So, what brought you over to see me today?

Your learning objectives for mastering the examination of the cranial nerves and motor system are:

- review the three important principles guiding the neurologic examination, being: Is the mental status intact? Are right-sided and left-sided findings symmetric? If the findings are asymmetric or otherwise abnormal, does the causative lesion lie in the central nervous system or in the peripheral nervous system?

- Identify and test the integrity of the 12 cranial nerves.

- Master testing of the motor system, especially muscle strength but also movement, bulk, tone, and cerebellar function.

- Learn to grade muscle strength.

- Note that cerebellar function includes rapid alternating movements of the arms and legs, point-to-point movements from finger to nose, and heel to shin, and gait.

**Health History**

By eliciting the patient’s concerns before the examination, you prepare for an examination that is efficient and productive.

Common or concerning symptoms relating to the nervous system include: headache; dizziness or vertigo; generalized, proximal, or distal weakness; numbness and abnormal or loss of sensation; loss of consciousness, fainting, or syncope; seizures; tremors; and involuntary movements.

In clinical practice, a neurologic examination begins with an assessment of mental status. Specifically, now is a good time to observe the patient’s appearance and behavior, speech and language, mood, memory, and orientation.

Please refer to Chapter 5: Behavior and Mental Status in Bates’ 11th edition for an in-depth discussion of formal testing of mental status.

**Anatomy Review—Cranial Nerves**

Let’s briefly review the location of the cranial nerves within the peripheral nervous system.
The peripheral nervous system consists of both cranial nerves and the peripheral nerves projecting from the spinal cord.

Twelve pairs of cranial nerves emerge from within the skull and mediate complex motor and sensory functions. Cranial Nerve I and II are actually fiber tracts emerging from the brain. Cranial Nerves III through VII arise from the diencephalon and brain stem. Several of the cranial nerves are specialized, producing smell, vision, or hearing.

**Examing Cranial Nerves I–XII**

With the patient’s health history in mind, and after good hand hygiene, you are ready for the physical examination.

To examine the cranial nerves, you may begin with Cranial Nerve I, the olfactory nerve, which mediates the sense of smell.

If you do assess its function, first be sure each nasal passage is open by compressing one side of the nose and asking the patient to sniff through the other.

With his eyes closed and one of the patient’s nostrils occluded, pass a mildly aromatic and familiar substance such as vanilla, cloves, cinnamon, or coffee under the open nostril. If the patient detects the smell, ask him to identify it.

Cranial Nerve II, the optic nerve, mediates vision.

To assess its function, check the patient’s visual acuity...visual fields...and removing glasses if necessary, inspect the optic fundi of both eyes.

In the fundi, be sure to inspect the ratio of the caliber of arteries to veins, usually 1:3 and changes in the arteries like vascular narrowing. Also look for papilledema, pallor from optic atrophy, and any cup enlargement suggesting glaucoma.

Cranial Nerves III, IV, and VI, the oculomotor, trochlear, and abducens nerves, control eye movements. Because these nerves work together so closely, they are examined as a group.

Check the extra ocular movements in the six cardinal directions of gaze, and look for conjugate movements in any of the six directions, which causes diplopia.

Ask the patient which, if any, direction makes the diplopia worse. Inspect the eye closely for asymmetric deviation of movement.

Determine if the diplopia is monocular or binocular by asking the patient to cover one eye, or perform the cover-uncover test.

Test for convergence of the eyes by asking the patient to look at your finger as you move it toward the bridge of his nose. Eyes can usually follow your finger to within 5 to 8 centimeters.
Identify any nystagmus, an involuntary jerking of the eyes with quick and slow components.

Note the direction of the gaze in which it appears, the plane of the nystagmus (horizontal, vertical, rotary, or mixed) and the direction of the quick and slow components. Note that nystagmus is named for the direction of the quick component, for example, right gaze nystagmus.

Ask the patient to fix his or her vision on a distant object and observe if the nystagmus increases or decreases.

Look for ptosis, which is drooping of the upper eyelids seen in palsy of Cranial Nerve III and myasthenia gravis. A slight difference in the width of the palpebral fissures may be normal variation in approximately one-third of all people.

The motor portion of Cranial Nerve V, the trigeminal nerve, innervates the muscles of mastication. The sensory portion of the nerve mediates facial sensation and the sensory part of the corneal reflex.

To palpate the temporal and masseter muscles in turn, ask the patient to clench the teeth. Note the strength of muscle contraction. Then ask the patient to move the jaw from side to side.

The sensory portion of the trigeminal nerve has three divisions: the ophthalmic, maxillary, and mandibular divisions.

To test the sensory portion of the trigeminal nerve, explain to the patient how you will assess for pain.

That is sharp.

Okay.

With the patient’s eyes closed, test for pain sensation using the sterile, sharp end of a broken cotton swab stick or some other suitable sharp object to stimulate the patient’s forehead and cheeks at the points indicated.

Occasionally, substitute the dull end for the sharp one as you test scattered areas.

