

DIABETES MELLITUS

Introduction:

Diabetes mellitus is a chronic disorder of impaired carbohydrate, protein and lipid metabolism that is caused by the deficiency of insulin.

Insulin is a hormone produced by the pancreas, control the level of glucose in the blood by regulating the production and storage of glucose.

Pancreas secretes glucagon (from the alpha cells) and insulin (from the beta cells). Glucagon raises the blood glucose level while insulin lowers the blood glucose.

Diabetes mellitus is a group of metabolic disease characterized by elevated level of glucose in the blood (Hyperglycemia) resulting from either defect in insulin secretion, insulin action or both.

-American Diabetes Association, 2016

	Normal	Prediabetes	Diabetes
A1C or HbA1C	< 5.7%	5.7 – 6.4%	≥ 6.5%
FPG or FBS	< 100mg/dl	100 – 125mg/dl	≥ 126mg/dl
OGGT	< 140mg/dl	140 – 199mg/dl	≥ 200mg/dl
RPG or RBS			≥ 200mg/dl

Diabetes is diagnosed at an A1C of $\geq 6.5\%$, fasting blood glucose of $\geq 126\text{mg/dl}$, oral glucose tolerance test of $\geq 200\text{mg/dl}$, blood glucose of $\geq 200\text{mg/dl}$.

Epidemiology:

- The number of people with diabetes rose from 108 million in 1980 to 422 million in 2014.
- In 2014, 8.5% aged 18 years and older had diabetes.
- In 2019, diabetes was the direct cause of 1.5 million deaths and 48% of all deaths due to diabetes occurred before the age of 70 years.
- Between 2000 and 2019, there was a 3% increase in mortality rates from diabetes. In lower-middle-income countries, the mortality rate due to 20%diabetes increased 13%.
- According to CDC 90 to 95% of cases involve type 2 diabetes.

Risk factors:

1) Non modifiable risk factors:

- Genetics or Family history of diabetes (e.g., parents or siblings with diabetes).
- Race/ethnicity (e.g., Southeast Asians, African Americans, Hispanic Americans, Native Americans, Pacific Islanders).
- Age equal of more than 45 years.
- History of gestational diabetes or delivery of a baby over 4 kg.

2) Modifiable risk factors:

- Obesity (i.e., $\geq 20\%$ over desired body weight or body mass index $\geq 30 \text{ kg/m}^2$).
- Previously identified impaired fasting glucose or impaired glucose tolerance.
- Hypertension ($\geq 140/90 \text{ mm Hg}$)
- High density lipoprotein (HDL) cholesterol level $\leq 35 \text{ mg/dl}$ (0.90 mmol/L) and/or triglyceride level $\geq 250 \text{ mg/dl}$ (2.8 mmol/L).

Classification of diabetes mellitus:

Diabetes Mellitus is broadly classified into three types:

1. Type 1 Diabetes Mellitus (T1DM):

- It is known as Insulin Dependent Diabetes Mellitus (IDDM) or Juvenile Diabetes.
- Sudden onset which usually occurs in children and before age of 30 years but can be seen in older adults and 40% develop it before 20 years of age.
- Accounts for 5% to 10% of Diabetes Mellitus.
- Autoimmune destruction of beta cells in the islets of Langerhans in the pancreas, the loss of function of beta cells resulting in little production or absolute insulin deficiency requiring injections of insulin to control diabetes, prevent ketoacidosis and sustain life.
- Glucose taken from food cannot be stored in the liver anymore but remains in the blood stream.

