

Understanding Diabetes Mellitus Causes, Symptoms, and Complications

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SUMMARY

This work aims to explain what diabetes is. Diabetes Mellitus (DM) is a metabolic syndrome of multiple origins, resulting from the lack of insulin and/or the inability and/or lack of insulin to adequately exert its effects, characterizing elevated blood sugar levels (hyperglycemia), which leads to acute symptoms and characteristic chronic complications. His disorder involves the metabolism of glucose from fat and protein and has consequences both when it comes on quickly and when it sets in slowly.

Keywords: Diabetes Mellitus; Insulin; Hyperglycemia

Introduction

Diabetes is considered a risk factor; mainly due to the significant alterations it causes in lipid metabolism. Diabetes mellitus is a syndrome of impaired metabolism of carbohydrates, fats, and proteins, caused by the absence of insulin secretion or by reduced tissue sensitivity to insulin. A characteristic aspect of this disease is the defective or deficient secretory response of insulin, which is manifested in the inappropriate utilization of carbohydrates (glucose), with consequent hyperglycemia. Diabetes occurs because the pancreas cannot produce enough of the hormone insulin to meet the body's needs, or because this hormone cannot work properly (insulin resistance). If an individual does not have glucose in the cells, the body will get energy from another source (lipids). Glucose is the main signal for the pancreas to release insulin from the β cells of the islets of Langerhans. Cells have insulin receptors, and insulin binds to the receptors and mobilizes glucose transporters (GLUTs), in adipose tissue it has GLUT 4, and in the pancreas, it has GLUT 2. GLUTs go to the surface of cells and transport glucose inside cells. Most of the glucose goes to the glycolytic pathway, where most of it is transformed into glycogen (glucose

storage). Diabetes is a disorder in the body's glucose metabolism, in which glucose in the blood passes through the urine without being used as a nutrient by the body. Diabetes is associated with increased mortality, a high risk of developing microvascular and macrovascular complications, and neuropathies. It can cause blindness, kidney failure and limb amputations, being responsible for excessive healthcare costs and a substantial reduction in work capacity and life expectancy.

Types of Diabetes Mellitus

Type 1 Diabetes Mellitus: It is the most aggressive type and causes rapid weight loss. It occurs in childhood and adolescence. It causes autoimmune destruction of the β cells of the islets of Langerhans. Autoantibodies against β cells against insulin, against tissue glutamic decarboxylase, and tyrosine phosphatase. The individual does not produce insulin, or glucose and does not enter the cells, and the blood glucose level rises. Type 1 diabetes usually appears up to the age of 30, mainly affecting children and adolescents, although it can affect people of any age. It is characterized by an absolute deficiency of insulin production in the pancreas; thus, causing difficulties for the liver to compose and maintain glycogen stores which are vital for the

body, thus accumulating sugar in the blood, leading to hyperglycemia, that is, a high blood glucose level. Thus, the efficiency of the cells is reduced to absorb amino acids and other necessary nutrients, definitively requiring the exogenous use of the hormone. In some patients, in the first months of the disease, there may be no need to use insulin, which will inevitably occur after a few months due to the destruction of the pancreatic insulin reserve. In type 1 diabetes, the sudden onset of the disease with an exuberant clinical picture is more frequently observed. These individuals are generally thin or of normal weight and are quite unstable, making metabolic control of the disease difficult and diabetic ketoacidosis may develop [1]. The type 1 diabetic pancreas does not produce insulin. Without the hormone, glucose does not enter the cells and accumulates in the blood and symptoms begin to appear. When blood sugar exceeds the threshold, this excess is eliminated in the urine. It is noticed when the diabetic when urinating in the toilet, some splash on the floor takes on a sticky appearance of water. The body loses fluid due to excessive urination and the consequence is thirst of the diabetic. The change in appetite is also noted and the individual feels hungrier.

