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Comprehensive Approach to NCLEX-RN HAAD and DHA Examinations

HIGHLIGHTS

- Systematic review of the content from examination point of view
- Fully illustrated flowcharts and diagrammatic representations
- More than 600 practice questions including alternate item formats

Renjith Augustine

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CHAPTER

3 Neurological System

Chapter Objectives

- Keynotes in the neurological system
- Anatomy of the nervous system
- Various diagnostic measures
- Disorders in the nervous system

KEY TERMS

ICP	GCS
MRI	Flaccidity
LP	Tensilon
LOC	Neurons

KEYNOTES

- The deficiency of dopamine leads to parkinsonism.
- Restrict caffeine before the patient going for EEG.
- Provide dim light for a patient with meningitis.
- The common neurotransmitters are dopamine, acetylcholine, serotonin, epinephrine, amino acids, etc.
- Increase dopamine is seen in schizophrenia.
- Elevate the head end of bed in patient with cerebral edema.
- The mode of communication for a patient with CVA and Aphasia is pen and paper or magic slate.
- Normal CSF glucose level 50–70 mg/dl.
- Normal CSF protein 15–45 mg/dl.
- Normal CSF volume is 125–150 ml.
- Normal CSF pressure is 50–175 mm H_2O.
- Presence of RBC in CSF indicates infection.
- Absence of smell is known as anosmia.
- Ataxia is unsteady gait.
- Apraxia is the inability to perform previously learned activity.
- Agnosia is the inability to recognize objects and attach meaning to them.
- Presence of oligoclonal bands in CSF indicates multiple sclerosis.
- Doll's eye test is contraindicated in cervical spinal injury.
- Cryptococcosis is the most common CNS fungal infection.
- Pill rolling movements of hands is the type of tremor in Parkinson's disease and levodopa is the drug of choice.
- Bell's palsy is also known as facial paralysis.
- The priority nursing care of a patient with GBS is monitor for respiratory failure.
- About 750–900 ml of blood is received by the brain in every one minute.

ANATOMY

The nervous system, a network of nerves and fibres helps all the parts of the body to communicate with each other. It also reacts to changes both outside and inside the body. The nervous system uses both electrical and chemical means to send and receive messages (Fig. 1).

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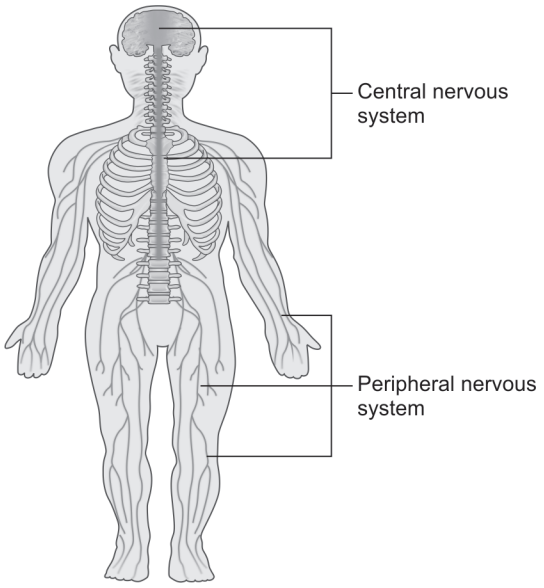
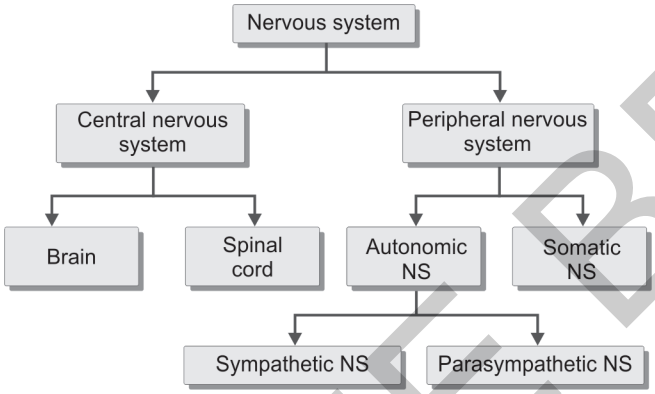


Fig. 1: Structure of nervous system



Peripheral Nervous System

The peripheral nervous system (PNS) is the part of the nervous system that is outside the brain and spinal cord consists of nerves and ganglia.

Autonomic Nervous System

The autonomic nervous system (ANS) is a part of peripheral nervous system that controls all the involuntary activities of the body, such as breathing, heartbeat, and digestive processes.

Somatic Nervous System

The somatic nervous system (SoNS) is a part of peripheral nervous system consist of afferent and efferent nerves, such as cranial nerves, spinal nerves, etc. which controls all the voluntary movement of muscles in our body.