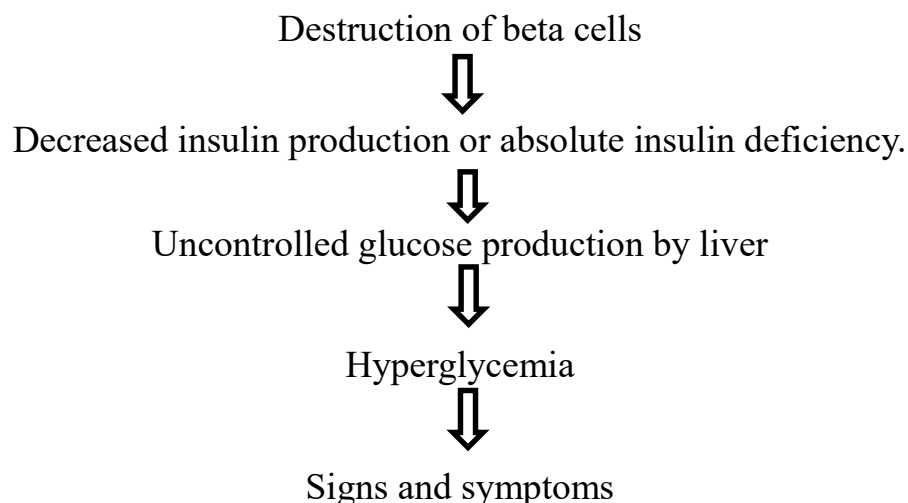
- A common underlying factor in the development of type 1 diabetes is a **genetic susceptibility**.
- The kidney will not reabsorb the glucose once it has exceeded the renal threshold, so it will appear in the urine and be called glycosuria.
- Excessive loss of fluids is accompanied by excessive excretion of glucose in the urine leading to osmotic diuresis.
- There is **fat breakdown** which results in **ketone production**.

Causes of Type 1 DM:

Etiology is not well understood. And includes:

- Autoimmune response
- Genetic susceptibility
- Toxins, unidentified viruses, and environment factor

Pathophysiology of Type 1 DM:



2. Type 2 Diabetes Mellitus (T2DM):

- It is known as Non-Insulin Dependent Diabetes Mellitus (NIDDM), Adult or maturity onset diabetes.
- Usual presentation is slow and occurs most in adults over age 30 years; however, it is now more frequently seen in younger adults and adolescents who are overweight.
- Accounts for around 90% of all cases of Diabetes.

- The pancreas usually continues to produce insulin. However, the insulin is either insufficient or is poorly utilized by the tissues and the response to insulin is diminished (insulin resistance).
- Insulin is ineffective and is initially countered by an increase in insulin production to maintain glucose homeostasis, but over time, insulin production decreases, resulting in T2DM.
- There is enough insulin present to prevent fat breakdown.

Causes of Type 2 DM:

- Idiopathic
- Genetic
 - Concordance in identical twins 80%
 - Both parents' diabetes 50% risk to the child.
- Constitutional factors
 - Obesity
 - Inactivity
 - Hypertension

Pathophysiology of Type 2 DM:

Decreased sensitivity of insulin receptor and post receptor defect



Impaired glucose utilization



Increased hepatic glucose synthesis.



Hyperglycemia

3. Gestational Diabetes Mellitus (GDM):

- GDM is defined as the onset of carbohydrate intolerance that initially presents during pregnancy and revolves upon delivery.
- GDM is when pregnant women who have never had diabetes before having high blood glucose level during pregnancy.
- It is a type of diabetes that develops around 2 to 5% of all pregnancy.

- According to the American Diabetes Association (ADA), GDM complicates 7% of all pregnancies.
- It can occur anytime during pregnancy and usually detected between 24 to 28 weeks of gestation.
- American Diabetes Association (ADA) made recommendation that all pregnant women should be screened for the presence of T2DM at the initial prenatal visit using the standard diagnostic criteria (2011). Women who are negative for T2DM at that time should be screened for GDM at 24 to 28 weeks of gestation.
- Women with GDM and their offspring have an increased risk of developing type 2 diabetes mellitus in the future. So, they should be screened for diabetes 6 to 12 weeks postpartum and continue to have lifelong screening at least every 3 years.
- In most cases, GDM has no external symptoms and is detected through screening.

