GLAND: PANCREAS; HORMONE: INSULIN

TYPE 2 DIABETES MELLITUS
- A chronic multisystem disease characterized by disorder of hyperglycemia resulting from defects in insulin secretion, insulin action, or both, leading to abnormalities in carbohydrate, protein, and fat metabolism.
- Leading cause of
  - Adult blindness
  - End-stage renal disease
  - Nontraumatic lower limb amputations

Changes in Glucose Regulation

<table>
<thead>
<tr>
<th>Alteration</th>
<th>Description/Definition</th>
<th>Manifestations</th>
<th>Interventions and Therapies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in glucose regulation</td>
<td>Changes in insulin secretion, regulation, and response alter the body’s ability to control blood glucose levels.</td>
<td>Clinical manifestations can include hypoglycemia or hyperglycemia, diabetic ketoacidosis, weight gain, thirst, frequent urination, increased susceptibility to infection, fatigue, and other symptoms.</td>
<td>Depending on the etiology, treatment may include insulin replacement therapy, changes to diet and exercise, blood glucose monitoring, and diabetes medications such as metformin or rosiglitazone.</td>
</tr>
</tbody>
</table>

Etiology and Pathophysiology

- Normal glucose and insulin metabolism is:
  - Produced by β-cells in islets of Langerhans
  - Released continuously into bloodstream in small increments with larger amounts released after food
  - Stabilizes glucose level in range of 70 to 110 mg/dL.
- Insulin
  - Promotes glucose transport from the bloodstream across the cell membrane to the cytoplasm of the cell
  - Cells break down glucose to make energy
  - Liver and muscle cells store excess glucose as glycogen
  - Skeletal muscle and adipose tissue are considered insulin-dependent tissues
Etiology and Pathophysiology

- T2DM – hyperglycemia that occurs despite availability of endogenous insulin
- Level of insulin produced varies in T2DM, and despite availability of insulin, its functioning is impaired by insulin resistance
- Insulin resistance exceeds the ability of the pancreas to compensate, over time the pancreas fails to produce enough insulin to meet body needs

Etiology and Pathophysiology

- Risk factors: overweight, obesity, inactivity, illnesses, medications, increasing age, and family history
- Greater prevalence in ethnic groups
  - African Americans
  - Asian Americans
  - Hispanics
  - Native Hawaiians/Pacific Islanders
  - Native Americans
- Metabolic syndrome increases risk for type 2 diabetes
  1. Elevated glucose levels
  2. Abdominal obesity
  3. Elevated BP
  4. High levels of triglycerides
  5. Decreased levels of HDLs
- 3 of 5 = METABOLIC SYNDROME

Gerontologic Considerations

- Increased prevalence and mortality
- Glycemic control challenging
  - Increased hypoglycemic unawareness
  - Functional limitations
  - Renal insufficiency
- Meal planning and exercise
- Patient teaching must be adapted to needs
Clinical Manifestations
Type 2 Diabetes Mellitus

- Nonspecific symptoms
  - Classic symptoms of type 1 may manifest
- Fatigue
- Recurrent infection
- Prolonged wound healing
- Visual changes
- Weight loss
- Polyuria
- Polydipsia
- Polyphagia

Fall 2019 - Spring 2020

A patient screened for diabetes at a clinic has a fasting plasma glucose level of 120 mg/dL (6.7 mmol/L). Which statement by the nurse is best?

a. "You will develop type 2 diabetes within 5 years."
b. "You are at increased risk for developing diabetes."
c. "The test is normal, and diabetes is not a problem."
d. "The laboratory test result is positive for type 2 diabetes."

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Diagnostic Studies

Hemoglobin A1C level: 6.5% or higher
Fasting plasma glucose level: higher than 126 mg/dL
Two-hour plasma glucose level during OGTT: 200 mg/dL (with glucose load of 75 g)
Classic symptoms of hyperglycemia with random plasma glucose level of 200 mg/dL or higher

A1C
Glycosylated hemoglobin: reflects glucose levels over past 2 to 3 months
Used to diagnose, monitor response to therapy, and screen patients with prediabetes
Goal: < 6.5%
Diagnostic Studies
- ↑ Triglycerides, cholesterol, LDL, VLDL
- ↓ HDL
- Hemoglobin A1C value > 6.5%
- Glycosuria
- Ketonuria
- Albuminuria
- ABG - acidosis

