

Introduction to the Neurologic Examination

Learning Objectives:

- Develop a screening neurologic examination suitable for use in a primary care setting
- Understand normal findings and their variations from this exam
- Recognize common abnormal findings and their significance
- Apply the results of a screening neurologic examination to the workup of a patient's complaints

Overview:

The neurologic examination is one of the most detailed physical examinations still in use today. While many elements of the general physical examination have been supplanted by more sensitive and specific pieces of technology (ear now replaced with ultrasound,) the neurologic exam remains a valuable tool, with few alternatives.

It is important to keep in mind that there is no such thing as a 'complete neurologic exam.' Each patient is examined as an individual and the exam is tailored to their complaints and the information obtained during your history taking. Of course, this is true of all forms of physical exam, but there is a nearly endless number of specialized examination techniques and neurological examinations must strike a balance between focus and breadth.

Today we will focus on what most would consider the bare minimum components of a thorough screening neurologic examination.

Approach to patients with neurologic complaints:

1. Take an appropriately thorough history
2. Design and execute a focused neurologic examination, appropriate to the presenting complaint, condition, and setting
3. **Record these findings in a standardized format**
4. Localize the lesion(s)*
5. Determine working diagnosis and a differential for that diagnosis
6. Develop appropriate plan

* This is the extra step that will make you a competent neurologic investigator

Components of a Neurologic Exam

1. Mental status
2. Cranial nerves
3. Motor
4. Coordination and Gait
5. Sensory
6. Reflexes

Goals of Neurologic Assessment for Primary Care Physicians

1. Localize the lesion(s) to determine working diagnosis
2. Determine degree of acuity and seriousness
3. Determine need for consultation with/referral to specialist

Tools required for a Neurologic Exam

1. Small vial of ground coffee (or bar of soap) [for CN I] (only if you're legit)
2. Ophthalmoscope
3. Rosenbaum chart
4. Tuning forks [128 Hz (one with weight on tines) for temperature and vibration, 512 Hz for hearing]
5. Reflex hammer – queen square or Tromner, never show up to a clinical rotation with that orange triangle thing.
6. Cotton swabs and cotton wisps
7. Familiar objects like coin, keys, paper clip

But first, and always first, HISTORY:

History in a patient with a neurologic complaint

- Formulate an impression of the patient while taking the history
 - o Patient's description of symptoms, collateral history/corroboration if needed
 - o Temporal course/other aspects of OLD CARTS as appropriate
 - o Family history: Include FH of neurologic disorders such as genetic disorders, stroke, epilepsy, migraine
 - o Past medical history illnesses
 - o Relevant ROS such as unintentional weight loss
 - o Drug use and abuse and toxin exposure
- *Elements of neurologic history aligned with neurologic exam elements: a neurologic ROS*
 - o Basic Neuro PMH:
 - Headaches? Other pain? Seizure or seizure disorder? Lost consciousness? Have you ever fainted?
 - o Mental Status:
 - Cognition: Any trouble with memory? Trouble thinking?
 - Mood: Any changes in your mood, like being depressed? [or behavior?]
 - Sleep: Trouble getting to sleep? Staying asleep?
 - o "Cranial Nerves" (plus other parts of nervous system)
 - Trouble with vision? With hearing?
 - Any "dizziness"? If yes, clarify as light-headedness? Spinning/sense of movement? Unsteadiness? Other...
 - Any difficulty with speech? Trouble swallowing?
 - o Motor
 - Tremors? Other involuntary movements?
 - Weakness? Paralysis?

- Coordination and Gait:
 - Any trouble with coordination of your arms or legs?
 - Any problems with losing control of your bowel? Of your bladder?
 - Unsteadiness when you walk?
 - Any other type of problem with your walking?
- Sensory
 - Pain
 - Numbness? Tingling?

