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A REVIEW ON DIABETES MELLITUS

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ABSTRACT

Diabetes mellitus (DM) is a metabolic disorder and a chronic severs diseases that occurs due to a deficiency of insulin or the destruction of the beta cells of pancreas, which results in high blood sugar levels, this can happen because the body does not produce enough insulin or is unable to effectively use the insulin it does produce. High blood sugar leads to symptoms of polyuria (frequent urination), polydipsia (increased thirst), and polyphagia (increased hunger). Diabetes can cause many complications, including retinopathy, nephropathy, cardiovascular diseases (CVD), foot ulcer, chronic kidney diseases (CKD), diabetic ketoacidosis and nonketotic hyperosmolar coma. There are main three types of diabetes: Type 1 DM or insulin independent diabetic mellitus (IDDM), where the body's fails to produce due to autoimmune destruction of the insulin-producing beta cells in the pancreas. This is also known as "juvenile diabetes". Type 2 DM or non-insulin independent diabetic mellitus (NIDDM): This type caused by of Insulin resistances and beta-cell dysfunction leading to insufficient insulin production. It's also known as "adult-onset diabetes". Gestational diabetic is occurs when pregnant women due to hormonal changes during pregnancy. Various treatments are available for diabetic mellitus. Type 1 DM is managed primarily *Insulin Therapy, blood glucose monitoring, and carbohydrates counting.* Type 2 DM which is management of various medications controlled by orals hypoglycemic agents can cause low blood sugar then resulting the hypoglycemia. The Diagnosis of diabetic mellitus which used by diagnostic test include *fasting blood glucose test, oral glucose tolerance test, hemoglobin A1 c (HbA1c), urine glucose test, and C-peptide test.* Diabetes mellitus is currently an incurable, and without proper treatment, it can lead to severe complication.

KEYWORDS: Diabetes mellitus, diagnosis, cause and treatment.

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic disorders characterized by high blood sugar levels (hyperglycemia) resulting from defects in insulin secretion, insulin action, or both. Insulin is a hormone produced by the pancreas that helps regulate blood sugar levels by allowing cells to absorb glucose for energy. When the body cannot produce enough insulin or effectively use it, glucose build up in the bloodstream, leading to various health complications.[1]

There are main three types of diabetes: **Type 1DM or insulin independent diabetes mellitus (IDDM)**, this is autoimmune condition where the body's immune system attacks and destroys the insulin-producing cells in the pancreas. It is usually diagnosed in children and young adults, and people with type 1 diabetes require lifelong insulin therapy. **Type 2 DM or non-insulin independent diabetes mellitus (NIDD)**, this more common form, typically associated with lifestyle factors such as poor diet, lack of exercise, and obesity. In type 2 diabetes, the body either becomes resistant to insulin or does not produce enough of it. It is more prevalent in adults but is increasingly being seen in younger population due to rising obesity rates. Then third category known as **Gestational Diabetes**, which occurs during pregnancy and typically revolves after childbirth, although it can increase the risk of developing type 2 diabetes later in life. **Risk factors** for developing diabetes include genetic predisposition, age, obesity physical inactivity, poor diet, and other factors such as high blood pressure and abnormal cholesterols levels. **Symptoms of diabetes** can vary but often include excessive thirst, frequent urination, fatigue, blurry vision, and slow wound healing,. If left untreated, diabetes can lead to serious complication like heart disease, kidney failure, nerve damage, vision loss and even amputations. **Management of diabetes** typically involves lifestyle changes, including a healthy diet and regular physical activity, Medications, including orals medication and insulin injections, are often necessary to help control blood sugar levels. Diabetes is a major global health concern, with millions of people affected worldwide. Early diagnosis and management are crucial in preventing or minimizing complications associated with the disease.[2][3][4]

Etiology of DM[5]

The term "etiology" comes from the Greek word "aetiologia," meaning the study of causes and origins of disease. In the case of diabetes, the etiology reefer's to the factors that cause the disease.

1. Juvenile-onset (insulin dependent) diabetes: It's believed that this type of diabetes has an autoimmune cause, where the body's immune system attacks its own cells.
2. Viruses: certain viruses, like coxsackie B, mumps, and rubella (German measles), have been linked to changes in cells of the pancreas that produce insulin.
3. Genetics: The role of genetics in the diabetes is still debated. It's thought that some genetics factors might make the pancreas more vulnerable to the effects of viruses, leading to diabetes.
4. Problems with Insulin Receptors: In some cases, tissues in the body don't respond well to insulin. This can be due to a decrease in the number of insulin receptors or the receptors not functioning properly. This results in insulin resistance, especially in the liver, muscles, and fat cells, and it can lead to high insulin levels in the blood.
5. Obesity and Insulin Deficiency: Excess body fat can cause a relative deficiency in insulin. The pancreas might not be able to produce enough insulin to keep up with the body's needs.
6. Rare causes: There are also other rare causes of diabetes, such as specific genetic disorder (like "Maturity onset diabetes of the young" or "MODY), other hormone-related disorder, surgery to remove the pancreas, or gestational diabetes (diabetes during pregnancy).
7. Receptor Imbalance: Specific receptor in the body, such as those for glucagon-like peptide-1 (GLP-1) or peroxisome proliferator-activated receptor (PPAR-γ), and enzyme like α- glucosidase and dipeptidyl peptidase –IV, can sometimes become imbalanced, controlling to the development of diabetes.
8. Research Focus: Current research on diabetes is looking onto the role of oxidative stress (damage caused by free radicals), advanced glycation end products (compound formed when sugar attaches to proteins), protein kinase C (an enzyme involved in the cell signaling), and the polyol pathway (a metabolic pathway) in the development of diabetes.