Clinical Features:

1. Polyuria or increased urination:
Occurs because the kidneys remove excess sugar from the blood, resulting in a higher urine production.
2. Polydipsia or increased thirst:
The body loses more water as polyuria happens, triggering an increase in the patient's thirst.
3. Polyphagia or increased appetite:
Although the patient may consume a lot of food, but glucose could not enter the cells because of insulin resistance or lack of insulin production.
4. Fatigue and weakness
The body does not receive enough energy from the food that the patient is ingesting.
5. Blurred vision
Prolonged high blood glucose can cause glucose absorption in the lens of the eye, damages small blood vessels of the eye which leads to changes in its shape, resulting in vision changes.

6. Tingling and numbness in hands or feet
It occurs due to a decrease in glucose in the cells.
7. Unexplained weight loss
There is no insulin available to move glucose into the cells, glucose builds up in the blood stream. Then kidney work to remove glucose through urination which is not used as energy. So, the body starts to burn fat and muscle for energy, resulting in weight loss.
8. Slow wound healing
Instead of entering the cells, glucose crowds inside blood vessels, hindering the passage of white blood cells which are needed for wound healing.
9. Dry skin
Because of polyuria, the skin becomes dehydrated.
10. Recurrent infection
Due to the high concentration of glucose, bacteria thrive easily.
11. Dizziness and Headache

Diagnostic investigation:

- History taking
- Physical examination
- Glycosylated hemoglobin (HbA1C or A1C)
 - Measures average blood glucose for past two or three months or over approximately the last 120 days (average lifespan of the RBCs on which the test is based).
- Fasting blood sugar (FBS)
 - Fasting means after not having anything to eat or drink (except water) for at least 8 hours before the test.
 - Done in empty stomach, usually in the morning before breakfast.

- Oral Glucose tolerance test (OGTT)
 - It is a 2-hour test, done before and 2 hours after 75 gm oral glucose intake.
- Blood glucose random (RBS)
 - Can be done at any time (casual blood glucose).
- Postprandial blood sugar (PPBS)
 - Done 2 hours after standard meal.
- General random blood sugar (GRBS)
 - Finger stick blood glucose.
 - Rapid screening test that may be performed anywhere, including community-based screening programs.
 - The test involves sticking the patient's finger for a blood sample, which is then placed on a strip. The strip goes into a machine that reads the blood sugar level.
 - Only accurate to within about 10% to 20% of true laboratory values.
- Urine test for ketone
- Urine test for glucose

American Diabetes Association criteria for the diagnosis of diabetes

1. Glycated hemoglobin (A1C) $\geq 6.5\%$. The test should be performed in a laboratory using a method that is NGSP (National Glycohemoglobin Standardization Program) certified and standardized to the DCCT (Diabetes Control and Complications Trial).

OR

2. Fasting plasma glucose (FPG) ≥ 126 mg/dL (7 mmol/L). Fasting is defined as no caloric intake for at least 8 hours.

OR

3. 2-hour plasma glucose ≥ 200 mg/dL (11.1 mmol/L) during an OGTT (oral glucose tolerance test). The test should be performed as described by the World

Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.

OR

4. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥ 200 mg/dL (11.1 mmol/L).

(In the absence of unequivocal hyperglycemia, diagnosis requires two abnormal test results from the same sample or in two separate test samples).

Management:

I. Medical management:

➤ Nutritional management:

Nutrition, Diet, and weight control are foundation of diabetes management.

- Dietary fat should provide 25-35% of total intake of calories but saturated fat intake should not exceed 10% of total energy.
- Cholesterol consumption should be restricted and limited to 300 mg or less daily.
- Protein intake can range between 10-15% total energy (0.8-1 gm/kg of desirable body weight).
- Carbohydrates provides 50-60% of total caloric content of the diet. Although it has been traditionally recommended that carbohydrates should be complex and high in fiber, more emphasis should be placed on the total amount of carbohydrates consumed than the source of carbohydrates.
- Excessive salt intake should be avoided.

➤ Exercise:

- Exercise lowers the blood glucose level by increasing the uptake of glucose by body and by improving insulin utilization. It also improves circulation and muscle tone.
- Patient who has blood glucose levels exceeding 250mg/dl and who have ketones in their urine not begin exercising until the urine test negative for ketones and the blood glucose level is closer to normal.

