Management of Type-I Diabetes: A Right Procedure to Normal Life Expectancy

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Abstract

Management of type 1 diabetes (T1D) is a great challenge for the healthcare professionals and at present there is no known strategy to prevent it. The common symptoms of T1D are polyuria, polydipsia, weight loss, hypoglycaemia, marked hyperglycaemia, ketonemia, and insulin deficiency with nonresponsive to oral agents. It is a life-threatening multifactorial autoimmune disease with progressive β-cell destruction that leads to severe endogenous insulin deficiency. The scientists are not sure why these β-cells are damaged. T1D is incurable and usually treated with lifelong insulin injections and careful attention to diet and physical activity. As a result, ultimately the patients become physiological dependence on exogenous insulin. The purpose of this study is to provide various information and treatment strategy of type 1 diabetes (T1D).

Keywords: Type 1 diabetes, insulin, β-cells, hyperglycaemia, hypoglycaemia

1. Introduction

Diabetes mellitus (DM) is a chronic disease in which blood glucose levels are above normal. After eating, food is broken down into glucose that is carried by the blood to all cells of the body. Insulin helps blood glucose to enter the cells of the body for making energy. If high blood sugar level remain untreated for a long-time can lead to serious health problems and creates various other chronic diseases (Ambler et al., 2021; Mohajan & Mohajan, 2023a).

There are two main types of diabetes mellitus: type 1 diabetes (T1D) and type 2 diabetes (T2D). Although both of them result hyperglycaemia, but the pathophysiology and etiology of the diseases are different (Thomas et al., 2019). Type 1 diabetes (T1D) is a metabolic disease characterized by hyperglycaemia. It is incurable and an insulin-dependent disease, and glycemic control is needed in an emergency basis (Atkinson et al., 2014). It accounts for approximately 5–10% of all cases of diabetes. Before the discovery of insulin a century ago, T1D was associated with a life expectancy as short as a few months (Holt et al., 2021).

Insulin hormone is a 51-residue anabolic protein, which is synthesized by β-cells in the Islets of Langerhans of the pancreas, and can control the blood glucose efficiently (Bliss, 1982). Glucose is produced in the body from the digestion of carbohydrate rich foods, such as bread, rice, potatoes, chapattis, cereals, etc., and from sugar and other sweet foods. It also comes from the liver, which makes glucose (ADA, 2022). The exact cause of development of T1D is unknown; but genetic and environmental factors are considered for this condition (IDF, 2017). Neither insulin nor any medication can cure diabetes, but only help to manage it (Mohajan & Mohajan, 2023d).

Children are affected more frequently from type 1 diabetes (T1D) (more than 90% of total T1D) before the age of 30, and it affects about 10% of total diabetes patients. It can also develop among older adults or at any age,

and in people of every race, shape, and size. It is also called "juvenile diabetes", as it is infected the adolescent individuals (Craig, 2011). Usually, it is developed over a few weeks (e.g., over 2-6 weeks) when the insulin producing β-cells in the pancreas have been destroyed. As a result, T1D patients become in lifelong dependence on exogenous insulin, diet and regular physical exercise and activities (Daneman, 2006). The lifespan of people with childhood onset T1D is shorter than that of the general population (Secrest et al., 2010).

Management of T1D is a challenging matter for various physiological and behavioral reasons. For the maintaining adequate metabolic control of the patients who use insulin both hypoglycaemia and hyperglycaemia measurement are essential (Bode et al., 2005).

2. Literature Review

In any research area, the literature review is an introductory section, where the seminal works of previous researchers in the same field within the existing knowledge are highlighted (Polit & Hungler, 2013). It helps novel 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). It is a secondary source and does not report a new or an original experimental work (Gibbs, 2008). Jane L. Chiang and her coworkers have tried to enhance the ability to recognize and manage T1D to prevent its associated complications, and to eventually prevent this disease efficiently (Chiang et al., 2014). Harsimran Singh and his coauthors have developed the Hyperglycaemia Avoidance Scale (HAS) with the help from an expert panel including physicians, psychologists, diabetes healthcare professionals and semi-structured interviews conducted with T1D patients to assess the extent of potentially problematic avoidant attitudes and behaviors in people with T1D. HAS is a reliable and valid measure to help quantify the extent and impact of high blood glucose related concerns in a structured way (Singh et al., 2014).

Mary Lowth has discussed that hypoglycaemia is mainly a feature of diabetes on treatment that is also seen in some medical conditions, such as insulinoma and renal disease (Lowth, 2012). Xuemei Wang and her coworkers have carried out a systematic review and meta-analysis using the available literature reporting findings on mobile health interventions that may improve the management of T1D (Wang et al., 2019). Richard I. G. Holt and his coauthors have realized that there exist huge gaps in the knowledge of the prevention, diagnosis and treatment of the T1D. But the patients need higher quality research evidence on which to determine their optimal care. They have noticed the inequalities in treatment experienced by many people with T1D and have advised for better services to ensure that all individuals with T1D have access to the care they need (Holt et al., 2021).