Diabetes Mellitus Type 2: Type 2 diabetes is caused by insulin resistance and obesity. It occurs in people older than 40 years. The pancreas secretes insulin normally, but insulin and glucose remain in the blood and in cells that have little glucose. The pancreas releases too much insulin, which causes the β cells to break down. The destroyed β cells do not produce insulin and the individual needs to take insulin and drugs to increase insulin sensitivity. Type 2 diabetes mellitus is a heterogeneous syndrome resulting from defects in insulin secretion and action, and the pathogenesis of both mechanisms is related to genetic and environmental factors. Type 2 diabetes is caused by reduced sensitivity of target tissues to the effect of insulin. This decreased sensitivity to insulin is often described as insulin resistance. To overcome insulin resistance and prevent glucose buildup in the blood, there must be an increase in the amount of insulin secreted. Although it is not known what causes type 2 diabetes, it is known that in this case, the hereditary factor is much more important than in type 1 diabetes. There is also a connection between obesity and type 2 diabetes, although obesity does not necessarily lead to diabetes.

Causes of Type 1 Diabetes Mellitus

Diabetes occurs when the body does not produce enough insulin to maintain a normal serum insulin concentration or when cells do not respond properly to insulin. People with type 1 diabetes mellitus (insulin-dependent diabetes) produce little or no insulin. Most people with type 1 diabetes develop the disease before the age of 30. Scientists believe that an environmental factor (possibly a viral infection or a nutritional factor in childhood or early adulthood) causes the immune system to destroy insulin-producing cells in the pancreas. For this to happen, some genetic predisposition is likely necessary. Whatever the cause, in type 1 diabetes more than 90% of the insulin-pro-

ducing cells (beta cells) in the pancreas are permanently destroyed. The resulting insulin deficiency is severe, and to survive, the individual with type 1 diabetes must receive regular injections of insulin. In type 2 diabetes (non-insulin-dependent diabetes), the pancreas continues to make insulin, sometimes at higher-than-normal levels. However, the body develops a resistance to its effects, and the result is an insulin-related deficit [2].

What is Insulin and How Does it Work for Diabetes?

Insulin is an anabolic hormone that has a very important role in the body of all human beings, but it is also known for its use in the treatment of diabetes. Insulin plays a central role in the regulation of glucose homeostasis, that is, in the control of the blood glucose level. In addition, it reduces glucose production by the liver and increases the uptake of this hormone in adipose and muscle tissue. Insulin, by controlling the level of glucose in the blood, can also help regulate metabolism, acting as an option in the face of the partial or total deficiency of insulin absorption by the pancreas, common in this disease. Insulin is mainly used as a treatment for type 1 carriers, who are deficient in insulin and therefore need regular applications of the hormone³. For those with type 2 diabetes, treatment is based on changes in lifestyle and eating habits, but medications and even insulin may also be indicated in some cases for better blood glucose control or as the disease progresses³. For patients who need it, there are currently several types of insulin on the Brazilian market. The use of each will depend on the need for the time of action, onset, peak and duration of the effect, which are indicated by the doctor [3].

Types of Insulin

There are several types of insulin, which vary according to the time of action in the body. To choose the most suitable one, the doctor will analyze how the person's pancreas controls glucose. The chosen one will be the one with the action most like that of the organ. The main types of insulin used by people who have diabetes are.

Ultra-Rapid Acting Insulin: The effect occurs a few minutes after application. The peak occurs 30 to 60 minutes later and its action lasts three to five hours. It should be injected immediately before meals or shortly after, depending on the type of medication. This type of insulin has a clear appearance and being of shorter duration, leaves the bloodstream quickly, minimizing the risk of hypoglycemia (low blood glucose concentration) during periods of fasting, and between meals.

Fast-Acting Insulin: The action begins about 30 minutes after application, while the peak occurs two to three hours later. Its duration is from three to six hours. It must be injected 30 to 45 minutes after meals and, like ultra-rapid-acting insulin, it is clear in appearance.

Intermediate-Acting Insulin: Intermediate-acting insulin takes two to four hours to start working. The peak occurs four to 12 hours

after application and lasts for 12 to 18 hours. Generally, it should be applied once a day, before going to bed. It seems cloudy.

Slow Acting Insulin: The onset of action begins one hour after application, but the peak occurs only six to 12 hours later. The action usually lasts all day. It is usually applied once a day, before going to bed, and it looks clean.

