Paradigm Academic Press
Innovation in Science and Technology
ISSN 2788-7030
NOV. 2023 VOL.2, NO.6

Hyperglycaemia Among Diabetes Patients: A Preventive Approach

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doi:10.56397/IST.2023.11.05

Abstract

Hyperglycaemia is a presence of too much high glucose (sugar) in the bloodstream if it is not well-controlled. When the blood glucose level (BGL) is above 15 mmol/l, the situation is considered as hyperglycaemia. Long-term uncontrolled hyperglycaemia can affect type 1 diabetes (T1D) and type 2 diabetes (T2D) patients, as well as pregnant women with gestational diabetes. If it is not treated for a long-time, different vital organs of the body, such as the eyes, nerves, kidneys, and blood vessels may permanently damage. Diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS) are diabetes emergencies and life-threatening complications in hyperglycaemia. Prevention and treatment of hyperglycaemia and its related complications are necessary for a healthy life of diabetes patients. This study tries to discuss the causes, symptoms, prevention, and treatment of hyperglycaemia with highlights on DKA and HHS.

Keywords: hyperglycaemia, morbidity, diabetic ketoacidosis, hyperosmolar

1. Introduction

The term “hyperglycaemia” comes from the Greek syllables hyper- (high/excessive), glyc- (sweet/sugar), and -aemia (of the blood) (Sharma, 2021). Hyperglycaemia is a high blood glucose level (BGL) in diabetes patients that is characterized by increased thirst, frequent urination, nausea and vomiting, extreme tiredness, fruity-smelling breath, weight loss, and healing of injuries more slowly (Umpierrez et al., 2012). It can affect people with type 1 diabetes (T1D) and type 2 diabetes (T2D), as well as pregnant women with gestational diabetes (Wendland et al., 2011; Mohajan & Mohajan, 2023p). When blood glucose level is more than 15 mmol/l, the situation is considered as hyperglycaemia (Delfs et al., 2020). A blood sugar reading of 10 mmol/l or above it target range is too high, and if it is 18.7 mmol/l or more can be dangerous and need to meet with general physician (Singh et al., 2014). Incidence of hyperglycaemic crisis is increasing commensurately with the increase worldwide in prevalence of diabetes. Hyperglycaemia is the life-threatening for the nature of diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic states (HHS) with overlapping features (Hackel, 2014).

Hyperglycaemia can happen due to missing a dose of insulin or other diabetes medications, eating too much carbohydrate or sugar rich food than usual, less active than usual, being stressed, emotional or excited, drinking too much alcohol, and having an infection, such as thrush, cystitis or a wound infection. Also it may happen suddenly during a major illness or injury or during a chronic T1D or T2D (Yasuda et al., 1982; Kitabchi et al., 2008). It is associated with increased morbidity and mortality in acute ischemic stroke and heart attack (Garg et al., 2004). Diabetes patients can be at risk of hyperglycaemia if they are not alert about their routine-wise diet, exercise, and medication. If it is untreated for a long-time can damage nerves (neuropathy), blood vessels of the retina that could lead to blindness, kidney damage or kidney failure, bone and joint problems, teeth and gum infections, and organs that increases risk for cardiovascular disease, such as heart attack and stroke (Umpierrez

et al., 2012; Mohajan & Mohajan, 2023a).

When insulin is not found to use glucose, the body looks for alternate sources of glucose to use for energy. The ready alternative of energy in the body is fat that is burnt for energy and release toxic ketones. The buildup of ketones in the body can lead to diabetic ketoacidosis, which can lead to a diabetic coma (Wolfsdorof et al., 2014). After development of hyperglycaemia, the patients need to change medicine, food, and exercise plan. If hyperglycaemia becomes worse when blood glucose levels stay above 240 mg/dl (13.3 mmol/l), the patients might have diabetic ketoacidosis with fruity smelling breath, nausea and vomiting, abdominal pain, shortness of breath, dehydration, dry mouth, weakness or confusion, and loss of consciousness (Westerberg, 2013).

