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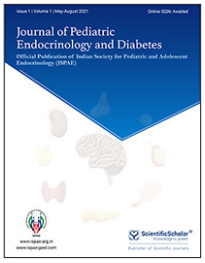

Invited Editorial Commentary

Hybrid closed-loop insulin delivery system and postprandial glycemia

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The global prevalence of diabetes is increasing, particularly in low-income and lower middle-income countries. Type 1 diabetes mellitus (T1D) has emerged as a major health-care challenge in India impacting a significant proportion of the population. As per the International Diabetes Atlas, 2021, 10th Edition data, India has the highest number of children and adolescents with T1D in the world with approximately 229,442 individuals in the age group of 0–19 years living with T1D and an estimated 24,000 newly diagnosed cases emerging each year.[1]

The management of T1D continues to be a global health concern. While diabetes awareness, education, and access to health care continue to be a challenge in India, diabetes technology on the other hand is continuously evolving to improve the quality of life and care for persons with diabetes.[2]

As per the latest International Society for Pediatric and Adolescent Diabetes (ISPAD) 2022 guidelines, multiple daily insulin injections or wherever affordable, advanced hybrid closed-loop (AHCL) systems, and regular self-monitoring of glucose using fingerstick blood glucose measurements or continuous glucose monitoring (CGM, continuous, or intermittently scanned) are strongly recommended and have become standard of care in T1D management to improve time in range by minimizing hypoglycemia and hyperglycemia in all children and adolescents with T1D.[3]

Insulin administration and blood glucose monitoring technology have seen a huge transformation in the past two decades and health-care providers must stay current on the available systems and make their patients aware and guide them about the same. Flexibility in the lives of individuals with T1D, glycemic control, and prognosis have remarkably improved over the years with technological advancements, especially after the introduction of CGM and AHCL in particular.[4]

While protein and/or fat in moderate amounts in a meal blunt the post-meal blood glucose response, managing meals with high fat (20 g fat) and protein (25–30 g) is always a challenge, as it causes late meal spikes from 3 h to 5 h post-meal.[5] The ISPAD 2022 guidelines recommend that the impact of dietary fat and protein must be considered when determining the insulin bolus dose and delivery.[3]

Evidence suggests that insulin doses may need to be substantially increased (e.g., 20–65% higher for high fat, high protein [HFHP] meals) as there is a wide variation in sensitivities to different macronutrients. Campbell *et al.* reported that when on basal bolus insulin regimen, carbohydrate counting at meal time followed by a small secondary postprandial bolus injection at 3 h prevents late hyperglycemia, without hypoglycemia, after a high-carbohydrate, high-fat meal.[3,6]

Different strategies are required for different foods, and dosing algorithms will need to incorporate multiple strategies for meals of varying macronutrient compositions. Recent data in children and adolescents using pump therapy found a mean additional 30% of the dose for a very high-protein meal and up to 60% more for an HFHP meal may be required. Studies reported that the optimal duration of the dual wave/combination bolus increases with fat amount, from 73 min for 20 g of fat (75%/25%) to 105 min for 60 g of fat (50%/50%). An increase in insulin dose must be made carefully after monitoring glucose at 3, 5, and 7–8 h after the meal to prevent hypoglycemia.[3,5,7]

AHCL systems now available in India have helped to improve the ease of insulin delivery, dose appropriately for different kinds of meals, and minimize the risk of hyperglycemia and most importantly severe hypoglycemia which is one of the most undesirable and feared complications of treatment with insulin. The pump functions in both manual and automatic mode. When working in manual mode, the pump administers insulin according to the basal schedules set and suspends delivery of basal insulin in case of predicted hypoglycemia. Bolus insulin is delivered manually as per the insulin-to-carbohydrate ratio set and the input of carbohydrates.[2]

The system using sensor and smart guard technology in auto mode is designed to automatically adjust insulin delivery based on sensor data, helping individuals stay in the target glucose range. It requires the individual to enter carbohydrate amounts at meal times and factor in additional carbohydrates for HFHP meals and bolus ahead of time (pre-bolus) to ensure blood glucose levels are in range post-meals. The system delivers auto correction boluses to reduce the risk of high blood glucose if hyperglycemia is predicted and this feature may also help manage the occasional missed meal boluses. The auto-correction feature in the AHCL is also useful to take care of the late blood glucose rise when HFHP meals are eaten.

The safe meal bolus feature is helpful in preventing lows as it reduces bolus dose delivery if hypoglycemia is predicted. Depending on the CGM trend and past insulin delivery, active insulin, and food bolus may be reduced to help mitigate a low glucose episode.[2,4]

The study in this issue titled "Efficacy of the MiniMed™ 670G hybrid closed-loop system in managing postprandial glucose excursion with high-protein high-fat foods in children and adolescents under free-living conditions" by Lim *et al*. aimed to explore the impact of manual mode in standard insulin pump therapy and auto mode with AHCL in managing glucose excursions caused by HFHP foods and to obtain feedback from families about each mode.[8] The researchers observed that there was no significant difference between auto and manual modes for the mean net incremental area under the glucose × time curve, irrespective of meal type. However, the qualitative data revealed that five of seven families felt more confident eating HFHP meals in auto mode.

One of the key takeaways from this study is the potential for the AHCL system to bridge the gap between dietary habits and diabetes management in India. This system, by continuously monitoring glucose levels and adjusting insulin delivery, can help individuals overcome the complexities of HFHP meals. This is particularly relevant in the Indian context, where traditional diets often consist of such foods, especially during festivities and occasions when achieving glucose control is most challenging.

While AHCL insulin delivery systems are still a distant dream for the majority in India, its use is slowly but steadily increasing, empowering Indians with T1D to enjoy a wider variety of foods while maintaining stable blood glucose levels.

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