Compare symmetrical areas on both sides of the face.

If you suspect an abnormality, confirm it by testing further for temperature sensitivity by using two test tubes filled with hot and cold water.

A tuning fork, which usually feels cold, may also be used, and made warmer by running it under hot water and drying it before use.

Next, test for light touch using a wisp of cotton. Ask the patient to respond whenever you touch the skin.

To test the corneal reflex, ask the patient to remove contact lenses, which frequently diminish or abolish this reflex.

Prepare a fine wisp of cotton.
Ask the patient to look up and away from you. Approach the patient from the side out of his line of vision and lightly touch the cornea with the cotton. Normally, the patient’s eyes blink and tear.

The sensory limb of this reflex is carried in Cranial Nerve V, and the motor response in Cranial Nerve VII. Cranial Nerve VII, the facial nerve, innervates all the muscles of facial movement and expression. It also mediates taste sensation in the anterior two-thirds of the tongue.

To assess this nerve, inspect the patient’s face at rest and during conversation. Note any asymmetry and look for tics or other involuntary movements.

Next, ask the patient to show his teeth...close his eyes so tightly that you can’t open them...wrinkle his forehead...puff out his cheeks...and tense his neck muscles. Normally, the patient can do these maneuvers easily and symmetrically.

Cranial Nerve 8, the acoustic nerve, mediates hearing and vestibular function.

Assess hearing, with the whispered voice test.

[WHISPERING WITH INCREASING LOUDNESS]

Nine, X, one...

Nine, X, one.

If hearing loss is present, determine if the loss is conductive from impaired “air though ear” transmission, or sensorineural, from damage to the cochlear branch of Cranial Nerve VIII.

Test for lateralization by performing the Weber test...

Yes.

Is it the same in both ears?

Yes.

Okay.

Next, compare air and bone conduction by performing a Rinne test.

Tell me when it stops.

It stopped.

Still hear it?

Yes.

Cranial Nerves IX and X, which are the glossopharyngeal and vagus nerves, mediate the sensory and motor functions of the palate, the pharynx, and the larynx.
To test these nerves, ask the patient to say “ahh” or yawn as you observe the soft palate and the pharynx.

The soft palate should rise promptly and symmetrically and the uvula should remain midline, and each side of the posterior phalanx moves medially like a curtain.

Warn the patient that you are going to test the gag reflex which consists of elevation of the tongue and soft palate and constriction of the pharyngeal muscles.

Stimulate the back of the throat lightly on each side in turn and note the gag reflex.

Many normally healthy people have a diminished gag reflex.

Cranial Nerve XI, the spinal accessory nerve, innervates the sternomastoid and upper trapezius muscles.

From behind, ask the patient to shrug his shoulders upward against your hands. During this maneuver, evaluate the strength and contraction of the trapezius muscles.

Turn your chin into my hands, strong.

From in front of the patient, ask the patient to turn his head to each side against your hand. Observe the contraction of the opposite sternomastoid muscle and notice the force of the movement against your hand.

Cranial Nerve XII, the hypoglossal nerve, mediates the tongue’s motor functions, which in turn affect articulation of words. First, listen to the articulation of the patient’s words.

Inspect the patient’s tongue as it lies on the floor of his mouth. Observe for atrophy and fasciculations. Some coarser restless movements are often seen in a normal tongue.

Ask the patient to stick out his tongue. Note any asymmetry or deviation from the midline.

Ask the patient to move the tongue from side to side and note symmetry of the movement.

**Examining the Motor System**

As you assess the motor system, focus first on body position and involuntary movements, then assess the important characteristics of the muscles—bulk, tone and especially strength. Also assess coordination.

Observe the patient’s body position during movement and at rest. Watch for involuntary movements such as tremors, tics, or fasciculations.

Inspect the size and contours of the muscles. Do the muscles look flat or concave, suggesting atrophy? If so, is the atrophy unilateral or bilateral? Is it proximal or distal?

Atrophy of hand muscles may occur with normal aging. When looking for atrophy, pay special attention to the hands...shoulders...and thighs.
In older adults, look especially for wasting of the quadriceps, which increases risk of falls.

Then evaluate the patient's muscle tone or resistance to passive stretch. Encourage the patient to relax.

Take one hand in yours and while supporting the elbow, flex and extend the patient's fingers, wrist, elbow, and put the shoulder through a moderate range of motion. On each side note muscle tone—the resistance offered to your movements. Remember: In muscle testing, the patient resists and the examiner overcomes the patient's resistance.

To assess muscle tone in the legs, support the patient's thigh with one hand, grasp the foot with the other, and flex and extend the patient's knee and ankle on each side. Note the patient's resistance to your movements. Assess both legs in turn.

As you assess muscle strength, keep in mind that a person's dominant side is usually slightly stronger than the non-dominant side.

You will grade your patient's muscle strength...on a scale of 0 to 5, with 0 indicating no muscular contraction detected ... and 5 indicating active movement against full resistance without evident fatigue. This is considered a “normal” response.