PATHOPHYSIOLOGY OF DM

Diabetes Mellitus is a condition where the body has trouble controlling blood sugar (glucose) levels. In type 1 diabetes, the body's immune system mistakenly attacks the cells in the pancreas that make insulin, a hormone needed to help sugar enter cells for energy. In type 2 DM, the body becomes resistant to insulin, meaning the cells don't respond well to it, and the pancreas can't makes enough insulin to keep blood sugar levels normal. As a results, which can lead to problems with the heart, kidney, nerves, and eyes over time.[6][7][8][9]

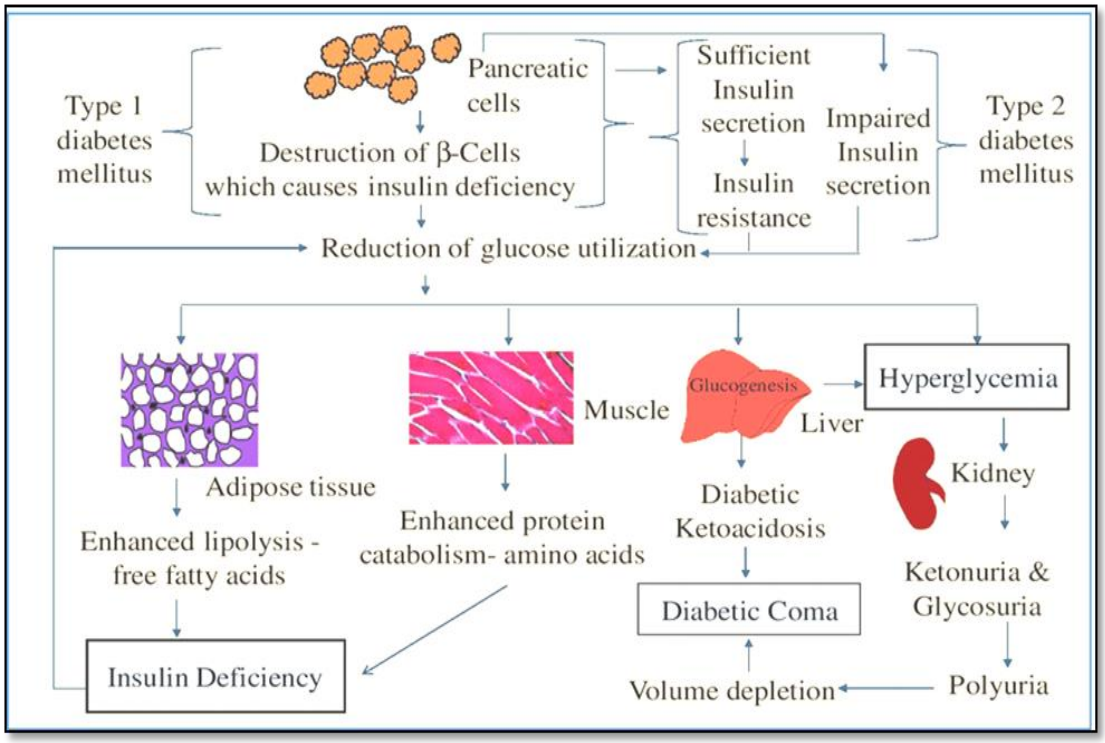

Figure: 1. pathophysiology of Diabetes Mellitus.