Interprofessional Care – Goals of Diabetes Management
- Decrease symptoms
- Promote well-being
- Prevent acute complications
- Delay onset and progression of long-term complications
Need to maintain blood glucose levels as near to normal as possible

Patient teaching:
- Drug therapy
  - Oral hypoglycemic medication
  - Insulin
- Nutritional therapy
- Exercise
  - weight loss may be sufficient for patients with type 2 diabetes
- Self-monitoring of blood glucose

DRUG THERAPY – ORAL AGENTS
Mechanisms of Action of Type 2 Diabetes Drugs (Fig 48-3, pg. 1123)
- Work on 3 defects of type 2 diabetes
  - Insulin resistance
  - Decreased insulin production
  - Increased hepatic glucose production
Can be used in combination with varying oral agents and with insulin
Can be combination oral therapy
### Oral Agents

**Biganides**
- **Metformin (Glucophage)**
  - Most effective first line treatment for type 2 diabetes.
  - Reduces glucose production by liver
  - Enhances insulin sensitivity
  - Improves glucose transport

**Contraindications:**
- Renal, liver, cardiac disease
- Excessive alcohol intake
- Withhold if patient is undergoing surgery or radiologic procedure with contrast medium
  - 1-2 days before and for 48 hours after
- Monitor serum creatinine

**Contraindications:**

---

**Sulfonylureas**
- **Glipizide (Glucotrol)/Glyburide (Glynase)**
  - ↑ Insulin production from pancreas
  - Side effect: hypoglycemia

**Thiazolidinediones**
- **Pioglitazone (Actos)**
  - ↑ glucose uptake in muscle
  - Side effect:
    - Weight gain, edema,
    - Increase risk for bladder cancer, exacerbate HF

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### Audience Response Question

A patient with type 2 diabetes calls the clinic with complaints of nausea, vomiting, and diarrhea. What is a priority for the nurse to advise the patient of?

- a. Withhold the regular dose of insulin
- b. Drink cool fluids with high glucose content
- a. Instruct the patient to remain nothing by mouth
- b. Use a less strenuous form of exercise than usual until the illness resolves
Mealtime Insulin (Bolus)

What patients require blood sugar checks?
- Diabetic
- Surgical
- NPO
- Enteral/parenteral feeding
- Medications
- Pancreas problems

How often to check blood sugar?

POINT OF CARE TEST

- AC/HIS, Q6hr, Q4hr ...
- S&S hypoglycemia
- Change in neurological status
  - Anytime nursing assessment warrants need to find an etiology for patient’s ineffective behaviors

DRUG THERAPY
- INSULIN

Exogenous (injected) insulin
- Insulin from an outside source
- Required for type 1 diabetes
- Prescribed for patients with type 2 diabetes who cannot manage blood glucose levels by other means

Human insulin
- Genetically engineered in laboratories

Categorized according to onset, peak action, and duration
- Rapid-acting
- Short-acting
- Intermediate-acting
- Long-acting

Insulin Regimens

- Basal-bolus regimen
  - Most closely mimics endogenous insulin production
  - Rapid- or short-acting (bolus) insulin before meals
  - Intermediate- or long-acting (basal) background insulin once or twice a day
- Goal: achieve glucose level of 80-130 mg/dL before meals
- Ensure appropriate food intake
Mealtime Insulin (Bolus)

- Rapid-acting (bolus):
  - Humalog (Lispro)
    - Onset of action 15 minutes
    - Injected within 15 minutes of mealtime

- Short-acting (bolus):
  - Regular (Humulin R/Novolin R)
    - Onset of action 30 to 60 minutes
    - Injected 30 to 45 minutes before meal

<table>
<thead>
<tr>
<th>Blood sugar</th>
<th>Low dose scale</th>
<th>Med dose scale</th>
<th>High dose scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;70 mg/dL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>70-130</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>131-200</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>201-300</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>&gt;301</td>
<td>8</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>&gt;400</td>
<td>10</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>&gt;500</td>
<td>12</td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>

(Basal) Background Insulin

- Used to manage glucose levels in between meals and overnight
- Long-acting (basal): Insulin glargine (Lantus)
  - Released steadily and continuously with no peak action for many people
  - Administered once or twice a day
  - Do not mix with any other insulin or solution

- Intermediate-acting insulin: NPH (Humulin N/Novolin N)
  - NPH
  - Duration 12 to 18 hours
  - Peak 4 to 12 hours
  - Can mix with short- and rapid-acting insulins
  - Cloudy; must agitate to mix
Combination Insulin Therapy

