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Mini Review

Alterations Blood Glucose Homeostasis during Enteral Nutrition

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Abstract

Considerable alterations of glucose metabolism are found in critical states associated with stress factors such as trauma, major surgery or sepsis. In oncological patients such disorders may be associated with the use of chemoradiotherapy.

Prolonged stress is characterized by progressing metabolic dysregulation in which gluconeogenesis shows resistance to the inhibiting actions of insulin and glucose. This resistance refers not only to the insulin influence on glucose homeostasis. Stress is associated also with resistance to other insulin effects, such as lipolysis suppression. The degree of insulin resistance is positively related to the severity of the stress response.

Hyperglycemia is a frequent complication of enteral and parenteral nutrition in hospitalized patients. Patients receiving enteral nutrition frequently require insulin to prevent hyperglycemia.

Managing hyperglycemia in these patients should include optimization of carbohydrate content and administration of intravenous or subcutaneous insulin therapy.

Keywords: Blood Glucose Homeostasis; Hyperglycemia; Nutrition Parenteral; Enteral Nutrition

Introduction

In patients with severe diseases often have disorders alterations blood glucose homeostasis. The pathogenesis of these disorders is complex. Hyperglycemia, be it secondary to diabetes, impaired glucose tolerance, impaired fasting glucose, or stress-induced is common in the critically ill [1].

In physiological conditions human body maintains the blood sugar level in a comparably tight range 60-160 mg/dL (3,3-8,9 mmol/L) independently to ingested food or energy expenditure. Many mechanisms which regulate glucose metabolism are involved in maintenance of this homeostasis.

Stress that follows critical states may lead to a profound impairment of that homeostasis, including occurrence of hyperglycemia. The first, who noticed that, was Claude Bernard in 1877. Other authors, when confirming that phenomenon, used such terms as: "traumatic diabetes", "diabetes of injury" or "stress diabetes" [2].

Prolonged stress is characterized by progressing metabolic dysregulation in which gluconeogenesis shows resistance to the inhibitory effects of insulin and glucose [1,3,4].

Stress-caused impairment of carbohydrate metabolism occurs through a number of mechanisms such as the increase of glucose production. Although glycogenolysis increases the hepatic production of glucose directly after the onset of a stress factor, it is only a temporary effect because glycogen stores run out very quickly. Hyperglycemia that is typical for phase two results from an increase of gluconeogenesis.

Investigations showed that hyperglycemia which accompanies stress should be linked to insulin resistance. However, this insulin resistance does not apply solely to the insulin influence on glucose homeostasis. Stress is also associated with resistance against other effects of insulin e.g. the suppression of lipolysis. Lipotoxicity is emerging as a significant contributor to the development of insulin resistance. The level of hyperglycemia is directly proportional to the severity of stress response [5-7].

Hyperglycemia develops commonly in the critically ill and impacts outcomes in patients with diabetes, but - even more so - in patients with stress-induced hyperglycemia.

It is believed that 30-60% of patients with stress-induced diabetes suffer from previously undiagnosed glucose intolerance or diabetes. An analysis of research results on the presence of glucose homeostasis dysfunction in critically ill patients, based on literature, was presented by Fahy et al [8].

Therapeutic procedure in seriously ill patients with alterations blood glucose homeostasis

Procedures for the treatment of patients with previously autoimmune diagnosed diabetes (type 1 diabetes and type LADA diabetes), in which the basis of treatment is intensive insulin therapy, are strictly defined [9-11].

The subject of discussion is the treatment of patients with type 2 diabetes and patients with hyperglycemia without previously diagnosed diabetes. In patients previously treated with oral hypoglycemic agents, discontinuation should be considered. This applies first of all to metformin, which is the most commonly used

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drug in type 2 diabetes. Insulin therapy should be used in these patients.

Also in patients with stress-induced hyperglycemia the drug of choice is insulin [4]. Nutrition is an important component of treatment. In severe patients, oral nutrition is usually impossible. They needed to start artificial nutrition enteral or parenteral.

The indications and the way of conducting enteral nutrition have been discussed extensively in the literature [12,13].

Special group requiring determinations for artificial nutrition are patients with cancer [14,15].

In oncological patients, the basic energy demand is often increased. Increasing the amount of food taken by the patient, reduces the loss of body weight and tissues and improves the functional parameters of the body [16,17].

In this group of patients, the need to implement nutritional therapy is associated not only with surgical procedures, but also with the use of chemoradiotherapy [18].