Sympathetic Nervous System

The sympathetic nervous system (SNS) is one of two main divisions of the autonomic nervous system controls body's response to perceived threat (arousing) and is responsible for "fight-or-flight" response.

Parasympathetic Nervous System

The parasympathetic nervous system is one of the two main divisions of the autonomic nervous system controls homeostasis and body at rest (calming) and is responsible for body's "rest-and-digest" response.

Central Nervous System

The central nervous system (CNS) is a part of nervous system which consist of brain and spinal cord that controls all the activities of body and mind.

BRAIN

The brain is one of the largest and most complex organs in our body. The weight of brain is 1200 gm.

Functions of Brain

- Thinking or cognition
- Perception or sensing
- Emotion or feeling
- Behavior control
- Physical or somatic control
- Signaling (being responsive and active to stimuli)

Anatomy of Brain (Fig. 2)

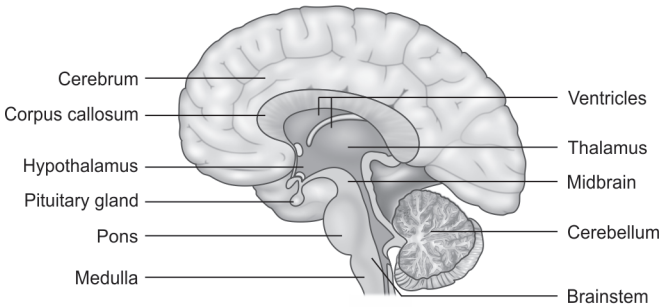


Fig. 2: Structure of brain

Three Parts

1. Cerebrum
2. Cerebellum
3. Brainstem

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Cerebrum

It is the largest part of the brain, consisting of two cerebral hemispheres.

- Right hemisphere: Receives the sensory information from the left side of the body.
- Left hemisphere: Receives the sensory information from the right side of the body.

If there is any cessation of blood supply to a part of brain, it may leads to unilateral neglect syndrome.

Cerebellum

It is a part of brain that coordinates all the motor activities of the body.

Brainstem

It consist of mid brain, pons and medulla. Medulla is the respiratory as well as vomiting syndrome.

Limbic system is a part of brain considered as emotional brain.

Cerebral Cortex

It is the outer gray matter which protects the brain from trauma. There are five lobes:

- *Frontal lobe:* Speech sensation, personality and behavior, also known as Broca's area of speech
- *Occipital lobe:* Vision sensation
- *Temporal lobe:* Responsible for hearing, Wernicke's area of speech
- *Parietal lobe:* Responsible for sensory information, taste and smell.

Diencephalon

It is a part of brain that consists of thalamus and hypothalamus.

- Thalamus: Relay station for discrimination of sensory signals, such as pain, temperature, touch, etc.
- Hypothalamus: Play major role in regulation of vital functions, such as blood pressure, sleep, food, etc.

Meninges (Fig. 3)

It is a membrane covering the brain which protects from trauma. There are three layers:

- Dura mater: Outer tough layer
- Arachnoid mater: Middle layer
- Pia mater: Inner layer

The space between the arachnoid mater and pia mater is called subarachnoid space.

There are four ventricles of brain. They are the communicating network of cavities which produce a fluid called as cerebrospinal fluid (CSF).

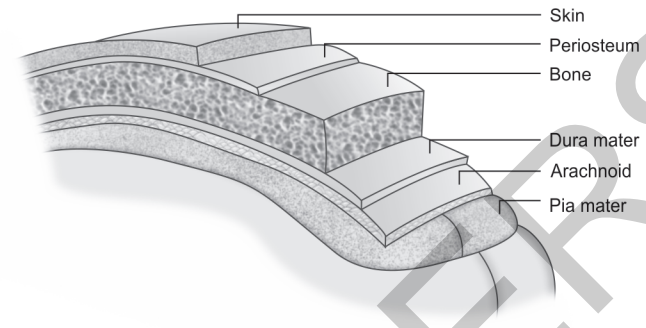
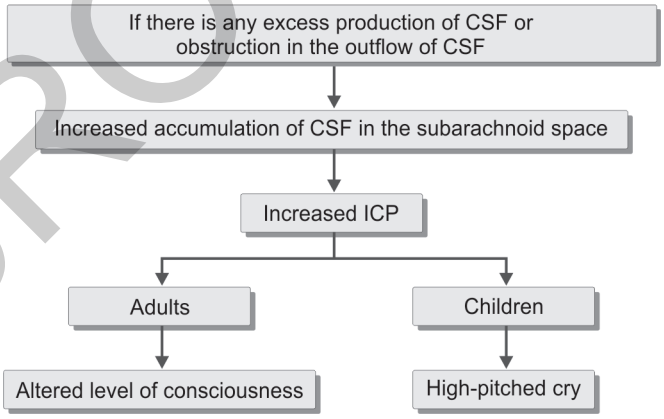


