Does the patient have evidence of neurologic compromise?

- Assessment of neurologic compromise requires a thorough history for evidence of muscle weakness, gait disturbances, paresthesias, numbness, radicular pain, and bowel or bladder disturbances. The neurologic examination includes testing muscle strength, evaluating sensation and reflexes and analyzing the gait (Bahngle et al. 2013)

Cranial Nerves

- 12 pairs of cranial nerves
CN I – Olfactory Nerve
- Offer something familiar for the patient to smell and identify, for example: coffee, orange, cinnamon.

CN II – Optic Nerve
- The Optic nerve (CN II) is tested in five ways:
  - Acuity - Snellen Chart
  - Colour – Ishihara Plates (color blindness)
  - Fields – patient looking at you wiggle fingers in all 4 quadrants
  - Reflexes – pupillary response with pen light
  - Fundoscopy

CN III – Oculomotor Nerve
CN IV – Trochlear Nerve
CN VI – Abducent Nerve
- Eye movement
- Remind patient to keep their head perfectly still directly in front of you
- Move finger in all directions and have them follow with their eyes
- Important: patient must hold their head perfectly still

CN V - Trigeminal Nerve
- Sensory and Motor -- sensory supply to the face and motor supply to the muscles of mastication.
- Sensory
  - 3 sensory branches: ophthalmic, maxillary and mandibular
    - test the sensory branches by lightly touching three places on each side of the face: forehead, cheek and jawline.
    - test the corneal reflex (sensory supply to the cornea is from this nerve)
- Motor
  - clench their teeth together, observing and feeling the bulk of the masseter and temporalis muscles
  - open their mouth against resistance
  - jaw jerk on the patient by placing your left index finger on their chin and striking it with a tendon hammer = slight protrusion of the jaw

CN VII – Facial Nerve
- motor branches to the muscles of facial expression
  - crease up their forehead (raise their eyebrows)
  - close their eyes and keep them closed against resistance
  - puff out their cheeks
  - reveal their teeth.

CN VIII - Vestibulocochlear Nerve
- innervates the hearing apparatus of the ear and can be used to differentiate conductive and sensori-neural hearing loss
- Rinne test: place a sounding tuning fork on the patient’s mastoid process and then next to their ear and ask which is louder. A normal patient will find the second position louder.
- Weber’s test: place the tuning fork base down in the centre of the patient’s forehead and ask if it is louder in either ear. Normally it should be heard equally in both ears.
CN IX – Glossopharyngeal Nerve
- sensory supply to the palate
- gag reflex or by touching the arches of the pharynx

CN X – Vagus Nerve
- motor supply to the pharynx.
- speaking gives a good indication to the efficacy of the muscles
- uvula should be observed before and during the patient saying “aah”.
  - It should lie centrally and not deviate on movement

CN XI – Accessory Nerve
- motor supply to the sternocleidomastoid and trapezius muscles
- shrug their shoulders
- turn their head against resistance

CN XII – Hypoglossal Nerve
- motor supply to the muscles of the tongue
- signs of wasting or fasciculation
- on protrusion of tongue check for deviation to either side
  - Suggestive of a weakening of the muscles on that side

Sensory Exam
- The main goal of the sensory exam is to determine which, if any, components of the sensory system are damaged, it is important to consider the principle patterns of sensory loss resulting from disease of the various levels of the sensory system (Reeves et al 2008)

Sensory Exam
- Relies on patient’s cooperation and examiner’s ability to evaluate inconsistencies
- Start at top and move down
- Repeat if you need to
- Dermatomes
  - Normal and equal bilaterally
- Patient’s eyes closed during sensory exam
Spinal Tracts
- Spinothalamic (pain, temperature, and light touch)
  - Pain: pin or toothpick
  - Light touch: compare distal and proximal and right to left
- Dorsal column (vibration, proprioception, and touch localization)
  - Vibration: C128 tuning fork
  - Proprioception: test fingers and toes and then at larger joints if losses are detected
- Hemispheric (stereognosis, graphesthesia)
  - Stereognosis, the ability to distinguish objects by feel alone
  - Graphesthesia, the ability to decipher letters and numbers written on skin by feel alone

Cervical/Lumbar ROM
- All directions
  - Flexion vs Extension
  - Right vs Left
- Amount of effort
- What spaces are opening/closing