General precaution of exercise

- ✓ Use proper footwear and if appropriate, other protective equipment.
- ✓ Avoid exercise in extreme hot and cold.
- ✓ Inspect feet daily after exercise.
- ✓ Avoid exercise during periods of poor metabolic control.
- ✓ Exercise at the same time and in the same amount each day.

➤ Monitoring blood glucose:

- Blood glucose monitoring is a cornerstone of diabetes management, and self-monitoring of blood glucose is necessary.
- Glycosylated hemoglobin is the blood test reflects average blood glucose level over a period of approximately 2 to 3 months.
- Urine testing for glucose.
- Testing for ketones (or ketone bodies).

➤ Pharmacological therapy:

Insulin therapy:

Types of Insulin for People with Diabetes:

- Rapid acting insulin:

Usually taken before a meal to cover the blood glucose elevation from eating. Begins to work about 15 minutes after injection, peaks in about 1 hour after injection, and last between 2-4 hours.

- Short acting insulin (Regular):

It is usually administered 20 to 30 minutes before a meal to cover the blood glucose elevation from eating. Usually reaches the bloodstream within 30 minutes after injection, peak anywhere from 2-3 hours after injection, and is effective for approximately 4-6 hours.

- Intermediate-acting Insulin:

Covers the blood glucose elevations when rapid-acting insulins stop working. Generally, reaches the bloodstream about 2-4 hours after injection, peaks 4-12 hours later, and is effective for about 16-20 hours. Usually taken after food.

- Long-acting Insulin:

This type of insulin is often combined, when needed, with rapid- or short-acting insulin. Reaches the bloodstream several hours after injection and tends to lower glucose levels up to 24 hours.

Time course	Agent	Onset	Peak	Duration	Indications
Rapid acting	Lispro (Humalog)	10-15 minutes	1 hours	2-4 hours	Used for rapid reduction of glucose level, to treat postprandial hyperglycemia, and/or to prevent nocturnal hypoglycemia
	Aspart (NovoLog)	5-15 minutes	40-50 minutes	2-4 hours	
	Glulisine (Apidra)	5-15 minutes	30-60 minutes	2 hours	
Short acting	Regular (Humulin R, Novolin R, Iletin II Regular)	30-60 minutes	2-3 hours	4-6 hours	Usually given 20-30 minutes before a meal: may be taken alone or in combination with longer-acting insulin
Intermediating acting	NPH (neutral protamine Hagedorn)	2-4 hours	4-12 hours	16-20 hours	Usually taken after food
	(Humulin N, Iletin II Lente, Iletin NPH, Novolin N[NPH])	3-4 hours	4-12 hours	16-20 hours	
Long acting	Glargine (Lantus)	1 hours	Continuous (no peak)	24 hours	Used for Basal dose
	Detemir (Levemir)	6 hours		24-36 hours	

	Glargine (Toujeo)				
Rapid acting inhaled insulin	Afrezza	< 15 minutes	≈ 50 minutes	2-3 hours	Used as rapid acting insulin

Oral hypoglycemic agents:

These are effective when used in Type 2 DM that cannot be treated with diet and exercise.

- ✓ There are several agents-
 - Sulfonylureas: chlorpropamide, glipizide
 - Biguanides: metformin
 - Alpha glucosidase inhibitors: acarbose

➤ Education:

Teaching patient to self-administer insulin.

- selecting syringes.
- Storage and dose preparation.
- Blood glucose monitoring.
- Interpretation of results.
- Frequency of testing.
- Blood glucose therapy goals.

II. **Nursing management:**

Assessment

- Assess physical condition: Assess the patient's blood pressure while sitting and standing to detect orthostatic changes.
- Assess the body mass index and visual acuity of the patient.
- Perform examination of foot, skin, nervous system.
- Laboratory examinations: HgbA1C, fasting blood glucose, lipid profile, microalbuminuria test, serum creatinine level, urinalysis, and ECG must be requested and performed.

