

Carbohydrate counting and insulin therapy: A strategic association for autonomy and quality of life of patients with type 1 diabetes mellitus



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ABSTRACT

Carbohydrate Counting is a nutritional strategy to determine the amount of carbohydrates contained in meals consumed by diabetic patients and must be inserted in the broad context of health care for these patients. The importance of associating Carbohydrate Counting with Insulin Therapy is emphasized and the need for health professionals involved in clinical monitoring to train these patients in the knowledge of their therapy, through educational strategies, aiming to improve their quality of life and autonomy. The association of Contagem with insulin therapy, combined with knowledge about the different glycemic responses, application methods and types of insulin and other concepts inherent to the routine care of diabetic patients, can promote greater flexibility and assertiveness in food choices.

Keywords: Carbohydrate Count, Insulin Therapy, Diabetes Mellitus.

1 INTRODUCTION

1.1 TYPE 1 DIABETES MELLITUS: DEFINITION, NUTRITIONAL THERAPY AND INSULIN THERAPY

Diabetes Mellitus (DM) is defined, at diagnosis, as a condition of sustained hyperglycemia under fasting conditions or in situations of overload, such as after the ingestion of meals or predetermined portions, per protocol, of glucose (Sociedade Brasileira de Diabetes, 2023a).

Among the most cited types of diabetes in the literature is Type 1 Diabetes Mellitus (DM1), whose diagnostic particularity is the absence of insulin production, a fact that occurs with even greater prevalence during the first and second decades of life, but which can also be detected in the adult phase of patients (*Latent Autoimmune Diabetes in Adults* – LADA) (Ross et al., 2016).

Diet associated with insulin therapy and physical exercise correspond to the main pillars for optimal glycemic control, significantly reducing the chances of DM complications. In the case of patients with DM1, for whom the application of insulin is a mandatory protocol, this association has



unique particularities. This is because the insulin applied has, in general terms, two basic objectives. The first contributes to the basal control of blood glucose and the second ensures the metabolization of glucose from the patients' diet. The two cases are known as basal bolus application and prandial bolus or meal (Fritz et al., 2020).

1.2 INSULIN THERAPY

According to the Carbohydrate Counting Manual revised and published in 2023, there are three types of insulin therapies. Traditional Therapy uses intermediate-acting (basal bolus) and rapid (meal bolus) insulins; Multi-Dose Therapy, with ultra-slow or intermediate-acting insulins (basal bolus) and ultra-fast or rapid insulins (bolus meal); and Continuous Insulin Infusion Therapy (Insulin Pump), which uses only ultra-rapid insulin, managing it according to the baseline goal or meal.

Insulin applications are organized and prescribed schematically so that the patient's blood glucose is controlled under the conditions in which they are fed and in the interval periods between meals, as well as fasting periods (such as night sleep) (Oliveira et al., 2022).

Considering that there is an average recommendation of six meals a day and observing that there are patients with large fluctuations in blood glucose, frequently configuring states of hyper and hypoglycemia, the importance of organizing these therapies becomes evident: diet and insulin (Cuppari, 2018; SBD, 2023a).

2 CARB COUNTING: INITIAL REFLECTIONS

In this context, more than 20 years ago, the Carbohydrate Counting strategy was created. According to the Carbohydrate Counting Manual (SBD, 2023b), the goal of this strategy is to understand and account for carbohydrates ingested by the patient. To this end, it is remembered that not only the carbohydrates themselves must be considered, but also the sources of fat and protein, which are partially converted into glucose during the digestive process. In addition to the known macronutrients, fiber is also considered in this accounting since it is not absorbed and must be reduced when in significant amounts in the portions consumed.

The prescription of diets is the exclusive responsibility of the professional nutritionist and the prescription of insulin dosages is a medical activity. The multidisciplinary team, partially represented here by these two professionals, needs to understand all the dynamics that involve the choice, purchase, and access to food, as well as the access, storage and management of insulin application, not forgetting other organic dysfunctions that the patient may have. For this reason, nurses, social workers, physiotherapists, dentists, among many other professionals, are fundamental in the multidisciplinary team (Oliveira et al., 2022).



Faced with this complex network of health care for diabetic patients focused on insulin administration *versus* food and glycemic control, there is the main character, who is the patient. Although evident, it is always necessary to emphasize that knowledge guarantees the autonomy and quality of life of patients with chronic non-communicable diseases such as Diabetes Mellitus. Knowledge brings awareness of the disease and the appropriation of care methods (Muttoni, Maria and Fulginiti, 2020).

In the case of food, specifically, the possibilities of food choices are diverse. There is a range of food possibilities, according to financial availability and accessibility, which can be in the daily lives of patients with DM1. However, this range can be very restricted when the patient has not been guided to make their own choices in a safe way (Miranda, Reis, and Oliveira, 2023).