Motor Strength Exam:
Manual Muscle Testing
- 0/5 – no visible or palpable contraction.
- 1/5 - muscle contraction is noted but no movement occurs
- 2/5 - contract but cannot move the body part fully against gravity. When gravity is reduced or eliminated during a change in body position, the muscle is able to move the body part through its full range of motion.
- 3/5 - fully contract muscle and move body part through its full range of motion against the force of gravity. But when resistance is applied, the muscle is unable to maintain the contraction.
- 4/5 - muscle yields to maximum resistance. The muscle is able to contract and provide some resistance, but unable to maintain the contraction with full resistance.
- 5/5 - This means the muscle is functioning normally and is able to maintain its position even when maximum resistance is applied.

using the + or – (Sears, 2011)
Cervical Muscle Strength: testing and findings

- CERVICAL PLEXUS (C1–C4)
  - C1 - Motor to head and neck extensors, infrahyoid, rectus capitis, anterior and lateral, and longus capitis.
  - C2 - Sensory to lateral occiput and submandibular area; motor to C1 plus longus colli.
  - C3 - Sensory to lateral occiput and lateral neck, overlapping C2 area; motor to head and neck extensors, infrahyoid, longus capitis, longus colli, levator scapulae, scaleni, and trapezius.
  - C4 Sensory to lower lateral neck and medial shoulder area; motor to head and neck extensors, longus colli, levator scapulae, scaleni, trapezius, and diaphragm.

Note through entire exam: observe for atrophy of any muscle, (i.e. 1st interoccous)

(Schafer, 1987)

Cervical Muscle Strength: testing and findings (cont’d)

- BRACHIAL PLEXUS (C5–T1):
  - C5 - Sensory to clavicle level and lateral arm (axillary nerve); motor to deltoid, biceps; biceps tendon reflex. Primary root in shoulder abduction, exits between C4–C5 discs.
  - C6 - Sensory to lateral forearm, thumb, index and half of 2nd finger (sensory branches of musculocutaneous nerve); motor to biceps, wrist extensors; brachioradialis tendon reflex. Primary root in wrist extension, exits between C5–C6 discs.
  - C7 - Sensory to second finger; motor to wrist flexors, fingers flexors, triceps; triceps tendon reflex. Primary root in finger extension, exits between C6–C7 discs.
  - C8 - Sensory to medial forearm (medial antebrachial nerve), ring and little fingers (ulnar nerve); motor to finger flexors, interossei; no reflex applicable. Primary root in finger flexion, exits between C7–T1 discs.
  - T1 - Sensory to medial arm (medial brachial cutaneous nerve); motor to interossei; no reflex applicable. Primary root in finger abduction, exits between T1–T2 discs.

(Schafer, 1987)

Lumbar Muscle Strength: testing and findings

- Muscle strength is tested by examining the:
  - L2 nerve root (which supplies the iliacus muscle and is tested by no flexion)
  - L3 nerve root (quadriceps, tested by knee extension)
  - L4 nerve root (bilialis anterior, assessed by evaluating ankle dorsi- and inversion at the subtalar joint)
  - L5 nerve root (extensor hallucis longus and extensor digitorum longus, tested by asking the patient to dorsiflex the great toe, then the other toes)
  - S1 nerve root (flexor hallucis longus, flexor digitorum longus, and tenuocutaneus, tested by asking the patient to plantar-flex the great toe, then the other toes, and then the ankle)

The patient is also asked to walk a few steps on the toes and then on the heels. Inability to toe-walk indicates S1 nerve root involvement; inability to heel-walk indicates L5 or L4 involvement. If the patient cannot heel-walk, ask him or her to squat; inability to do so indicates L4 problems.

(Bahngle et al, 2013)

Pronator Drift

- also known as pyramidal drift

A positive result indicates spasticity. This sign can appear due to an upper motor neuron lesion or various other conditions (including inborn errors of metabolism) which include spasticity as a symptom

(Schafer, 1987)

Straight Leg Raise

- Patient lying down on his or her back on an examination table or exam floor, the examiner lifts the patient's leg while the knee is straight.

It is a positive test, if the patient experiences pain in the back or down the leg when the straight leg is at an angle of between 30 and 70 degrees.