CLASSIFICATON OF DIABETES MELLITUS

Diabetes mellitus is a group of metabolic disorders characterized by high blood sugar (hyperglycemia) resulting from defects in insulin secretion, insulin action, or both, there are several types of diabetes, each with different causes, mechanisms, and classifications. Below is a detailed classification of diabetes mellitus:[10]

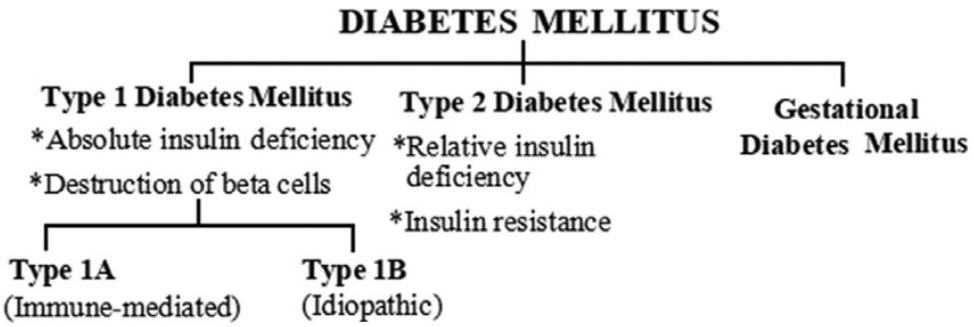

Figure 2: Classification of Diabetes Mellitus.

Type 1 Diabetes Mellitus (T1DM) or Insulin Dependent Diabetes Mellitus (IDDM)[7][11]

T1DM is a long-term autoimmune disease where blood sugar levels become high (a condition called hyperglycemia). This happens because the body doesn't produce enough insulin due to destruction of insulin-producing cells (called β-cells) in the pancreas.

T1DM is one of the most common hormone and metabolism-related conditions in children. In most cases (about 70-90%), the loss of β-cells is caused by the immune system attacking the body's own cells. This form is known as autoimmune T1DM (or type 1a diabetes). A smaller number of people have idiopathic T1DM (or type 1b diabetes), where no sign of an immune response or auto antibodies are found. This type seems to have a strong genetic cause. Unless otherwise stated, the "T1DM" usually refers to the autoimmune form.

Genetic Factors[3]

Researchers have identified at least 18 genetics regions with type 1 diabetes, known as IDDM1 through IDDM18 (Insulin-Dependent Diabetes Mellitus 1-18). Of these, IDDM1 is the most significant and includes the HLA (Human Leukocyte Antigen) genes. These genes are responsible for producing proteins that make up the major histocompatibility complex (MHC), which plays a crucial role in regulating the immune system's response to foreign substances.

Certain variations in the HLA region can alter immune system function, increasing the risk of developing type 1 diabetes. Ongoing research continues to uncover additional genes and chromosomal regions that may also contribute to the disease.

In certain individuals, the onset of type 1 diabetes can be predicted up to three years in advance by detecting islet cell autoantibodies (ICAs) in the blood. These autoantibodies are early indications that the immune system is beginning to attack the insulin-producing cells in the pancreas.

Type 2 Diabetes Mellitus or Non-Insulin Dependent Diabetes Mellitus[12][13]

Type 2 diabetes is the most common form of diabetes and usually develops in adults. However, due to rising obesity and lack of physical activity, more teenagers and young adults are now receiving a diagnosis of type 2 diabetes or **prediabetes**, which is an early warning stage.

In type 2 diabetes, the cells in the body — especially in the fat, muscles, and liver — **don't respond properly to insulin**. This is known as **insulin resistance**. Because of this, sugar (glucose) cannot enter the cells to be used for energy. Instead, it accumulates in the bloodstream, leading to high blood sugar levels. Insulin resistance usually happens **slowly over time**.

Gestational Diabetes[14][15]

Gestational diabetes is a condition where a woman develops high blood sugar levels during pregnancy. This may occur if the individual had pre-existing type 2 diabetes prior to pregnancy or developed it during pregnancy. High blood sugar during pregnancy increases the risk of health problems for both the mother and the baby.

Mother diagnosed with gestational diabetes and their new borns, have a higher chance of developing type 2 diabetes later in life. High blood sugar during pregnancy can lead to complications such as having a very large baby (macrosomia, birth weight of 4.5 kg or more), babies that are larger than normal for their stage of development (large for gestational age), high blood pressure During pregnancy, such as in cases of preeclampsia, Early delivery, also known as preterm birth, and the need for cesarean section due to the baby's size.

Several factors can increase the risk of developing gestational diabetes. These factors include being overweight or obese, as well as having a history of gestational diabetes in a previous pregnancy, having a family history of diabetes, being older in age during pregnancy, having polycystic ovary syndrome (PCOS), living a sedentary lifestyle, and exposure to harmful environmental substances.

Causes of Diabetes Mellitus[16][17]

Diabetes mellitus can be caused by several factors that affect how the body produces or uses insulin. Some of the main causes are explained below:

1. **Problems with β-cell function**

There may be a defect or abnormality in the glucose receptors of the β-cells in the pancreas. This makes the cells respond only to high levels of blood glucose, or this may be attributed to a reduced number of β-cells. In both cases, insulin secretion is affected and may eventually lead to complete β-cell failure.

2. Insulin resistance in body tissues

The body's cells, especially in the liver, muscles, and fat, may become less sensitive to insulin. This occurs when the number of insulin receptors decreases, a process known as down regulation. Some people may have high insulin levels (hyperinsulinemia) but normal blood sugar, along with other issues like abnormal cholesterol (dyslipidemia), high uric acid (hyperuricemia), and belly fat. This condition is referred to as insulin resistance and is associated with blood vessel damage, also known as angiopathy.