In the application of insulin for the bolus meal, also called prandial bolus, the goal is that the amount applied is sufficient to metabolize the amount of food ingested. Specifically, metabolizing the amount of glucose that will be produced from that consumption. Thus, to determine the amount of insulin to be applied, there are two ways according to the guidelines of the Carbohydrate Counting Manual of the Brazilian Society of Diabetes (SBD, 2023b).

In the first (ideal) way, the patient knows how to identify the amount of carbohydrates contained in the meal that will be consumed and has the knowledge to convert this amount into the insulin dosage that will be applied. For this, other knowledge besides Carbohydrate Counting will be necessary. One of them is the concept of Insulin-Carbohydrate Ratio, which corresponds to the amount of carbohydrates that 1 unit of insulin is capable of metabolizing, and this insulin is of the fast or ultra-fast acting type, exactly those used for the bolus meal. Thus, we have the example of a patient whose Insulin-Carbohydrate Ratio is 1:15 (1 unit of insulin for 15 grams of carbohydrates) who will consume a lunch with 60 grams of carbohydrates, identified in his count, and, for this reason, will apply 4 units of insulin prescribed by the doctor.

At first, these calculations seem complex, but routine, exercise, and clinical follow-up make this flow operationalized in an organic way, due to the numerous repetitions. After all, the patient eats several times a day and counting will be exercised in a way that corresponds to this frequency.

However, explaining the second way of determining the insulin dose to be applied, the patient's lack of knowledge regarding Carbohydrate Counting is put on the agenda. In this case, the choices become limited and the guidelines and calculations prescribed by the nutritionist become the only guidelines and options for the patient's daily menu. On the prescribed diet, the nutritionist may be based on information pre-defined by the doctor, such as the Insulin-Carbohydrate Ratio and possibly a fixed dose of insulin to be applied before meals. In this case, the conversion of the previously prescribed fixed dose into the amount of carbohydrates to be consumed will be done by the nutritionist, based on the patient's Insulin-Carbohydrate Ratio. An example of this situation is a patient referred to



a nutritionist with 5 units of insulin for lunch and an Insulin-to-Carbohydrate Ratio of 1:10. In this case, the nutritionist will calculate a lunch whose amount of carbohydrates should be 50 grams.

As part of dietary planning, the dietitian will take care to calculate more than one lunch option (as well as the other meals of the day) for the patient in order to avoid food monotony. However, as much as there are options, it is evident that there is still a restriction and a limit on the patient's autonomy of choices in common everyday situations, such as the lack of a prescribed item or a change of routine (travel, celebrations, etc.).

If the objective of health professionals is to contribute to the quality of life of patients in their various areas of activity, it is notorious to highlight that having freedom with adequate knowledge is an important part of this definition of quality of life. To this end, each professional should guide their patients regarding the established therapy (Ribeiro et al., 2023).

Doctors and nurses should differentiate between the types of insulin prescribed, their purposes, storage methods, hygiene care, and application. Nutritionists should promote nutrition education in addition to the diet that can be prescribed. And, for patients with DM1, the main goal of nutritional education is to empower the patient regarding Carbohydrate Counting (Gabriel et al. 2016; Cunha et al., 2020).

3 CARBOHYDRATE COUNTING METHODS

In several Carbohydrate Counting Manuals (SBD, 2023b, Lamounier, 2020, Muttoni, Maria, and Fulginiti, 2020), the two counting methods described below are mentioned.

3.1 DIRECT COUNT

In this method, also called the carbohydrate gram method, the count is based precisely on the nutritional composition found in centesimal nutrient composition tables or even on labels. Generally preferred by professional nutritionists, as they already have the habit and access to bibliographic sources that provide this information, the direct counting method is often used in the prescription of diets and meal plans. Nutritional composition tables, such as the Brazilian Table of Food Composition (TACO, 2011), can be sources of more accurate information.

For the patient, the use of this method is more challenging due to the difficulty of accessing food composition tables that are typically specific to the work routine of nutritionists. However, with the advent of apps and the great expansion of mobile access, much of this data has been compiled into the databases of these apps. This now allows users to enter the food and its quantities consumed and, in return, obtain the carbohydrate values corresponding to that portion. Some of these applications even allow the insertion of data such as the Insulin-Carbohydrate Ratio, enabling the final conversion calculation to determine the amount of insulin to be applied at that time (Ribeiro et al., 2023).



Technology has brought a greater possibility of access to this method to patients, however, it is also important to emphasize the need to have a telephone with this technology and to know how to handle it. Because of this and other factors related to knowledge and literacy, the next method is important.

