 0.0001$, 95 % CI [−1.40, −0.70]) and −1.0 ($p < 0.0001$, 95 % CI [−1.40, −0.65]) respectively.

There was a significant decrease in HbA1c overall (Fig. 2) and in each individual age group (Table 2). When analyzed by glucose monitoring type, only those using continuous glucose monitoring had a significant decrease in HbA1c compared to those using a glucometer or flash glucose monitor. The longer the duration of T1D at the time of CSII start was associated with a larger HbA1c decrease. Each extra year of having diabetes was associated with a decrease in HbA1c by a mean of 0.07 % [SE 0.03] ($p = 0.006$). Similar to HbA1c, the longer the duration of diabetes, the more reduction was seen in IDAA1c. However, this was not found to be statistically significant (−0.06 [SE=0.06], $p = 0.28$).

Discussion

Guidelines published in 2007 by the European Society for Paediatric Endocrinology recommend a decrease of 10–20 % in TDD for patients with good glycemic control and few episodes of hypoglycemia [4]. Unfortunately, these guidelines do not specify which patients require a 10 % reduction, which patients require a 20 % reduction (except those with more frequent hypoglycemia), or anywhere in between. In addition, they recommend basal rates be 30–50 % of total daily dose, which is too broad a range to be practically helpful. They do not make recommendations on how to adjust I:C ratios or ISFs. These guidelines are also outdated given several advances in the field including new insulin pumps, continuous glucose monitors, new insulin analogs, and hybrid closed-loop systems.

A newer guideline from the International Society for Pediatric and Adolescent Diabetes recommends considering reducing TDD at initiation of CSII in patients who are at glycemic target or who have frequent or severe hypoglycemia. No specific recommendations for the amount of decrease are presented [11].

There are limited studies in the literature on insulin adjustments when switching from subcutaneous insulin to CSII. Most studies report a decrease in TDD of 20–25 % [7,8,12], which is consistent with the 2007 guidelines. However, a study in 2006 showed no statistical difference in TDD at 1 year on pump therapy [13], and a larger and more recent study in 2021 showed a decrease in TDD of only 9 %, but an increase in TDD in pubertal patients [14]. Interestingly, our study showed a slight increase in TDD, but when broken down by age this was only significant in the aged 5–12-year group. This may reflect the older half of this cohort who may be starting puberty and requiring higher doses.

Our study showed a small change from an average pre-CSII basal rate of 44 %, which is similar to other studies and the 2007 guidelines [4,7,8]. There are no reports in the literature on change in I:C ratios and ISFs from prior to starting CSII to after. Our study showed that overall, there was no strengthening in I:C ratios from prior to starting CSII to 1–3 months after. However, there was a significant strengthening of all I:C ratios from 1–3 weeks after starting CSII to 1–3 months later, except for dinner ratio in the TID/BID group. This most likely represents health care providers weakening the I:C ratios when ordering doses for CSII, which then have to be strengthened over the next few months. Similarly, the ISFs in all age groups were strengthened from 1–3 weeks after starting CSII to 1–3 months later, again indicating a weakening in the ISF when ordering doses for CSII. From prior to starting CSII to 1–3 months later there was only a strengthening of the ISF in the 5–12 year age group, which may reflect the older half of this cohort starting puberty and requiring higher doses, similar to the change in TDD seen.

In regard to HbA1c, our study was consistent with the literature showing a reduction with CSII therapy [2,8,12,13]. Interestingly, our study found that this improvement in HbA1c was most pronounced in the youngest age group. This may be because on MDI therapy, the youngest patients often have to round down on their insulin doses to the nearest 0.5 unit for fear of having unrecognized hypoglycemia, while on CSII therapy they are able to have smaller increments with more accurate doses and consequently better glycemic control.

Other things to note from our study was the increased use of continuous glucose monitors following CSII start. This is likely due to patients starting on hybrid closed-loop systems requiring a continuous glucose monitor, as well as due to improved insurance coverage for continuous glucose monitors during the study time period. In our population, we had more patients on Omnipod and Medtronic insulin pumps than Tandem insulin pump which could be due to the fact that Tandem was not covered under our provincial pump program during the study period.

There were some limitations in our study. Given the time period of our chart review, many of our patients were seen virtually because of the COVID-19 pandemic. This caused many of our diabetes visits to have missing information, specifically patients' weights and laboratory HbA1c levels. Of 152 patients, there were only 117 patients prior to starting CSII and 113 patients at 1–3 months post-CSII who had a weight documented and were included in the analysis of TDD. Patients who

were seen virtually also did not have a laboratory or point-of-care HbA1c level done at 1–3 months post-CSII. For those patients, the next available HbA1c on their chart was used. Due to government funding of only selected pumps, only 10 % of our study population was on hybrid closed loop with Tandem pump, so this limits the generalizability of our findings to this population.