Deep Tendon Reflexes

- Main Spinal Nerve Roots Involved
  - Biceps C5, C6
  - Brachioradialis C6
  - Triceps C7
  - Patellar L4
  - Achilles Tendon S1
Deep Tendon Reflexes

- The limbs should be in a relaxed and symmetric position.
- Compare each reflex immediately with its contralateral counterpart so that any asymmetries can be detected.
- Rating Scale:
  - 0: absent reflex
  - 1+: trace, or seen only with reinforcement
  - 2+: normal
  - 3+: brisk
  - 4+: nonsustained clonus (i.e., repetitive vibratory movements)
  - 5+: sustained clonus
- Deep tendon reflexes are normal if they are 1+, 2+, or 3+ unless they are asymmetric or there is a dramatic difference between the arms and the legs. Reflexes rated as 0, 4+, or 5+ are usually considered abnormal.
- In addition to clonus, other signs of hyperreflexia include spreading of reflexes to other muscles not directly being tested and crossed adduction of the opposite leg when the medial aspect of the knee is tapped. (Blumenfeld 2010)

Jendrassik maneuver

- Patient clenches the teeth, flexes both sets of fingers into a hook-like form and interlocks those sets of fingers together. The tendon below the patient’s knee is then hit with a reflex hammer to elicit the patellar reflex. The elicited response is compared with the reflex result of the same action when the maneuver is not in use.
- Often a larger reflex response will be observed when the patient is occupied with the maneuver, as the maneuver may prevent the patient from consciously inhibiting or influencing his or her response to the hammer.
- This maneuver is particularly useful in that even if the patient is aware that the interlocking of fingers is just a distraction in order to elicit a larger reflex response, it still functions properly.
- The maneuver can also be used to distract patients when performing other tests or procedures and any suitable distraction may be used; for example when looking for Romberg’s sign.

Reflexes

- Checking for hyper-reflexia (UMN sign)
  - thoracic or cervical involvement
- Fasciculations –ALS (especially tongue + drop foot)
- Spurling’s maneuver
- Hoffman’s
- Tinel’s
- Phalen’s
- Babinski

Hoffman’s Sign

- Testing for heightened reflexes

- Elicit this sign by holding the patient’s middle finger loosely and flicking the fingernail downward, causing the finger to rebound slightly into extension. If the thumb flexes and adducts in response, Hoffman’s sign is present.

Spurling’s Sign

- The Spurling test is a medical maneuver used to assess nerve root pain (aka radicular pain). It involves turning the patient’s head to the affected side and applying downward pressure to the top of the patient’s head. If radicular pain is elicited, this is called a positive Spurling's sign (i.e. the Spurling's test is positive).
- Spurling's test is somewhat specific when used for individuals with an abnormal electromyogram result but it is a very insensitive (clinical examination maneuver) in diagnosing cervical spondylosis or radiculopathy.
- It is a variant of the foraminal compression test (cervical compression test). In 2011, one study evaluated 207 patients with clinical cervical radiculopathy and correlated CT scan findings with clinical exam findings using the Spurling’s test. The Spurling’s test was 95% sensitive and 94% specific for diagnosing herniated disk patholology.
- Patients with a cervical radiculopathy (compression of a nerve ‘root’ in the neck) can present with a variety of symptoms, including pain, numbness and weakness. Many other disorders can produce similar symptoms. In addition to the clinical history, the neurological examination may also help in suggesting a cervical radiculopathy.
- (Blumenfeld, 2010)

Tinel’s

- It is performed by lightly tapping (percussing) over the nerve to elicit a sensation of tingling or “pins and needles” in the distribution of the nerve.

- For example, in carpal tunnel syndrome where the median nerve is compressed at the wrist, Tinel's sign is often “positive” causing tingling in the thumb, index, middle finger, and radial half of the fourth digit. Tinel’s sign is sometimes referred to as “distal tingling on percussion.” This distal sign of regeneration can be expected during different stage of somatosensory recovery.
Phalen/ Reverse Phalen Maneuver

- **Phalen Test** - diagnostic test for carpal tunnel syndrome. The patient is asked to hold their wrist in complete and forced flexion (pushing the dorsal surfaces of both hands together) for 30–60 seconds.