3.2 METHOD BY EQUIVALENTS

This method is recognized by some authors, such as Lamonier (2020), as the Substitute Method or List of Equivalents. In it, foods are organized in tables by groups, in which the association depends on the characteristic of the dominant nutritional composition in that item. Thus, there is the list of foods in the group of starch, fruits, other vegetables, meats, etc., as mentioned in the SBD (2023) and other nomenclatures and groups, such as the proposal by Lamounier (2020) and Muttoni, Maria and Fulginiti, (2020), placing, for example, the rice group.

In these lists, foods are organized into distinct portions and individualized according to the amount of carbohydrates they can provide. The concept of equivalent arises, for which the carbohydrate content that that individual portion of the list contains is defined.

A particularity and a challenge of this method are the different references of values contained in the Carbohydrate Counting Manuals. In the Manual previously proposed by the SBD (2009), 1 equivalent of the starch group contains 15 grams of carbohydrates, and this amount is provided by different amounts of each food in its group. As an example, 2 tablespoons of rice or 4 tablespoons of beans provide 15 grams of carbohydrates. In the Manuals of Lamounier (2020) and Muttoni, Maria and Fulginiti, (2020), the similar group is from the rice group whose homemade measurements are different and the respective amounts of carbohydrates as well, being 6 grams of carbohydrates for 1 tablespoon of rice and 2 grams for 1 tablespoon of beans.

Therefore, the guidance is that the nutritionist, recognizing the patient's profile and monitoring his/her glycemic evolution after the beginning of treatment, indicates a more appropriate manual and, if necessary, makes adaptations, changes or adjustments throughout the nutritional follow-up (Gabriel et al., 2016).

4 PROTEIN, FAT, FIBER, AND POLYOLS IN CARBOHYDRATE COUNTING

In the knowledge of carbohydrate counting, it is necessary to understand that other macronutrients have partial conversion to glucose throughout the digestive and absorptive process. Carbohydrates are the only ones with full conversion, but proteins and fats, despite partial conversions, also lead to an important impact on blood glucose with the added particularity of the later response time. This is because carbohydrates, in general, convert into glucose and raise patients' blood glucose



within 2 hours of ingestion. Proteins, on the other hand, have an average time of 3 to 4 hours and fats 5 hours postprandial (SBD, 2023b).

Of the total protein consumed, 35 to 60% is converted to glucose, and of the total fat, 10% is the conversion rate. In the case of proteins, there is a significant variation in the percentage conversion margin, but this can be adjusted in the calculations for the Carbohydrate Count according to the blood glucose monitoring recorded by the patient. The recommendation is that the value of 35% be used and later, if necessary, the conversion estimate can be adjusted.

In the case of fats, when calculating a 10% conversion in the lipid content consumed in food portions, in general, low values are obtained that, at first, do not seem to have an impact on the count. However, it is essential to understand that counting and insulin therapy also depend on a relative association with postprandial response time. A fattier food that contains other nutrients in its composition, such as fatty meats or preparations with high-fat sauces, is likely to bring about later responses. This implies that the time of action of the insulin applied before consumption may not be sufficient to cover the entire glycemic response expected for that meal. The result of this combination is delayed hyperglycemia caused by poor food choices and lack of knowledge of the association between food and insulin therapy.

Regarding fiber, technically called non-digestible polysaccharides, as its name suggests, there is a need for a discount of the total carbohydrates in that portion because they are not absorbed. The SBD (2009) suggests that this discount should be made in portions with amounts starting from 5 grams of fiber. The goal is to avoid overestimating the amount of carbohydrates capable of raising blood glucose. In addition, fibers delay gastric emptying and influence intestinal absorption and fecal bolus formation, also influencing the speed of glycemic alteration.

More recently, the SBD (2023b) also proposes that fibers should be reduced to the margin of 50% of their content, still considering portions equal to or greater than 5 grams as significant.

Also in this update, the concepts of polyols are highlighted, that is, sugar alcohols or sweeteners such as sorbitol, maltitol, xylitol, erythritol and lactitol. The recommendation is similar to that of fiber, reducing 50% of its content from the total amount of carbohydrates. For example, if a food has 16 grams of carbohydrates and 10 grams of maltitol (a type of polyol), the carbohydrate effectively absorbed will be 11 grams. This concept of absorbed carbohydrate is also given a specific nomenclature of "net carbs".

4.1 BOLUS MULTIONDA

As already shown, carbohydrate counting should be included in the context of insulin therapy, also based on knowledge about the different postprandial glycemic responses.



Foods high in fat and protein generate responses like "two or more waves of elevation." This is due to its digestion and absorption times. To this end, insulin application can be divided according to the expected response times in the food consumed (SBD, 2023a).

