Neurological System & Mental Status Assessment

Chapter 16, 17

Overview of Anatomy

• Central Nervous System
  – Brain
  – Spinal cord
• Peripheral Nervous System
  – 12 pairs of cranial nerves
  – Spinal and peripheral nerves
4 Regions of the Brain:

- **Diencephalon**: regulates consciousness
- **Brainstem**: connects the upper part of the brain with the spinal cord, consists of (pons, medulla, midbrain)
- **Cerebellum**: gait and coordination
- **Cerebrum**: thinking and higher functions
Hemispheres Divided into 4 Lobes

- Frontal – personality, behaviour, emotions, intellectual function
- Parietal - primary centre for sensation
- Occipital – Primary visual receptor centre
- Temporal – Primary auditory reception centre.
Brain tissue (gray and white matter)

- Gray matter consists of aggregations of neuronal cell bodies
- White matter consists of the neuronal axons that are covered with myelin; the myelin sheets allow nerve impulses to travel more rapidly
- Additional clusters of gray matter deep in the brain
  - Thalamus: regulates sensory impulses
  - Hypothalamus: regulates body temperature, pulse, BP, endocrine function, and emotions
  - Basal ganglia: affect movement
Sensory Pathways

• Receptors all over body
• Monitors conscious sensation, internal organ functions, body position, initiate motor reflexes
• Travels through afferent fibres of PNS
  – Spinothalamic tract – pain, temperature & crude or light touch
  – Posterior (Dorsal) columns – proprioception, vibration & finely localized touch.

Motor Pathways

Corticospinal or Pyramidal Tract

• Originate motor cortex, travel to brain stem, cross over, proceed down to synapse with lower motor neuron in spinal cord
• Mediate voluntary movement, particularly very skilled, discrete purposeful movements
• Higher, newer motor system
• Mapped in motor cortex in human looking pattern called somatotopic organization.
Motor Pathways

Extrapyramidal Tracts

- All motor nerve fibres originating in motor cortex, basal ganglia, brain stem & spinal cord that are outside pyramidal tract
- Lower, older motor system
- Maintain muscle tone & control automatic body movements like walking.

The Spinal Cord

- Cylindrical mass of nerve tissue encased within the bony vertebral column
- Contains important motor and sensory pathways that connect the peripheral muscles and nerves with the brain
- Also mediates reflex activity of deep tendon reflex
- divided into :cervical segments (C1-C8), thoracic segments (T1-T12), lumbar segments (L1-L5), sacral segments (S1-S5), and the coccygeal
PNS
(Cranial and Peripheral Nerves)

- 12 pairs of cranial nerves that originate in the brain (diencephalons or brainstem) and exit the cranium
- Spinal nerves attach to the spinal cord; each nerve has an anterior (ventral) root containing motor fibers and a posterior (dorsal) root containing sensory fibers
- Most peripheral nerves contain both sensory (afferent) and motor (efferent) fibers
- Spinal cord contains both gray and white matter
### Table 23-1 Cranial Nerves

<table>
<thead>
<tr>
<th>Number</th>
<th>Nerve</th>
<th>Division</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Olfactory</td>
<td>Sensory</td>
<td>Smell</td>
<td>Olfactory nerve: olfactory sensations (smell)</td>
</tr>
<tr>
<td>II: Optic</td>
<td>Sensory</td>
<td>Vision</td>
<td>Optic nerve: vision sensations</td>
</tr>
<tr>
<td>IV: Trochlear</td>
<td>Motor</td>
<td>Motor</td>
<td>Trochlear nerve: down &amp; inward movement of eye</td>
</tr>
<tr>
<td>V: Trigeminal</td>
<td>Mixed</td>
<td>Motor</td>
<td>Trigeminal nerve: muscles of mastication. Sensory: sensation of face/scalp, cornea, mucous memb. mouth/nose.</td>
</tr>
<tr>
<td>VI: Abducesens</td>
<td>Motor</td>
<td>Motor</td>
<td>Abducesens nerve: lateral movement of eye</td>
</tr>
<tr>
<td>VIII: Acoustic</td>
<td>Sensory</td>
<td>Sensory</td>
<td>Acoustic nerve: hearing &amp; equilibrium</td>
</tr>
<tr>
<td>XI: Spinal</td>
<td>Motor</td>
<td>Motor</td>
<td>Spinal nerve: movement of trapezius &amp; sternomastoid muscles</td>
</tr>
<tr>
<td>XII: Hypoglossal</td>
<td>Motor</td>
<td>Motor</td>
<td>Hypoglossal nerve: movement of tongue</td>
</tr>
</tbody>
</table>

