# ENDOCRINE SYSTEM

## MAJOR COMPONENTS

- **Glands-** secrete their products directly into the chemical substances secreted by the endocrine glands.
- **Hormones-** chemical substances secreted by the endocrine glands.
- **Target cells/ receptor**

## FUNCTIONS OF HORMONES

- Regulates and integrates body's metabolic activities.
- Functions together with the nervous system.

## ENDOCRINE GLANDS

### HYPOTHALAMUS

- Produce and secrete pro- hormones (hormones that stimulate or inhibit production/ release of pituitary hormones.)

**Hormones:**

- **Releasing and inhibiting hormones**
  - Corticotropin- releasing hormone (CRH)
  - Thyrotropin- releasing hormone (TRH)
  - Growth hormone- releasing hormone (GHRH)
  - Gonadotropin- releasing hormone (GnRH)
- **Action:** Controls the release of pituitary hormones.

### PITUITARY GLAND

❖ **Hypophysis**

- Commonly referred to as the master gland because of the influence it has on secretion of hormones by other endocrine glands.

❖ **Anterior Pituitary**

- **Somatostatin/ Growth hormone (GH)**
  - Inhibits growth hormone and thyroid- stimulating hormone.
  - Stimulates growth of bone and muscle, promotes protein synthesis and fat metabolism, decreases carbohydrate metabolism.
- **Adrenocorticotropic hormone (ACTH)**
  - Stimulates synthesis and secretion of adrenal cortical hormones.
- **Thyroid-stimulating hormone (TSH)**
  - Stimulates synthesis and secretion of thyroid hormones.
- **Follicle- stimulating hormone (FSH)/ Sertoli cell-stimulating hormone (males)**
  - Female: stimulates growth of ovarian follicle, ovulation.
  - Male: stimulates sperm production
- **Luteinizing hormone (LH) / Leydig cell-stimulating hormone (males)**
  - Female: stimulates development of corpus luteum, release of oocyte, production of estrogen and progesterone.
  - Male: stimulates secretion of testosterone, development of interstitial tissue of testes
- **Prolactin**
  - Prepares female breast for breast- feeding.
- **Melanocyte- stimulating hormone**

❖ **Posterior Pituitary**

- **Antidiuretic Hormone (ADH)/ Vasopressin**
  - Increases water reabsorption by kidney
- **Oxytocin**
  - Stimulates contraction of pregnant uterus, milk ejection from breasts after child birth

## ADRENAL CORTEX

- The outer portion of the adrenal gland; stimulated by ACTH to produce corticosteriods.
- **Hormones:**
  - **Mineralocorticoids (aldosterone)**
    - Increase sodium absorption, potassium loss by kidney.
  - **Glucocorticoids (cortisol)**
    - Affect metabolism of all nutrients; regulates blood glucose levels, affects growth, has anti- inflammatory action, and decreases effects of stress
  - **Adrenal androgens**
    - Have minimal intrinsic androgenic activity; they are converted to testosterone and dihydrotestosterone in the periphery

## ADRENAL MEDULLA

- The center of the adrenal gland that reacts to autonomic nervous system signals to release catecholamines.
- **Hormones:**
  - **Epinephrine/Adrenaline**
    - Serve as neurotransmitters for the sympathetic nervous system.
    - Prepares the body for the fight or flight response by converting glycogen, stored in the liver, to glucose and increasing cardiac output.
  - **Norepinephrine/Noradrenaline**
    - Serve as neurotransmitters for the sympathetic nervous system.
    - Produces effect similar to epinephrine and produces extensive vasoconstriction

## THYROID GLAND

- Butterfly- shaped organ located in the lower neck, anterior to the trachea.
  - **Thyroid hormones: triiodothyronine (T3), Thyroxine (T4)**
    - Increase the metabolic rate; increase protein and bone turnover.
    - Regulate cellular metabolic activity.
    - T3 is produced predominantly from peripheral conversion of T4.
    - T3- Metabolism
    - T4- Heat
  - **Calcitonin**
    - Lower blood calcium and phosphate levels.
    - Secreted in response to high blood calcium levels.
    - Inhibits bone resorption.

## PARATHYROID GLANDS

- Small glands, usually four, surround the posterior thyroid tissue; they are often difficult to locate and may be removed accidentally during thyroid or other neck surgeries.
- **Hormones:**
  - **Parathormone (PTH, parathyroid hormone)**
    - Regulates serum calcium.
    - Raise blood calcium levels by increasing calcium resorption from kidney, intestines and bones.

## PANCREATIC ISLET CELLS

- A slender, elongated organ lying horizontally in the posterior abdomen behind the stomach which function as an exocrine and an endocrine gland.
- **Hormones:**
  - **Glucagon** (alpha cells)
    - Increases blood glucose concentration by stimulation of glycogenolysis and gluconeogenesis.
    - **Glycogenolysis-** breakdown of stored glucose.
    - **Gluconeogenesis-** production of new glucose from amino acids and other substances.
  - **Insulin** (beta cells)
    - Lower blood glucose by facilitating glucose transport across cell membranes of muscle, liver, and adipose tissue
  - **Somatostatin** (delta cells)
    - Delays intestinal absorption of glucose.

## KIDNEY

❖ Paired organs located on either side of the vertebral column. They are between the 12th thoracic and 3rd lumbar vertebrae in the posterior abdomen behind the peritoneum.

- **1,25- Dihydroxy vitamin D**
  - Stimulates calcium absorption from the intestine.
- **Renin**
  - Activates renin- angiotensin-aldosterone system.
- **Erythropoietin**
  - Increases red blood cell production

## TESTES

- Male gonads
- Two almond-shaped organs suspended inside the scrotum; primary function is for reproduction.
- **Steroid Hormone:**
  - **Androgen (Testosterone)**
    - Affect development of male sex organs and secondary sex characteristics; aid in sperm production.

## OVARIES

❖ Female gonads
❖ Two almond-shaped organs located at the anterior pelvis; primary function is for reproduction.
❖ **Steroid Hormones:**
- **Estrogen**
  - ➢ Affect development of female sex organs and secondary sex characteristics
- **Progesterone**
  - Regulates the endometrium of the uterus
  - Maintains pregnancy

## DISORDERS OF ANTERIOR PITUITARY GLAND

## GIGANTISM

❖ **Description:**
- Oversecretion of GH results in gigantism in children; a person may be 7 or even 8 feet tall.
- Noticed at puberty.
- Epiphyseal plate still open.
- Enlargement of bones of head, hands & feet.

❖ **Causes:**
- **Tumor of somatotrophs** (signs of increased ICP)

❖ **Diagnostic Tests:**
- CT and MRI.
- Serum levels of pituitary hormones.

❖ **Clinical Manifestations:**
- More than 7 feet tall.
- Weak and lethargic.
- Severe headaches.
- Visual disturbance.
- Diplopia.
- Loss of color discrimination.
- Decalcification of the skeleton.