3. Elevated levels of hormones such as glucagon, along with obesity, contribute to the condition

Too much glucagon or being overweight can lead to relative insulin deficiency, where insulin production cannot keep up with the body's needs. Some theories suggest that this may be related to changes in nitric oxide metabolism, which affects blood flow to nerves and causes nerve damage.

4. Other rare forms of diabetes

Some cases of diabetes are caused by specific genetic problems, such as Maturity-Onset Diabetes of the Young (MODY). It may also arise from other hormonal disorders, surgical removal of the pancreas (pancreatectomy), or gestational diabetes during pregnancy.

5. Imbalance in specific receptors and enzymes

An imbalance in certain receptors can also lead to diabetes. These include the GLP-1 receptor, PPARγ receptor, and β3 adrenergic receptor. Enzymes like α-glucosidase and DPP-IV are also involved in how the body processes sugar and insulin.

6. Nerve damage in diabetes (diabetic neuropathy)

Recent studies suggest that diabetic nerve damage may be caused by oxidative stress, advanced glycation end-products (AGEs), protein kinase C activity, and changes in the polyol pathway, all of which can harm nerves over time.

SYMPTOMS OF DIABETES MELLITUS[18][19][20][21][10]

1. Frequent Urination (polyuria)

- Cause: Diabetes results in high blood sugar (hyperglycemia), and when blood sugar levels become too high, the kidney work harder to filter and absorb the excess glucose. If the kidney can't keep up, the excess glucose spills into the urine, dragging water with it. This leads to increased urination.
- Effect: The body needs to eliminate the excess glucose, and the kidneys filter it out into urine. This makes you needs to urinate more often. In some cases, it may cause nighttime awakenings due to the need to urinate.

2. Increased Thirst (polydipsia)

- Cause: As your body loses more fluids through urination, dehydration sets in. the dehydration triggers the sensation of thirst as your body attempts to rehydration itself
- Effect: You may find yourself drinking much more water than usual, sometimes even feeling thirsty all the time. This is a response to losing fluids and trying to compensate for the loss.

3. Extreme Hunger (polyphagia)

- Cause: The body's inability to efficiently use glucose for energy (due to either insufficient insulin or insulin resistance) can cause cells lack energy. This leads to an increase in hunger as the body tries to get more fuel to function.
- Effect: Even if you eat normal meals you may fell hunger, as your body isn't able to properly convert the food into usable energy. This sensation is particularly pronounced in individuals with type 1 diabetes, where the body doesn't produce enough insulin, and Type 2 diabetes, where insulin resistance is present.

4. Unexplained Weight Loss

- Cause: In both type 1 diabetes mellitus and type 2 diabetes mellitus, the body's inability to absorb glucose from the blood into cells means the cells can't use the glucose foe energy. The body then begins to break down fat and muscles tissue for energy instead.
- Effect: Despite eating normally or even more than usual, people with diabetes may lose weight because their body is breaking down into its own tissues for energy. This is more common Type 1 diabetes, but can also occur in uncontrolled Type 2 diabetes.

5. Fatigue

- Cause: High blood sugar prevents glucose from entering cells to be used for energy. As a result, the body lacks the fuel it needs to function properly, leading to tiredness and fatigue.
- Effect: Without enough usable energy, even simple tasks can become exhausting. The body might also feel weak and sluggish, affecting daily activities and overall well-being.

6. Blurred Vision

- Cause: Elevated blood glucose levels can lead to the accumulation of glucose in lens of the eye, causing the lens to swell and change shape. This effect the ability of the eye to focus properly.

- Effect: This cause blurry vision, making it difficult to see clearly. The issue may appear intermittently, depending on fluctuations in blood glucose levels, but over time, prolonged high blood sugar can lead to more serious eye issues, such as diabetic retinopathy.

7. Slow-Healing Sores or Cuts

- Cause: High blood glucose levels can impair the body's ability to heal itself by weakening the immune system and reducing blood circulation. The immune system become less effective at fighting off infections and the body repair itself.
- Effect: Minor cuts or injuries may take longer to heal, and you may experience infections that don't heal quickly or easily. Individuals with diabetes are also more susceptible to developing ulcers or other chronic wounds.

8. Frequent Infections

- Cause: high blood sugar can weaken the immune system's making it makes it harder for the body to fight off infections. Additionally high glucose levels in the blood can make it easier for bacteria and fungi to grow.
- Effect: Individuals with diabetes have an increased risk of recurrent infections, particularly urinary tract infections (UTIs) and skin infections, and fungal infection like yeast infections. These infections can be harder to treat and take longer to resolve in people with poorly controlled blood sugar.