Ahmed Iqbal and his coworkers have aimed at improved metabolic control with concomitant reduction of hypoglycaemia. They have provided an overview of the recent advances in T1D management focusing on novel insulin preparations, ways of insulin administration and glucose monitoring and the role of metformin or sodium-glucose co-transporter to inhibitors in T1D management. They have also discussed current understanding of the effects of hypoglycaemia on human body and strategies to mitigate the risks associated with hypoglycaemia (Iqbal et al., 2018). Irene Tagliente and her coworkers have carefully analyzed the limits and methods of the management of diabetes in adolescents and adults, and have tried to identify possible factors for future improvement (Tagliente et al., 2016).

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). Methodology is a system of explicit rules and procedures in which research is based, and against which claims of knowledge are evaluated (Ojo, 2003). It provides the research design and analysis procedures to perform a good research (Hallberg, 2006). Research methodology is the systematic procedure adopted by researchers to solve a research problem (Kothari, 2008).

We have taken attempt to discuss briefly the symptoms of T1D. Then we have discussed hyperglycaemia and hypoglycaemia. Finally, high risks factors and treatment of T1D are introduced briefly. The paper is prepared on the basis of secondary data sources. The essential and necessary data are collected from previous research articles of reputed journals, published books of world famous authors, handbooks of renowned scholars, conference papers on recent important topics, websites, etc.

4. Objective of the Study

The key objective of this study is to discuss the aspects of type 1 diabetes mellitus. Other minor objectives of the study are as follows:

- to point to hyperglycaemia,
- to highlight on the hypoglycaemia, and
- to show the risks factors of type 1 diabetes.

5. Symptoms of T1D

Type 1 diabetes is an insulin-dependent diabetes mellitus. Insulin is a hormone in the body that allows glucose to enter the cells and provide energy for daily life. The β-cells in the pancreas of T1D patients are attacked and destroyed by their own immune system that lacks of insulin production (Mohajan & Mohajan, 2023e). When almost all β-cells are damaged and insulin is no longer produced, more glucose gathers in the blood, and symptoms of T1D are seen. The main symptoms of T1D are hyperglycaemia, increased thirst, increased urination, ketosis, extreme hunger, extreme tiredness, rapid weight loss, nausea, genital itching, body mass index (BMI) below 25, blurred vision, labored breathing, nausea, vaginal yeast infections for women, fruity or sweet odor on the breath, etc. (de Ferranti et al., 2014; Holt et al., 2021).

If T1D is not diagnosed and treated with insulin in a timely, diabetic ketoacidosis (DKA) is developed. It is an acute and severe complication of diabetes that is the result of high levels of blood glucose and ketones mainly due to poor control of diabetes (Muñoz et al., 2019). DKA is a life threatening situation and requires emergency treatment. The signs and symptoms of DKA are fruity odor on the breath, shortness of breath, confusion, nausea, vomiting, extreme weight loss, etc. Sometimes a serious life-threatening condition may happen that can result in a diabetic coma and even ultimately the situation can reach to death (Peters et al., 2015; Dhatariya & Vellanki, 2017).

6. Hyperglycaemia

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 is associated with increased morbidity and mortality in acute ischemic stroke and heart attack (Garg et al., 2004). It can affect people with T1D and T2D, as well as pregnant women with gestational diabetes (Wendland et al., 2011). Diabetes patients can be at risk of hyperglycaemia if they are not alert about their routine wise diet, exercise, and medication. When blood glucose level is more than 15mmol/l, the situation is considered as hyperglycaemia (Delfs et al., 2020). A blood sugar reading of 10mmol/l or above it target range is too high, and if it is 18.7mmol/l or more can be dangerous and need to meet with physician (Singh et al., 2014).

Hyperglycaemia can happen due to missing a dose of insulin or other diabetes medication, 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). 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, 2023f).

In this situation, the patient 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). 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 (Wolfsdorf et al., 2014).