❖ **Management:**
- **Pharmacological Management**
  - Bromocriptine (Parlodel)
    - ✓ A dopamine antagonist
  - Octreotide (Sandostatin)
    - ➢ A synthetic analogue of GH
- **Surgical Management**
  - Hypophysectomy.

- **Stereotactic Radiation Therapy**
  - Requires use of a neurosurgery- type stereotactic frame, may be used to deliver external beam radiation therapy precisely to the pituitary tumor with minimal effect on normal tissue.

**Nursing Interventions**

- ✓ Record height and head circumference.
- ✓ Provide nursing care when receiving radiation therapy, perioperative care.
- ✓ Prepare the client for surgical removal of a pituitary tumor.
- ✓ Assist child in interacting normally with peers.

## ACROMEGALY

❖ **Description:** An excess of Growth hormone in adults, results in bone and soft tissue deformities and enlargement of the viscera without an increase in height.
- ✓ Closed epiphyseal plate.

❖ **Diagnostic Tests:**
- CT and MRI.
- Serum levels of pituitary hormones.

❖ **Clinical Manifestation:**
- Transverse enlargement of bones
- Broad skull
- Protruding jaw
- Prognathism
- Broadening of hands and feet
- Thickening heel pads
- Lips become heavier
- Enlarged tongue
- Soft tissue enlargement ( brain, heart, internal organs)
- Coarse features

❖ **Management:**
- **Pharmacological Management**
  - ✓ Bromocriptine (Parlodel) - a dopamine antagonist.
  - ✓ Ocreotide (Sandostatin) - a synthetic analogue of GH
- **Surgical Management**
  - ✓ Hypophysectomy
- **Stereotactic Radiation Therapy**
- **Nursing Management**
  - ✓ Prepare the client for pituitary irradiation and hypophysectomy if indicated.
  - ✓ Monitor post- surgical clients for signs of complications:
- Hemorrhage
- Transient diabetes insipidus
- Rhinorrhea, which may indicate cerebrospinal leak.
- Adrenal insufficiency
- Thyroid insufficiency
- Infection, particularly meningitis (marked by fever, nuchal rigidity, headache)
- Visual disturbances, decreased visual field
  - ✓ Monitor for hyperglycemia, cardiovascular and neurologic problems.

❖ **What is Hypophysectomy?**
- ✓ Partial / complete removal of pituitary gland.
- ✓ Approaches may include transfrontal, subcranial, oronasal transphenoidal.
- **Nursing care:**
  - ✓ Insulin therapy
  - ✓ Medication to treat peptic ulcer
  - ✓ Blood glucose monitoring
  - ✓ Assessment of stools for blood
  - ✓ Deep breathing is taught before the surgery
  - ✓ Head of bed is raised for at least 2 weeks to decrease pressure on the sella turcica and to promote drainage
  - ✓ Observe for post-nasal drip and check for glucose
  - ✓ Patient is cautioned against engaging in activities that increases ICP
  - ✓ Measure I & O, daily weight

- ✓ Warm saline mouth rinses

**DWARFISM**

❖ **Description:** Generalized limited growth resulting from insufficient secretion of growth hormone during childhood.

❖ **Diagnostics Tests:**
- X-ray
- Computed tomography and MRI
- Blood sample

❖ **Clinical Manifestation:**
- Overweight for height
- Underdeveloped jaw
- Abnormal teeth position
- High voice
- Delayed puberty

❖ **Management:**
- **Pharmacological Management**
  - ✓ Somatrem (Protropin)
  - ✓ Somatropin (Humatrope)
- **Nursing Interventions**
  - ✓ Provide psychologic support and acceptance for alteration of body image.
  - ✓ Assist in ambulation; avoid high impact activities.

**HYPERPROLACTINEMIA**

❖ **Female:**
- Prolactin-secreting tumors
- Amenorrhea
- Galactorrhea

❖ **Male:**
- Gynecomastia
- Decreased sex drive
- Impotence

**DISORDERS OF POSTERIOR PITUITARY GLAND**

**SYNDROME OF INAPPROPRIATE ANTI-DIURETIC HORMONE (SIADH)**

❖ **Description:** Excessive ADH secretion from the pituitary gland even in the face of subnormal serum osmolality. Patients cannot excrete dilute urine, retain fluids, and develop a sodium deficiency known as dilutional hyponatremia.

❖ **Causes:**
- Bronchogenic carcinoma
- Severe pneumonia
- Pneumothorax
- Malignant tumors
- Head injury
- Brain surgery or tumor
- Infection
- Some medications

❖ **Diagnostic Tests:**
- Decreased serum osmolality (<280mOsm/kg)
- Elevated ADH level (NV: 0-4.7pG/mL)
- Plasma osmolality and serum sodium levels are decreased
- Urinalysis detects elevated urine sodium and osmolality
- Serum ADH level is elevated.

❖ **Clinical Manifestations:**
- Decreased urine output
- Weight gain
- Altered mental status headache, confusion, lethargy, seizures, and coma in severe hyponatremia
- Delayed deep tendon reflex

❖ **Management:** (Eliminating the underlying cause)
- **Pharmacological management:**
  - ✓ Diuretics- Furosemide (Lasix)
  - ✓ Demeclocycline- drugs that render the kidneys less sensitive to ADH
- **Nursing Management:**
  - ✓ Monitor fluid intake and output, daily weight, urine and blood chemistries and neurologic status
  - ✓ Provide supportive measures and explanations of procedures and treatments to assist patient to deal with this disorder
  - ✓ Restrict fluid intake as indicated
  - ✓ Regularly assess mental status

**DIABETES INSIPIDUS (DI)**

❖ Disorder of the posterior lobe of the pituitary gland that is characterized by a deficiency of ADH (vasopressin )

❖ **Causes:**
- Head trauma
- Brain tumor
- Surgical ablation/ irradiation of the pituitary gland
- Infections of the central nervous system (meningitis, encephalitis, tuberculosis)
- Tumor (eg. Metastatic disease, lymphoma of the breast or lungs)
- Failure of the renal tubules to respond to ADH, nephrogenic (hypokalemia, hypercalcemia, lithium, demeclocycline [Declomycin]).

❖ **Clinical Manifestations:**
- Excessive thirst (2 to 20L of fluid intake daily)
- Dilute urine with a specific gravity of 1.001 to 1.005
- Dehydration
- Nocturia
- Weight loss
- Tachycardia
- Hypotension
- Weakness

❖ **Diagnostic Tests:**
- Plasma osmolality and serum sodium levels are elevated.
- **Water (fluid) deprivation test-** demonstrate inability of the kidneys to concentrate urine despite increased plasma osmolality and low plasma vasopressin level.
- **Vasopressin test-** demonstrates that the kidneys can concentrate urine after administration of ADH, this differentiates central from nephrogenic diabetes insipidus.