9. Tingling or Numbness in Hands or Feet (Neuropathy)

- Cause: High blood sugar over time can damage the nerves, especially in extremities (hands, feet, legs). This condition is called diabetic neuropathy. The nerves in the peripheral parts of the body (like the hands and feet) are the most communally affected.
- Effect: The damage to nerves causes a feeling of tingling, numbness, or a "pins and needles" sensation. It can also lead to pain or weakness in the affected areas. In severe cases, this damage can lead to difficulty with movement or balance.

10. Darkness Skin (Acanthosis Nigricans)

- Cause: Acanthosis Nigerians is often a sign of insulin resistance, which occurs when the body's cells don't respond well to insulin. As a result, the pancreas increases insulin production to compensate, and higher levels of insulin in the bloodstream can cause changes in skin pigmentation.
- Effect: This condition is characterized by dark, thickened patches of skin, Fat typically accumulates in body folds, such as the neck, armpits, and groin, or under the breasts. It can also appear on the elbows or knee. While it is a common sign of type 2 diabetes, it can also be seen in other conditions associated with insulin resistance.

Complication of DM[22][23]

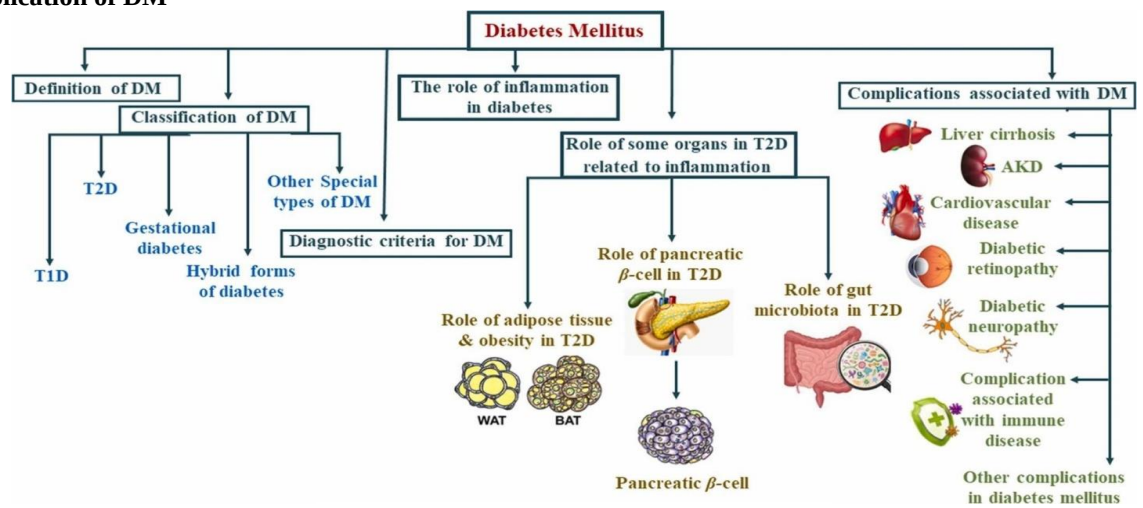

Figure 3: Complications of Diabetes Mellitus.

1. Acute Complications

These complications arise quickly, often as a result of extremely high or low blood glucose levels.

a) Diabetes Ketoacidosis (DKA)

- **Cause:** Diabetic ketoacidosis (DKA) primarily occurs in type 1 diabetes but can also develop in type 2 diabetes.in certain conditions. It happens when the body begins to break down fat instead of glucose for energy because there is insufficient insulin. This results in the production of ketones, which are acidic byproducts.

- **Symptoms**
  - Hyperglycemia
  - Increased frequency of urination
  - Dehydration
  - Nausea and vomiting
  - Deep, labored breath (kussmaul respiration)
  - Fruity-smelling breath (due to ketones)
- Outcome: if not treated properly, DKA can lead to coma or death.

b) Hyperosmolar hyperglycemic state (HHS)

- **Cause:** HHS is more common in Type 2 diabetes and occurs when blood sugar levels become extremely high (often over 600mg/dL), leading to dehydration and an imbalance in electrolytes, but without significant ketone production.

- **Symptoms**
  - Extreme thirst and dehydration
  - Very high blood sugar
  - Confusion or altered mental state
  - Seizures (in severe cases)
- Outcomes: HHS can lead to coma or death if untreated.

c) Hypoglycemia

- **Cause:** Hypoglycemia occurs when blood sugar levels fall too low (below 72mg/dL), this often leads to of taking too much insulin or other diabetes medication, skieeping meals, or excessive physical activity.

- **Symptoms**
  - Shaking or trembling
  - Sweating
  - Confusion or dizziness
  - Irritability or mood swings
  - Blurred vision
  - Seizures or loss of consciousness (in severe cases)

- **Outcomes:** Severe hypoglycemia can lead to coma or death if not treated immediately.