Neurologic Examination:

1. General: describe the patient's general appearance. This is the most qualitative component of your examination. Keep it free form but remain descriptive.
 - Are they well appearing?
 - Are they unkempt?
 - Do they appear much older or younger than stated age?
2. Mental Status:
 - Level of consciousness – ranges from alert (normal) to coma. There is variability in the terms used by different clinicians when it comes to the levels in between: stupor, lethargic, drowsy, and obtunded. It is best to avoid the words 'lethargic' and 'drowsy' as their technical definitions are not as widely accepted.
 - Obtundation – the patient is not alert, with lessened interest in their environment. The level of impairment is mild-moderate, with more tendency towards sleep and drowsiness in between.
 - Stupor – the patient is severely impaired, asleep by default. This state is similar to sleep, except the patient cannot be fully aroused by all but intense stimulation, and even then often does not fully awaken.
 - Coma – unarousable unconsciousness. This is distinct from sleep, not to be thought of as ultra-deep sleep. Patients may make only reflexive movements. Eyes are closed
 - Orientation – this refers to the patient's understanding of where they are in time and space. Commonly reported as 'oriented x 4,' meaning that the patient was able to demonstrate knowledge of 4 different axis of orientation. Some standard orientation questions include:
 - Where are you?
 - Who are you?
 - What is the date today?
 - Who is the president?
 - Why are you here? (Situational orientation)
 - Language – a bedside language examination is helpful in assessing different types of aphasia. The language exam is distinct from the speech exam and is focused on the cognitive aspects of speech.
 - Naming – ask the patient to name a few objects in the room

- Repetition – ask the patient to repeat a phrase. I usually use ‘today is a sunny day.’
- Comprehension – this is usually indirectly assessed throughout your interaction with the patient. When directly assessing comprehension, you will ask the patient to follow simple and multi-step commands such as
 - Close your eyes (midline command)
 - Raise your arms (appendicular command)
 - Take this piece of paper with your left hand, fold it in half, and place it on the ground (multi-step command)
- Fluency – also indirectly assessed, looking for stuttering, word-finding difficulty, and/or paraphasic errors.
- Speech – quality of speech, more interested in the motor components of speech.
 - Dysarthria – multiple types but beyond the scope of the screening exam. This is commonly referred to as slurred speech.
 - Prosody – rhythm of speech. Some patients with cerebellar disorders can take on a monotonous rhythm called ‘scanning dysarthria.’
 - Volume – patients with hypokinetic disorders such as parkinsonism frequently develop hypophonia, where their speech becomes soft and quiet, worsening as they go.

3. Cranial Nerves:

- CN I Olfactory Nerve – not frequently tested.
 - Important to use non-noxious stimuli such as coffee, light perfumes, citrus. Noxious stimuli like alcohol or other solvents may cause a false negative finding of intact sense of smell.
 - A standardized, reliable, and validated test called the University of Pennsylvania Smell Identification Test is available for use, utilizing scratch offs. It is not used in routine clinical practice.
 - Deficits of CN I are referred to as ‘anosmia’ or ‘hyposmia,’ meaning total loss of smell and reduced loss of smell respectively. This can be seen in head injury, neurodegenerative diseases such as Parkinson’s disease, and more recently are recognized as a common symptom of SARS-COV-2 infection.
- CN II Optic Nerve
 - Visual Fields - For screening, both eyes can be tested together, but if there is a vision complaint they should be tested individually. You will ask the patient to look at your nose, standing about 2-3 feet apart. Holding your hands up equidistant between you and the patient, you can ask them to tell you the number of fingers you are holding up in each of the four quadrants of vision. If you maintain your hand placement about halfway between you and the patient you can be confident that they are seeing what you are seeing.
 - Fundoscopic exam – covered by Dr. Feinberg. Briefly, using a direct ophthalmoscope you will look at the retina, optic disc, macula, and vasculature. Of particular interest in a neurologic exam you will look for disc edema, which

can be either papilledema or true optic disc edema. Papilledema refers to swelling of the nerve fiber layer due to elevated intracranial pressure. Other types of disc edema include inflammation from optic neuritis, infiltrative diseases, ischemic/vascular disease, and others. Disc atrophy may also be seen as a consequence of an old optic nerve lesion.

