

## EDITORIAL

# The Warsaw School of Insulin Pump Therapy: achievements and widespread implications for the diabetes clinic

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“We have no answer so far as to why increasing numbers of young children are developing diabetes, and that is why this group of patients is a great challenge for diabetes healthcare providers.”

The worldwide epidemiological data on Type 1 diabetes mellitus incidence rates suggest that a discussion on the proper method of insulin therapy, to prevent late complications, is urgently needed [1]. Poland is a good example of this, because the rate of Type 1 diabetes in children has doubled since the beginning of the economical transformation that started in the late 1980s [2]. Moreover, such as in other countries, in Poland this new phenomenon affects children below 7 years old in particular. We have no answer so far as to why increasing numbers of young children are developing diabetes, and that is why this group of patients is a great challenge for diabetes healthcare providers. Children of preschool age are a very specific group. Their behaviors, emotions and physical development-stage profiles can be characterized by the following markers:

- Difficulties in keeping to a regular meal schedule
- Preferring frequent and small meals
- Satisfying hunger with carbohydrate-rich products

Children in this age group often have a deep fear of needles and syringes, are emotionally labile and their physical activity patterns are unpredictable. Metabolic instability has also been observed in this

age group, along with frequent and marked fluctuations in the diurnal blood glucose profiles, recurrent hypoglycemic episodes and rapidly progressing disturbance of the acid–base balance. This is the reason why we often call this type of diabetes a ‘brittle’ one. It seems that only flexible, intensive insulin therapy can adequately respond to these demands [3]. There is a risk that if we apply it in an increased number of injections, it could cause greater stress for children, as well as their parents [4]. Therefore, continuous subcutaneous insulin infusion (CSII) may be a good way to replace multiple daily injection therapy to improve management of young children with Type 1 diabetes [5]. Some promising benefits of glucose level control in preschool children were observed in one of the first clinical studies on the CSII method; the improvement in decreasing HbA<sub>1c</sub> and maintaining its proper level up to 2–4 years after the introduction of the CSII method [6,7]. Moreover, this improvement was seen alongside a significant lowering of the risk of severe hypoglycemia. According to the results of a study by Boland *et al.*, the rate of severe hypoglycemia has decreased from 46/100 per year to 20/100 per year after introducing CSII [8]. The results of a randomized controlled study showed an improvement in parents’ quality of life after the CSII method was



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implemented [9]. Thus, we considered the flexible, intensive insulin pump therapy as an alternative to the multiple daily injections in treating young children.

Based on the knowledge described above, at the beginning of 2000, we took the decision to launch a national program in Poland (OPPLP), in which CSII was offered to the youngest children with diabetes [10]. Sixteen pediatric diabetes centers across the country took part in this program, supported financially by the charity organization, Wielka Orkiestra Świątecznej Pomocy (WOSP). The main goal of the OPPLP was to educate healthcare providers (physicians, dietitians and nurses) on the application of the CSII method and the assessment of the clinical effect of using it in the youngest group of patients. Thereby, this cross-sectional, national, multicenter study has been conducted in two stages. In the first stage, education of healthcare providers lasted from 2003 to 2005, and the second stage (in which we were assessing clinical effects of the method) lasted from 2005 to 2008. In order to facilitate the clinical data collection, we used an electronic network system (enCapture) with a central server to provide all measures of  $HbA_{1c}$  in one central laboratory. In a group of 920 patients, 734 were using CSII and 186 were treated by the multiple daily injection method. Out of all patients, 71.7% were of prepubertal age (mean age 8 years), and the median of diabetes duration was 3.1 years. Assessing the metabolic control by  $HbA_{1c}$ , the median was 7.3% (1657 measurements taken), and 60.1% of patients received  $HbA_{1c}$  below 7.5%. In the whole group (920 patients), we noticed 23 events of severe hypoglycemia (0.9/100 patients per year) and 34 events of ketoacidosis (1.33/100 patients per year). The results of metabolic control measured by  $HbA_{1c}$  shows that there were not the significant differences in the quality of treatment between the pediatric diabetes centers that participated in the OPPLP study. This effect was probably owing to the first stage of the OPPLP in which training in pump therapy was offered to the healthcare providers. We also found that 45.5% of parents took the decision to introduce insulin pump therapy to their child with the intention to improve their quality of life and in 45% of cases to solve the problem of needle phobia. In 10% of cases, poor metabolic control and recurrent hypoglycemia were the indications for CSII [11].