### Reflexes

- **Spinal reflexes**: An abnormal reflex helps us locate a pathologic lesion:
  - **Deep tendon response**
    - ankle reflex (Sacral 1 primarily)
    - knee reflex (Lumbar 2,3,4)
    - Supinator (brachioradialis) reflex (Cervical 5, 6)
    - biceps reflex (Cervical 5, 6)
    - triceps reflex (Cervical 6, 7)
  - **Superficial reflexes** by stimulating the skin: cutaneous reflexes
    - Abdominal reflexes  —— upper (thoracic 8, 9, 10)
      —— lower (thoracic 10, 11, 12)
    - Plantar responses (Lumbar 5, Sacral 1)
Subjective Data Collection

- Headache
- Head injury
- Dizziness/vertigo
- Seizures
- Tremors
- Weakness
- Incoordination
- Numbness or tingling
- Difficulty swallowing
- Difficulty speaking
- Significant past history
- Environmental/occupational hazards.

Sequence of Assessment

- Mental Status
- Cranial nerves
- Motor system
- Sensory system
- Reflexes.
Mental Status Exam

1. Appearance and behavior

2. Speech and language

3. Mood

4. Thoughts and perceptions

5. Cognitive Functions

1. Appearance and behavior
   - **Level of consciousness**: alertness or state of awareness of the environment (awake, alert). Understanding questions,
   - **Posture and motor behavior**: note body posture and patient’s ability to relax
   - **Dressing, grooming, personal hygiene**: look at pt dressed it is clean, fastened properly, how does it compare to other, are both side the same.
   - **Facial expression**: observe face while pt at rest and during conversation or interacting with other, is there any variation or congruency with topics (anxiety, depression, apathy, anger, elation), immobile facial expression (Parkinson's)
   - **Manner, affect, and relationship to persons and things**
**Level of consciousness:**

- **Alertness:** arousal intact, the person opens the eyes, looks at you, responds fully and appropriately to stimuli.
- **Lethargy:** speak in a loud voice. An abnormal response would be the patient appears drowsy, but opens the eyes and looks at you, responds to your questions, and then falls asleep.
- **Obtundation:** shake gently as if awakening a sleeper. An obtunded patient opens the eyes and looks at you, but responds slowly and somewhat confused.
- **Stupor:** arouses from sleep only after painful stimulus, pinch a tendon, rub the sternum, and roll a pencil across a nail bed.
- **Coma:** repeated painful stimuli. Unarousable and with eyes closed.

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**Level of Consciousness (Arousal): Techniques and Patient Response**

<table>
<thead>
<tr>
<th>Level</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness</td>
<td>Speak to the patient in a normal tone of voice. An alert patient opens the eyes, looks at you, and responds fully and appropriately to stimuli (arousal intact).</td>
</tr>
<tr>
<td>Lethargy</td>
<td>Speak to the patient in a loud voice. For example, call the patient name or ask “How are you?”</td>
</tr>
<tr>
<td>Obtundation</td>
<td>Shake the patient gently as if awakening a sleeper.</td>
</tr>
<tr>
<td>Stupor</td>
<td>Apply a painful stimulus. For example, pinch a tendon, rub the sternum, or roll a pencil across a nail bed. (No stronger stimuli needed!)</td>
</tr>
<tr>
<td>Coma</td>
<td>Apply repeated painful stimuli.</td>
</tr>
</tbody>
</table>
2. **Speech and language**: Note the characteristics, and if any disorders of speech: look for those affecting the voice, the articulation of words, the production and comprehension of language.