- Not pupils – while CNII is the first arm of the reflex arc, the pupil examination is grouped with CNIII as it is controlled by sympathetic and parasympathetic fibers running with CNIII.
- CN III, IV, VI. Oculomotor Nerve, Trochlear Nerve, and Abducens Nerve
 - Pupils – assess for reactivity to light both directly and indirectly. The pupils should be roughly equal in size (within 1mm.) The pupils should be round.
 - Accommodation – this refers to the ‘accommodation reflex’ which includes pupil constriction, lens accommodation, and convergence of the eyes. Tested by slowly bringing your finger towards the patients nose while having them focus on it. You can observe the pupils constricting and the eyes converging but you cannot directly observe accommodation. Some people get picky about this so just tell them that when you said you testing accommodation, you were referring to the reflex, not the lens change.
 - Extraocular movements – like visual fields, this should be tested individually when indicated, but for screening purposes both eyes can be tested together. Moving the finger slowly in an H pattern, or better in a six-speed pattern. Observe for any dysconjugate movements and solicit the patient for any complaints of double vision.
 - Nystagmus – these are quick, involuntary movements of the eyes with a fast phase in one direction and a slow phase in the opposite direction. Some small amount of end-gaze nystagmus (a few beats,) is normal in the extreme lateral eye movements. Up or down-gaze nystagmus is always pathological and should be considered as an indication of a CNS lesion.
 - Saccades – quick, voluntary eye movements. Test by holding index fingers and ask the patient to quickly move their eyes between the two targets. Do this horizontally and vertically. Deficits of vertical saccade movements with preserved horizontal saccades is indicative of a mid-brain lesion.
- CNV Trigeminal Nerve – facial sensation.
 - Test with light touch in V1, V2, and V3 distributions on both sides.
 - Deficits of CNV do not usually manifest with pure midline splitting, and a finding of such can indicate a non-organic etiology of a patient’s complaint.
 - A jaw jerk (tapping on a half-way opened, relaxed jaw at the chin,) can be tested but is usually included in the reflex examination section.
 - Other aspects of CNV are not routinely tested such as jaw proprioception or muscles of mastication weakness as they mostly lack localizing value.
- CN VII Facial nerve – facial strength

- Ask patient to:
 - Raise their eye brows
 - close the eyes strongly, as if they got soap in the eyes. You can check eye opening resistance with this.
 - Smile largely, show teeth.
 - Can add in taste sensation with a lemon stick (available in hospitals)
 - Can check for hyperacusis with finger rub in each ear, or with tuning fork. Patients with true hyperacusis will usually move away from the tuning fork rapidly, be sure to have the bedrails up.
 - CN VIII Vestibulocochlear Nerve
 - For screening, it is sufficient to rub your fingers lightly by each ear and ask the patient if they can hear it and if it is equal on both sides.
 - To differentiate between sensorineural from conduction hearing loss:
 - Rinne test: compare each ear with 512 hz tuning fork for both air conduction and bone conduction.
 - Air conduction: hold the ringing tuning fork by each ear.
 - Bone conduction: placing bottom of tuning fork on mastoid process.
 - A normal test is Air > bone conduction.
 - Weber test for localization. Performed by placing ringing tuning fork on forehead or bridge of nose. Ask patient if sound is equal in both ears.
 - CN IX, X: glossopharyngeal Nerve & Vagus Nerve - uvula and soft palate assessment
 - Uvula should be midline and the soft palate should have a roughly equal arch on each side.
 - CN XI Spinal Accessory nerve:
 - Can be assessed by having the patient shrug the shoulders. Observe for equal rise and for a lag. Can check strength by testing resistance.
 - CN XII Hypoglossal Nerve:
 - Have the patient protrude the tongue, observe if it deviates from midline.
 - It will deviate towards the weaker side.
 - If assessing for tongue fasciculations, such as might be seen in ALS, check with the tongue relaxed in the mouth.
4. Motor Examination:
- Movement: Observation for too much (tics, tremor, chorea, etc.) or too little
 - Muscle bulk: An aspect of the muscle tissue
 - Inspect and palpate upper arms, forearms, and small muscles of hand (dorsal and palmar surfaces)
 - Inspect and palpate thighs, calves and dorsum of feet