2. Chronic Complication

These develop over a long period due to ongoing Elevated blood glucose levelsthat damage blood vessels nerves, and tissues. Chronic complication can affect nearly every organ in the body.

a) Cardiovascular Disease[23]

- **Cause:** high blood sugar levels can damage the blood vessels, increasing the risk of heart disease, stroke, and peripheral artery disease (PAD). The damage to blood vessels leads to the buildup of fatty deposits(atherosclerosis), narrowing blood vessels and reducing blood flow.
- **Condition**
  - Coronary artery disease (CAD): Increase the risk of myocardial infarctions.
  - Stroke: reduced blood flow to the brain.
  - Peripheral artery disease (PAD): poor circulation in the legs, leading to pain and An elevated risk of infection

b) Kidney Disease (Diabetic Nephropathy)

- **Cause:** Prolonged high blood sugar can damage the kidney's filtering system, leading diabetic nephropathy, which may result in kidney failure.

- **Symptoms**
  - Swelling in the legs, ankle, or feet
  - High blood pressure
  - Protein in the urine (early sign)
  - Eventually, end-stage kidney disease (ESKD) or renal failure can occur, requiring dialysis or a kidney transplant.

d) Retinopathy (Diabetic Eye Disease)

- **Cause:** High blood sugar damages the blood vessels in the retina (the light-sensitive tissue at the back of the eye), leading to diabetic retinopathy. Over time, this can lead to blindness.

- **Symptoms**
  - Blurred vision
  - Floaters or spots in the field of vision
  - Vision loss (in severe cases)

- **Outcome:** diabetic retinopathy is a leading cause of blindness in adults, but early detection through regular eye exams can help prevent significant vision loss.

e) Foot problems

- **Cause:** Nerve damage (neuropathy) and poor circulation increases the risk of infections, ulcers, and foot deformities in people with diabetes.

- **Conditions**
  - Bacterial infections: due to poor circulation and a weakened immune system.
  - Fungal infections: such as yeast infections, which are more common in people with diabetes.
  - Dry skin and itching: Due to dehydration and poor circulation.

f) Cognitive Decline and Dementia

- **Cause:** Persistent elevated blood glucose levels and the damage to blood vessels and nerves are linked to an increased risk of cognitive decline and dementia, including Alzheimer's disease.

- **Symptoms**
  - Memory problems
  - Difficulty concentrating
  - Confusion and poor decision-making
- **Outcome:** People with diabetes, especially those with poorly controlled blood sugar levels, have an increased risk of developing cognitive issues and dementia in older age.

g) Gum Disease (Periodontal Disease)

- **Cause:** High blood sugar levels contribute to the growth of harmful bacteria in thwe mouth, leading to gum infection.

- **Conditions**
  - Swollen or bleeding gums
  - Tooth loss due to gun infection (Periodontitis)
  - Poor healing of oral wounds

- **Outcome:** People with Individuals with diabetes are at a higher risk of developing severe gum disease and tooth loss.

3. Increased risk of Infection

Diabetes weakens the immune system, increasing susceptibility to infections. Elevated glucose levels create an environment conducive to bacterial and fungal growth, making it easier for infections to take hold. Common infections in people with diabetes include

- Urination tract infection (UTIs)
- Respiratory infections
- Skin infections
- Fungal infections, such as athlete's foot or yeast infections

Diagnosis of DM[24][25]

Diagnostic tests for Diabetes Mellitus

Fasting Blood Glucose Test

- **Purpose:** This test measures the blood glucose levels after fasting for at least 8 hour (overnight). It helps to determine whether a person's blood sugar is within a normal range.

- **Normal range**
  - **Normal range:** Less than **100mg/dL.**
  - **Prediabetes**: 100-125 mg/dL **(**this known as **impaired fasting glucose)**
  - **Diabetes**: 126mg/dL or higher on two separate occasions.

- **Interpretation:** Elevated fasting blood glucose levels indicate impaired glucose regulation or the presence of diabetes. A level of ≥**126 mg/dL** conforms a diagnosis of **Diabetes mellitus.**

Oral Glucose Tolerance Test (OGTT)

- **Purpose:** The Oral Glucose Tolerance Test (OGTT) measures the body's ability to process glucose.The test is used to diagnose **Type 2 diabetes, Gestational diabetes**, and **prediabetes.**

- **Procedure**
  - The test starts with a fasting blood glucose measurement.
  - The person then drinks a sugary solution containing a specified amount of glucose (usually 75 grams of glucose).
  - Blood glucose levels are measured at 1 hour and 2 hour after drinking the solution.

- **Normal Range**
  - **Normal:** Less than **140 mg/dL** at 2 hours.
  - **Prediabetes (Impaired glucose Tolerance):** 140-190 mg/dL at 2 hours.
  - **Diabetes:**200 mg/dL or higher at 2 hours.

