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METHODS OF CHECKING NEUROLOGICAL STATUS

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Abstract: *The neurological examination is an assessment tool to determine a patient's neurologic function. It is beneficial in a variety of ways as it allows the localization of neurologic diseases and helps in ruling in or ruling out differential diagnoses. Neurological diseases can present a myriad of ways, including cognitive/behavioral, visual, motor, and sensory symptoms.*

Keywords: *Physicians, neurologic examination, certain symptom, intracranial pressure, younger children.*

Certain red flags during examination allow early detection of life-threatening neurologic diseases and recognize disorders that may negatively impact the quality of life.[1]

The neurologic examination is useful in both ambulatory and emergency settings. It provides the physician a tool to recognize neurologic involvement in certain disease states, and thereby allow proper work-up and treatment for these patients. It is also beneficial in intensive care units, particularly in monitoring neurologic sequelae of diseases like strokes, intracranial tumors, and traumatic brain injury.[2][3] In emergent settings, rapid assessment of the severity of an injury and neurologic involvement is crucial and leads to fast decision-making in patient management, as well as improvement of patient survival rates.[4]

The neurological exam can be intimidating and challenging to perform for most physicians. It is particularly challenging to perform in certain age groups like infants, younger children, and older uncooperative adults.[5] In the examination of a pediatric patient, proper diagnoses begin with understanding which specific age groups are prone to developing certain disease processes. It is also important to keep in mind that the manifestation of certain neurologic illnesses can be vastly different in children and adults.

The assessment of how a patient feels about their symptoms can provide a better insight into their quality of life.[6]

Physicians encounter an extensive range of patients with different illnesses daily. These can range from relatively benign to life-threatening conditions. This range of potentials highlights the importance of a physician's ability to recognize red flags early on in the disease processes. These red flags are picked up in history or during a neurological examination. A good example would be a patient who presents with chronic headaches, which can be a benign condition like migraine or life-threatening like a tumor. The presence of nausea and vomiting in the patient's history may still be present in migraines or may be a sign of increased intracranial pressure. An abnormal neurological examination can then direct the physician to the diagnosis (e.g., ataxic gait in these patient points to a cerebellar lesion). The physician can then refer the patient for appropriate diagnostic imaging and direct the management.[7]

Recognizing red flags can be challenging for physicians, particularly when it comes to neurologically related disorders. The complexity of the neurologic examination, the interpretation of results, and the correlation to the neuroaxis are often challenging. This fact highlights the need for increased awareness of what constitutes a proper neurological examination and what each specific finding suggests. It is also important to note that some positive results, especially in isolation, can be a normal variant.

A neurological examination should also be tailored and focused on specific disease presentations. Certain maneuvers can be incorporated to increase the sensitivity of an exam for a certain symptom; an elderly patient with memory deficits will require a more in-depth cognitive assessment than a young patient with ptosis.

A basic neurologic examination can be performed rapidly with practice. The presence of an abnormal result usually warrants further investigation and referrals to specific specialties. It helps to recognize and therefore manage diseases earlier in their course. A complete neurologic examination should contain an assessment of sensorium, cognition, cranial nerves, motor, sensory, cerebellar, gait, reflexes, meningeal irritation, and long tract signs. Specific scales are useful to improve interobserver variability.

Glasgow Coma Scale

The Glasgow coma scale (GCS) is a standard to determine the level of awareness in trauma or critically ill patients who present with impaired consciousness. It is a 15 point scale that gives a general idea of the extent of brain injury. [12] The GCS is divided and scored according to eye-opening, verbal response, and motor response. The eye-opening response is scored as spontaneous – 4, opens to verbal command – 3, opens to pain – 2, and no response – 1. The verbal response is scored as oriented – 5, confused – 4, inappropriate responses – 3, incomprehensible sounds – 2, and no response – 1. The motor response is scored as obeys commands – 6, spontaneous movement or localizes to painful stimuli – 5, withdrawal from pain – 4, abnormal flexion (decorticate) – 3, abnormal extension (decerebrate) – 2, and no response – 1. The scores are added and classified as follows: Minor brain injury – 13 to 15 points, moderate brain injury- 9 to 12 points, and severe brain injury- 3 to 8 points.[8]