7. Hypoglycaemia

Hypoglycaemia is considered as a decrease in blood glucose below the physiologic range. It is one of the most common problems related to diabetes (Briscoe & Davis, 2006). If plasma blood glucose level is less than 4mmol/l irrespective of symptoms, the condition is called hypoglycaemia (hypos). However, in severe hypoglycaemia blood glucose levels could be in 2.8 to 3.3mmol/l (Boucai et al., 2011). It is the most common side effect of taking insulin. It is a widespread, erratic and possibly risky unexpected result of administer insulin for the T1D patients treatment. Even T2D patients face same condition when they have to treat with insulin. It is a manifestation of disease rather than a specific diagnosis (Donnelly et al., 2005). When a diabetes patient takes too much medication, such as insulin or sulfonylureas or glinides tablets; also practices of low feeding, missed or late meal, enough low carbohydrate foods, and huge exercise; and during the adjustment of insulin dose, and hot weather, might face low blood sugar (Cryer, 2008). Some illness, such as vomiting, diarrhoea, loss of appetite, consumption of excessive alcohol, and fasting can cause hypoglycaemia (Clarke et al., 1991).

Symptoms of hypoglycaemia are hunger, weakness, unusual behaviors, ataxia nervousness, aggression, headache, trembling, tachycardia, shaking, sweating, anxiety, lethargy, irritable, faintness, seizure, dizziness, confusion, abnormalities, numbness of the lips and fingers, difficulty in speaking, blurry eyes with apparent vision or lack

of coordination, and coma. Some people are in hypoglycaemia, but face no symptoms (Morgan et al., 2018). Hypoglycaemia may happen during sleeping, and then the symptom seems crying out or having nightmares; and feeling tired, irritable, confused after waking up (Hanefeld et al., 2013).

Hypoglycaemia is a potentially life threatening emergency that requires immediate and appropriate treatment. These symptoms can worsen if hypoglycaemia is not treated timely (Cowett & Loughead, 2002). The hypoglycaemia patient should take 15-20g of a short-acting carbohydrate, which is the equivalent of one of the following: 5-7 glucose tablets or 120mls lucozade or 200ml pure smooth orange juice or 150ml coke or 20g glucose gel (Martyn-Nemeth et al., 2016). The patient then checks his/her blood glucose level after 10 minutes and takes more glucose until the blood glucose level is more than 4mmol/l or the symptoms have improved. At this situation the patient may take 15-20g of slower acting carbohydrates, such as sandwich, piece of fruit, bowl of cereal, glass of milk, etc. (Davidson, 1981; Kreider et al., 2017).

8. Treatment of T1D

Overweighed and obese persons, smoker, physically inactive persons are in high risks of developing DM (Mohajan & Mohajan, 2023c). If T1D remains untreated for a long-time the patient may face serious health complications, such as heart disease, stroke, high blood pressure, circulation problems, gum disease, nerve damage and damage to the blood vessels, kidney failure, blindness, and amputations of the foot or leg (Ehrmann et al., 2020).

T1D patients need injections of insulin every day for the rest of their lives. They may need 2 to 4 injections per day. They have also to take a healthy balance diet. In the absence of insulin therapy, T1D patients will eventually progress to metabolic decompensation and life-threatening diabetic ketoacidosis (Balasubramanyam et al., 2008). The choice of insulin regime depends on many factors, such as age, weight, diet, duration of diabetes, lifestyle, physical activity level, targets of diabetes control, and puberty status. Daily insulin dosage varies greatly between individuals and changes over time (Bellin et al., 2012). Accurate diagnosis, education, insulin regimen, use of adjuvant therapies, access to newer technologies, and need for psychosocial support are essential for the proper treatment of T1D patients (Holt et al., 2021).

Ketone bodies are produced when insulin concentrations are too low to prevent lipolysis. If left untreated, ketosis can lead to progressive dehydration and diabetic ketoacidosis (DKA). Patients with DKA should be managed in hospitals with specialists experienced in the management of the condition. Patients with severe DKA are at risk of cerebral oedema should ideally be monitored in an intensive care unit (ICU) (Dhatariya & Vellanki, 2017). Continuous glucose monitoring (CGM) is the standard method for most adults with T1D (Feig et al., 2017). Metformin is used for the treatment of T2D; but it can be also used for the people with T1D to reduce effective insulin dose requirements and associated weight gain (Livingstone et al., 2017).

Physical activity is an important component of the overall management of T1D. The benefits of physical activity are cardiovascular fitness, long-term healthy body weight maintain, lower blood glucose level, stress management, reduce insulin requirement, social interaction and the promotion of self-esteem fostered by team play. Physical activity should be avoided if fasting glucose levels are greater than 240 mg/dl and ketones are present (Mohajan &Mohajan, 2023b).

9. Conclusions

Type 1 diabetes is increasing worldwide rapidly that is the commonest in children and adolescents. In the 21st century, significant advances have been made in the management of T1D due to discovery and development of insulin, daily management of food and medicine through the physical activities, advances in technology for the treatment of both hypoglycaemia and hyperglycaemia patients, and continuous help of the healthcare professionals. From this study we realized that T1D is not a death sentences and after discovery of insulin it can be managed efficiently, and a T1D patient may expect normal life expectancy.

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