Fig. 3: Layers of meninges

- Normal CSF volume is 125–150 ml
- Normal CSF pressure is 50–175 mm H_2O
- The CSF is produced from the ventricles of the brain and it is drained into the subarachnoid space. It maintains ICP.
- Normal ICP is 5–15 mm Hg



Neurons (Fig. 4)

It is the structural and functional unit of nervous system. It consists of axon, dendrite and cell body.

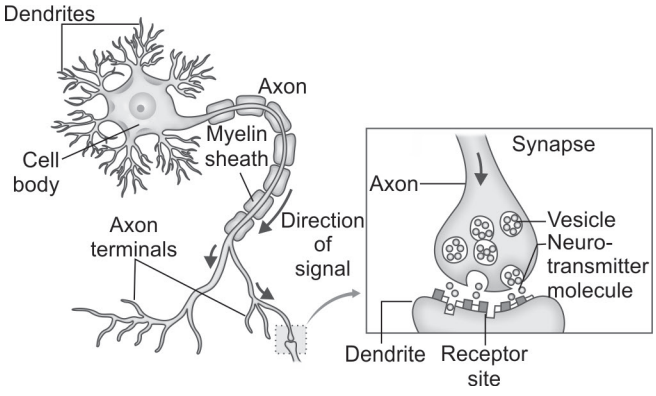


Fig. 4: Structure of neuron

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- The transmission of impulse from one neuron to another is called synaptic transmission (i.e. from the presynaptic area to the postsynaptic area). It takes place from the axon of one neuron to the dendrite of another.
- For the easy transmission of impulse, there are a number of neurotransmitters present in the synaptic cleft. They are:
  - Dopamine
  - Serotonin
  - Amino acid
  - Epinephrine
  - Acetylcholine
- From the presynaptic area to the postsynaptic area, if there is any impairment in the transmission of these neurotransmitters will result in certain disorders.
  - Increase dopamine—schizophrenia
  - Decrease dopamine—parkinsonism
  - Increase serotonin—mania
  - Decrease serotonin—depression
  - Increase epinephrine—mania
  - Decrease epinephrine—depression

Spinal Cord (Fig. 5)

Spinal cord is the most important structure between body and brain. It extends from foramen magnum to first or second lumbar vertebrae. The length of spinal cord is 18 inches (45 cm).

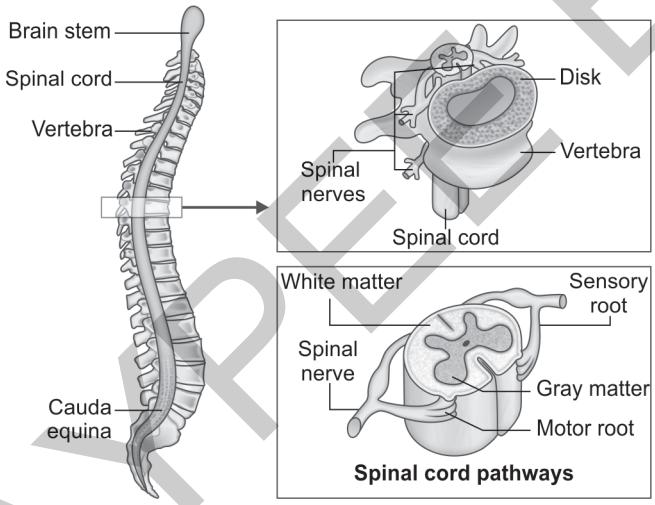

Fig. 5: Structure of spinal cord

- Spinal cord consists of an H-shaped gray mater (cell body) in the center and surrounded by white mater (nerve tract and fibers).
- There are 31 pairs of spinal nerves and 12 pairs of cranial nerves in the peripheral nervous system. The spinal nerves carry impulses to and from the spinal cord and the cranial nerves carry impulses to and from the brain.
- Spinal nerves are divided into 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal nerve. Dorsal and ventral roots enter and leave the vertebral column respectively, through intervertebral foramen at the vertebral segments corresponding to the spinal segment.
- The arterial blood supply to the spinal cord in the upper cervical regions is derived from two branches of the vertebral arteries, the anterior spinal artery and the posterior spinal arteries.