3. **Mood**: is a more sustained emotion that may color a person’s view of the world.

4. **Thought and perceptions**:
   - **Thought process**: the logic, relevance, organization, coherence of the patient’s thought as it leads to selected goals, or how people think.
   - **Perceptions**: sensory awareness of objects in the environment and their interrelationship (external stimuli); also internal stimuli, such as dreams or hallucinations.

5. **Cognitive function**
   - **Orientation**: Being aware to person, place, and time.
   - **Attention**: ability to focus on one task or activity.
   - **Remote memory**: long term memory, refers to intervals of years.
   - **Recent memory**: short term memory, refers to minutes, hours, or days.
   - **New learning ability**: immediate repetition of material, followed by storage or retention of information.
Cranial Nerve Assessments

I – *Olfactory nerve* – smell
- Test if: report loss of smell, had head trauma, with abnormal mental status or when suspect intracranial lesion
- Each nostril should identify odour – may ↓ with aging
- Occlude each & test with non-noxious smells: coffee, toothpaste, orange, vanilla, soap, peppermint

II – *Optic nerve* – vision
- visual acuity/visual fields, ophthalmoscopic exam– chpt 14

III, IV, VI – *Occulomotor, Trochlear, & Abducens* – Extra ocular eye movements
- Check pupil size, regularity, equality, direct & consensual light reaction & accommodation
- Check extraocular movements by cardinal positions of gaze

V – *Trigeminal Nerve* – mastication, sensation of face, corneal reflex
- Test motor component: Assess muscles of mastication - palpate temporal & masseter muscles as person clenches teeth, try to separate jaws by pushing down on chin; normally you cannot.
- Test sensory function: eyes closed test light touch sensation – touch cotton wisp to forehead, cheeks & chin
- Corneal reflex – omit unless clt has abnormal facial sensation or movement – remove contact lenses – bring wisp of cotton in from the side & lightly touch cornea not conjuctiva – person should blink bilaterally – tests sensory afferent neuron of cranial nerve V and motor efferent in cranial nerve VII.
Assess the Muscles of Mastication by Palpating the Temporal and Masseter Muscles

With the Person's Eyes Closed, Test Light Touch Sensation by Touching a Cotton Wisp to these Designated Areas on Person's Face: Forehead, Cheeks, and Chin.
With the Person Looking Forward, Bring a Wisp of Cotton in from the Side (to Minimize Defensive Blinking) and Lightly Touch the Cornea—Not the Conjunctiva.

Cranial Nerve Assessments

VII – Facial Nerve – facial muscle movement, taste
- Motor Assessment: Note mobility & facial symmetry as clt smiles, frowns, closes eyes tightly, lifts eyebrows, shows teeth & puffs cheeks
- Do not test taste routinely – only if suspect facial nerve injury — ask person to identify taste of sugar, salt lemon juice

VIII – Acoustic nerve – hearing acuity
- Test hearing in normal conversation, whispered voice test, Weber & Rinne – chpt. 15.
Note Mobility and Facial Symmetry as the Person: Smiles, Frowns, Closes Eyes Tightly, Lifts Eyebrows, Shows Teeth, and Puffs Cheeks.

Bel's pals y
Cranial Nerves Assessments

IX & X – Glossopharyngeal & Vagus nerves

• Motor: Depress tongue with blade, note pharyngeal movement as person says “ahhhh” or yawns – uvula & soft palate should rise in midline, tonsillar pillars should move medially
• Touch posterior pharyngeal wall with blade & note gag reflex
• Voice sounds should be smooth & not strained
• Sensory: IX mediates taste on posterior 1/3 of tongue but too difficult to test

XI – Spinal Accessory nerve – sternomastoid & trapezius muscle strength

• Ask person to turn head against resistance, shrug shoulders against resistance.