Begin by testing flexion of the biceps muscle by having the patient bend his arm at the elbow and pull against your hand.

And test extension of the triceps by having the patient push, against your hand.

Next, test flexion of the patient's wrist...

...and extension of the patient's wrists.

Next, test the patient's grip. Cross your middle and index fingers to cushion them and ask the patient to squeeze as hard as possible while you try to remove your fingers. Normally you should have trouble removing them.

Continue testing muscle strength by asking the patient to turn his palm down and spread his fingers. Check abduction by trying to force them together.

Test opposition of the thumb by asking the patient to try to touch the tip of his little finger with his thumb while you resist the movement. This may be impaired in carpal tunnel syndrome.

Examination of the motor system of the lower extremities is best performed with the patient lying supine on the examination table.

Test flexion at the hip by placing your hand on the patient's thigh and asking the patient to raise the leg against your hand.

Then test hip extension by the gluteus maximus by placing your hand on the patient's posterior thigh and providing resistance.
To test hip abduction by the gluteus medius and gluteus minimus, place your hands firmly on the table outside the patient's knees. Ask the patient to spread both legs against your hands.

To test the hip adductors, place your hands between the patient's knees and ask the patient to bring the knees together. Note the strength.

Continue by testing muscle strength at the knee by supporting the patient's knee in flexion and asking the patient to straighten the leg against your hand.

The quadriceps is the strongest muscle in the body so expect a forceful response.

To assess knee flexion by the hamstrings, shift your hand position but leave the patient's leg flexed at the knee. Tell the patient to keep the foot down as you try to straighten the leg.

Finally, test dorsiflexion at the ankle by asking the patient to pull up against your hand...

...and plantar flexion by asking the patient to push down against your hand.

**Assessment of Coordination**

Coordination of muscle movement requires that four areas of the nervous system function in an integrated way. The motor system for muscle strength. The cerebellar system for rhythmic movement and steady posture. The vestibular system for balance and for coordinating eye, head, and body movements. The sensory system for position sense.

To assess coordination, observe the patient's performance in rapid alternating movements, point-to-point movements, and standing in specified ways.

For rapid alternating movements, show the patient how to strike one hand on the thigh, raise the hand, turn it over, and then strike the back of the hand down on the same place. Urge the patient to repeat these movements as rapidly as possible.

Now ask the patient to tap the distal joint of the ventral thumb with the tips of the fingers in sequence. Observe the speed, rhythm, and smoothness of the movements.

Ask the patient to repeat these movements on the other hand.

For the legs, ask the patient to tap your hand as quickly as possible with the ball of each foot in turn. Note any slowness or awkwardness. The feet normally perform less well than the hands.

Next, assess point-to-point movements. Ask the patient to touch your index finger and then the nose alternately several times. Move your finger continuously so that the patient has to change directions, and observe the smoothness and accuracy of the movements and watch for any tremor.

Then, with your finger held steady in one place, ask the patient to touch it ...then raise the arm overhead... and then lower it to touch your finger again.
After several repeats, ask the patient to close both eyes and try several more times. Normally a person can touch the examiner’s finger successfully with eyes open or closed.

To test the heel-to-shin movement of the legs, ask the patient to place one heel on the opposite knee and then slide it down the shin to the big toe. The patient should be able to do this smoothly and accurately. Repeat with the patient’s eyes closed to test for position sense.

Continue the examination by observing the patient's gait, which provides information about coordination, position sense, and muscle strength.

As the patient walks across the room, observe posture, balance, arm swing, and leg movements. Normally, balance is easy, the arms swing at the sides, and turns are accomplished smoothly.

Next ask the patient to walk heel-to-toe in a straight line. This kind of gait—also called tandem walking—demonstrates cerebellar function and position sense.

Then have the patient walk on the toes to test the strength of plantar flexion...

...and on the heels to test dorsiflexion at the ankles. These actions also test balance.

Next ask the patient to hop in place, first on one leg and then the other. This ability indicates an intact motor system in the legs, normal cerebellar function, and good position sense.

Finally ask the patient to do a shallow knee bend, first on one leg and then on the other.

Support the patient if you think there is danger of falling.

The Romberg test primarily tests position sense. Ask the patient to stand with feet together and eyes open.

Then, have the patient do the same thing for 30 to 60 seconds with eyes closed. Note the patient’s ability to maintain an upright position with only minimal swaying.

Now check for pronator drift by asking the patient to hold both arms forward and parallel with palms up and eyes closed for about 20 to 30 seconds. Normally, patients can hold their arm positions well.

Finally, ask the patient to keep both arms up and eyes closed while you tap the arms briskly downward. Normally the patient’s arms return smoothly to the horizontal position.

**Recording Your Findings**

A clear, well-organized clinical record—employing language that is neutral, professional, and succinct—is one of the most important adjuncts to patient care.

After practice and further review of this video, make sure you have mastered the important learning objectives for examining the patient’s cranial nerves and motor system.