- To best detect generalized atrophy, look at muscles that are not affected by exercise (small muscles of hand)
- Tone - check by having the patient relax their extremities to the best of their abilities, and passively move the limb. It is helpful to move it in a chaotic pattern so that the patient has difficulty anticipating the direction of movement. Axial tone can also be tested by having the patient relax their neck and passively have their head tilted/turned/flexed.
- Strength - Muscle strength: Record on scale of 0/5 to 5/5
 - 0= No muscular contraction detected
 - 1= A barely detectable flicker or trace of movement
 - 2= Active movement of the body part, with gravity eliminated
 - 3= Active movement against gravity
 - 4= Active movement against gravity with some resistance
 - 5= Active movement against full resistance without evident fatigue
 - Some will include 4+/5 and 4-/5 to indicate subtle strength differences between each side, though this is imprecise. It is better to use the above scale and simply comment on your examination that a patient had, for instance, 4/5 strength bilaterally at the biceps with greater resistance on the left.
- Rapid alternating movements - these are tests of basal ganglia and cerebellar function.
 - Have the patient tap the thumb and index finger quickly, observing for maintenance of rhythm, speed, and amplitude. Similarly this can be assessed with supination/pronation, open/close fist.
 - Irregularities of varying rhythm and speed can be signs of cerebellar dysfunction, which a decrementing speed and amplitude localize to the basal ganglia.

5. Sensation: Individual modalities should be tested throughout.

- Light touch - can use cotton tip or your hands
- Temperature - can use metal object like your reflex hammer or tuning fork
- Vibration - use a 128hz tuning fork base, test at the great toe first before moving more proximally. Very mild distal vibration loss can be normal in advanced age.
- Proprioception - ask the patient to close their eyes. Hold the great toe at the interphalangeal joint on the lateral sides and move the great toe up and down. Ask the patient to identify the direction of movement.
 - Even small movements should be perceptible in a healthy adult. Take care to grip only the lateral aspects of the toe as pressure on the plantar surface or nail bed can give away the direction of movement when proprioception is poor.
- Romberg test - have the patient stand in front of you with feet naturally distanced (don't ask them to put the feet together.) Assess the tendency to sway with eyes open and compare with eyes closed.

- A worsening sway with eyes closed is a positive test and indicates a deficit in proprioceptive pathways, sometimes called a sensory ataxia.
- https://www.youtube.com/watch?v=XVGx_NZ1pJQ
- CORTICAL sensory modalities: Can the brain put together sensory information for higher level interpretation? Can only test these if associated PRIMARY sensory modalities are intact
 - Test stereognosis: With eyes closed, identify common object (coin, key, paper clip) placed in hand bilaterally
 - Test graphesthesia: With eyes closed, have patient identify number or letter written in palm of hand bilaterally
 - Two point discrimination: Differentiate two closely spaced points
 - Test for “extinction”: Does one stimulus “block” another? The blocked (“ignored”) side is the abnormal one.
 - Double simultaneous stimulation: Identical stimulus on both sides simultaneously. Patient identifies only the stimulus presented in the normal side (or visual field)

6. Coordination:

- Finger-nose-finger - hold out your index finger and ask the patient to touch their nose, then touch your finger. Keep your finger in the same place. Observe the accuracy of the end points and the pathway in between. Do not move your finger. Test both sides
- Heel to shin - have the patient place their heel on the opposite shin, and move it quickly up and down the shin. Observe for accuracy of placement and ability to keep the heel on the shin during the movement. Test both sides.