Epidemiology of Type 1 Diabetes Mellitus

Type 1 diabetes has an uneven racial distribution, with a lower frequency in black and Asian individuals and a higher frequency in the European population, mainly in populations from the northern regions of Europe. The incidence of type 1 diabetes varies widely, from 1 to 2 cases per 100,000 per year in Japan to 40 per 100,000 in Finland. In the United States, the prevalence of type 1 diabetes in the general population is about 0.4%. The incidence of type 1 diabetes has increased in recent decades in some countries such as Finland, Sweden, Norway, Austria, and Poland. Explanations for these regional and ethnic differences are based on genetic and environmental differences. In Paraguay, 10% of the population suffers from diabetes. Data from the National Diabetes Program from January to October 2020. Diabetes in Paraguay currently represents 9.7% of the total population, approximately 700,000 people live with this pathology, of which only 50% know about their disease. The number of people cared for in health services by the Ministry of Public Health is 100,000, of which 66% are female and 34% male. For their part, pregnant women attended reached 3,500, while children and adolescents with type 1 diabetes reached 1,800 patients. The investment made in insulins for the patients reached the sum of Gs. 36,767,044.00 and in medicines and supplies a total of Gs. 54,667,336,000.

Pathogenesis of Diabetes Mellitus Type 1

This form of diabetes results from a marked and complete absence of insulin caused by a reduction in the mass of beta cells. Type 1 diabetes (IDDM) usually develops in early childhood, manifesting and accentuating puberty. Patients depend on insulin to survive; hence the name insulin-dependent diabetes mellitus. Without insulin, they develop severe metabolic complications, including acute ketoacidosis and coma. The course of the disease is not acute, but rather a slowly evolving self-harm process that probably develops over the years in a preclinical phase. In the period of manifestation of the disease, with the presence of hyperglycemia and ketosis, insulin-secreting cells are already in very low numbers or practically absent. The presence of lymphomononuclear-type inflammatory infiltrate and the absence of insulin-secreting cells, beta cells, characterize the histology of type 1 diabetes, macrophages, and Natural Killer (NK) cells, thus being a process dependent on cellular immunity. Three interconnected mechanisms are responsible for islet cell destruction: genetic susceptibility, autoimmunity, and environmental insult. Genetic susceptibility linked to specific class II major histocompatibility complex alleles is

thought to predispose certain individuals to the development of islet beta cell autoimmunity. The autoimmune reaction develops spontaneously or, more likely, is triggered by an environmental agent, causing mild initial injury to the beta cells [4].

Symptoms of Diabetes Mellitus

Both types of diabetes can have very similar symptoms if there is a significant increase in blood glucose.

Symptoms of high blood sugar include:

- a. Increased thirst
- b. Increased urination
- c. Increased hunger

When blood glucose is higher than 160 to 180 mg/dL (8.9 to 10.0 mmol/L), glucose appears in the urine. When the level of glucose in the urine rises further, the kidneys excrete more water to dilute a large amount of glucose. Because the kidneys make too much urine, people with diabetes urinate a lot and often (polyuria). Excessive urination creates abnormal thirst (polydipsia). Once the excess calories are lost in the urine, the person may lose weight. To compensate, the person often feels excessively hungry. Other symptoms of diabetes include.

- a. Blurry vision
- b. Drowsiness
- c. Nausea
- d. Decreased resistance during physical activity.

Diabetes Type 1

In people with type 1 diabetes, symptoms start suddenly and dramatically. A serious condition called diabetic ketoacidosis, a complication in which the body produces too much acid, can develop quickly. In addition to the usual diabetic symptoms of excessive thirst and urination, early symptoms of diabetic ketoacidosis also include nausea, vomiting, fatigue, and abdominal pain, especially in children. Breathing tends to become deep and rapid as the body tries to correct the acidity of the blood (see Acidosis), and the breath has a fruity odour like acetone. Without treatment, diabetic ketoacidosis can progress to coma and death, sometimes rapidly. Once type 1 diabetes has started, some people have a long but temporary phase in which blood glucose levels are near normal (honeymoon phase) due to partial recovery of insulin secretion.