Hyperglycemia during enteral nutrition

A serious problem with the use of artificial nutrition is the occurrence of hyperglycemia. This is a serious complication because it is associated with an increased risk of complications. Hyperglycemia is a frequent complication of enteral and parenteral nutrition in both patients with and without diabetes. An extensive discussion of this issue was presented by Gosmanov and Umpierrez [19].

The authors pointed out that the pathogenesis of this phenomenon is complex. They play a role both elevation of blood glucose occurs as the result of increased hepatic glucose production and reduced glucose utilization by peripheral tissues during the stress, raise levels of stress hormones and cytokines, insulin resistance associated with down-regulation of intracellular signaling through the insulin receptor. It is not insignificant for the occurrence of hyperglycemia in enterally fed patient's continuous intestinal glucose exposure on secretion and action of incretin hormones or reduced intestinal expression of glucose transporters [20]. Many authors pay attention on the importance of identifying and distinguishing the differences between stress-induced hyperglycemia, newly diagnosed hyperglycemia, and hyperglycemia in persons with established diabetes mellitus [21,22].

Alleviation of hyperglycemia in patients during enteral nutrition therapy

Managing hyperglycemia in these patients should include optimization of carbohydrate content and administration of intravenous or subcutaneous insulin therapy [19]. Hyperglycemia in hospitalized patients is defined as blood glucose levels >140mg/dL (7.8mmol/L). Insulin therapy should be initiated for treatment of persistent hyperglycemia starting at a threshold ≥180mg/dL (10.0mmol/L). Once insulin therapy is started, a target glucose range of 140-180 mg/dL (7.8–10.0 mmol/L) is recommended for the majority of critically ill patients [23].

The treatment regimen should be reviewed and changed as necessary to prevent further hypoglycemia when a blood glucose value is <70mg/dL (3.9mmol/L). For patients receiving enteral feedings who require insulin, insulin should be divided into basal, nutritional, and correctional components. At the outset need to determine state the type of diabetes (i.e., type 1 or type 2 diabetes) or no previous history of diabetes.

The American authors have made recommendations American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) for glycemic control in patients who receive nutrition support. As target they recommend a target blood glucose goal range of 140-180 mg/dL (7.8-10 mmol/L) while hypoglycemia be defined as a blood glucose concentration of <70mg/dL (<3.9mmol/L) [24].

Principles of proceeding in patients with type 1 diabetes to ensure that they continue to receive basal insulin even if the feedings are discontinued. The continuous subcutaneous insulin infusion (CSII) and continuous glucose monitoring (CGM) is most often used in these patients. This reduces the risk of hypoglycemia [25-27].

They also used scanning systems flash glucose monitoring (FGM). In these patients are usually used insulin analogs.

In patients with type 2 diabetes or no previous history of diabetes insulin therapy usually starts with low dose basal insulin in combination with supplemental regular insulin it shown to be effective in providing glycemic control in majority of patients.

If the use of basal insulin does not give a satisfactory level of glycemic control, it is necessary to add rapid-acting insulin. For patients receiving enteral bolus feedings, approximately 1 unit of regular human insulin or rapid-acting insulin should be given per 10-15 g carbohydrate subcutaneously before each feeding [28-30]. Extensive presentation on the basis of literature presented Corsino et al [31]. The recommended total daily insulin dose for most patients should start between 0.3 to 0.5 unit/kg/day. Fatati et al suggested starting artificial nutrition, and presenting at least two consecutive blood glucose > 120mg/dL (>6,7mmol/L) [32].

Each patient was given at least 1U of insulin for every 10grams of glucose infused. In range between 145 and 180 mg/dL (8,1 and 10,0 mmol/L). Usually requires insulin therapy in patients with diabetes or may require insulin treatment in patients not known to be diabetic.

Verçoza Viana et al, presented an analysis of the literature regarding insulin regimen to treat hyperglycemia in hospitalized patients on nutritional support (NS) [33]. According to the authors the best insulin regimen to treat hyperglycemia in such patients has not yet been established. A recent discussion of the issue of treatment of stress-induced hyperglycemia in critically ill patients presented by Belgian authors [34]. When the critical hyperglycaemia patient is diagnosed, first the hypokalemia correction and the elimination of drugs that impair glucose tolerance are necessary.

Conclusions

Enteral nutrition is the second best option after oral nutrition and should be preferred over parenteral nutrition in hospitalized patients. Hyperglycemia is a common side effect of inpatient enteral nutrition therapy. Therapy depends on whether they are patients with type 1 diabetes, type 2 diabetes or other types of diabetes or if they are patients without previously diagnosed diabetes. The treatment of choice in these conditions is insulin therapy. The way it is performed depends on the type of diabetes, the age of the patient, the clinical condition, and the severity of metabolic disorders.

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