7. Reflexes: One of the most powerful tools in the neurologist’s toolbox. It provides indispensable localizing value to the examination of weakness. This is a test of the muscle stretch reflex, initiated by the muscle spindle. Also called the myotatic reflex. Also called the deep tendon reflexes (unfortunately a confusing title, as it is not a golgi tendon reflex.) Stretch reflexes should be checked at:

- Biceps (C5/C6)
- Triceps (C7)
- Brachioradialis (C5/C6)
- Patella (L2-L4)
- Achilles (S1)
- Optional - medial hamstring (L5)
- Rating reflexes:
 - 0 = no reflex
 - 1+ = can only get reflex with Jendrassik maneuver (voluntary contraction of other muscles—can put a “J” after the #)
 - 2+ = normal
 - 3+ = increased
 - 4+ = clonus (muscle contracts multiple times after one strike)

- Babinski Reflex: nociceptive reflex of the lower extremity. The bottom of the foot is stroked with moderate intensity, in a C-shape around the lateral aspects of the plantar surface.
 - I prefer to document the direction of the great toe, which would be up-going (abnormal) or down-going (normal).
 - A normal response in a healthy adult is for the great toes, and to variable extent the rest of the toes, to curl down or flex.
 - Normal (downgoing, flexor, negative Babinski):
<https://www.youtube.com/watch?v=9nNb32VWA7Q>
 - An abnormal response is a fanning out and upward movement of the great toe. Many people refer to this as a positive or negative babinski, which is needlessly confusing.
 - Of note, babies have upgoing toes for anywhere between 6 months and 2 years, and it is perfectly normal.
 - Abnormal (upgoing, extensor, positive Babinski):
<https://www.youtube.com/watch?v=ZFu7bdbnZx8>
- Hoffman's sign: Indicates an UMN lesion
 - Hoffman's sign in UE has same significance
 - <https://www.youtube.com/watch?v=xfguBiqsoDk>
- Gait: Similar to reflexes, gait is a powerful assessment tool, relying on many neurological systems working in coordination. Gait is both a voluntary and automatic movement. There are many different pathologic gait patterns which can be recognized quickly, sometimes before the patient has even reached the exam room.
- Important aspects of gait to include in your exam are:
 - Posture - upright, stooped, hyperextended
 - Stride length
 - Stance - normal width is 1 - 3 inches, widened can indicate cerebellar or proprioceptive dysfunction. Overly narrow gait can indicate spasticity in the lower extremities
 - Pace - neurodegenerative diseases like parkinson's disease can cause abnormalities of pace, where a patient may be very slow to start, have intermittent freezing, or festination (speeding up to catch up with a forwardly displaced center of gravity.)
 - Arm swing may be reduced, or take on abnormal twisting postures with dystonia
- A normal turn is a quick 1 - 2 step pivot. If a patient takes several steps to turn around, moving the whole body with each step, this is called 'en bloc' turning and is again associated with parkinsonian disorders.
- Heel and toe walking are helpful for assessing plantar and dorsiflexion strength in the lower extremity
- Asking a patient to run is an excellent challenge to gait which can reveal non-organic gait problems.

- Walking is an automatic movement which can sometimes be the only way to get someone to truly relax their upper extremities, revealing subtle involuntary movements or abnormal postures.
- Great resources on gait:
 - Characteristics disorders of gait:
<https://stanfordmedicine25.stanford.edu/the25/gait.html>
 - Hemiplegic: circumduction of leg, stiff knee, scraping of shoe
<https://www.youtube.com/watch?v=BtqWxBUd94I>
 - Spastic paraplegic: slow, stiff, delayed hip flexion
<https://www.youtube.com/watch?v=OD7y6l9NwpQ>
 - Steppage gait: flopping feet, feet lifted higher than necessary
https://www.youtube.com/watch?v=ny0b_Audmak
 - Sensory ataxia: feet wide apart (=wide base), uneven steps, heavy heel strikes and foot stamping <https://www.youtube.com/watch?v=nJ5yH29pb20>
 - Cerebellar: wide base, irregularity, reeling, staggering on turning
<https://www.youtube.com/watch?v=eBvzFkcvScg>
 - Parkinsonian (festinating): stooped posture, short steps, acceleration, chasing center of gravity <https://www.youtube.com/watch?v=nbl7-bzp9gg>