❖ **Management:**
- **Pharmacological Management**
  - ✓ **Desmopressin (DDAVP)-** intranasal synthetic vasopressin, could also be administered intramuscularly
  - ✓ **Thiazide diuretics, mild salt depletion and prostaglandin inhibitor** for nephrogenic DI
- **Nursing Management:**
  - ✓ Replace fluids as indicated
  - ✓ Encourage the client to drink fluids in response to thirst
  - ✓ Teach the patient about follow- up care and emergency measures
  - ✓ Demonstrate correct medication administration
  - ✓ Advise wearing a medical identification bracelet.

## DISORDERS OF THE THYROID GLAND

### GOITER

- **Description:** Thyroid tumors or enlargement sufficient to visible swelling in the neck.

- **Classifications:**
  - **Toxic Goiter-** accompanied by hyperthyroidism.
  - **Non- Toxic Goiter-** associated with a euthyroid state.
- **Types of Goiter**
  - **Endemic (Iodine-Deficient) Goiter**
    - ✓ Most common type
    - ✓ Caused by iodine deficiency
    - ✓ Simple/ colloid goiter
    - ✓ Usually no symptoms only swelling; tracheal compression when excessive.

    **Treatment:**
      - ➢ Supplementary iodine
      - ➢ Iodized salt
      - ➢ SSKI
  - **Nodular Goiter**
    - ✓ Areas of hyperplasia (overgrowth)
    - ✓ Slowly increase in size
    - ✓ Can cause local pressure symptoms in the thorax
    - ✓ Some are malignant or with hyperthyroid state
  - **Thyroid Cancer**
    - ✓ External radiation of the neck, or chest in infancy and childhood increases the risk of thyroid carcinoma.

### HYPERTHYROIDISM

- **Other terms:** Grave's disease/ Basedow's/ Parry's disease.
- **Description:** Results from an excessive output of thyroid hormones caused by abnormal stimulation of the thyroid gland by circulating immunoglobulins.
- Diffuse toxic non-nodular goiter
- Autoimmune disease
- **Clinical Manifestations:**
  - **Thyrotoxicosis**
    - ✓ Nervousness
    - ✓ Irritable and apprehensive
    - ✓ Palpitations
    - ✓ Tachycardia
    - ✓ Heat intolerance
    - ✓ Diaphoresis
    - ✓ Flush skin, warm, soft and moist
    - ✓ Tremors
  - **Exophthalmos**
    - ✓ Bulging eyes, which produces a startled facial expression
    - ✓ von Graefe's sign: eyelid lag when looking downwards
    - ✓ Dalyrimple's sign: upper eyelid retraction
  - **Goiter**
    - ✓ Swelling of the thyroid gland
    - ✓ Increased appetite
    - ✓ Progressive weight loss
    - ✓ Amenorrhea
    - ✓ Osteoporosis
    - ✓ Myocardial hypertrophy
- **Diagnostic tests:**
  - Thrill at the anterior neck
  - Bruit at the anterior neck

- Decrease Thyroid stimulating hormone.
- Increase in free T4
- Increase in radioactive iodine uptake

❖ **Management:**

**Pharmacological Management:**

1. **Radioactive Iodine Therapy**
   - ✓ Action: Destroy the overactive thyroid cells
   - ✓ Health teaching:
     - ➢ Observe for thyroid storm.
     - ➢ Propranolol may be given to control symptoms.
     - ➢ Contraindicated during pregnancy because it crosses the placenta and while breastfeeding.
2. **Antithyroid Medications**
   - ✓ Action: Block the utilization of iodine by interfering with the iodination of tyrosine and the coupling of iodotyrosines in the synthesis of thyroid hormone.
   - ✓ Propylthiouracil (PTU)
   - ✓ Methimazole (Tapazole)
   - ✓ Health teaching:
     - ➢ With any sign of infection, especially pharyngitis and fever or the occurrence of mouth ulcers, the patient is advised to stop the medication, notify the physician immediately, and undergo hematologic studies.
     - ➢ Agranulocytosis is the most toxic side effects.
     - ➢ Methimazole is the treatment of choice during pregnancy.
3. **Adjunctive Therapy**
   - ✓ Action: Iodine or iodide compounds decrease the release of thyroid hormones from the thyroid gland and reduce the vascularity and size of the thyroid.
   - ✓ Potassium iodide (KI),
   - ✓ Lugol's solution
   - ✓ Saturated solution of potassium iodide (SSKI)
   - ✓ Health Teaching:
     - ➢ Iodine compounds are more palatable in milk or fruit juice.
     - ➢ Administer through a straw to prevent staining of the teeth
     - ➢ Beta- adrenergic blocking agents are important in controlling the sympathetic nervous system effects of hyperthyroidism.

- **Surgical Management:**
  - ✓ Subtotal Thyroidectomy
    - ➢ The surgical removal of about five sixths of the thyroid.
    - ➢ Health teaching: Before surgery, PTU is administered until signs of hyperthyroidism have disappeared
    - ➢ A beta- adrenergic blocking agent (eg. Propranolol) may be used to reduce the heart rate and other signs and symptoms of hyperthyroidism
    - ➢ Iodine (Lugol's solution or KI) may be prescribed in an effort to reduce blood loss
    - ➢ Medications that may prolong clotting (eg. Aspirin) are stopped several week
    - ➢ Patients receiving iodine medication must be monitored for evidence of iodine toxicity (iodism), which requires immediate withdrawal of medication
  - ✓ Symptoms of Iodism
    - ➢ Swelling of the buccal mucosa
    - ➢ Excessive Salivation
    - ➢ Coryza
    - ➢ Skin eruptions

- **Nursing Management:**
  - ✓ Improving nutritional status
    - ➢ Discourage highly seasoned foods and stimulants to reduce diarrhea
    - ➢ High calorie, high protein foods are encouraged
    - ➢ Weight and dietary intake are recorded
  - ✓ Enhancing coping measures
    - ➢ Use calm, unhurried approach
    - ➢ The environment is kept quiet and uncluttered

- ✓ Improving Self- Esteem
  - ➢ Eye care and protection drops or ointment
  - ➢ The patients should also be discouraged from smoking.
- ✓ Maintaining Normal Body Temperature
  - ➢ Maintain the environment at a cool, comfortable temperature
  - ➢ Cool baths and cool or cold fluids are encouraged

## HYPOTHYROIDISM

- ❖ Description: State of insufficient serum thyroid hormone.
- ❖ Cause: Autoimmune thyroiditis
- ❖ **Myxedema**
  - Refers to the accumulation of mucopolysaccharides in subcutaneous and other interstitial tissues
  - Mucinous (mucus-filled) edema
  - Extreme symptoms of severe hypothyroidism