NEUROLOGICAL ASSESSMENT

Assessment of Cranial Nerves

CN I	Olfactory nerve—sense of smell
CN II	Optic nerve—sense of vision
CN III	Oculomotor nerve—responsible for pupillary constriction
CN IV	Trochlear nerve—down ward and inward movement of eye
CN V	Trigeminal nerve—responsible for corneal reflex, largest cranial nerve
CN VI	Abducens nerve—lateral deviation of eye
CN VII	Facial nerve—facial movement
CN VIII	Acoustic nerve or vestibulocochlear nerve—responsible for hearing and balance
CN IX	Glossopharyngeal nerve—movement of pharynx and swallowing
CN X	Vagus nerve—longest cranial nerve, mixed cranial nerve, movement of larynx, pharynx
CN XI	Spinal accessory—movement of sternomastoid muscle and trapezius muscle
CN XII	Hypoglossal nerve—movement of tongue

- ***CN I (olfactory):*** Ask your patient to identify at least two common substances, such as coffee and cinnamon. Make sure his nostrils are patent before performing this test.
- ***CN II (optic):*** Test visual acuity with a Snellen chart and the Rosenbaum nearvision card.
- ***CN III (oculomotor), CN IV (trochlear), and CN VI (abducens):*** Assess these nerves together using the corneal light reflex test, the six cardinal positions of gaze, and the cover-uncover test. Also, inspect the size, shape, and symmetry of your patient's pupils and papillary reactions to light.
- ***CN V (trigeminal):*** To assess the sensory component of the trigeminal nerve, ask your patient to close his eyes and then touch him with a wisp of cotton on his forehead, cheek, and jaw on each side .Next, test pain perception by touching the tip of a safety pin to the same three areas.

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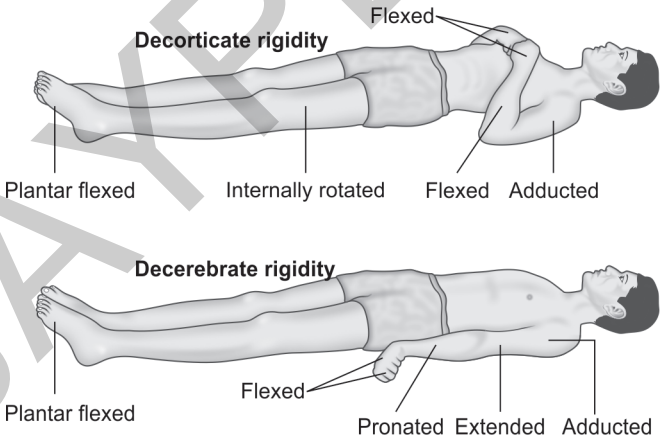
- ***CN VII (facial):*** To assess the sensory component, test taste by placing items with various tastes on the anterior portion of your patient's tongue, for example, sweet, sour, and bitter. To test motor function, observe his face for symmetry at rest and while he smiles, frowns, and raises his eyebrows.
- ***CN VIII (acoustic):*** To assess this nerve, use Weber's test—strike a tuning fork lightly against your hand and place the vibrating fork on your patient's forehead at the midline or on the top of his head—and the Rinne test—strike the tuning fork against your hand and place the vibrating fork over his mastoid process.
- ***CN IX (glossopharyngeal) and CN X (vagus):*** Test these nerves together because their innervation overlaps in the pharynx. Listen to your patient's voice. Then check his gag reflex by touching the tip of a tongue blade against his posterior pharynx and asking him to open wide and say "ah." Watch for symmetrical upward movement of the soft palate and uvula and for the midline position of the uvula.
- ***CN XI (spinal accessory):*** Assess this nerve by testing the strength of the sternocleidomastoid muscles and the upper portion of the trapezius muscle.
- ***CN XII (hypoglossal):*** Observe your patient's tongue for symmetry. His tongue should be midline without tremors or muscle twitching. Test tongue strength by asking him to push his tongue against his cheek as you apply resistance.

Assessment of the Level of Consciousness

- Orientation to time, place and person
- Speech of the patient
- Monitor for abnormal posturing
  - **Decorticate posturing:** Also known as flexor, extension of the legs, internal rotation and flexion of arms.
  - **Decerebrate posturing:** Also known as extensor.