2. Literature Review

In any type of research, literature review is an introductory section, where works of previous researchers are included (Polit & Hungler, 2013). It is a secondary source and does not report a new or an original experimental work (Gibbs, 2008). In qualitative research literature review helps novice researchers to understand the subject, and it serves as an indicator of the subject that has been carried out before. It also assists all researchers to improve research questions and to move forward energetically in the current research (Creswell, 2007). A good literature review can ensure that a proper research question has been asked and a proper research methodology has been chosen (Baglione, 2012; Torraco, 2016).

Lisa Kirsten Broadley and her coworkers have observed that nurses frequently care for patients diagnosed with diabetes in various clinical arenas. Therefore, an awareness of the nursing management of hyperglycaemia is essential. They have described in some details about the underlying causes of hyperglycaemia, and have highlighted how nurses should care for patients using current guidance to inform nursing management (Broadley et al., 2019). Rajesh Garg and his coauthors have shown that hyperglycaemia is associated with increased mortality and morbidity in acute ischemic stroke (Garg et al., 2004).

Jeannette Goguen and Jeremy Gilbert have realized that diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS) are diabetes emergencies with overlapping features that require treatment and monitoring for multiple metabolic abnormalities and vigilance for complications (Goguen & Gilbert, 2018). Y. V. Lakshmi Narasimham and his coauthors have compared the clinical features and biochemical profile in DKA to assess the response in the patients with standard treatment of DKA (Narasimham et al., 2015). Haradhan Kumar Mohajan and Devajit Mohajan have discussed the aspects of body fitness in different articles for the development of health of diabetes patients and older citizens (Mohajan & Mohajan, 2023a-i).

Joseph I. Wolfsdorf and his coauthors have recommended concerning fluid management to reflect recent findings from a randomized controlled clinical trial showing no difference in cerebral injury in patients rehydrated at different rates with either 0.45% or 0.9% saline (Wolfsdorf et al., 2018). Eduardo Menéndez Torre and his coworkers have divided the hyperglycaemia treatment into three steps: First step, if the hyperglycaemia is not severe (HbA1c: 6.5%-8.5%), metformin is the medication of choice. If blood glucose levels are high (HbA1c>8.5%), the initial treatment must begin with several oral drugs in combination or with insulin. In second step, patients add a second synergistic drug, and must receive personalized treatment in accordance with their characteristics. In third step, patients introduce basal insulin as the option of choice rather than triple oral therapy, which is reserved only for cases of resistance to insulin (Torre et al., 2011).

3. Research Methodology of the Study

Research is a hard-working search, scholarly inquiry, and investigation aimed at the discovery of new facts and findings (Adams et al., 2007). The academicians take it as an essential and influential work to lead in academic empire (Pandey & Pandey, 2015). Methodology is a system of explicit rules and procedures in which research is based, and against which claims of knowledge are evaluated (Ojo, 2003). Methodology in any creative research is the organized and meaningful procedural works that follow scientific methods efficiently (Kothari, 2008). It relates the nature and power to science, truth, and epistemology (Ramazanoglu & Holland, 2002). Research methodology shows the ways to the researchers for organizing, planning, designing and conducting a good research. (Legesse, 2014)

We have started main body of our research through the discussion of causes and symptoms of hyperglycaemia. Then we tried to discuss the diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS) that are life-threatening complications of the hyperglycaemia of diabetes patients (Mohajan & Mohajan, 2023j-m). Finally, we have tried to highlight on the prevention and treatment of hyperglycaemia. To prepare this article, we have mainly followed qualitative research approaches. In this paper, we have depended on the secondary data sources of the hyperglycaemia of diabetes. We have used both published and unpublished secondary data sources of optimization to prepare the research paper. We have taken help from the published journal articles, printed books of famous authors, conference papers, internet, websites, etc. (Mohajan & Mohajan, 2023n-r)

4. Objective of the Study

The vital objective of this study is to discuss the hyperglycaemia of diabetes patients. Other non-vital objectives of the study are as follows:

- to highlight the types of hyperglycaemia,
- to search on the causes and symptoms of hyperglycaemia, and
- to focus on the prevention and treatment of hyperglycaemia.