Mental Status

The mental status examination begins during the interview. Assessment of the patient's cognitive abilities such as language usage, chronology in the recollection of events, and significance of answers will give a clinician a general feel of the patient's condition. A quick mental status exam may involve asking for orientation to time, place, and person. A healthy patient is recognized to be "awake," "alert" (responding appropriately), and "oriented" (aware of self, place, and time). If disorientation or memory lapses (especially in the elderly) are present, a mini-mental status examination can be done. This will assess further the patient's orientation, registration, attention, recall, language, repetition, complex commands, and visuospatial function. Any abnormality in a specific function may warrant further investigation that is not covered by this article. Abnormalities in these areas can point to lesions in specific areas of the cortex (e.g., difficulty in repetition may involve the arcuate fasciculus of the dominant hemisphere—the pathway between Wernicke's area and Broca's area). Mood and affect also require assessment.[9]

Cranial Nerves

The cranial nerves innervate the structures in the head and neck. The olfactory nerve and optic nerve exit from the cerebrum. The cranial nerves 3 to 12 exit from the brainstem. Abnormality in cranial nerve function helps in localizing the lesion to a specific level of the brain or brainstem. Cranial nerves have motor, sensory and autonomic functions. It is important to note that, in general, a singular cranial nerve deficit points to a lesion of the peripheral nerve. A lesion in the brainstem, being a busy structure, will involve multiple cranial nerve deficits, as well as motor and sensory tracts to the extremities.

Olfactory nerve (Cranial nerve I) - This is the least tested of cranial nerves in the clinical setting. To test function involves the assessment of the patient's sense of smell. Start with one nostril while covering the opposing nostril to allow for proper detection of any abnormal findings. Do this for both sides. The most common causes of anosmia, the loss of smell, are the following: infections, allergies, or nasal polyps. Other causes include trauma (fracture of the cribriform plate), Parkinson disease, lesions at the base of the skull (meningioma), or rare genetic conditions.[10]

Optic nerve (Cranial nerve II) – Assessment of the optic nerve function includes a test for visual acuity and visual fields. Each eye is tested separately. Most problems with visual acuity are ophthalmologic in origin; however, damage to this nerve, like pseudobulbar neuritis or pressure from a pituitary tumor, can present with monocular blindness and visual field cuts. The extent of involvement will depend on what they can see during the examination as compared to the baseline. Furthermore, the pupillary light reflex can be tested by shining a light directly into the eye. The afferent limb of this reflex is found on the optic nerve; the sensory input. Shining a light on one eye should show a constriction of the pupils on both eyes. The failure of the pupils to constrict could indicate either an optic nerve lesion, a lesion of the efferent limb (oculomotor nerve), or any lesion along the pathway. A dilated pupil that is unresponsive to light may indicate a lesion on the efferent limb of the pathway, while a constricted pupil can point to a lesion on the cervical sympathetic chain. A fundoscopic examination is also done to visualize the optic disk. Abnormalities like papilledema or retinal hemorrhages are red flags that can point to life-threatening conditions like increased intracranial pressure and subarachnoid hemorrhage.

Oculomotor, trochlear, and abducens nerves (Cranial nerve III, IV, and VI) are the nerves for extraocular muscle movement. Assessment involves drawing an invisible "H" in front of the patient and asking the patient to follow with their eyes. Abnormal findings present as disconjugate gaze or double vision. The involvement of the third cranial nerve by compression (aneurysm of the posterior communicating artery) leads to dilated pupil, ptosis, and eyes looking outward and downward. Lateral rectus palsy is due to the involvement of the sixth cranial nerve; it can be a false localizing sign in increased intracranial pressure (bilateral lateral rectus palsy). The involvement of the pathways in the brainstem (e.g., lacunar infarct, multiple sclerosis) can lead to internuclear ophthalmoplegia. This condition occurs when the medial longitudinal fasciculus (MLF), a heavily myelinated pathway that allows for coordinated horizontal gaze, is damaged.

Trigeminal nerve (Cranial nerve V) – this nerve supplies the sensation to the face, the motor nucleus is responsible for biting and chewing. Assessment of this nerve involves asking the patient to clench their jaw and test for the sensation of the ophthalmic, maxillary, and mandibular branches. Therefore, a weakness of the muscle of mastication or sensory deficit on the ipsilateral side suggests its involvement. This is also the afferent pathway for the blink reflex (the efferent pathway being the facial nerve). A corneal reflex is usually performed in comatose patients to assess brainstem function. An absence in an awake patient may point to a localized lesion affecting either the trigeminal nerve the facial nerve or both.