- Pupillary reaction of the patient
- Motor function, movement of extremities
- Glasgow coma scale

Eye opening (4)		*Verbal response (5)*		*Motor response (6)*	
Spontaneous	4	Oriented	5	Obeys command	6
To verbal stimuli	3	Confused	4	To painful stimuli	5
To pain	2	Inappropriate words	3	Withdrawal	4
No response	1	Inappropriate sound	2	Flexion	3
		No response	1	Extension	2
				No response	1

  - Total score is 15
  - Minimum score is 3
  - Maximum score is 15
  - If the score is less than 7, patient is in coma state

DIAGNOSTIC MEASURES

- **Skull X-ray:** Radiographic examination of the skull to rule out any fracture or deformity. It is contraindicated in pregnant women.
- **CT scan:** Used to detect intracranial space occupying lesion, withhold all metformin preparations because it react with iodine to form metformin induced iodine lactic acidosis.
- **MRI scan:** Magnetic rays are used to detect the intracranial space lesions in brain and spinal cord, contraindicated in pregnant women because it may cause increase in amniotic fluid temperature and cause fetal toxicity.
- **Lumbar puncture:** Insertion of a needle between L3 and L4 to remove CSF for diagnostic and treatment purpose. It is contraindicated in patients with increased ICP because the withdrawal may cause rapid decline in the CSF pressure. While performing LP position the patient in a fetal position (ask the patient to lie in left lateral position and draw the knees toward abdomen and chin towards the trunk).
- **Myelography:** It is used to rule out IVDP (inter vertebral disc prolapse) or tumor. LP is performed, remove a small amount of CSF, mix the dye in the CSF and reinsert again. The dye may be oil based or water based or air based.
  - If water based or oil based dye is used provide flat position with head of bed elevation to prevent

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the upward displacement of dye and to prevent meningeal irritation.
  - If air based dye is used provide flat position with head lower than the trunk.
- **EEG (electroencephalography):** It is used to rule out the severity of seizure or epilepsy. Withhold all caffeinated beverages and anticonvulsant medications before the test because it may cause false reading.
- **Cerebral angiography:** Used to rule out cerebral vessels and tumors. Injection of radiopaque substance into the cerebral circulation via carotid artery, vertebral artery, femoral artery or brachial artery followed by X-ray. Maintain pressure dressing after the procedure to prevent bleeding.

DISORDERS

Increased ICP

Due to any trauma or RTA, there will be an obstruction in the outflow of CSF which results in the excessive accumulation of CSF in the subarachnoid space results in increased ICP.

Clinical Manifestation

- Altered level of consciousness
- Nuchal rigidity
- Increased systolic pressure
- Widened pulse pressure
- Decreased heart rate
- Vomiting (projectile)
- High pitched cry in children

Nursing Care

- Monitor for increased ICP
- Monitor for Cushing's triad (increased systolic pressure, widened pulse pressure and decreased heart rate)
- Avoid administering morphine sulfate
- Provide mechanical ventilation with slight hyperventilation (to keep the $PaCO_3$ 30–35 mm Hg which results in vasoconstriction and decreases ICP)
- Provide head of bed elevation 30–45 degree
- Administer osmotic diuretics, such as mannitol

Stroke

It is also called as CVA or brain attack. It is the sudden cessation of blood supply to a part of brain. It occurs as a result of ischemia or hemorrhage secondary to thrombi or emboli.

There are two types of stroke:

- Ischemic stroke (83%)
- Hemorrhagic stroke (17%)

Clinical Manifestation

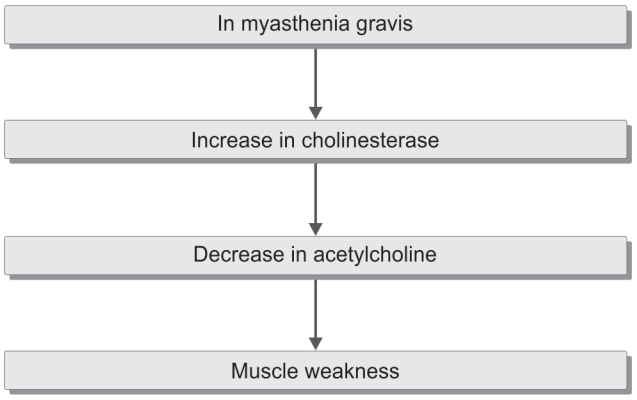
- Headache
- Seizures and disorientation
- Fever
- Aphasia (speech disturbance)
- Apraxia (loss of ability to perform skilled activities)
- Unilateral neglect syndrome (in case of right hemisphere damage, there will be paralysis of the left side of the body and, in case of left hemisphere damage, there is paralysis of the right side of the body).

Nursing Care

- Maintain a patent airway
- Maintain blood pressure of 150/100 mm Hg to proper ensure cerebral perfusion
- Monitor for increased ICP
- Provide head of bed elevation 30–45 degree
- Always approach the patient from the unaffected side
- Reposition the patient every 20 minutes (affected side only for 20 minutes)
- Administer thrombolytic agents, such as streptokinase and urokinase
- Administer anticoagulants, such as heparin and warfarin.
- Administer corticosteroids and osmotic diuretics to decrease cerebral edema.