5. Causes of Hyperglycaemia

During digestion, the body breaks down carbohydrates to make glucose that is a main source of energy. Glucose is absorbed by cells and moves directly into the bloodstream with the help of insulin that is a hormone made by the pancreas (Kitabchi et al., 2009). Some common causes of hyperglycaemia are stress, an illness, such as a cold, a lack of exercise, less physical activity than usual, dehydration, eating too much carbohydrate or sugary food and drinks, missing a dose of medication, or taking an incorrect dose, over-treating an episode of hypoglycaemia, not taking enough insulin, steroids medicines (Dunning, 2014; Mohajan, 2022; Mohajan & Mohajan, 2023q). Hyperglycaemia causes osmotic diuresis which leads to excessive loss of free water and electrolytes (sodium and potassium chloride) with secondary hypovolemia, decreased tissue perfusion, lactic acidosis, and the resultant extracellular fluid volume (ECFV) depletion (Hackel, 2014).

6. Symptoms of Hyperglycaemia

Symptoms of hyperglycaemia in people with diabetes tend to develop slowly over a few days or weeks. In some cases, there may be no symptoms until the blood sugar level is very high. Some common symptoms of hyperglycaemia are excessive urination, blurred vision, headache, unintentional weight loss, dryness of the skin with itching or dryness in the mouth, delayed wound healing, frequent infections, such as vaginal infections, ear infections, skin rashes, etc. Also the patients feel very thirsty and drink much water, feel tired or lethargic, feel irritable, difficulties in concentrating (NICE, 2015). Extreme hyperglycaemia is incorporated with polyuria, polydipsia, and weight reduction. At one stage the patient may encounter torpidity, central neurologic shortfalls, or modified mental status, and advances to an insensible state (Yari et al., 2020).

7. Diabetic Ketoacidosis

Diabetic ketoacidosis (DKA) is the complication of diabetes and is defined as an acute metabolic decompensation caused by increasing ketones in the blood (Porth, 2015). It is a condition caused by the body needing to break down fat as a source of energy, and is a most common acute hyperglycaemic emergency in people with diabetes mellitus. Ketone bodies provide alternative usable energy sources in the absence of intracellular glucose (Wolfsdorf et al., 2018). DKA is characterized by hyperglycaemia, hyperosmolarity, ketosis, and acidosis. It is a serious, life-threatening complication of diabetes that can progress to cerebral edema, coma, and even death (Karrar et al., 2022). Risk factors for DKA are insulin omission, infection, myocardial infarction (MI), abdominal crisis, trauma, and possibly continuous subcutaneous insulin infusion (CSII) therapy, thyrotoxicosis, cocaine, atypical antipsychotics, and possibly interferon (Hamblin et al., 1989).

DKA is diagnosed when the blood glucose is more than 11 mmol/l (200 mg/dl), capillary/venous pH is less than 7.3, bicarbonate (HCO_3–) is less than 15 mmol/l, moderate to severe dehydration is seen, and ketones (Ketonemia and Ketonuria ≥3 mmol/l) are present (Foster & McGarry, 1983). It develops when insulin levels are insufficient to meet the body's basic metabolic requirements due to the accumulation of ketones from the breakdown of free fatty acids (Wang et al., 2008). Some causes of DKA are insulin omission or manipulation, untreated T1D, inadequate dosing of insulin and medications, weak monitoring, insulin pump or infusion site malfunction, etc. (Misra et al., 2013) It usually takes days to develop DKA among adults, but it can take hours in children with acute illness, insulin omission or insulin pump failure (Lee et al., 2017).