Diabetes Type 2

People with type 2 diabetes may not have symptoms for years or decades before being diagnosed. The symptoms can be subtle. Increased urination and thirst are moderate at first, but gradually worsen over several weeks or months. The person ends up feeling extremely tired, is more likely to have blurred vision, and may become dehydrated. In the early stages of diabetes, blood glucose is sometimes unusually low, a condition called hypoglycemia. Because

people with type 2 diabetes make some insulin, they usually don't have ketoacidosis even when type 2 diabetes hasn't been treated for a long time. In rare cases, blood glucose levels are extremely high (may even exceed 1000 mg/dL [55.5 mmol/L]). This increase is often due to some other type of stress, such as an infection or the use of medications. When blood glucose becomes too high, a person can experience severe dehydration, which can lead to confusion, drowsiness, and seizures, a condition called hyperosmolar hyperglycemic state. Many people with type 2 diabetes are diagnosed with routine blood glucose tests before they have extremely high blood glucose levels.

Complications De La Diabetes

Diabetes damages the blood vessels, causing them to narrow and therefore limiting blood flow. Once the blood vessels throughout the body are affected, a person can experience many complications of diabetes. Many organs can be affected, particularly the following:

- a. Stroke causing brain,
- b. Eyes (diabetic retinopathy), which causes blindness,
- c. Heart causing a heart attack,
- d. Kidneys (diabetic nephropathy), which causes chronic kidney disease,
- e. Nerves (diabetic neuropathy), which causes decreased sensation in the feet.

High blood sugar also causes problems with the immune system; therefore, people with diabetes mellitus are particularly susceptible to bacterial and fungal infections.

Diagnosis

A person will be diagnosed with diabetes if they have an unusually high blood glucose level. Doctors screen people who are at risk for diabetes but don't have symptoms.

Blood Glucose Measurement: Doctors measure blood glucose in people who experience symptoms of diabetes, such as increased thirst, urination, or hunger. Also, doctors can test blood glucose in people who have conditions that could be complications of diabetes, such as frequent infections, foot ulcers, and thrush. To accurately measure blood glucose levels, doctors typically use a blood sample taken after a person has fasted overnight. Diabetes can be diagnosed if fasting blood glucose levels are above 125 mg/dl (6.9 mmol/l). However, it is possible to use blood samples that were taken after the person had eaten. Some rise in blood glucose after eating is normal, but even after eating, the value should not be too high. Diabetes can be diagnosed if the result of a random (non-fasting) blood glucose measurement is greater than 199 mg/dL (11.0 mmol/L).

Haemoglobin A1C: The doctor may also measure the blood level of a protein called haemoglobin A1C (also called glycosylated or glycosylated haemoglobin). Hemoglobin is a red substance that

carries oxygen in red blood cells. When the blood is exposed to high blood glucose levels for a long time, glucose binds to haemoglobin and forms glycosylated haemoglobin. The haemoglobin A1C level (reported as the percentage of haemoglobin that is A1C) reflects long-term trends in blood glucose values rather than rapid changes. Haemoglobin A1C measurements can be used to diagnose diabetes when the test is performed by a certified laboratory (not with instruments used at home or in a doctor's office). A person with a haemoglobin A1C level of 6.5% or higher has diabetes. If the level is between 5.7 and 6.4, the person has prediabetes.

Oral Glucose Tolerance Test: Another type of blood test, the oral glucose tolerance test, can be done in certain cases, as a preventive test in pregnant women to try to detect the presence of gestational diabetes or to evaluate an older person who has symptoms of diabetes but whose fasting glycemia is normal. However, it is not routinely used to detect the presence of diabetes because the test can be very cumbersome. In this test, while the person is fasting, a blood sample is taken to determine fasting blood glucose, and then the person drinks a special liquid that contains a standard amount of glucose. Other blood samples are taken over the next two to three hours and checked to see if blood glucose rises to an unusually high level. Another type of blood test, the oral glucose tolerance test, may be done in certain cases, as a preventive test in pregnant women to try to detect the presence of gestational diabetes or to evaluate an elderly person who presents symptoms of diabetes but whose fasting blood glucose is normal. However, it is not routinely used to detect the presence of diabetes because the test can be very cumbersome. In this test, while the person is fasting, a blood sample is taken to determine fasting blood glucose, and then the person drinks a special liquid that contains a standard amount of glucose. Other blood samples are taken over the next two to three hours and checked to see if the blood glucose rises to an unusually high level.

Preventive Diabetes Screening: Blood glucose is often measured during a routine physical exam. Regularly measuring blood glucose is very important, especially in the elderly, as diabetes is very common in older people. A person can have diabetes, especially type 2, and not know it. Doctors do not usually screen for type 1 diabetes, even in people who are at high risk for type 1 diabetes (for example, brothers, sisters, and children of people with type 1 diabetes). However, preventive testing is important in people at risk for type 2 diabetes, including those who.