Myasthenia Gravis

It is a neuromuscular disorder characterized by considerable muscle weakness. It occurs more common among women than men, in women 15–35 years of age and men over 40 years. Thymus gland abnormalities may lead to myasthenia gravis.



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Clinical Manifestation

- Weakness
- Respiratory failure
- Dysphagia
- Diplopia
- Diminished breath sound

Nursing Care

- Monitor the respiratory status
- Encourage the client to sit up while eating
- Check the gag reflex and swallowing reflex
- Administer anticholinesterase medications, such as neostigmine, tilstigmin, physostigmine
- Prepare the patient for tensilon test
- Monitor for myasthenia crisis and cholinergic crisis
- Administer corticosteroids (prednisone)
- Prepare the patient for thymectomy, removal of thymus gland.

Tensilon Test (Fig. 6)

- The other names of tensilon is edrophonium. It is the test used to diagnose myasthenia gravis and to differentiate between myasthenia crisis and cholinergic crisis.
- The priority nursing care of a patient undergoing Tensilon test is keep atropine ready in the emergency tray.

Myasthenic Crisis

- It is the acute exacerbation of myasthenia gravis characterized by weakness, dyspnea, bowel and bladder incontinence, increase respiration and pulse.

Management

- Administer increases dose of anticholinesterase medication.

Cholinergic Crisis

- It occurs as a complication of overmedication of anticholinesterase. It is manifested as blurred vision, hypotension, etc.

Management

- Avoid anticholinesterase medication
- Administer antidote (atropine sulfate)

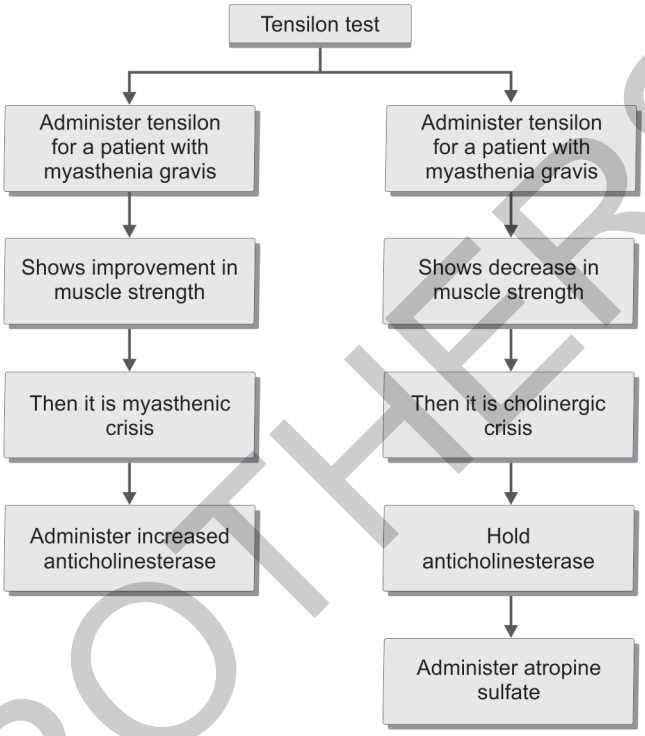

Fig. 6: Tensilon test

Parkinsonism

It is a degenerative disorder characterized by depletion of dopamine in the postsynaptic area leads to inhibition of excitatory muscles (slowing of activities).

Clinical Manifestation

- Bradykinesia and tremor
- Akathisia
- Poor handwriting
- Poor hand-motor coordination

Nursing Care

- Assist with activities of daily living (ADL)
- Provide a safe environment, side rails on bed
- Maintain adequate nutrition
- Assist the patient to improve communication abilities
- Instruct the patient to wear low healed shoes
- Administer anti-Parkinson's drugs (levodopa and carbidopa)
- Avoid administering vitamin B6 along with levodopa and carbidopa

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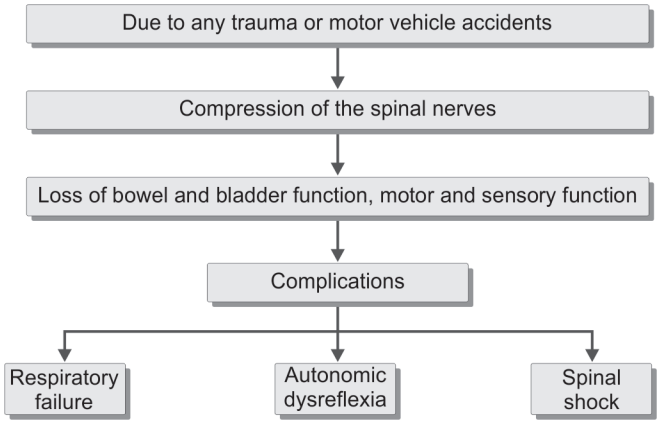
- Avoid administering MAOI along with levodopa and carbidopa, because it may cause hypertensive crisis.