- ❖ **Clinical Manifestations:**
  - Hair loss
  - Brittle nails
  - Dry skin
  - Numbness and tingling of the fingers
  - Hoarseness of voice
  - Amenorrhea, anovulation
  - Loss of libido
  - Subnormal body temperature
  - Bradycardia
  - Weight gain
  - Thickened skin
  - Masklike and expressionless face
  - Cold intolerance
  - Slow Speech
  - Enlarged tongue
  - Deafness
  - Personality and cognitive changes
  - Myxedema Coma
    - ✓ Sign of depression, diminished cognitive status, lethargy and somnolence, depressed respiratory drive, narcosis and coma
- ❖ **Management:**
  - **Pharmacological Management**
    - ✓ Synthetic levothyroxine (Synthroid or Levothroid)
  - **Prevention of Cardiac Dysfunction**
    - ✓ Patients may have elevated serum cholesterol, atherosclerosis, and coronary artery disease
    - ✓ Angina or dysrhythmias can occur. The nurse must monitor for myocardial ischemia or infarction.
  - **Prevention of Medication** Interactions
    - ✓ Thyroid hormones may increase blood glucose levels
    - ✓ Bone loss and osteoporosis may also occur with thyroid therapy.
  - **Supportive Therapy**
    - ✓ Arterial blood gases
    - ✓ In all patients with hypothyroidism, the effects of analgesic agents, sedatives, and anesthetic agents are prolonged
  - **Nursing Management:**
    - ✓ **Fatigue**
      - ➢ Space activities to promote rest and exercise as tolerated
      - ➢ Assist with self-care activities when patient is fatigued
      - ➢ Provide stimulation through conversation and non- stressful activities
    - ✓ **Cold intolerance**
      - ➢ Provide extra layer of clothing or extra blanket
      - ➢ Protect from exposure to cold and drafts.

- ✓ **Constipation**
  - ➢ Encourage increased fluid intake within limits of fluid restriction.
  - ➢ Provide foods high in fiber.
  - ➢ Encourage increased mobility within patient's exercise
  - ➢ Encourage patient to use laxatives and enemas sparingly.

## DISORDERS OF PARATHYROID GLANDS

### HYPERPARATHYROIDISM

- ❖ **Description:** Overproduction of parathormone by the parathyroid glands, is characterized by bone decalcification and the development of renal calculi (kidney stones) containing calcium.
- ❖ **Clinical Manifestations:**
  - Apathy
  - Fatigue
  - Muscle Weakness
  - Nausea
  - Vomiting
  - Constipation
  - Hypertension
  - Cardiac Dysrhythmias
  - Hypercalcemia
  - Renal stones
  - Skeletal Pain and Tenderness
  - Pathologic fractures
  - Shortening of body stature
- ❖ **Diagnostic tests:**
  - Elevated serum calcium
  - Elevated concentration of Parathormone
  - X-ray bone changes
  - Double- antibody parathyroid hormone test
  - Ultrasound
  - MRI
  - Thallium Scan
  - Fine- needle biopsy
- ❖ **Complications:**
  - **Hypercalcemic crisis**
    - ✓ Result in neurologic cardiovascular and renal symptoms that can be life threatening.
- ❖ Management:
  - Pharmacological Management:
    - ✓ Antacids for peptic ulcer
    - ✓ Stool softener for constipation after surgery
    - ✓ Phosphate therapy
    - ✓ Cytotoxic agents
    - ✓ Calcitonin
    - ✓ Bisphosphonates
  - **Surgical Management:**
    - ✓ Parathyroidectomy
- ❖ **Criteria:**
  1. Younger than 50 years of age.
  2. Unable or unlikely to participate in follow-up care.
  3. Serum calcium level more than 1.0. Mg/dl (0.25 mmol/L) above normal reference range.
  4. Urinary calcium level greater than 400 Mg/ day.
  5. 30% or greater decrease in renal function.
  6. Complaints of primary hyperparathyroidism

❖ **Nursing Management:**
- **Hydration Therapy**
  - ✓ Daily fluid intake of 2000 mL or more
  - ✓ Cranberry juice
  - ✓ Thiazide diuretics are avoided
- **Mobility**
  - ✓ Walking
  - ✓ Rocking chair
- **Diet**
  - ✓ Avoid a diet with restricted or excess calcium
- **Pre- operative care:**
  - ✓ Prepare the client
  - ✓ Force fluids to prevent dehydration
  - ✓ Reduce added calcium
  - ✓ Strain the urine for calculi
  - ✓ Post-operative care:
  - ✓ Assess for renal calculi, report hematuria or flank pain
  - ✓ Protect the client
  - ✓ Assist with ADL
  - ✓ Encourage weight bearing
  - ✓ Provide relief of constipation
  - ✓ Monitor nutritional status

## HYPOPARATHYROIDISM

❖ **Description:** Inadequate secretion of parathormone after interruption of the blood supply or surgical removal of parathyroid gland tissue during thyroidectomy, or radical neck dissection.

❖ Deficiency of parathormone results in:
- Increased blood phosphate (hyperphosphatemia)
- Decreased blood calcium (hypocalcemia) levels.

❖ **Clinical Manifestations:**
- Tetany
- Numbness, tingling and cramps in the extremities
- Stiffness in the hands and feet.
- Bronchospasm
- Laryngospasm
- Carpopedal spasm/Positive Trousseau's sign
- Positive Chvostek's sign
- Dysphagia
- Photophobia
- Cardiac dysrhythmia
- Seizures
- Anxiety
- Irritability

❖ **Diagnostic Tests:**
- Serum calcium 5 to 6 Mg/ dL or lower
- Serum phosphate levels are increased
- X-ray calcification

❖ **Management:**
- Pharmacological Management
- IV Calcium gluconate- after thyroidectomy if tetany occurs.
- Parenteral Parathormone- monitor for allergic reaction.
- Oral tablets of calcium salt
- Aluminum hydroxide gel
- Aluminum carbonate- after meals to bind with phosphate and promote its excretion through the GI tract.

- Vitamin D- enhanced absorption of Calcium.
- Care of postoperative patients who have undergo thyroidectomy, parathyroidectomy or radical neck dissection.
- Calcium gluconate at bedside.
- Be alert for possible laryngeal spasm, keep a tracheostomy set available.
- Institute seizure precaution.
- Minimize environmental stimuli. Environment free of noise, drafts, bright lights, or sudden movement
- Encourage a diet high in calcium and low in phosphorus. Milk, milk products and egg yolks must be avoided because they are high in phosphorus.

## DISORDERS OF ADRENAL GLANDS

### PHEOCHROMOCYTOMA

❖ **Description:** Tumor that is usually benign and originates from the chromaffin cells of the adrenal medulla.
❖ It is one form of hypertension that is usually cured by surgery; however, without detection and treatment, it is usually fatal.