Check Equal Strength by Asking the Person to Rotate the Head Forcibly Against Resistance
Cranial Nerves Assessment

XII – Hypoglossal nerve – tongue

• Inspect tongue – watch for wasting or tremors, should thrust midline as person protrudes
• Ask person to say “light, tight, dynamite” note lingual speech is clear & distinct.
Motor System Assessment

• Muscles – size, symmetry, strength, tone, involuntary movements
• Cerebellar Function – balance & coordination tests – gait, tandem walking, Romberg test, hop in place, rapid alternating movements, thumb to each finger, finger to finger test, finger to nose test, heel to shin tests.

Motor System Examination

– Body position during movement and rest
– Watch for involuntary movements: note (location, quality, rate, rhythm, amplitude, relation to activity, posture)
  - **Tics**: repetitive twitching of a muscle group at inappropriate time
  - **Tremor**: involuntary contraction of opposing muscle group in a rhythmic movement as in Parkinson's disease
  - **Chorea**: sudden, rapid jerky, purposeless movement as in Huntington’s disease
– **Muscle Bulk**
  - Compare size and contours of muscle (flat, concave? Unilateral or bilateral, proximal or distal). Look for:
    - **Atrophy**: abnormally small muscle with wasted appearance.
      - Happen in disuse, injury to lower motor neuron disease such as polio.
    - **Hypertrophy**: increased size and strength occur with isometric exercise
      - Look at the thenar and hypothenar muscle (convex and full)
      - Look at the space between metacarpals (full, slightly depressed)
  
– **Tone**: is the normal degree of tension (contraction) in voluntary relaxed muscle
  - Shows as mild resistance to passive stretch
  - Decreased resistance suggests peripheral disease in nervous system, cerebella, or spinal injury
  - Limited ROM, pain, flaccidity (decrease resistance or hypotonic); spasticity or rigidity (increased resistance).

– **Strength**: test muscle power
  Ask the pt to move against your resistance
  - **Paresis** or weakness: diminished strength
  - **Paralysis** or plegia: is absence of strength
  - **Hemiparesis** or hemiplegia: paralysis of one side of the body

  **Grading Muscle Strength:**
  - 5: Full ROM against gravity, full resistance.
  - 4: Full ROM against gravity, some resistance.
  - 3: Full active ROM with gravity.
  - 2: Full active ROM with gravity eliminated (Passive motion).
  - 1: Slight contraction barely detected
  - 0: No contraction.
• Muscle strength of the upper trunk:
  - Test flexion (biceps) and extension (triceps) at the elbow:

• Test extension at the wrist (radial nerve):

• Test the grip:
• Test finger abduction (ulnar nerve)

Finger abduction

• Test opposition of the thumb (median nerve):

Opposition of thumb
- **Muscle strength of the lower trunk:**
  - flexion, extension, lateral bending of the spine
  - Thoracic expansion, diaphragmatic excursion during respiration
  - Test flexion at the hip:

  ![Flexion of hip](image)

  Test adduction at the hip:
  - Place your hand between pt knee
  - Ask pt to bring his leg together against you

  Test abduction at the hip:
  - Place your hand at the outer side of the knee
  - Ask pt to spread legs against your hand

  Test extension at the hips:
  - Have the pt push the posterior thigh down against your hand
• Test flexion at the knee:
- Flex pt knee, foot resting on the bed
- Ask pt to keep the foot down as you try to straight the leg

• Test extension at the knee

• Test dorsiflexion and planterflexion at the ankle

dosiflexion  Plantar flexion
Coordination

- Coordination requires that four areas of the nervous system function in an integrated way:
  - Motor system for motor strength
  - Cerebellar system for rhythmic movement and steady posture
  - Vestibular system for balance and coordinating eye, head, body
  - Sensory system, for position sense