Spinal Cord Injury

A spinal cord injury is an injury to the spinal cord results in loss of function, such as mobility or feeling.



Common Sites

- Cervical—C_5, C_6, C_7
- Thoracic—T_{12}
- Lumbar—L_1

Clinical Manifestation

- Loss of bowel and bladder function
- Loss of motor function
- Loss of sensory function
- Respiratory failure (injury at C_4)
- Bowel and bladder incontinence (injury at S_2 and S_3)
- If the injury between C_1 and C_8, it results in quadriplegia (paralysis of four extremities)
- If the injury between T_1 and L_4, it results in paraplegia (paralysis of lower extremities)
- Absence of sweat in the paralysed area.

Nursing Care

- Assess the injury site , if any patient admitted in the hospital with complaints of RTA always suspect for spinal cord injury (improper handling may results in complete transection of the cord from partial transection)
- Immobilize the patient, place the patient on a spinal backboard
- Provide flat position for the patient except in autonomic dysreflexia
- Place the patient in a skull tongs or halo traction in case of any suspected cervical fracture
- Use log rolling technique while moving the patient
- Monitor for complications.

Autonomic Dysreflexia

It is also known as autonomic hyper-reflexia. It occurs when the injury is above T_6. It is manifested as restlessness, severe hypertension, pupillary dilation, etc.

Management

- Raise the head end of bed 30–45 degree
- Administer antihypertensive medications
- Provide catheterization.

Spinal Shock

It is also called flaccidity or flaccid paralysis or neurogenic shock. It is manifested as hypotension, bradycardia.

Meningitis

- It is the inflammation of the meninges or subarachnoid space (see the Fig. 3, layers of meninges).
- It is the inflammation of the arachnoid mater and pia mater of the brain and spinal cord.
- It is the inflammation of the CSF
- The mode of transmission of meningitis is droplet infection or direct contact.
- It may be viral or bacterial meningitis.

Clinical Manifestation

- Fever and chills
- Headache, photophobia and irritability
- Vomiting and seizures
- Positive Kernig's sign (make the patient to lie down in supine position, flex the legs 90 degree angle to the thigh, suddenly extend the lower leg, there will be pain the hamstring muscle, indicates meningeal irritation)
- Positive Brudzinski's sign (ask the patient to lie in supine position, flex the neck towards the chest, the legs will also flex in case of meningeal irritation).

Nursing Care

- Assess the signs and symptoms of increased ICP
- Provide head of bed elevation 30 degree
- Monitor the CSF (decreased CSF glucose and increased CSF protein in meningitis)
- Provide dark and quiet room
- Provide respiratory isolation for 24 hours after initiation of antibiotic therapy
- Administer prescribed antibiotics
- The drug of choice for meningococcal meningitis is rifampicin.

Seizures

- Seizure is a sudden abnormal electrical discharge in the brain cells.
- Epilepsy is a chronic seizure activity.

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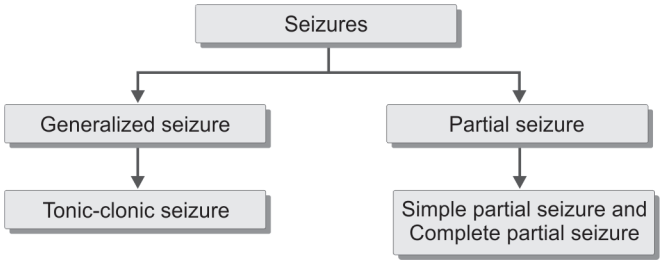
- Status epilepticus is a chronic epileptic episodes without interval of consciousness.

Types



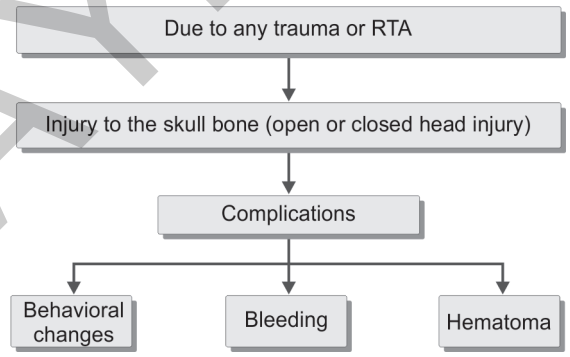
- **Generalized seizure:** Initial onset in both hemispheres, usually involves loss of consciousness and bilateral motor activity.
- **Partial seizure:** Begins in focal area of brain and symptoms are appropriate to a dysfunction of that area.
- **Tonic-clonic seizure:** It consist of a tonic phase and clonic phase. It begins with aura (warning sign). Tonic phase last for 20 seconds and is manifested as sudden stiffness. Clonic phase is manifested as jerky movements. This type of seizure ends with a period of postictal period of confusion and drowsiness.
- **Simple partial seizure:** Seizure confined to one hemisphere of brain.
- **Complex partial seizure:** Seizure begins in one focal area and spread to both hemispheres.