❖ **Clinical Manifestations:**
- Vertigo
- Blurring of Vision
- Diaphoresis
- Air hunger
- Palpitations
- Tachycardia
- Tremors
- Flushing
- Anxiety
- Nausea and Vomiting

- **Five H's**
  - ✓ Hypertension
  - ✓ Hyperhidrosis
  - ✓ Hypermetabolism
  - ✓ Hyperglycemia
  - ✓ Headache

- **Vanillylmandelic acid (VMA) test**
  - ✓ A 24- hour specimen of urine is collected.
  - ✓ A number of medications and foods, such as coffee and tea (including decaffeinated varieties), bananas, chocolate, vanilla, and aspirin, may alter the results of this test.

- **Total plasma catecholamine (epinephrine and norepinephrine)**
  - ✓ Measured at supine and at rest for 30 minutes.
  - ✓ Values of epinephrine greater than 400 pg/ mL (2180 pmol/ L ) or norepinephrine values greater than 2000 pg/ Ml (11,800 pmol/ L ) are considered diagnostic of pheochromocytoma.

- **Clonidine suppression test**
  - ✓ May be performed if the results of plasma and urine tests of catecholamines are inconclusive.

- **CT, MRI, and Ultrasonography**

❖ **Management:**
- **Pharmacological Management: Antihypertensive:**
  - ✓ Alpha- adrenergic blocking agents (eg, phentolamine [Regitine])
  - ✓ Smooth muscle relaxants (eg, sodium nitroprusside [Nipride])
  - ✓ Phenoxybenzamine (Dibenzyline), a long-acting alpha adrenergic blocker,

- ✓ Calcium channel blockers such as nifedipine (Procardia)
- ✓ Beta- adrenergic blocking agents such as propranolol (Inderal)

- **Surgical Management: Adrenalectomy**
  - ✓ The patient needs to be well hydrated before, during, and after surgery to prevent hypotension.
  - ✓ Corticosteroid replacement is required if bilateral adrenalectomy has been necessary.
  - ✓ Hypotension and hypoglycemia may occur in the postoperative period because of the sudden withdrawal of excessive amounts of catecholamines.

- **Nursing Management:**
  - ✓ Advise bed rest, with head of bed elevated to promote orthostatic decrease in blood pressure.
  - ✓ Monitor ECG changes, arterial pressures, fluids and electrolyte balance and blood glucose levels.
  - ✓ Encourage patient to schedule follow-up appointments to observe for return of normal blood pressure
  - ✓ Give instructions regarding long term steroid therapy, including the risk of skipping doses or stopping medication abruptly.

**ADDISON'S DISEASE**

❖ **Descriptive:** Adrenocortical insufficiency, occurs when adrenal cortex function is inadequate to meet the patient's need for cortical hormones.

❖ Autoimmune or idiopathic atrophy of the adrenal glands is responsible for the vast majority of cases.

❖ **Clinical Manifestations:**
- Muscle weakness
- Anorexia
- Fatigue
- Emaciation
- Dark pigmentation
- Hypotension
- Low blood glucose
- Low serum sodium
- High serum potassium
- **Addisonian Crisis-** characterized by cyanosis and the classic signs of circulatory shock (pallor, apprehension, rapid, and weak pulse, rapid respirations and low blood pressure)

❖ **Diagnostic Tests:**
- Early morning serum cortisol less than 165nmol/ L and plasma ACTH more than 22.0 pmol/ L
- Decreased levels of blood glucose **(Hypoglycemia)**
- Decreased level of serum sodium **(Hyponatremia)**
- Increase in serum potassium **(Hyperkalemia)**
- Increased white blood cell count **(Leukocytosis)**

❖ **Management:**
- **Pharmacological Management:**
  - ✓ **Hydrocortisone (Solu- Cortef)** is administered by IV, followed by 5% dextrose in normal saline- immediate treatment for crisis.
  - ✓ **Vasopressor** amines may be required if hypotension persists.
  - ✓ **Antibiotics** may be administered if infection has precipitated adrenal crisis
  - ✓ During stressful procedures or significant illnesses, additional supplementary therapy with **glucocorticoids** is required to prevent Addisonian crisis.

- **Nursing Management:**
  - ✓ Select foods high in sodium during GI disturbances and in very hot weather.
  - ✓ Administer hormone replacement as prescribed.
  - ✓ Modify the dosage during illness and other stressful situations.

- ✓ Monitor for signs and symptoms indicative of Addisonian crisis, which can include shock; hypotension; rapid, weak
- ✓ Avoid unnecessary activity and stress that could precipitate another hypotensive episode.
- ✓ Instruct the patient to inform other health care providers, such as dentists, about the use of corticosteroids.
- ✓ Wear a medical alert bracelet; and to carry information at all times about the need for corticosteroid

**CUSHINGS DISEASE**

❖ **Description:** Excessive, rather than deficient, adrenocortical activity caused by use of corticosteroid medications.

❖ Is infrequently the result of excessive corticosteroid production secondary to hyperplasia of the adrenal cortex, tumor of the pituitary gland.

❖ **Clinical Manifestations:**
- Buffalo Hump
- Central obesity, thin extremities
- Skin is thin, fragile, and easily traumatized
- Ecchymosis
- Weakness
- Hypertension
- Moon faced appearance
- Acne
- Weight gain
- Slow healing
- Virilization
- Hirsutism
- Breast atrophy
- Loss of libido

❖ **Diagnostic Tests and Findings:**
- **Dexamethasone suppression test**
  - ✓ Increase in serum sodium
  - ✓ Increase blood glucose levels
  - ✓ Decrease in serum potassium,
  - ✓ Reduction in the number of blood eosinophils,
  - ✓ Disappearance of lymphoid tissue
  - ✓ Plasma and urinary cortisol levels increased

❖ **Management:**
- **Pharmacological Management:**
  - ✓ **Adrenal enzyme inhibitors**
    - ➢ Metyrapone [Metopirone]
    - ➢ Aminoglutethimide [Cytadren]
    - ➢ Mitotane [Lysodren]
    - ➢ Ketoconazole [Nizoral])
  - ✓ **Hydrocortisone** may be given after adrenalectomy
- **Surgical Management:**
  - ✓ **Transsphenoidal hypophysectomy**
  - ✓ **Bilateral Adrenalectomy**
    - ➢ Lifetime replacement of adrenal cortex hormones is necessary.

- **Radiation of the pituitary gland**

**Nursing Management:**
- ✓ Establishing a protective environment
- ✓ Recommend foods high in protein, calcium and vitamin D to minimize muscle wasting

- ✓ Space rest periods throughout the day
- ✓ Meticulous skin care
- ✓ Low carbohydrate, low sodium diet

## DISORDER OF THE PANCREATIC ISLETS

### DIABETES MELLITUS

❖ Group of metabolic diseases characterized by increased levels of glucose in the blood (**hyperglycemia**) resulting from defects in insulin secretion, insulin action, or both.