- Can mix short- or rapid-acting insulin with intermediate-acting insulin in same syringe
- "Clear, then cloudy"
- Provides mealtime and basal coverage in one injection
- Commercially premixed or self-mix

Insulin

- Administration of insulin
  - Given by subcutaneous injection
  - Absorption is fastest from abdomen*, followed by arm, thigh, and buttock
  - Do not inject in site to be exercised
  - Rotate injections within and between sites
  - Regular insulin may be given IV

  • Usually available as U100 insulin (1 mL contains 100 U of insulin) *HIGH ALERT*
  • No alcohol swab for self-injection; wash with soap and water;

- Problems with insulin therapy
  - Hypoglycemia – discussed later in acute complications
  - Allergic reaction
  - Lipodystrophy
The nurse plans a class for patients who have newly diagnosed type 2 diabetes mellitus. Which goal is most appropriate?

- Make all patients responsible for the management of their disease
- Involve the family and significant others in the care of these patients
- Enable the patients to become active participants in the management of their disease
- Provide the patients with as much information as soon as possible to prevent complications

Nutritional Therapy

- The cornerstone of care for person with diabetes and prediabetes
- ADA Healthy Food Choice; Healthy balance of carbohydrates, fats, and proteins
- Individual needs to personal lifestyle, health goals, cultural preferences
- Maintain pleasure of eating
- Emphasis on achieving glucose close to normal as safely, lipid, and BP goals

- Weight loss
  - Nutritionally adequate meal plan with ↓ fat and CHO
  - Spacing meals
  - Regular exercise

- Energy from food intake can be balanced with energy output = exercise
  - Alcohol
    - Can cause severe hypoglycemia
    - 1 drink/day for women; 2 drinks/day for men
    - Mixed drinks often contain sweetened mixers and can lead to elevated blood glucose levels

Exercise

- Minimum 30 minutes/week aerobic
- Resistance training three times/week
- Monitor blood glucose
- Caution about injecting into site that is to be exercised
- Exercise 1 hour after a meal
- Snack to prevent hypoglycemia
- Do not exercise if blood glucose level > 300 mg/dL and if ketones are present in urine
  - Body response to stress
  - Further increase blood glucose

Benefits:

- ↓ Insulin resistance and blood glucose
- Glucose-lowering effect up to 48 hours after exercise
- Weight loss
- ↓ Triglycerides and LDL, ↑ HDL
- Improve BP and circulation
Collaboration

• *RN*
• Certified Diabetic Educator
• Registered Dietitian
  with expertise in diabetes management
• Health Care Provider
• Podiatrist
• Psychologist/ Psychiatrist

• Bariatric Surgery
  – Patients with type 2 diabetes or associated co-morbidities difficult to manage with lifestyle and drug therapy
  – Studies have shown that patients with T2DM who have bariatric surgery for morbid obesity show complete remission in ¾ of cases

Nursing Implementation

• Acute illness and surgery*:
  Tight Hyperglycemic Control
  – Too much insulin working
  – Blood glucose level secondary to counterregulatory hormones
  – Ordered monitoring of blood glucose
  – Type 2 diabetes may necessitate insulin therapy (even though not taking insulin at home)

  What will you tell the patient who says to you: “Does this mean I will have to be on insulin at home now?”

  Diet vs. NPO
  – Ordered IVF
    • If normal diet not possible, supplement with CHO-containing fluids while continuing medications

  What happens to the patient who is NPO and with insulin orders?

Acute Complications of T2DM

• Hypoglycemia (cold & wet)
  – Too much insulin working
• Hyperglycemia (warm & dry)
  – Not enough insulin working
• Hypoglycemia – worsens rapidly
• Somogy Effect
• Dawn Phenomenon
• Hyperosmolar hyperglycemic syndrome (HHS)
• Diabetic ketoacidosis (DKA) *
Hypoglycemia

- **Causes**
  - Too much insulin or oral hypoglycemic agents
  - Too little food
  - Delaying time of eating
  - Too much exercise

- Symptoms can also occur when high glucose level falls too rapidly

- Too much insulin in proportion to glucose in the blood
- Blood glucose level < 70 mg/dL (<45-60 mg/dL)
  - Symptomatic vs. asymptomatic
  - Neuroendocrine hormones released
  - Autonomic nervous system activated