- a. You are over 45 years old,
- b. have prediabetes,
- c. Are overweight or obese,
- d. Having a sedentary lifestyle,
- e. Have high blood pressure and/or a lipid disorder, such as high cholesterol,
- f. Have cardiovascular disease,

- g. Having a family history of diabetes,
- h. Had diabetes during pregnancy or had a baby born weighing more than 4 pounds,
- i. Have polycystic ovary disease.

Are of African American, Hispanic, Asian American, or American Indian ethnicity People with these risk factors should be screened for diabetes at least once every three years. The risk of diabetes can be estimated using online risk calculators. Your doctor may test your fasting blood glucose and haemoglobin A1C or perform an oral glucose tolerance test. If the test result is on the threshold between normal and abnormal, the doctor performs preventive tests more frequently, at least once a year.

Tratamiento De La Diabetes Mellitus

Diet, exercise, weight loss, education. In type 1 diabetes, insulin injections in type 2 diabetes, often oral medications and sometimes injections of other medications or insulin. Diet, physical activity and education are the cornerstones of diabetes care and are often the first recommendations given to people with mild diabetes. Losing weight is important for people who are overweight. People who continue to have high blood glucose levels despite lifestyle changes or whose blood glucose is very high, as well as people with type 1 diabetes (regardless of blood glucose level), need medication. Since a person with diabetes is less likely to have complications if he closely controls his blood glucose, the goal of diabetes care is to keep blood glucose as close to normal as possible. Treating high blood pressure and high cholesterol, which can contribute to circulation problems, can also help prevent some of the complications of diabetes. It is recommended that people with risk factors for heart disease take a daily dose of low-dose aspirin. Everyone with diabetes between the ages of 40 and 75 takes a statin drug (a drug that lowers cholesterol levels) regardless of the person's cholesterol level. People younger than 40 and older than 75 who are at high risk of heart disease should also take a statin. It is helpful for diabetics to carry or wear clinical identification (such as a bracelet or tag) to alert healthcare professionals to the presence of diabetes. This information allows healthcare professionals to initiate rapid salvage treatment, especially in cases of injury or mental status changes [5]. La cetoacidosis diabética y el estado hiperglucémico hiperosmolar son emergencias médicas, ya que pueden conducir al coma y la muerte. El tratamiento es similar para ambos y se basa en la administración de líquidos e insulina por vía intravenosa.

Diabetes Treatment Goals

Experts recommend that people maintain their blood glucose value.

- a. Between 80 and 130 mg/dl (4.4 and 7.2 mmol/l) fasting (before meals)
- b. Below 180 mg/dl (10.0 mmol/l) two hours after meals Hemoglobin A1C levels should be less than 7%.

Because aggressive treatment to achieve these goals increases the risk of excessive lowering of blood glucose values (hypoglycemia), these goals are adjusted for some people for whom hypoglycemia is specifically undesirable, such as the elderly. Some other goals are to keep your systolic blood pressure below 140 mmHg and your diastolic blood pressure below 90 mmHg. For people with diabetes who have heart disease or are at high risk for heart disease, the goal for blood pressure is less than 130/80 mmHg.

General Treatment of Diabetes: People with diabetes benefit greatly when they learn about the disease, understand how diet and physical activity affect blood glucose, and know how to avoid complications. A nurse who specializes in diabetes education can provide information on diet management, physical activity, blood glucose monitoring, and medication management. People with diabetes should stop smoking and consume only moderate amounts of alcohol (up to one drink a day for women and two for men).

Dieta Para Personas Con Diabetes: Diet control is very important in people with both types of diabetes mellitus. The doctor recommends following a healthy and balanced diet, and that the person strives to maintain a healthy weight. Meeting with a nutritionist or diabetes education specialist to create an optimal eating plan can be beneficial for people with diabetes. This plan includes avoiding simple sugars and processed foods, increasing your intake of dietary fibre, and limiting portion sizes of foods high in carbohydrates and fats (especially saturated fats). People taking insulin should avoid long periods between meals to prevent hypoglycemia from occurring. Although the presence of protein and fat in the diet contributes to the number of calories a person consumes, only the carbohydrate content has a direct effect on blood glucose. The American Diabetes Association has many helpful diet tips, including recipes. Cholesterol-lowering drugs are necessary to reduce the risk of developing heart disease, even when a person follows a proper diet.