❖ **Risk Factors:**

- Family history of diabetes
- Obesity
- Race (African Americans, Hispanic Americans, Native Americans, Asian Americans, Pacific Islanders)
- Age > 45 yrs. Old
- Hypertension
- HDL cholesterol level <35 mg/dl and triglyceride level >250 mg/dl

❖ **Classification of DM:**

- Type 1 diabetes
- Type 2 diabetes
- Gestational diabetes
- Diabetes mellitus associated with other conditions or syndromes

❖ **Diagnostic tests and findings:**

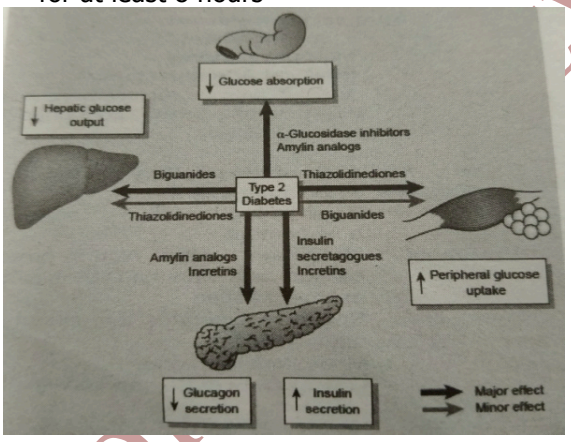
- Fasting plasma glucose
- Random plasma glucose
- Oral Glucose Tolerance Test (OGTT)

❖ **Criteria of the diagnosis of Diabetes Mellitus:**

1. Symptoms of diabetes plus casual plasma glucose concentration equal to or greater than 200 mg/dl (11.1mmol/L). Casual is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss.

**Or**

2. Fasting plasma glucose greater than or equal to 126 mg/dl (7.0 mmol /L). Fasting is defined as no caloric intake for at least 8 hours




**or**

3. Two-hour postprandial glucose equal to or greater than 200 mg/dL (11.1 mmol/L) during an 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 win water.

### TYPE 1 DIABETES MELLITUS

❖ **Description:**

- Characterized by destruction of the pancreatic beta cells.
- Abnormal response in which antibodies are directed against normal tissues of the body, responding to these tissues as if they were foreign.

- Destruction of the beta cells results in decreased insulin production, unchecked glucose production by the liver, and fasting hyperglycemia.
- Glucose derived from food cannot be stored in the liver but instead remains in the bloodstream and contributes to postprandial (after meals) hyperglycemia
- If the concentration of glucose in the blood exceeds the renal threshold for glucose, usually 180 to 200 mg/dl (9.9 to 11.1 mmol/L), the kidneys may not reabsorb all of the filtered glucose; the glucose then appears in the urine (glycosuria).
- When excess glucose is excreted in the urine, it is accompanied by excessive loss of fluids and electrolytes. This is called osmotic diuresis.
- Fat breakdown occurs, resulting in an increase production of ketone bodies, which are the byproducts of fat breakdown.
- Ketone bodies are acids that disturb the acid-base balance of the body when they accumulate in excessive amounts. The result is diabetic ketoacidosis (DKA).

## TYPE 2 DIABETES MELLITUS

❖ **Description:**
- The two main problems:
  - ✓ Increased Insulin resistance
  - ✓ Decreased Insulin sensitivity
  - ✓ Impaired insulin secretion**.**
- Idiopathic
- This is called metabolic syndrome, which includes **hypertension, hypercholesterolemia, and abdominal obesity.**
- Despite the impaired insulin secretion that is characteristic of type 2 diabetes, there is enough insulin present to prevent the breakdown of fat and the accompany production of ketone.

❖ **Management:**

❖ **Nutritional Therapy**
- To promote a 1-to-2-pound weight loss per week,
- 500 to 1000 calories are subtracted from the daily total.
- The caloric distribution currently recommended is higher in carbohydrates than in fat and protein.
- Foods high in carbohydrates, such as sucrose are not totally eliminated from the diet but should be eaten in moderation because they are typically high in fat and lack vitamins, minerals, and fiber.
- Additional recommendations include limiting total intake of dietary cholesterol to less than 300 mg/day.
- Increase fiber in the diet may improve blood glucose levels, decrease the need the exogenous insulin, and lower total cholesterol and low-density lipoprotein levels in the blood
- Alcohol is absorbed before other nutrients and does not require insulin for absorption. Large amounts can be converted to fats, increasing the risk for DKA
- It is important that patients read the labels of "health foods" especially snacks because they often contain carbohydrates and saturated fats, which may be contraindicated in people with elevated blood lipid levels

❖ **Exercise**
- Exercise lower blood glucose levels by increasing the uptake of glucose by body muscles and by improving insulin utilization
- Exercise at the same time (preferable when blood glucose levels are at their peak) and in the same amount each day.
- Regular daily exercise
- Walking is a safe and beneficial.
- Eat 15-g carbohydrate snack before engaging in moderate exercise to prevent unexpected hypoglycemia.
- Use proper footwear. Avoid exercise in extreme heat or cold. Inspect feet daily after exercise. Avoid exercise during periods of poor metabolic control

❖ **Self- Monitoring of Blood Glucose**
- This allows for detection and prevention of hypoglycemia and hyperglycemia and plays a crucial role in normalizing blood glucose levels,

❖ **Glycated hemoglobin** (also referred to as glycosylated hemoglobin, HgbA1C, or A1C)
- is a blood test that reflects average blood glucose levels over a period of approximately 2 to 3 months.

❖ **Testing for Ketone**
- ✓ Ketone in the urine signal that there is adeficiency of deficiency of insulin and control of type 1 diabetes is deteriorating. The risk of DKA is high.

❖ **Pharmacologic Therapy**

✓ **Insulin Therapy**

✓ In type 1 diabetes, exogenous insulin must be administered **for life** because the body loses the ability to produce insulin.

| TIME COURSE | AGENT | ONSET | PEAK | DURATION | INDICATION |
|---|---|---|---|---|---|
| **Rapid-acting** | Lispro (Humalog) | 10-15 min | 1h | 2-4 h | Used for rapid reduction of glucose |
| | Aspart (Novolog) | 5-15 min | 40-50 min | 2-4 h | Level, to treat postprandial |
| | Glulisine (Apidra) | 5-15 min | 30-60 min | 2 h | Hyperglycemia, and/or to prevent noctumal hypoglycemia |
| **Short-acting** | Regular (Humalog R, Novolin R, Iletin II Regular | ½-1 h | 2-3 h | 4-6 h | Usually administered 20-30 min before a meal; may be taken alone or in combination with longer-acting insulin<br>Can be incorporated to an IV infusion |
| **Intermediate - acting** | NPH (neutral protamine Hagedorn) | 2-4 h | 4-12 h | 16-20 h | Usually taken after food |
| | (Humulin N, Iletin II Lente, Iletin II NPH) | 3-4 h | 4-12 h | 16-20 h | |
| | Novolin L [Lente], Novolin N [NPH] | | | | |
| **Long-acting** | Glargine (Lantus)<br>Determir (Levemir) | 1 h | Continuous (no peak) | 24 h | Used for basal dose |

✓ **Human insulin** preparations have a shorter duration of action than insulin from animal sources because the presence of animal protein triggers an immune response that results an in the binding of animal insulin**.**

✓ **Short-acting insulins** are called regular insulin (marked R on the bottle). Regular insulin is a clear solution and is usually administered 20 to 30 minutes before a meal. Regular insulin is the only insulin approved for IV use.