The facial nerve (Cranial nerve VII) supplies the muscles of facial expression, stapedius muscle, and taste to the anterior two- of the tongue. Assessment of this nerve involves asking the patient to move their facial muscles by asking them to raise their eyebrows, close their eyes tightly, smile, and blow up their cheeks. The location of weakness in facial muscles can differentiate between peripheral or central involvement. A weakness with the movement of the entire right side of the face is indicative of either a peripheral lesion or damage to the facial nucleus on the ipsilateral side, like in Bell's palsy or a pontine infarct. A weakness of the lower half of the face with sparing of the forehead is suggestive of a lesion above and contralateral to the facial nerve (stroke involving the motor cortex). This is because the forehead has innervation from both the left and right sides of the motor cortex. Damage to the facial nerve can also present with hyperacusis and loss of taste to the anterior 2/3 of the tongue.

The vestibulocochlear nerve (Cranial nerve VIII) supplies functions in hearing and equilibrium. Gross assessment of function can be done by whispering words behind the patient, rubbing fingers or hair together close to the ear, and asking if the patient can hear. If a hearing deficit is established, doing a Weber and Rinne test can differentiate sensorineural from conductive hearing loss. A normal Rinne exam will exhibit air conduction (AC) greater than bone conduction (BC). A conductive hearing loss will show BC greater than AC. In patients with sensorineural hearing loss, AC will be greater than BC, but for a shorter duration when compared to a normal subject. A normal Weber test shows hearing the sound/vibration equally in both ears. A conductive hearing loss will lateralize the sound to the abnormal ear while a sensorineural hearing loss will lateralize to the normal ear.

The glossopharyngeal and vagus nerves (Cranial nerve IX and X) innervate the pharynx and posterior third of the tongue. The vagus nerve innervates the pharynx, larynx, and gastrointestinal tract motility and function. Assessment of these nerves includes listening as the patient talks, watching out for hoarseness, or nasal speech. The patient can also be asked to swallow some water and observed for coughing or gurgling speech, which may indicate weakness of the muscles involving swallowing. Ask the patient to open the mouth and say "ah," and observe the palatal arch for asymmetry. The deviation of the uvula to one side indicates a vagal nerve lesion on the opposite side.

The spinal accessory nerve (Cranial nerve XI) innervates the muscles of the thorax, back, and shoulders. Assessment involves asking the patient to turn their head to the side against resistance and shrug their shoulders. The weakness of the sternocleidomastoid or atrophy of the trapezius muscle may indicate involvement.

The hypoglossal nerve (Cranial nerve XII) innervates the motor component of the tongue. Assessment involves inspection of the tongue in the relaxed position inside the mouth, the presence of increased corrugation and fasciculations may indicate a lower motor neuron involvement. Also, ask the patient to stick out the tongue, the deviation to one side is indicative of a lesion on the same side.

Motor Exam

The inspection of the muscles is the first step in doing the motor examination. Any visible scars, deformities, fasciculations, and asymmetry (swelling or atrophy) should be noted. This is followed by palpation to assess for mass lesions or tenderness if present.

The range of motion (ROM) is used to assess tone and helps localize injury or disease to the joints or muscles. On doing the passive ROM, the physician check's for flaccidity, spasticity, and rigidity. The active ROM can give a clue to strength and pain-related causes of decreased range. The presence of spasticity or flaccidity can help differentiate an upper motor neuron from a lower motor neuron cause of weakness, while the presence of cogwheel rigidity points to a specific disease like Parkinsonism.

Finally, the assessment of muscle strength is done. The manual muscle testing is scored as follows: 0 - None: No visible or palpable contraction, 1 - Trace: Visible or palpable contraction (only slight), 2 - Poor: Full ROM with gravity eliminated, 3 - Fair: Full ROM against gravity, 4 - Good: Full ROM against gravity with moderate resistance, and 5 - Normal: Full ROM against gravity with maximum resistance.

Assessment of muscle strength should occur in an orderly fashion. Testing should be done to differentiate proximal from distal muscle weakness, as well as compare the left and right sides. The location of the weakness concerning other neurologic deficits can help differentiate a cortical lesion (hemiplegia from a stroke), from a brainstem lesion (crossed deficits from an MS plaque), from a spinal cord lesion (presence of dermatomal level), from a peripheral nerve lesion (neuropathy or radiculopathy), and a muscular disease (myasthenia gravis).