People with type 1 diabetes and some people with type 2 diabetes can use the carbohydrate counting method or the carbohydrate exchange system to match the insulin dose to the carbohydrate content of the meal. "Counting" the number of carbohydrates in a meal is a method used to calculate the amount of insulin a person needs to take before eating. However, the carbohydrate/insulin ratio (the amount of insulin taken for each gram of carbohydrate in a meal) varies from person to person, and the person with diabetes should work closely with a nutritionist who has experience working with people with diabetes to master the technique. Some experts recommend using the glycemic index (a measure of the impact of carbohydrate-containing foods eaten on blood glucose) to separate fast-metabolizing carbohydrates from slow-metabolizing ones; however, there is little evidence to support this type of approach [6].

Physical Activity for People with Diabetes: An adequate amount of physical activity (at least 150 minutes a week, spread over

three days) can also help a person control weight and improve blood glucose levels. Since the value of blood glucose decreases during physical activity, the person must be aware of the presence of symptoms of hypoglycemia. Some people need to eat a small snack during prolonged physical activity, lower their insulin dose, or both.

Weight Loss for People with Diabetes: Many people, especially those with type 2 diabetes, are overweight or obese. Some people with type 2 diabetes can avoid or delay taking medication to achieve and maintain a healthy weight. Weight loss is also important for these people because being overweight contributes to the development of diabetes complications. If a person with diabetes has difficulty losing weight through diet and physical activity alone, a doctor may prescribe weight-loss medication or recommend bariatric surgery (surgery that causes weight loss).

Prevention of Diabetes Complications: Proper foot care and regular eye exams can help prevent or delay the onset of diabetes complications. People with diabetes receive the Streptococcus pneumonia vaccine, and your doctor usually recommends getting a flu shot annually, as people with diabetes are at risk of infection.

Pharmacological Treatment of Diabetes: There are many medicines used to treat diabetes. People with type 1 diabetes need insulin injections to lower their blood glucose levels. Most people with type 2 diabetes need to take medicine by mouth to lower their blood sugar, but some also need insulin or other injected medicines.

Treatment Monitoring

Blood glucose control is an essential part of diabetes care. Routine blood glucose monitoring provides the information needed to make necessary adjustments in medications, diet, and physical activity. It can be dangerous to wait until you have symptoms of low or high blood glucose to test it. Many things cause a change in blood glucose values:

- a. Diet
- b. Exercise
- c. Stress
- d. Disease
- e. Medicines
- f. Time of the day

The blood glucose value can rise considerably if the person eats foods whose carbohydrate content is higher than expected. Emotional stress, infections, and many medications tend to increase blood glucose levels. Blood glucose levels rise in many people in the early morning hours due to the normal release of hormones (growth hormone and cortisol), a reaction called the dawn phenomenon. Blood glucose levels can rise significantly when the body releases certain hormones in response to low blood glucose levels (Somogyi effect). The practice of physical activity can cause an excessive reduction in blood glucose levels [7].

Conclusion

Diabetes is a chronic disease and there is still no cure, but it can be well controlled, avoiding complications that reduce the quality of life of patients or even shorten their lives. Most diabetes cases correspond to type 2 diabetes mellitus, which is currently considered a global public health problem. Diabetes mellitus, whether type 1 or 2, is a syndrome characterized by significant alterations in carbohydrate, lipid, and protein metabolism. These metabolic changes are the result of insulin deficiency and/or resistance which, when not adequately controlled, can lead to acute or chronic complications. Acute complications generally result from sporadic events, while chronic complications are generally caused by poor glycemic control over the years. Diabetes mellitus offers good possibilities of control, however, if it is not well controlled, it ends up producing potentially fatal lesions, such as myocardial infarction, stroke, blindness, impotence, kidney disease, leg ulcers and even limb amputations. On the other hand, with good follow-up, chronic complications can be avoided, and the diabetic patient can have a normal quality of life. In addition to drug treatment, it is important to note that the prevention and treatment of type 2 diabetes mellitus are associated with lifestyle changes, mainly related to diet and physical exercise.

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