✓ **Intermediate-acting insulins** are called NPH insulin (neutral protamine Hagedorn) or lente insulin. Intermediate-acting insulins.

✓ **"Peakless" basal or very long-acting insulins** that's is, the insulin is absorbed very slowly over 24 hours and can be given once a day.

- **Complications of Insulin Therapy**

✓ **Local Allergic Reactions.**

➢ Redness, swelling, tenderness, and induration or 2- to 4-cm wheal) may appear at the injection site 1 to 2 hours after the insulin administration.

✓ **Systematic Allergic Reactions.**

➢ When they do occur, there is an immediate local skin reaction that gradually spreads into generalized urticaria (hives).

➢ These rare reactions are occasionally associated with generalized edema or anaphylaxis.

✓ **Insulin Lipodystrophy**

➢ **Lipodystrophy** refers to a localized reaction, in the form of either lipoatrophy of lipohypertrophy, occurring at the site of insulin injections.

➢ **Lipoatrophy** is loss of subcutaneous fat; it appears as slight dimpling or more serious pitting of subcutaneous fat

✓ **Resistance to Injected Insulin**

➢ Most patients have some degree of insulin resistance at one time or another. The most common being obesity, which can be overcome by weight loss

✓ **Morning hyperglycemia**

➢ An elevated blood glucose level on arising in the morning is caused by an insufficient level of insulin, which may be caused by several factors: the dawn phenomenon, the Somogyi effect, or insulin waning

- **Oral antidiabetic agents**
  - ✓ **Sulfonylureas**
    - ➢ Stimulate beta cell of the pancreas to secrete insulin; may improve binding between insulin and insulin receptors of increase the number of insulin receptors or increase the number of insulin receptors
  - ✓ **Biguanide**
    - ➢ Inhibits production of glucose by the liver
    - ➢ Increase body tissues sensitivity to insulin
    - ➢ Decrease hepatic synthesis of cholesterol
    - ➢ The only biguanide in the market: Metformin
  - ✓ **Alpha-glucosidase inhibitors**
    - ➢ Delay absorption of complex carbohydrates in the intestine and slow entry of glucose into systemic circulation.
  - ✓ **Non-sulfonylureas Secretagogues (Meglitinides and phenylalanine derivatives)**
    - ➢ Stimulate pancreas to secrete insulin
  - ✓ **Thiazolidinediones (Glitazone)**
    - ➢ Sensitized body tissue to insulin; stimulate receptor sites to lower blood glucose and improve action of insulin
  - ✓ **Dipeptide-pepidase-4 (DDP-4) Inhibitors**
    - ➢ Increase and prolongs the action of incretin, a hormone that increases insulin release and decreases glucagon levels, with the result of improved glucose control

**CAUSE OF MORNING HYPERGLYCEMIA**

| Characteristic | Treatment |
|---|---|
| **Insulin Waning**<br>Progressive rise in blood glucose from bedtime to morning | Increase evening (predinner or bedtime) dose of intermediate acting or long-acting insulin, or institute a dose of insulin before the evening meal if one is not already part of the treatment regimen. |
| **Dawn Phenomenon**<br>Relatively normal blood glucose until about 3 am, when the level begins to rise | Change time of injection of evening intermediate-acting insulin from dinnertime to bedtime. |
| **Somogyi Effect**<br>Normal or elevated blood glucose at bedtime, a decrease at 2-3 am to hypoglycemic levels, and a subsequent increase caused by the production of counterregulatory hormones | Decrease evening (predinner or bedtime) dose of intermediate acting insulin, or increase bedtime snack. |

- ✓ **Storing Insulin**
  - ➢ Vials not in use, including spare vials. should be refrigerated.
  - ➢ Insulin should not be allowed to freeze and should not be kept in direct sunlight
  - ➢ The insulin vial in use should be kept at room temperature to reduce local irritation at the injection site
  - ➢ The patient should be instructed to always have a spare vial of the type or types of insulin he or she uses.
  - ➢ Cloudy insulins should be thoroughly mixed by gently inverting the vial or rolling it between the hands before drawing the solution into a syringe or a pen
  - ➢ Bottles of intermediate-acting insulin should also be inspected for flocculation, which is a frosted, whitish coating
- ✓ **Mixing Insulins.**
  - ➢ Longer-acting insulin must be mixed thoroughly before drawing into the syringe.
  - ➢ Regular insulin should be drawn up first.
- ✓ **Withdrawing Insulin**
  - ➢ Inject air into the bottle of insulin equivalent to the number of units of insulin to be withdrawn
- ✓ **Selecting and Rotating the Injection Site.**
  - ➢ The four main areas for injection are the abdomen, upper arms (posterior surface) thighs (anterior surface), and hips.

- The speed of absorption is greatest in the abdomen and decreases progressively in the arm, thigh, and hip, respectively.
- Systematic rotation of injection sites within an anatomic area is recommended to prevent localized changes in fatty tissue (lipodystrophy).
- Administer each injection 0.5 to 1 inch away from the previous injection. Another approach to rotation
- Patient should try not to use the same site more than once in 2 to 3 weeks.
- Insulin should not be injected into the limb that will be exercised because this will cause the drug to be absorbed faster, which may result in hypoglycemia.

✓ **Preparing the Skin**.
- They should be cautioned to allow the skin to dry after cleansing with alcohol.
- The alcohol may be carried into the tissues, resulting in a localized reddened area and a burning sensation.

✓ **Inserting the Needle.**
- For a normal or overweight person, a 90- degree angle is the best insertion angle.
- Aspiration is generally not recommended with self-injection of insulin.

✓ **Disposing of Syringes and Needles.**
- Used sharps should be placed in a puncture-resistant container.

## COMPLICATIONS OF DIABETES MELLITUS

### HYPOGLYCEMIA

❖ Occurs when the blood glucose falls to less than 50 to 60 mg/dL (2.7 to 3.3 mmol/L), because of too much insulin or oral hypoglycemic agents, too little food, or excessive physical activity.

❖ **Clinical Manifestation:**

- **Mild hypoglycemia**
  - ✓ Sweating
  - ✓ Tremor
  - ✓ Tachycardia
  - ✓ Palpitation
  - ✓ Nervousness
  - ✓ Hunger.