• Rapid alternating movements (Cerebellar)

  In Arms:
  - Pat thigh alternating with palm and back of hand; tap sequential fingers
  - Tap the distal joint of the thumb with tips of index finger as rapidly as possible

  In Legs:
  Ask pt to tap your hand as quickly as possible with the ball of each foot in turn note any slowness
• Point to point movements (Cerebellar)
  – Check finger to nose and heel to shin
  – Observe accuracy and smoothness
  – Cerebellar incoordination gets worse with eyes closed
**Gait**

- Ask the patient to walk across the room, turn around, and then come back
- Walk heel to toe (tandem walking) (brings out subtle incoordination)
- Walk on toes, then on heels (tests strength and balance)

- Hope in place on each foot in turn
- Do shallow knee bend, in one leg then on the other
- Rising from a sitting position without arm support

**Ataxia:** uncoordinated or unsteady gate

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– **Stance (posture):**
  
  - **Romberg test:** test of position sense, patient stand feet together, eyes closed, for 20-30 sec. dose patient able to maintain upright position  
    - Positive: when lose balance, sways, widens base of feet to avoid falling  
  - **Pronator drift test:**  
    - stand for 20-30 sec, arms up, palms up, eyes closed;  
    - then instruct the patient to keep arms up, tap the arms briskly downward, the patient should be able to keep arms up back smoothly.  
    - Abnormal finding: downward drift of arm with flexion of elbow and fingers; or pronation of one arm (Corticospinal tract lesion).
Assessment of the Sensory System

- Careful sensory assessment helps to establish the level of spinal cord lesion and determine peripheral lesions.
- To evaluate the sensory system, several kinds of sensation are assessed:
  - Pain & Temperature (spinothalamic tracts)
  - Position and vibration (posterior columns)
  - Light touch (posterior columns and spinothalamic tracts)
  - Discriminative sensation (involve the cortex)
• Sensory testing quickly fatigues many patients and then produces unreliable results
• Therefore:
  – Pay special attention to areas where there are symptoms such as numbness or pain
  – Where there are motor or reflex abnormalities that suggest a lesion of the spinal cord or PNS
  – Where there are trophic changes (such as absent or excessive sweating)
  – Repeated testing at another time is often required to confirm abnormalities

• The following patterns of testing allow one to identify sensory deficits accurately and efficiently
  – Compare symmetric areas (arms, legs, trunk)
  – Compare the distal with the proximal areas of the extremities
  – When testing position and vibration, first test fingers and toes; if ok, ok everywhere
  – Vary the pace of testing
  – When you detect an areas of sensory loss, map out boundaries in detail (start from point of decrease sensation then move up)
• Pain: sharp or dull?, does this feel same as this?
  – Analgesia: absence of pain sensation
  – Hypalgesia: decreased sensitivity to pain
  – Hyperalgesia: increased sensitivity to pain
• Temperature: not necessarily performed if pain sensation is normal.
  – Hot or cold sensation?
• Light Touch: with a “wisp of cotton” touch skin lightly; avoid pressure.
  – Anesthesia: absence of touch sensation
  – Hypesthesia: is a decreased sensitivity to touch
  – Hyperesthesia: increased sensitivity to touch.

• Vibration: using low pitch tuning fork 128 Hz
  – Start from distal interpharangeal joints then at interphalyngeal joint of big toe
  – Be sure it is a vibration or pressure
  – If it is impaired proceed to more proximal bony prominences (wrist, elbow, medialmalleouls)
  – Common causes of lost of sensation of vibration is (DM, alcoholism, vitamin B₁₂ deficiency, posterior column disease)
• Position: using your thumb and index finger pull big toe “up” and “down”.

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Testing Pain Sensation

A

B

Testing Light Touch

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Assessing Vibration Sensation

Kinesthesia (Position)
• **Discriminative Sensations**: it is an additional technique to test the ability of sensory cortex to correlate, analyze, interpret sensations.

