OPTIMIZATION OF TYPE 1 DIABETES THERAPY THROUGH TECHNOLOGY

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Abstract

The use of modern technology in type 1 diabetes (T_1DM) management is one of the most discussed topics nowadays.

At present, the available devices include: CSII pumps, sensors augmented pumps (SAP), sensors augmented pumps with predictive low glucose suspend monitoring systems (PLGM) which also offer alarms/prediction for hyperglycemia.

Key-words: **type 1 diabetes, technology**

The use of modern technology in type 1 diabetes (T_1DM) management is one of the most discussed topics nowadays. In our country, the access to the use of various continuous subcutaneous insulin infusion (CSII) devices and blood glucose monitoring systems has increased. At present, the available devices include: CSII pumps, sensors augmented pumps (SAP), sensors augmented pumps with predictive low glucose suspend monitoring systems (PLGM) which also offer alarms/prediction for hyperglycemia. There are several types of continuous glucose monitoring systems (CGMS):

A. intermittently viewed (iCGMS) which shows continuous glucose measurements retrospectively at the time of checking [1];

B. real-time (rtCGMS) which uniformly tracks the glucose concentrations in the body's interstitial fluid, providing near real-time glucose data [1]. In this category, is also included the subcutaneous implantable sensor which requires a minor surgical.

Taking into consideration the wide variety of these systems, the essential aspect is to choose the most suitable system according to the safety profile, accuracy and patient preference.

Although glycated hemoglobin (HbA_1c) has long been a traditional method of evaluating glycemic control, it does not reflect the intra/inter-daily glycemic excursions that may lead to acute events such as hypoglycemia or postprandial hyperglycemia. These events are correlated to the occurrence of micro– and macro-vascular complications. *The Diabetes Control and Complications Trial* (DCCT), followed by *Epidemiology of Diabetes Interventions and Complications* (EDIC) [2], highlighted that increased HbA1c contributed to the type 1 diabetes complications. The *UK Prospective Diabetes Study* (UKPDS) [3], confirmed the importance of a good glycemic control but also emphasized the control of the other components of the metabolic syndrome and the health impact on individuals with type 2 diabetes. Most global organizations recommend an HbA1c target <7.0% (53mmol/ml) for adults [4] and <7.5% (58mmol/ml) in the case of children [5].

Structured blood glucose self-monitoring (SBGM) has shown significant improvement in glycemic control and in patients quality of life, but it cannot predict future hypoglycemia or give alarms regarding its occurrence [6]. Both rtCGM and iCGM, by measuring the glycosylation reaction from interstitial

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Received: 2.05.2019, accepted: 15.05.2019, published: 24.05.2019

Citation: Morariu D. Optimization of type 1 diabetes therapy through technology. Journal of School and University Medicine 2019;6(2):20-22

tissue, facilitate the monitoring of time spent in glycemic targets ("time in range"). However, only rtCGM can alert the user if its glycemic trend is towards hypo/hyperglycemia.

The American Diabetes Association (ADA) recommends the use of insulin pumps for most adults, children and adolescents with DZ 1 (class A recommendation) and can be considered as a treatment option for all children and adolescents, especially those under the age of 7 years old (class C recommendation) [7], since safety has been shown over the past 15 years for the use of insulin pumps in the pediatric age group [8]. Data from the *Type 1 diabetes exchange registry* (T1DX) database focused on children < 6 years of age showed lower levels of HbA1c in those with insulin pump. The SWEET project (*Better Control in Pediatric and Adolescent Diabetes: Working to Create CEnTers of Reference*), in which our country is also a reference center, showed that approx. half of the 16,000 insulin pump users had lower HbA1c and total daily insulin dose compared to those using multiple daily injections (MDI) [9].

According to the *International Society for Pediatric and Adolescent Diabetes* (ISPAD), the conditions required for considering treatment through insulin pump are: recurrent severe hypoglycemia, wide fluctuations in blood glucose levels regardless of A1c, suboptimal diabetes control (ie. HbA1c exceeds target range for age), microvascular complications and/or risk factors for macrovascular complications, good metabolic control but insulin regimen that compromises lifestyle circumstances, young children and especially infants and neonates, children and adolescents with pronounced Dawn phenomenon, children with needle phobia, pregnant adolescents, preconception (ideally), ketosis prone individuals, competitive athletes [8].

Advanced settings of these devices include the ability to set temporary basal rates and the possibility to change the bolus delivery pattern. Temporary basal rates allow the adjustment of the usual baseline programmed rate in the pump by: reducing the insulin requirement delivered in case of physical activity or increasing the insulin requirement in case of intercurrent illnesses that induce increased glycemic values, which can be further increased by using medication (ie. glucocorticosteroids in asthma exacerbation). Different basal rates can be pre-programmed in days when insulin sensitivity is changed (ie. menstrual periods). Bolus insulin (for hyperglycemia correction or to cover the ingested carbohydrates) can be administered in several ways:

- immediately (the standard or normal bolus);
- extended (over a predefined period of time);
- dual (multiwave) – a combination of the two described above: one part is given immediately and the other part extended over a predetermined period of time [8], thus avoiding postprandial hypoglycemia and postprandial delayed hyperglycemia secondary to the slowly absorption and metabolism of protein and fats from dishes.

In the case of a bolus re-administration, the pump automatically reduces the amount of insulin that is still "active" from the previous bolus, preventing overlapping with the risk of hypoglycemia. Moreover, the use of the "Bolus Wizard" feature has shown a significant reduction in HbA1c, because estimating the insulin requirement according to the sensitivity in different time of the day, the amount and type of carbohydrate consumed and the level of physical activity is difficult for some people. SAP and PLGM suspend system automatically cease insulin administration to prevent hypoglycemic episodes until the blood glucose returns to normal. Beyond the automatic calculations, the quality of life of people with diabetes is a priority. Despite the numerous evidence supporting the use of insulin pumps, there are some barriers like image concerns and social integration and the effectiveness of therapy using technology. The discontinuation rate of insulin pump therapy is unrecognizable, but the reasons for withdrawal were the need for permanent wearing, discomfort or inconvenience of wearing the pump, glycemic control problems with a higher rate among girls [9,10]. Establishing realistic expectations from both the patient and their families from the beginning of the pump therapy initiation is essential in order to optimize the diabetes control and reduce the sense of burden that those living or caring for people with type 1 diabetes [8].

We live in the technology era focusing on both therapy and quality of life of people with T_1DM. In the nearest future this will be the main therapeutic

approach for T_1DM. With the diversity of systems and technologies available (which have proven safety and favorable results), the international consensus and guidelines are needed both to indicate the type of iCGMS, individualized rtCGMS, SAP or PLGM required, but also to offer more specific information regarding the interpretation of the data provided by these different types of devices.

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