Conclusion

In conclusion, our study found that the TDD for pediatric patients with T1D increased by 0.04 units/kg/day at 1–3 months post-CSII when comparing pre-CSII dose, which suggests that a decrease in TDD may not be necessary when changing to CSII from subcutaneous injections. Newer technology, including continuous glucose monitors, hybrid closed loop pumps, and rapid acting insulin analogs, have contributed to the ability to more aggressively aim for glycemic targets. Care should still be taken to individualize CSII dosing for each patient, so that patients with frequent hypoglycemia still have a reduction in their TDD.

Author contributions

SG and JH substantially contributed to the original conception and design of the study, implementation of the study, and interpretation of the results. SG contributed substantially to the acquisition of the data. GK performed all the statistical analysis and contributed to the interpretation of the results. All authors participated in the manuscript drafting, reviewed the manuscript for intellectual content and approved the final version.

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CRediT authorship contribution statement

Samantha Gerber: Writing – review & editing, Writing – original draft, Validation, Investigation, Data curation, Conceptualization. **Grace P.S. Kwong:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis. **Josephine Ho:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Punthakee Z, Goldenberg R, Katz P, Definition CD. Classification and diagnosis of diabetes, prediabetes and metabolic syndrome. Can J Diabetes 2018;42(Suppl 1):S10–5.
[2] Tamborlane WV, Sherwin RS, Genel M, Felig P. Reduction to normal of plasma glucose in juvenile diabetes by subcutaneous administration of insulin with a portable infusion pump. N Engl J Med 1979;300(11):573–8.
[3] Ahern JA, Boland EA, Doane R, Ahern JJ, Rose P, Vincent M, et al. Insulin pump therapy in pediatrics: a therapeutic alternative to safely lower HbA1c levels across all age groups. Pediatr Diabetes 2002;3(1):10–5.
[4] Phillip M, Battelino T, Rodriguez H, Danne T, Kaufman F, Endocrinology ESfP, et al. Use of insulin pump therapy in the pediatric age-group: consensus statement from the European Society for Paediatric Endocrinology, the Lawson Wilkins Pediatric Endocrine Society, and the International Society for Pediatric and Adolescent Diabetes, endorsed by the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2007;30(6):1653–62.
[5] Wherrett DK, Ho J, Huot C, Legault L, Nakhla M, Rosolowsky E, et al. Type 1 diabetes in children and adolescents. Can J Diabetes 2018;42(Suppl 1):S234–46.
[6] Meneghini L, Sparrow-Bodenmiller J. Practical aspects and considerations when switching between continuous subcutaneous insulin infusion and multiple daily injections. Diabetes Technol Ther 2010;12(Suppl 1):S109–14.
[7] Conrad SC, McGrath MT, Gitelman SE. Transition from multiple daily injections to continuous subcutaneous insulin infusion in type 1 diabetes mellitus. J Pediatr 2002;140(2):235–40.
[8] Colino E, Álvarez M, Carcavilla A, Alonso M, Ros P, Barrio R. Insulin dose adjustment when changing from multiple daily injections to continuous subcutaneous insulin infusion in the pediatric age group. Acta Diabetol 2010;47(Suppl 1):1–6.
[9] Cemeroglu AP, Thomas JP, Vande Zande LT, Nguyen NT, Wood MA, Kleis L, et al. Basal and bolus insulin requirements in children, adolescents, and young adults with type 1 diabetes mellitus on continuous subcutaneous insulin infusion (CSII): effects of age and puberty. Endocr Pract 2013;19(5):805–11.
[10] Neylon OM, White M, O Connell MA, Cameron FJ. Insulin-dose-adjusted HbA1c-defined partial remission phase in a paediatric population–when is the honeymoon over? Diabet Med 2013;30(5):627–8.
[11] Sherr JL, Schoelwer M, Dos Santos TJ, Reddy L, Biester T, Galderisi A, et al. ISPAD clinical practice consensus guidelines 2022: diabetes technologies: insulin delivery. Pediatr Diabetes 2022;23(8):1406–31.
[12] Sulli N, Shashaj B. Long-term benefits of continuous subcutaneous insulin infusion in children with type 1 diabetes: a 4-year follow up. Diabet, Med 2006;23:900–6.
[13] Berhe T, Postellon D, Wilson B, Stone R. Feasibility and safety of insulin pump therapy in children aged 2 to 7 years with type 1 diabetes: a retrospective study. Pediatrics 2006;117(6):2132–7.
[14] Demir G, Altinok YA, Ozen S, Darcan S, Goksen D. Initial basal and bolus rates and basa rate variability during pump treatment in children and adolescents. J Clin Res Pediatr Endocrinol 2021;13(2):198–203.