Symptoms of DKA are polyuria, polydipsia, dehydration, weight loss, nausea, vomiting, weakness, abdominal pain, fruity-smelling breath, shortness of breath, blurry vision, drowsiness, tachycardia, tachypnea, dry mouth, deep sighing respiration, flushed face, confusion, increased heart rate, and increased respirations. Lethargy and somnolence are symptoms of more severe decompensation (Edge et al., 2001; Wolfsdorf et al., 2018). The patient may present with wide range of manifestations like ketosis, ketoacidosis, ketoacidosis pre-coma and coma (Narasimham et al., 2015). DKA occurs in patients with type 1 diabetes (T1D) (70% to 90%) and is less common in those with type 2 diabetes (T2D) (10% to 30%), and mortality rate in diabetic ketoacidosis is 4% (Barski et al., 2013). It is an entirely preventable condition, and treatment involves volume expansion, insulin replacement, and prevention of hypokalemia (Rewers, 2012).

8. Severe Hyperglycaemia Complications

If the hyperglycaemia is not treated for a long-time, the patients may face diabetes-related complications, such as cardiovascular disease, nerve damage (neuropathy), kidney damage (nephropathy), kidney failure, damage to the blood vessels of the retina (retinopathy) that could lead to blindness, feet problems caused by damaged nerves or

poor blood flow that can lead to serious skin infections, ulcerations, bone and joint problems, teeth and gum infections, etc. (Holstein et al., 2001).

Hyperosmolar hyperglycaemic state (HHS) is a condition that occurs when the body makes insulin, but the insulin does not work properly. During HHS the body becomes dangerously dehydrated due to very high blood glucose levels; there is enough insulin production within the body to prevent ketosis. In this situation, blood glucose levels may be greater than 600 mg/dl (33.3 mmol/l) without ketoacidosis, an increase in serum osmolality (>320 mosmol/kg), and body cannot use either glucose or fat for energy (Kitabchi et al., 2008; Innes, 2016). As a result, glucose moves into the urine, and causes increased urination. If it is not treated properly, lead to life-threatening dehydration and patients may present with a fluid deficit of up to 7 liters (Chiasson et al., 2003).

HHS patients have visible signs, such as sunken eyes, slurred speech, inability to concentrate or confusion, and longitudinal furrows on the tongue (Wolfsdorf et al., 2014). HHS presents some clinical manifestations, such as polydipsia and polyuria in the early stages progressing to oliguria, fitting, coma and death if untreated (Rosenbloom, 2010). DKA is the most frequently regarded as hyperglycaemic crisis, but HHS occurs less frequently. However, HHS has much higher mortality rates than DKA (McNaughton et al., 2011).

9. Prevention and Treatment of Hyperglycaemia

The aim of hyperglycaemia treatment is to keep blood sugar levels normal, to restore circulating fluid volume and correct urea and electrolyte imbalance, to normalize osmolality, and to clear blood ketones and suppress ketogenesis as far as possible (Wolfsdorf et al., 2014). A hyperglycaemia patient should check blood glucose levels more often than usual, drink plenty of water and avoid drinks containing sugar, check urine for ketones, avoid alcohol or caffeine, change the dose of insulin (Goguen & Gilbert, 2018).

At present there is a series of drugs for treating diabetes, such as metformin, sulphonylureas, glinides, thiazolidinediones, disaccharidase inhibitors, dipeptidyl peptidase 4 (DPP-4) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, etc. (DeFronzo & Goodman, 1995). The choice of treatment is depended on the fatality of the disease, the patient's age, and weight. These medications have side effects and can be used according to the advice of specialists (Torre et al., 2011).

10. Conclusions

From this study we have observed that hyperglycaemia is a life-threatening complication for the diabetes patients. The diabetic ketoacidosis (DKA) increases ketones in the blood, which is mainly caused through the disruption of insulin that is potentially preventable. Hyperosmolar hyperglycaemic state (HHS) makes the body dangerously life-threatening dehydrated situation due to very high blood glucose levels and this condition also preventable through the treatment. Prevention and treatment are two key points of a diabetes patient through the keeping blood sugar levels normal to lead a healthy life.

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