4.2 EXTENDED BOLUS

Food consumption at some social events and types of restaurants are good examples for understanding. Parties lasting hours and rotations are situations in which food intake fluctuates and/or becomes intermittent, with sporadic "pinching" and without programming. For patients whose knowledge of counting is well established, it is possible to make an average estimate of consumption and, based on it, convert it into the amount of insulin needed for those hours, and there may be adjustments during the process. In these cases, continuous insulin infusion is more appropriate, being regulated as to the time and speed of administration (SBD, 2023a).

5 LABELS AND CARB COUNTING

In 2020, Anvisa published new rules on nutrition labeling, which came into force in 2022. With these modifications, some information about the content of fats and sugars became more evident to the consumer (BRASIL, 2022). Even so, the information contained in the nutritional information tables refers to the direct counting method of Carbohydrate Counting and lacks greater knowledge on the part of the consumer. In addition, depending on the type of product, it is necessary to perform calculations such as rules of three, since the portion consumed is not always exactly the one reported as a reference in the table.

In this context, the reflections previously pointed out regarding the knowledge passed on to the patient by the team, the choice of the most appropriate method for the patient's level of understanding, and the need for follow-up are reinforced, a clarifying and adjustable follow-up throughout the care process (Gabriel et al., 2016; Cunha et al., 2020).

6 OTHER CONCEPTS RELEVANT TO CARBOHYDRATE COUNTING

The definition of Carbohydrate Counting refers to the definition of the carbohydrate content of a portion consumed. However, for the count to be effectively inserted into the general context of glycemic control, it needs to be associated with the patient's entire therapeutic regimen. And, still in this line of reasoning, the reciprocal is also true. This is because it is not the diet that always needs to be adjusted to the prescribed medication. The opposite, when possible, can also be an extremely efficient strategy, i.e., medication being incorporated into the patient's eating routine (Cunha et al., 2020).



To do this, we start from two basic assumptions. The first is that food is already part of the patient's daily life. It will be adjusted by the nutritionist trying to preserve the life routine as much as possible, after all, this is a determining factor for treatment adherence and quality of life. Thus, medication schedules, as well as other particularities of prescribed medical therapy, if adjusted to this routine, will make the impact of the care process less costly on the patient's mental health and individual and family dynamics (Ross et al., 2016; Cuppari, 2018).

The second assumption is in line with what is evidenced in this chapter regarding the greater objective of empowering the patient regarding the scope of their autonomy. He needs to learn how to do carbohydrate counting to have more freedom in his choices and flexibility of schedules. From the moment this learning is consolidated, insulin applications will follow this new habitual routine of the patient, in which there are diverse choices and greater flexibility and variations in the amounts consumed (SBD, 2023b).

Still in this context of autonomy and, at the same time, of learning and adjustments, glycemic variations may be more significant than expected. Episodes of hypoglycemia and hyperglycemia also need to be explained and the management oriented to the patients (Cuppari, 2018).

Thus, in case of mild to moderate hypoglycemia, the immediate intake of carbohydrate portions that can vary from 5 to 30 grams, according to the age group and glycemic level, are recommended. For this, knowledge of carbohydrate counting is also necessary (SBD, 2023b).

On the other hand, in cases of hyperglycemia, these can be evaluated as results of failures in carbohydrate counting and/or in the conversion and application of insulin in previous meals, generating a delayed effect of elevation of blood glucose. In general, they are checked preprandially, that is, before the consumption of the next meal and currently many patients are afraid to eat due to hyperglycemia (Lamounier, 2020).

The guideline in these cases is to correct blood glucose. And, to understand how this correction is made, it is necessary to briefly explain the concepts of Sensitivity Factor (FS) and Bolus Correction. The SP is related to the reduction in blood glucose that the application of 1 unit of rapid or ultra-rapid insulin can generate. Thus, if a patient's FS is 1 to 50 mg/dL, it means that it is expected that their blood glucose can reduce by 50 mg/dL after application. If he has a preprandial blood glucose of 150 mg/dL and should be at 100mg/dL, he can apply this 1 unit with the objective of reduction (Bolus Correction), which can be applied together with the amount of insulin used in the Bolus Meal, according to medical guidance (SBD, 2023b).

7 FINAL THOUGHTS

Carbohydrate Counting is inserted in the context of the care of the diabetic patient, especially those with type 1 Diabetes Mellitus. For its greater effectiveness, it is essential to understand its



association with insulin therapy to promote greater flexibility in food choices. In this sense, expanded knowledge about the different glycemic responses, application methods and types of insulin are necessary, as well as other concepts inherent to the routine care of diabetic patients. Professionals need this knowledge and the sensitivity and responsibility of sharing it with patients, through clear and accessible educational strategies, aiming to improve their quality of life and autonomy.



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