Sensory Exam

The sensory exam involves the assessment of patient-reported symptoms that includes a diminished or exaggerated perception of sensation. Modalities tested include pain, temperature, vibration, and position sense. The location and pattern of sensory deficits are also helpful in localization. Pain sensation is assessed by using a sterile pin and test for sharpness or dullness. A tuning fork can be used to evaluate vibration sense. A piece of cotton can serve to assess for light touch, while the assessment for position sense can be done by testing the distal phalanx and asking the patient the position of the digit with eyes closed. An abnormal sensation can involve the sensory cortex, the thalamus, the brainstem, the spinal cord, and the peripheral nerves. Cortical lesions present with diminished sensation on the contralateral side, spinal cord lesions present as a sensory level, radiculopathies involve a specific dermatome, and neuropathies can have a glove and stocking distribution.

Gait

The assessment of a patient's gait can be as simple as watching the patient walk into the room. It is essential to keep in mind that gait changes can be brought about by several factors, including weakness, neuropathies, arthritic changes, excess weight, and pain. A specific gait disorder that is recognized can point to a particular disease process or neurologic involvement.

Assessment of the gait involves observing the stance, the stride, the balance, and the heel strike. Balance and strength could have further evaluation by asking the patient to walk on their tiptoes or heels and walking in tandem (the heel of the front foot touching the toe of the back foot in a straight line). Recognition of an extensive list of different gaits linked to various pathologies is crucial in the early detection of neurological diseases.Assessment of the gait also allows an understanding of a patient's level of functioning.

Some common abnormal gait recognized includes:

- Antalgic gait - altered gait due to pain, such as "limping."
- Paretic gait - due to partial paralysis/weakness (e.g., steppage gait)
- Spastic gait - due to stiffness of the limbs
- Ataxic gait - broad-based and uncoordinated gait, might be due to cerebellar or sensory involvement.
- Hypokinetic - shuffling and slow gait, might be due to basal ganglia involvement.
- Dyskinetic - disturbance due to involuntary movements like dystonia or athetosis

Deep Tendon Reflexes

The assessment of the deep tendon reflexes can be done by tapping a specific tendon with a reflex hammer and observing for a reflex muscle contraction. These tests a specific spinal cord level (biceps C5-C6, triceps C7, knees L3-L4, ankles S1-S2) and help in localizing the level of a lesion. Reflexes are scored as follows: 0 - absent, 1+ - trace, 2+ - normal, 3+ - brisk, 4+ - nonsustained clonus, and 5+ - sustained clonus.

Decreased deep tendon reflex is usually suggestive of a lower motor neuron lesion, like radiculopathy, but may also occur in spinal shock. On the other hand, the presence of hyperreflexia and clonus points to an upper motor neuron lesion.

Other reflexes include the Babinski reflex and the Hoffman reflex. The Babinski reflex involves stimulation of the lateral plantar aspect of the foot, the presence of an upgoing big toe indicates a positive result. Variations of this reflex include Chaddock reflex - stimulation of the lateral aspect of the foot, Oppenheim reflex - stroking the anterior and medial tibia downward, and Gordon reflex - squeezing the

calf muscle; the presence of the upgoing big toe indicates a positive response. On the upper extremity, a Hoffman reflex can be done by flicking the distal digit of the middle finger with the positive response being the involuntary flexion of the other fingers, including the thumb. A positive Hoffman reflex indicates cervical cord involvement. A positive response in these tests helps differentiate an upper motor lesion from a lower motor lesion.

Meningeal Signs

The presence of meningeal signs reflects an irritation of the meninges. Maneuvers include assessment of nuchal rigidity by passive flexion of the patient's neck, and the presence of pain and resistance indicates a positive result. Other maneuvers include the Kernig sign, where a passive extension of the knee while the leg is flexed at the hip in a supine patient causes pain, and the Brudzinki sign, where passive neck flexion causes reflex knee flexion in the supine position. The usual causes of meningeal irritation include CNS infections and subarachnoid hemorrhage.

It is crucial to remember that when examining a patient, a focused physical and neurologic exam is complementary to a detailed history and is key in achieving proper diagnoses.

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