• **Performed while the pt eyes are closing**
  – **Stereognosis** (object identification by feeling)
  – **Graphesthesia** (number identification by feeling)
  – **Two-point discrimination**: increase distance between 2 recognizable points indicate lesion of the sensory cortex
  – **Point localization**
  – **Extinction**: ask patient if feels your touch when you simultaneously stimulate areas on both sides of the body.
Deep Tendon Reflexes

• To elicit:
  – Ask the patient to relax
  – Position the limbs properly
  – Hold reflex hammer between your thumb and index finger
  – Strike the tendon briskly, using a rapid wrist movement
  – You may use either the pointed or the flat end of the hammer
  – Note speed, force, and amplitude of reflex response and grade the response

Reflexes are graded 0 to 4+

- 4+: Very brisk, hyperactive, with clonus
- 3+: Brisker than average; possible by not necessarily indicative of disease
- 2+: Average; normal
- 1+: Somewhat diminished; low normal
- 0+: No response

- Hyperactive reflex indicate CNS disease
- Absent or diminished of reflex indicate loss of sensation, relevant spinal segment damage, or PN damage
**Reinforcement:**
- Used when the reflexes are symmetrically diminished or absent
- It leads to isometric contraction of other muscles that may increase reflex activity
  e.g. to test arm reflex ask pt to clench teeth or squeeze one thigh with opposite hand
  if leg reflex are absent ask pt to lock fingers and pull one hand against the other (pull just before strike)

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**Deep tendon reflexes**

- **Biceps reflexes (C5,6)**
  - Tested while pt is sitting or lying down
  - Observe flexion at elbow, watch and feel the contraction of biceps muscle
• **Triceps reflexes (C6,7):**
  - Pt may be sitting or supine
  - Watch for contraction of the triceps muscle and extension at elbow

• **Supinator or Brachioradialis(C5,6):**
  - Strike the radius with the flat edge, 1-2 inch above the wrist
  - Watch for flexion and supination of the forearm
• **Abdominal reflex**
  - Above umbilicus (T8,9,10), below umbilicus (T10,11,12)
  - Use wooden end of a cotton tipped applicator or the back of the hammer
  - Note contraction of Abd muscle and deviation of the umbilicus toward stimulus
  - May be absent in PN or CN disorder

• **Knee reflex (L2,3,4):**
  - Pt sitting or lying down
  - Tap patellar tendon under the patella
  - Note contraction of quadriceps and extension at the knee (placing your hand at the anterior thigh lets you feel this reflex)
**Ankle reflex (primarily S1):**
- If pt in sitting position, dorsiflex the foot at the ankle
- Strike the Achilles tendon
- Watch and feel plantar flexion at the ankle and the speed of relaxation after muscle contraction

**Plantar Reflex**
- Also known as the Babinski response
- Take key or end of the hammer and stroke the lateral aspect of the foot, curving medially against the ball
- Normal response planter flexion of the toes
- Upward motion of the toe is abnormal.
- +ve Babinski: the big toe dorsiflex, other toes fanning.
Ankle clonus:
- Used when reflexes are hyperactive
- Support knee in a partly flexed position
- The other hand dorsiflex and plantarflex the foot for a few times
- Encourage pt to relax. Then sharply dorsiflex the foot and maintain position.
- Look and feel for rhythmic oscillation between dorsiflexion and plantarflexion
- In normal people ankle does not react to this stimulus
- Sustained clonus indicate CNS disease
Testing for Clonus

Meningeal Signs

- **Neck Mobility**: pain in the neck and resistance to flexion indicate meningeal inflammation, arthritis, or neck injury
- **Brudzinski’s Sign**: positive if flexion of hip and knees as you flex the neck.
- **Kernig's Sign**: Positive if pain and increased resistance to extending the knee when flex leg at the hip and knee and then straighten the knee.
  - Both Brudzinski's and Kernig's sign suggest meningeal inflammation/irritation