Currently, we observe that there have been significant changes in recommendations to

apply the CSII method [12]. The results of a national Polish study allowed us to claim that CSII is not only a helpful tool for improving metabolic control or protecting against hypoglycemic episodes, but it is also an optional form of therapy taking into account patients' needs and their different lifestyles, often from before the onset of diabetes [11]. In 2007, the indications for applying the pump therapy in children were adopted by the European Society for Pediatric Endocrinology, Lawson Wilkins Pediatric Endocrinology Society and the International Society for Pediatric and Adolescent Diabetes. They claim that CSII may be beneficial in young children and may be helpful for anxious parents [13]. Nowadays, in the majority of countries, national healthcare systems still unfortunately only consider medical indications for this form of therapy. This means CSII is not available for well-controlled or newly diagnosed patients. In my opinion, this strategy does not take care of one's 'metabolic memory' and behaviors, emotions and attitudes, which are being shaped as early as the first day of living with diabetes [14]. Similar opinions can be found in the results of one of the meta-analyses concerning the efficacy of using the insulin pump. The authors conclude that "CSII appears to be a useful method for patients," and ask why many healthcare authorities do not offer insulin pumps, and why those that do so only do in restricted numbers? [15].

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#### **The implication of insulin algorithms: a new concept of prandial insulin programming – the Warsaw School of Insulin Pump Therapy**

The positive effects of using insulin pump therapy in children raises questions about the proportions between basal and bolus insulin. According to the guidelines for the setting insulin in the CSII method, total daily dose is roughly divided between basal and bolus insulin delivered during day and night [5,16]. However, many studies indicate that the basal insulin contribution is lower in young children, and is often on the level of 20% of the total daily dose. During the remission phase it is also less than 25% of the total daily dose. The mean contribution of basal insulin in the overall pediatric population is approximately 30% of total daily dose [17]. If the CSII was supported by a glucose monitoring device, we could observe the relationships between the food intake ratio and postprandial glycemia excursion in a period of

time longer than 2 h. Moreover, based on the published studies, it was observed that prolonged insulin delivery in normal and square-wave bolus for a mixed meal helps to normalize glycemia if compared with a regular bolus setting. The authors of two studies, Jones *et al.* and Lee *et al.*, found that for a high-fat meal for dinner, such as pizza, the dual-wave bolus matched the postprandial glycemic control, as well fasting glucose level, in the most effective way [18,19].

Based on these results and after our own further research, we came to the assumption that it is not only carbohydrate products that lead to postprandial hyperglycemia. We established a hypothesis that the fat–protein nutrients also raise the blood glucose concentration for a prolonged time after a mixed meal. On the basis of these findings we introduced a new, fat–protein exchange unit to the food counting system. A fat–protein unit was defined as 100 kcal of fat and/or protein foods. We also established that the dose of the insulin in the standard bolus is calculated based on the number of carbohydrate units (10 g or 40 kcal), while the dose for the extended/square bolus is calculated as the number of fat–protein units multiplied by insulin ratios (dose of insulin that covers 10 g of carbohydrate product or 100 kcal from fat/protein products). Finally, the total dose of the insulin calculated for a meal was counted as the sum of insulin dose in standard and square boluses, which was labeled a multiwave one [20].

The logistics issue still needs to be resolved in implementing the new calculating procedure as

a relevant therapy improvement for the Type 1 diabetes population, which is multiaged, multifaceted and consists of people of very different capabilities. For pediatricians there is another question: how to introduce this complex new algorithm of insulin dosage calculations for young patients and their parents and ensure that the innovation will not be too difficult for them?

The use of new devices gave us a lot of experience and a deeper insight into how to tailor insulin doses for the changeable daily needs of patients. The flexible method of insulin pump therapy described in this article seems to be helpful for people living with diabetes, allowing them to keep their quality of life at comparable levels to the healthy part of the society. This kind of therapy decreases levels of stress and anxieties in everyday life. It gives freedom in food choice without glucose deterioration, and protects against recurrent hypoglycemia. As a new strategy of treatment it requires deep modifications of the education program offered to our patients, and our way of thinking in treating diabetes.

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