- **Interpretation**: A 2-hour blood glucose levels of≥**200 mg/dL** conforms **Diabetes.** The **OGTT** is considered one of the most accurate ways to assess insulin resistance and glucose tolerance.

Hemoglobin A1c (HbA1c) test

- **Purpose:** This test measures the average blood glucose level over the past **2-3 months.** The A1c test is used both to diagnose diabetes and to monitor blood sugar control in individuals who already have the condition.

- **Normal Range**
  - **Normal:** less than **5.7%**
  - **Prediabetes: 5.7% to 6.4%**
  - **Diabetes: 6.5% or higher**

- **Interpretation:** A higher A1c level reflects poorer long-term blood glucose control. It is particularly useful for assessing whether an individual's blood sugar is under control and is not as influenced by short- term fluctuations (like stress or illness).
- **Additional notes:** An A1c of 6.5% or greater on two distinct tests confirms in certain situation (e.g., people with anemia, pregnancy, or kidney disease).

Random Blood Glucose Test

- **Purpose:** This test measures blood glucose levels at any time of day, irrespective of the last meal. It's often used to quickly determine if blood glucose is elevated, particularly in emergency situation.

- **Normal Range**
  - Typically, blood glucose levels should be less than**140 mg/dL** at random times of day.

- **Diagnosis**
  - **Diabetes:** If the random blood glucose level is ≥**200 mg/dL** and the person exhibits symptoms of diabetes (e.g., polyuria, polydipsia, fatigue), it is likely a **diagnosis of Diabetes Mellitus.**
  - A **confirmatory test** (usually a fasting blood glucose or HbA1c) is needed for a definitive diagnosis.

Urine Glucose Test

- **Purpose:** While not commonly used for diagnosing diabetes, a **urine glucose test** can sometimes provide initial evidence of high blood glucose levels, especially in undiagnosed individuals.

- **Process:** This test detects the presence of glucose in the urine, which occurs when blood glucose levels exceed the kidney's ability to reabsorb glucose. This typically happens when blood glucose levels **≥180 mg/dL.**

- **Interpretation:** the presence of glucose in the urine can indicate **uncontrolled diabetes** but is not definitive for diagnosis. Other tests, like fasting glucose or A1c, are required for a more accurate diagnosis.

C-Peptide Test

- **Purpose:** This test measures the levels **of C-peptide**, a byproduct of insulin production. It can be distinguishing between **Type 1** and **Type 2 diabetes**, particularly in ambiguous cases.

- **How to Works:** Insulin is produced as a precursor called **proinsulin**, which splits into **insulin** and **C-peptide**. The C-peptide levels can how much insulin the pancreas is producing.

- **Interpretation**
  - Low C-peptide levels suggest **Type 1 Diabetes** (where insulin production is very low or absent due to beta-cell destruction).
  - Normal or high C-peptide levels suggest **Type 2 Diabetes** (where insulin is being produced but the body is resistant to it.)

Treatment of DM[26][27][28][29][30]

1. Treatment of Type 1 Diabetes Mellitus (T1DM)

Type 1 Diabetes is an autoimmune condition where the body cannot produce insulin. The primary treatment involves **insulin replacement** and careful management of blood glucose levels.

a) Insulin Therapy

Purpose: Since individuals with Type 1 diabetes cannot produce their own insulin, they must take insulin to regulate blood sugar levels.

Types of Insulin

1. **Rapid-acting insulin:** Begins to work within 15 minutes and lasts for a few hours. Examples: **Lispro, Aspart.**
2. **Short-acting insulin:** It takes approximately 30 minutes to begin workingandlasts for around 5-8 hours. Example: **Regular insulin.**
3. **Intermediate-acting insulin:** Starts working in 1-2 hours and lasts for 12-18 hours. Example: NPH insulin.
4. **Long-**acting insulin: Provides a steady release of insulin over 12 hours or longer. Example: Glargine, Detemir.
5. **Insulin pumps:** Devices that provide continuous delivery of insulin through a small tube placed under the skin.

Insulin Regimens

- **Basal-bolus regimen:** A combination of long-acting(basal) insulin and rapid-acting(bolus)insulin with meals.
- Continuous insulin infusion: Through and insulin pumps that delivers insulin in small amounts through the day.

Dosing and adjustments: insulin doses are adjusted based on blood sugar levels, carbohydrates intake, physical activities, and other factors. **Continuous glucose monitoring (CGM)** can help track real-time blood sugar levels.

b) Lifestyle Modification

Diet: People with type 1 diabetes should focus on a balanced diet with consistent carbohydrates intake to match insulin doses. This includes:

- Monitoring carbohydrates intake (counting carbs) to adjust insulin accordingly.
- Eating high-fiber nutrients-rich foods (vegetables, fruits, whole grains)

Exercise: regular physical activity (at least 50 minutes per week) can helps improve insulin sensitivity and control blood sugar levels.