- **Moderate hypoglycemia**
  - ✓ Inability to concentrate
  - ✓ Headache
  - ✓ Lightheadedness
  - ✓ Confusion
  - ✓ Memory lapses
  - ✓ Numbness of the lips and tongue
  - ✓ Slurred speech
  - ✓ Impaired coordination
  - ✓ Emotional changes
  - ✓ Irrational or combative behavior
  - ✓ Double vision
  - ✓ Drowsiness.

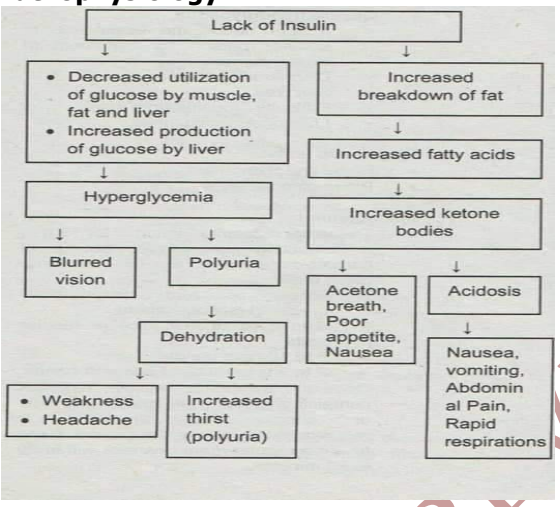
- **Severe hypoglycemia**
  - ✓ Patient needs the assistance of another person for treatment of hypoglycemia.
  - ✓ Disoriented behavior
  - ✓ Seizures
  - ✓ Difficulty arousing from sleep
  - ✓ Loss of consciousness.

❖ **Emergency measures:**
- Injection of glucagon 1mg (subcutaneously or intramuscularly.)
- A concentrated source of carbohydrate followed by a snack should be given to the patient on awakening
- In hospitals and emergency departments, for patients who are unconscious or cannot swallow, 25 to 50 mL of 50% dextrose in water (D5OW) may be administered IV.
- Assuring patency of the IV line because (D5OW) is very irritating to veins.
- Taking additional food when physical activity is increased
- Routine blood glucose tests are performed
- Wear an identification bracelet or tag stating that they have diabetes.
- Learn to carry some form of simple sugar with them at all times
- Refrain from eating high-calorie, high-fat dessert foods (eg, cookies, cakes, doughnuts, ice cream).

## DIABETES KETOACIDOSIS

❖ Caused by an absence or markedly inadequate amount of insulin. This deficit in available insulin results in disorders in the metabolism of carbohydrate, protein, and fat. The three main clinical features of DKA are:
- Hyperglycemia
- Dehydration and electrolyte loss
- Acidosis

❖ **Pathophysiology:**




❖ **Clinical Manifestations:**
- Polyuria
- Polydipsia
- Blurred vision
- Weakness
- Headache
- Orthostatic hypotension
- Weak and rapid pulse
- Anorexia
- Nausea and vomiting
- Abdominal pain
- Acetone breath
- Kussmaul's respiration – rapid, deep breathing

❖ **Diagnostic Tests and Findings:**
- Blood glucose levels may vary between 300 and 800 mg/dL
- Serum bicarbonate (0 to 15 mEq/L)
- Low pH (6.8 to 7.3)
- A low partial pressure of carbon dioxide
- (PCO2; 10 to 30 mm Hg)
- Increased levels of creatinine

- Increased blood urea nitrogen (BUN)
- Increased hematocrit

❖ **Management:**
- **Rehydration**
  - ✓ 0.9% Sodium chloride (normal saline solution) 0.65 to 1 Uh for2-3 hours
  - ✓ Half strength normal saline (0.45%)- hypernatremia
  - ✓ Monitoring fluid volume status
  - ✓ Vital signs
  - ✓ Lung assessment
  - ✓ Intake and output
  - ✓ Plasma expanders-severe hypotension
  - ✓ Monitor for signs of overload

- **Restoring Electrolytes**
  - ✓ Serum potassium level must be monitored frequently.
  - ✓ As much as 40 mEq/h may be needed for several hours.
  - ✓ Frequent (every 2 to 4 hours initially) ECGs and laboratory. measurements of potassium are necessary.
  - ✓ Because a patient's serum potassium level may drop quickly as a result of rehydration and insulin treatment, potassium replacement must begin once potassium levels drop to normal.
- **Reversing Acidosis**
  - ✓ Insulin is usually infused intravenously at a slow, continuous rate
  - ✓ Bicarbonate infusion to correct severe acidosis is avoided during treatment of DKA because it precipitates further, sudden decreases in serum potassium levels.
  - ✓ When mixing the insulin drip, it is important to flush the insulin solution through the entire IV infusion set and to discard the first 50 mL of fluid.
  - ✓ Insulin molecules adhere to the inner surface of IV infusion sets; therefore, the initial fluid may contain a decreased concentration of insulin.

## HYPERGLYCEMIC HYPEROSMOLAR NONKETOTIC SYNDROME (HHNS)

❖ Serious condition in which hyperosmolarity and hyperglycemia predominate, with alterations of the sensorium (sense of awareness)
❖ Ketosis is usually minimal or absent
❖ Persistent hyperglycemia causes osmotic diuresis, which results in losses of water and electrolytes

❖ **Clinical manifestations:**
- Hypotension
- Profound dehydration (dry mucous membranes, poor skin turgor)
- Tachycardia
- Alteration in sensorium
- Seizures
- Hemiparesis

❖ **Diagnostic tests and Findings:**
- Blood glucose- 600 to 1200mg/dL
- Osmolality exceeds 350 mOsm/kg

❖ **Management**
- Fluid replacement
- Correction of electrolyte imbalances
- Insulin administration
- Fluid treatment is started with 0.9% or 0.45%NS
- Central venous or hemodynamic pressure monitoring
- Potassium is added to IV fluids
- Insulin plays a less important role in the treatment of HHNS because it is not needed for reversal of acidosis

| Characteristic | DKA | HHNS |
|---|---|---|
| Patients most commonly affected | Can occur in type 1 or type 2 diabetes; more common in type 1 diabetes. | More common in type 2 diabetes, especially elderly patients with type 2 diabetes |
| Precipitating event | Omission of insulin; physiologic stress (infection, surgery, CVA,MI | PHYSIOLOGIC STRESS (infection surgery, CVA, MI) |
| Onset | Rapid (<24h) | Slower (over several days) |
| Blood glucose levels | Usually >250 mg/dL (>3.9mmol/L) | Usually >600 mg/dL (>33.3 mmol/L |
| Arterial pH level | 7.3 | Normal |
| Serum and urine ketones | Present | Absent |
| Serum osmolality | 300-350 mOsm/L | >350 mOsm/L |
| Plasma bicarbonate level | <15 mEg/L | Normal |
| BUN and creatinine levels | Elevated | Elevated |
| Mortality rate | <5% | 10-40% |