Nursing diagnosis

The following are diagnoses observed from a patient with diabetes mellitus.

- **Risk for unstable blood glucose level** related to insulin resistance, impaired insulin secretion, and destruction of beta cells.
- **Risk for infection** related to delayed healing of open wounds.
- **Deficient knowledge** related to unfamiliarity with information, lack of recall, or misinterpretation.
- **Risk for disturbed sensory perception** related to endogenous chemical alterations.
- **Impaired skin integrity** related to delayed wound healing.

Nursing intervention

- Administer insulin or oral anti diabetic drug as prescribed.
- Have the patient participate in supervised exercise program.
- Treat hypoglycemia reactions promptly by giving carbohydrates in the form of fruit juice, candy, honey or IV dextrose.
- Provide meticulous skin care, especially to the feet and leg.
- Assist the patient to develop coping strategies.
- Keep accurate records of vital signs, weight fluid intake, urine output, and caloric intake.
- Monitor diabetic effects on the cardiovascular peripheral vascular and nervous system.
- Observe for signs of urinary tract and vaginal infections and monitor the patient's urine for protein an early sign of nephropathy.
- Recommended regular ophthalmologic examinations.
- Teach the patient and the family how to monitor the patient's diet and how to care for his feet.

Standards of Care Guidelines Caring for Patients with Diabetes Mellitus:

- Assess level of knowledge of disease and ability to care for self.
- Assess adherence to diet therapy, monitoring procedures, medication treatment, and exercise regimen.
- Assess for signs of hyperglycemia: polyuria, polydipsia, polyphagia, weight loss, fatigue, blurred vision.

- Assess for signs of hypoglycemia: sweating, tremor, nervousness, tachycardia, light-headedness, confusion.
- Perform thorough skin and extremity assessment for peripheral neuropathy or peripheral vascular disease and any injury to the feet or lower extremities.
- Assess for trends in blood glucose and other laboratory results.
- Make sure that appropriate insulin dosage is given at the right time and in relation to meals and exercise.
- Make sure patient has adequate knowledge of diet, exercise, and medication treatment.
- Immediately report to health care provider any signs of skin or soft tissue infection (redness, swelling, warmth, tenderness, drainage).
- Get help immediately for signs of hypoglycemia that do not respond to usual glucose replacement.
- Get help immediately for patient presenting with signs of either ketoacidosis (nausea and vomiting, Kussmaul's respirations, fruity breath odor, hypotension, and altered level of consciousness) or hyperosmolar hyperglycemic nonketotic syndrome (nausea and vomiting, hyperthermia, muscle weakness, seizures, stupor, coma).

Complications of Diabetes Mellitus:

1. Acute complication
 - Hypoglycemia:
Hypoglycemia occurs because of an imbalance in food, activity, and insulin/oral antidiabetic agent.
 - Diabetic ketoacidosis:
Diabetic ketoacidosis (DKA) occurs primarily in type 1 diabetes during times of severe insulin deficiency or illness, producing severe hyperglycemia, ketonuria, dehydration, and acidosis.
 - Hyperglycemic hyperosmolar non ketotic syndrome (HHNK):
Primarily affects patients with type 2 diabetes, causing severe dehydration, hyperglycemia, hyperosmolarity, and stupor.

2. Long term complications

- Macro Vascular Complication
 - Coronary Artery Disease (CAD)
 - Stroke
 - Peripheral Vascular Disease (Myocardial infraction twice common in diabetic patient)
- Micro Vascular Complications
 - Retinopathy
 - Neuropathy
 - Nephropathy
 - Diabetic foot

Prevention of Diabetes Mellitus:

It is not yet known how to prevent type 1 diabetes. Type 2 diabetes, however, can be prevented in some cases.

- Control weight or maintain a healthy weight.
- Regular exercise and increase physical activity.
- Healthy diet and do not eat junk food.
- Eat high fiber diet.
- Split meals
- Avoid sedentary lifestyle.
- Quit smoking and alcohol.
- Drink lots of water