Nursing Care

- Remove all sharp objects near the patient side
- Maintain a patent airway
- Provide side lying position
- Administer anticonvulsant medications, such as Eptoin, carbamazepine
- The nursing care of a patient who is on anticonvulsants is monitor for gingival hypertrophy
- The drug of choice for status epilepticus is IV dilantin.

Head Injury

A head injury is any trauma to the scalp, skull, or brain. It may be a minor injury or major injury.



- **Closed head injury**: A head injury in which there is no break in the skull bone.
- **Open head injury**: A head injury in which the skull is open and entered the brain.
- **Contusion**: A bruising type of injury with changes in the level of consciousness.
- **Concussion**: A jarring type of injury with no loss of consciousness (temporary neural dysfunction).
- **Epidural hematoma**: Hematoma which is seen between dura mater and skull bone.
- **Subdural hematoma**: Hematoma which is seen below the dura mater (between dura mater and arachnoid mater).

Clinical Manifestation

- Hematoma and bleeding
- Seizure activity
- Visual disturbances
- Changes in the level of consciousness
- CSF drainage from ear and nose
- Battle sign: Ecchymosis around the mastoid process as a result of head injury

Nursing Care

- Maintain a patent airway
- Monitor the respiratory rate
- Monitor for increased ICP
- Administer morphine sulfate to decrease agitation (do not administer in case of increased ICP)
- Observe for CSF drainage
- Instruct the client to avoid coughing
- Administer mannitol
- Provide psychological support
- Prepare the patient for surgical correction

Surgical Correction (Intracranial Surgeries)

- **Craniotomy**: A surgical procedure that involves opening of the skull bone, an incision is made through the cranium to remove the accumulated blood or tumor.
- **Craniectomy**: Excision of a portion of the skull bone.
- **Cranioplasty**: Repair of a cranial defect with a metal or plastic plate.

Nursing Care (Preoperative)

- Provide emotional support to the patient and relatives
- Perform routine blood investigations
- Administer preoperative medications
- Shave the area, avoid enema because straining increases ICP
- Informed consent.

Nursing Care (Postoperative)

- Maintain a patent airway
- Monitor for increased ICP
- Provide mechanical ventilation with slight hyperventilation for 24–48 hours

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- Monitor for the drainage, notify the physician if it is more than 30–50 ml
- Restrict fluid intake 1500 ml per day
- Provide anti-embolism stocking
- Provide proper position, in case of supratentorial surgery elevate the head of bed 15–45 degree, in case of infratentorial surgery keep the head of bed flat or elevate 20–30 degree, in case of bone flap removal turn the patient to nonoperated site, in case of posterior fossa surgery position the client on the side with a pillow under the head.

Cerebral Aneurysm

It is the dilation of the weakened cerebral artery.

Clinical Manifestation

- Headache or head pain
- Diplopia
- Nuchal rigidity

Nursing Care

- Maintain a patent airway
- Provide dark and quiet room
- Provide semi Fowler's position
- Provide seizure precautions
- Limit the number of visitors

Bell's Palsy

It is also known as facial paralysis, damage to the 7th cranial nerve.

Clinical Manifestation

- Inability to raise the eyebrow
- Inability to close the eye lids
- Loss of taste, smile and complete paralysis of one side of face.

Nursing Care

- Administer corticosteroids
- Provide soft diet
- Instruct the client to chew on the unaffected side.

Trigeminal Neuralgia

It is the disorder of 5th cranial nerve (trigeminal nerve).

Clinical Manifestation

- Severe sharp facial pain
- Poor eating and hygiene habits

Nursing Care

- Assess the characteristics of pain
- Provide small and frequent feeding
- Avoid hot or cold fluids

Guillain-Barré Syndrome

Guillain-Barré syndrome (GBS) is a rare disorder in which your body's immune system attacks your nerves (nerve inflammation).

Clinical Manifestation

- Prickling, "pins and needles" sensations in fingers, toes, ankles or wrists
- Weakness in legs that spreads to your upper body
- Unsteady walking or inability to walk or climb stairs
- Difficulty with eye or facial movements, including speaking, chewing or swallowing.

Nursing Care

- Assess the cranial nerve function
- Monitor for respiratory distress
- The priority nursing care of a patient with GBS is monitor for respiratory failure
- Administer corticosteroids.

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