Blood Sugar Monitoring: Frequent monitoring of blood glucose is necessary to adjust insulin dosages and avoid complications like hypoglycemia or hyperglycemia.

c) Additional Medications

Pramlintide(symlin): A synthetic version of **amylin,** a hormone that is co-secreted with insulin in the pancreas. It helps controlled blood sugar levels and reduces post-meal spikes.

2. Treatment of Type 2 Diabetes Mellitus (T2DM)

Type 2 Diabetes is characterized by insulin resistance, where the body's cells do not respond properly to insulin. The treatment focuses on improving insulin sensitivity, reducing blood sugar levels, and managing risk factors like obesity.

a) Lifestyle Modifications

Diet: A healthy, well-balanced diet that emphasizes:

- Weight loss and portion control.
- Low-glycemic index (GI) foods (to helps control blood sugar spikes).
- High-fiber foods (whole grains, vegetables, legumes).
- Healthy fats (avocados, nuts, olive oil).
- Reducing sugary foods, processed carbohydrates, and high-fat meats.

Exercise: Regular physical activity improves insulin sensitivity, and helps control weight. This can include aerobic exercise (e.g., walking, cycling) and resistance training (e.g., weightlifting).

Weight management: weight loss, especially abdominal fat, can significantly improve insulin sensitivity and control blood glucose levels.

b) Medications

Orals Medications

1. **Metformin (Glucophase):** The first line medication. It reduces glucose production in the liver and improves insulin sensitivity in muscles and fats cells. It also aids in weight loss.
2. **Sulfonylureas (e.g., glyburide, Glipizide)**: stimulates the pancreas to produce more insulin. These are used when metformin is not enough to control blood sugar.
3. **DPP-4Inhibitors (e.g., Sitagliptin, sexagliptin):** Help increase insulin release and decrease glucose production by inhibiting the enzyme DPP-4.
4. **SGLT2 Inhibitors (e.g., Empagliflozin, Canagliflozin):** Prevents the kidneys from reabsorbing glucose into the blood, causing excess glucose to excrete in the urine.
5. **Thiazolidinediones (TZDs)(e.g., Pioglitazone):** Improve insulin sensitivity, especially in fat and muscles cells.
6. **Alpha-glucosidaseinhibitors(e.g., Acarbose):** Slow the absorption of carbohydrates in the intestines, which helps to prevents post-meal blood sugar spikes.

Injectable Medications

1. **GLP-1 Agonist(e.g., Liraglutide, Exenaglutide):** mimic the action of the glucagon like peptide 1 (GLP-1), a hormone that stimulates insulin release, reduces appetite, and slow gastric emptying.
2. **Insulin Therapy:** Some people with Type 2 diabetes may eventually require insulin therapy, especially if oral medications are insufficient to control blood sugar. Insulin may be used in combination with oral medications.

c) Blood Sugar Monitoring

Home Blood Glucose Monitoring (BGM): Regular monitoring of blood glucose levels (using a glucometer) to adjust medications, diet, and physical activity.

Continuous Glucose Monitoring (CGM): Continuous tracking of glucose levels in real-time, which is especially useful for those using insulin or for patients who have difficulty maintaining target glucose levels.

d) Surgical Intervention

Bariatric Surgery: For obese individuals with Type 2 diabetes, weight-loss surgery (such as gastric bypass) can lead to significant improvement or even remission of diabetes.

3. Treatment of Gestational Diabetes Mellitus (GDM)

Gestational diabetes occurs during pregnancy when the body cannot produce enough insulin to meet the increased demands. The treatment aims to keep blood glucose levels within a target range to prevent complications during pregnancy and childbirth.

a) Lifestyle Modifications

Diet: A healthy eating plan is crucial to control blood sugar levels:

- Eating small, balanced meal throughout the day to avoid large blood sugar spikes.
- Choosing complex carbohydrates (whole grains, vegetables) and fiber-rich foods.
- Limiting sugary foods and beverages.

Exercise: Regular physical activity, such as walking, can helps improve insulin sensitivity and manage blood sugar levels.

b) Medications **Insulin Therapy:** If blood sugar levels cannot be controlled with diet and exercise, **insulin injections** are the preferred treatment for gestational diabetes. Insulin does not cross the placenta, making it safe for the baby.

Oral Medications (e.g., Metformin, Glyburide): These may be used if insulin is not required. They help lower blood glucose but may not be as effective as insulin during pregnancy.

c) Monitoring

Blood Sugar Monitoring: Frequent blood glucose testing is necessary to keep blood sugar levels within the recommended range.

Fetal Monitoring: Regular ultrasounds and fetal heart rate monitoring are done to ensure the baby is developing properly.

CONCLUSION

Diabetes Mellitus is a serious and critical condition that affects many people today. Our lifestyle and daily habits play a major role in the development of this disease. This review provides us with a better understanding of diabetes mellitus and highlights the importance of making improvements in our everyday lives to prevent or manage this condition.

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