- Blood glucose level < 70 mg/dL (≤45-60 mg/dL)

- Hypoglycemia unawareness
  - No warning signs/symptoms until glucose level critically low
  - Related to autonomic neuropathy and lack of counterregulatory hormones
  - Patients at risk should keep blood glucose levels somewhat higher

Untreated hypoglycemia can progress to loss of consciousness, seizures, coma, and death

- Clinical Manifestations:
  - SKIN: Cool and wet
  - Shakiness
  - Palpitations
  - Nervousness
  - Diaphoresis, “Clammy”
  - Anxiety
  - Hunger
  - Palor
  - Altered mental functioning
    - Difficulty speaking
    - Visual disturbances
    - Slurred
    - Confusion
    - Coma

- Difficulty speaking
- Visual disturbances
- Stupor
- Confusion
- Coma

**Treatment: rule of 15:**
- Consume 15 g of a simple carbohydrate
  - Fruit juice or regular soft drink, 4 to 6 oz
- Recheck glucose level in 15 minutes
  - Repeat if still < 70 mg/dL

- Avoid foods with fat
- Decrease absorption of sugar

- Avoid overtreatment
- Give complex CHO after recovery
Hyperglycemia in the Morning

**Somogyi Effect** vs. **Dawn Phenomenon**

- **Somogyi Effect**
  - Combination of hyperglycemia during the night with a rebound morning rise in blood glucose to hyperglycemic levels
  - Rebound effect in which an overdose of insulin causes hypoglycemia and release of counterregulatory hormones causing rebound hyperglycemia
  - Check blood glucose levels between 0200-0400, and for S&S hypoglycemia
  - A bedtime snack, a reduction in the dose of insulin, or both can help to prevent the Somogyi effect
  - The treatment for Somogyi effect is less insulin in the evening.

- **Dawn Phenomenon**
  - A rise in blood glucose between 0400-0800 that is not a response to hypoglycemia.
  - This condition occurs in individuals with both T1DM and T2DM.
  - Morning hyperglycemia present on awakening
  - May be due to release of counterregulatory hormones in predawn hours (insulin, hormone and corticosterone, decreasing peripheral uptake of glucose)
  - Check bedtime, nighttime (between 0200-0400), and morning fasting blood glucose levels on several occasions
  - The treatment for Dawn phenomenon is an increase in insulin or an adjustment in administration time

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Hyperosmolar Hyperglycemic Syndrome (HHS)

- Able to produce enough insulin to prevent DKA, but not enough to prevent severe hyperglycemia, osmotic diuresis, and extracellular depletion
- As a result glucose is retained and water is lost
- Glucose and sodium accumulate in the blood and serum osmolarity

**Initiated by hyperglycemia**

- Urine output and with output, plasma volume and glomerular filtration rate
- As a result glucose is retained and water is lost
- Glucose and sodium accumulate in the blood and serum osmolarity.

*What body system is sensitively affected?*  
*What clinical manifestations will be seen?*  

**Precipitating factors**

- **Infection**: UTIs, pneumonia, sepsis
- Acute illness
- Newly diagnosed type 2 diabetes
- Impaired thirst sensation and/or inability to replace fluids

- Mortality is higher than DKA because metabolic changes are serious and because individuals with T2DM are older and have comorbidities (i.e. cardiac/renal)
Hyperosmolar Hyperglycemic Syndrome (HHS) –

**Treatment**

- Correct underlying precipitating cause once stabilized
- Establish and maintain adequate ventilation
- Correct shock with adequate IVF
- IV insulin
- Maintain fluid volume with isotonic or colloid solutions
- Monitor serum potassium and replace as needed

The healthcare provider has ordered Regular insulin 10 units IVP x 1 now. How will you prepare this?