- **Reverse Phalen’s test** - diagnostic test for carpal tunnel. This test is performed by having the patient maintain full wrist and finger extension for two minutes. The reverse Phalen’s test significantly increases pressure in the carpal tunnel within 10 seconds of the change in wrist posture and the carpal tunnel pressure has the tendency to increase throughout the test’s duration. In contrast, the change in carpal tunnel pressure noted in the standard Phalen’s test is modest and plateaus.

(Blumenfeld, 2010)

Babinski Sign

- Test the plantar response by scraping an object across the sole of the foot beginning from the heel, moving forward toward the small toe, and then arcing medially toward the big toe.

- The normal response is downward contraction of the toes. The abnormal response, called Babinski’s sign, is characterized by an upgoing big toe and fanning outward of the other toes. In some patients the toes are “silent,” moving neither up nor down, if the toes are downgoing on one side and silent on the other, the silent side is considered abnormal. The presence of Babinski’s sign is always abnormal in adults, but it is often present in infants, up to the age of about 1 year.

(Blumenfeld 2010)

Romberg’s Test/ Romberg Maneuver

- **Romberg’s test** or the **Romberg maneuver** is based on the premise that a person requires at least two of the three following senses to maintain balance while standing: proprioception (the ability to know one’s body in space); vestibular function (the ability to know one’s head position in space); and vision (which can be used to monitor and adjust for changes in body position).

- A patient who has a problem with proprioception can still maintain balance by using vestibular function and vision. In the Romberg test, the patient is stood up and asked to close his eyes. A loss of balance is interpreted as a positive Romberg’s test.

- The Romberg test is a test of the body’s sense of positioning (proprioception), which requires healthy functioning of the dorsal columns of the spinal cord.

- The Romberg test is used to investigate the cause of loss of motor coordination (ataxia). A positive Romberg test suggests that the ataxia is sensory in nature, that is, depending on loss of proprioception. If a patient is ataxic and Romberg’s test is not positive, it suggests that ataxia is cerebellar in nature, that is, depending on localized cerebellar dysfunction instead.

(Blumenfeld 2010)

Other Thoughts for Consideration

- **Repetitive movements**

History: buttons and zippers - myelopathy

Classifications for Spasticity and Reflexes

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in muscle tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in muscle tone, manifested by a catch or by minimal resistance at the end of the range of motion (ROM) when the affected part(s) is moved in flexion or extension</td>
</tr>
<tr>
<td>1+</td>
<td>Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in muscle tone, passive movement difficult</td>
</tr>
<tr>
<td>4</td>
<td>Affected part(s) rigid in flexion or extension</td>
</tr>
<tr>
<td>9</td>
<td>Unable to test</td>
</tr>
</tbody>
</table>

Blumenfeld M et al. PHYS THER. 2010;90:23-36
Spinal Stenosis

Differential Diagnosis

- Peripheral Neuropathy
- Radiculopathy
- Spinal Stenosis
- Spinal Instability
- Other neurological Conditions

Gait

- Posture standing – sagittal balance
- Posture moving
- Balance
- Weakness
- Toe and heel
- Cadence
- Assistive Device

Diagnostic Imaging

- Plain radiographs - AP and lateral, flexion and extension, scoliosis views
- Magnetic resonance imaging (MRI) – spinal stenosis, tumor, infection, disk pathology
- Computed tomography (CT) - fractures, scoliosis, contraindications to MRI (shows bony details better than MRI)
- Bone scans - infections, fractures, pathology
- Electrodagnostic studies - radiculopathy when clinical examination suggests multilevel root lesions, when symptoms do not match imaging studies, and when patients have backbreakaway weakness (fluctuating levels of strength in one or more muscle groups).
- Other useful diagnostic and laboratory studies may include the erythrocyte sedimentation rate to screen for malignancy and infection when these are suspected, blood culture for osteomyelitis, and bone aspiration and biopsy for histopathologic diagnosis of infection, malignancy, or other lesions. Also consider testing Vitamin B12, zinc, etc.

Peripheral Neuropathy (polyneuropathy)

Symmetrical damage to peripheral nerves

Common disorder that has many causes:

- Metabolic - diabetes mellitus, malnutrition of alcoholism, other nutritional deficiencies
- Toxic - environmental toxins or certain medications
- Inflammatory and Autoimmune conditions
- Infectious - Lyme disease, syphilis, or HIV

References