---

**Diabetic Ketoacidosis (DKA)**

- Most likely to occur in type 1 diabetes
- May be seen in type 2 when the pancreas cannot meet the extra demands for insulin
- Characterized by
  - Hyperglycemia
  - Ketosis
  - Acidosis
  - Dehydration

- Precipitating factors
  - Undiagnosed type 1 or type 2 diabetes
  - Poor self-management
  - Neglect
  - Illness
  - Infection
  - Inadequate insulin dosage

**Clinical Manifestations**

- Dehydration
- Lethargy and weakness – early sign
- Abdominal pain, anorexia, nausea/vomiting
- Kussmaul respirations w/ sweet, fruity breath odor
- Blood glucose level of ≥ 250 mg/dL
- Blood pH lower than 7.30 = metabolic acidosis
- Moderate to high ketone levels in urine or serum
**Diabetic Ketoacidosis (DKA) - Treatment**

- Ensure patent airway; administer O₂, Cardiac Monitor
- Establish IV access; begin fluid resuscitation
  - NaCl 0.45% or 0.9%
  - Add 5% to 10% dextrose when blood glucose level approaches 250 mg/dL
- Continuous regular insulin drip 0.1 U/kg/hr (per hospital protocol)
- Potassium replacement prn
- Frequent blood sugar checks

Less severe form may be treated on outpatient basis
Hospitalize for severe fluid and electrolyte imbalance, fever, nausea/vomiting, diarrhea, altered mental state

**DKA/HHS Nursing Management**

**What are your priority system assessments? Why?**
- VS
- Renal status
- Cardiopulmonary status
- Level of consciousness

**What will you monitor? Why?**
- IV fluids
- Blood glucose
- Insulin therapy
- Electrolytes
- Cardiac monitoring to detect hyper/hypo-kalemia

**Audience Response Question**

The nurse is caring for a patient with newly diagnosed T2DM who is admitted for Hyperosmolar Hyperglycemic Syndrome (HHS). The nurse would expect which fluid & electrolyte imbalance?

- a. Hypokalemia
- b. Hyperkalemia
- c. Fluid overload
- d. Normovolemia
Chronic Complications of Diabetes Mellitus

- Angiopathy
- Macrovascular Angiopathy
- Microvascular Angiopathy
- Diabetic Retinopathy
- Diabetic Nephropathy
- Diabetic Neuropathy
- Foot Complications
- Skin Problems
- Infection

Angiopathy – damage to blood vessels secondary to chronic hyperglycemia
Macrovascular – disease of large and medium-sized blood vessels
- Cerebrovascular disease, Cardiovascular disease, Peripheral vascular disease
Microvascular – thickening of vessel membranes in capillaries and arterioles
- Retinopathy
- Nephropathy
- Dermopathy

Diabetic Nephropathy
- Damage to small blood vessels that supply the glomeruli of the kidney
- Leading cause of end-stage renal disease
- Risk factors
  - Hypertension
  - Genetics
  - Smoking
  - Chronic hyperglycemia
- If albuminuria present, drugs to delay progression:
  - ACE inhibitors
  - Angiotensin Receptor antagonists
- Control of hypertension and blood glucose levels in a healthy range is imperative
**Chronic Complications**

**Diabetic Neuropathy**

- **Sensory**
  - Loss of protective sensation (upper/lower) → unawareness of injury
  - Risk for amputation
- **Peripheral artery disease**
  - ↓ Blood flow, ↓ wound healing, ↑ risk for infection
- **Treatment for sensory neuropathy**
  - Managing blood glucose levels
  - Drug therapy
    - Tricyclic antidepressants
    - Selective serotonin and norepinephrine reuptake inhibitors
    - Antiseizure medications
- **Autonomic**
  - Gastroparesis
  - Postural hypotension, resting tachycardia, painless myocardial infarction
  - Sexual function
    - Erectile dysfunction
    - Decreased libido
    - Vaginal infections
  - Neurogenic bladder → urinary retention
    - Empty frequently, use Credé’s maneuver
    - Medications
    - Self-catheterization

**Foot Complications**

- **Patient teaching to prevent foot ulcers**
  - Proper footwear
  - Avoidance of foot injury
  - Skin and nail care
  - Daily inspection of feet
  - Prompt treatment of small problems
- **Diligent wound care for foot ulcers**

**Skin Problems**

- **Diabetic dermopathy**
  - Most common
  - Red-brown, round or oval patches
- **Acanthosis nigricans**
  - Manifestation of insulin resistance
  - Velvety light brown to black skin
- **Necrobiosis lipoidica diabetica**
  - Red-yellow lesions
Chronic Complications

Infection

- Infection:
  - Defect in mobilization of inflammatory cells and impaired phagocytosis
  - Recurring or persistent infections
  - Treat promptly and vigorously
  - Patient teaching for prevention
    - Hand hygiene
    - Flu and pneumonia vaccine

- Psychologic Considerations:
  - High rates of
    - Depression
    - Anxiety
    - Eating disorders
  - Open communication is critical for early identification