Neurological examination

The neurological examination for medical student and MRCP PACES
Introduction
Introduce yourself (name and position)
Identity of patient (confirm name and date of birth)
Permission (consent and explain examination: “I’m going to examine your arms and legs in various different ways, I’ll talk you through it as I go. Is that OK?”)
Pain?
Position
Expose
Should be able to see hands to deltoid (upper limb) and toes to upper thigh (lower limb)
Mental state: examination (MSE) is a structured way of observing and describing a patient’s current state of mind, under the domains of appearance, attitude, behaviour, mood, speech, thought process, orientation, perception, cognition, abstraction and insight.
Inspection: Handshake
In the neurological exam above all others, inspection is vital. Introduce yourself with a (careful) handshake. This may provide the first clue to diagnosis:
Unable to see your hand (neglect, blindness)
Unable to lift their hand to shake yours (paralysis, weakness)
Unable to easily release your hand (myotonic dystrophy)
(Overall inspection):-
Explain that you’ll take a step back to look at them properly
Around the bed
Wheelchair, walking stick (mobility issues)
Catheter bag (possible spinal issues)
Spirometer (respiratory dysfunction e.g. in Guillain-Barre syndrome)
Asymmetry in positioning (unilateral weakness)
Posture
Muscle atrophy
Fasciculations
Upper Limbs
Closer inspection
Start by observing each muscle group looking for size, shape and symmetry
Atrophy occurs in unused muscle groups
Hypertrophy is caused by overuse of muscle groups. Hypertrophy (provided not due to deliberate exercise) is usually indicative of compensation of one muscle group for the loss of function in another muscle group, such as seen in muscular dystrophies
Now is a good time to look closer for wasting or fasciculations
Fasciculations are often best seen in the deltoid in the upper limb. They may be elicited by gently flicking the muscle if there is a clinical suspicion
Tone:
Muscle tone is its resistance to passive stretching
Ideally the patient needs to be fully relaxed so hold the patient’s hand in the handshake position and support their elbow, saying: “let me take the weight of your arm, try not to resist or help me move it”
Move each joint of the limb in a purposeful but non-predictable manner
The wrist often gives the most information. Supinate and pronate the hand, slowly and then briskly
Tone will either be:
1-decreased (hypotonia) which can occur in lower motor neuron lesions or
2-increased (hypertonia) classical of upper motor neuron lesions:

a-(Spasticity) is velocity dependent: the faster the limb is moved the greater the resistance produced. Spasticity is often described as “clasp knife” as resistance will change throughout movement

b-Rigidity has resistance that is constant throughout the stretch.

Rigidity is an extrapyramidal pathway sign (e.g. Parkinson’s) issue and is known as “lead pipe” rigidity. When tremor is superimposed it is described as “cog-wheel” rigidity
Power:
Power is rated on a scale of 0 to 5 according to the Medical Research Council (MRC) MRC grading scale for power
5 – Full Strength
4 – Movement against partial resistance
3 – Movement against gravity
2 – Movement with gravity eliminated
1 – Feeble contractions
0 – Absent voluntary contraction
Correct use of this scoring system can be helpful in progressive disorders and in the rehabilitation setting. Note that when time is short, full examination of each muscle group may not be possible. In such cases, you can test grip power by asking the patient to squeeze your index and middle finger. You can also ask the patient to pull you towards them and push you away. This covers basic proximal and distal muscle strength. The table below gives the general scheme for examination of power in the upper limb including a general overview of relevant basic anatomy. This is often performed with the patient sitting up in bed.
Testing power in the upper limbs:
You examine:
1 Muscle; 2 Nerve Root; 3 Nerve)
Examine (Shoulder abduction): “Lift your arms into a ‘chicken position’” Test each side together, push arms down at elbow. “Stop me from pushing your arms down” by this action you examine:
1: Deltoid (muscle)
2: C5 (nerve root)
3: Axillary Nerve(axillary nerve)
Examine (Arm flexion) “Put your arms in front of you in a ‘boxer position’ fist facing in” Place your hand around wrist and steadily pull out. “Stop me from pulling your arm out” then u examine:
1: Biceps
2: C6
3: Musculocutaneous Nerve

Arm extension: Stay in a ‘boxer position’.
Place your hand around wrist and push arm in.
“Push against my hand”
1: Triceps
2: C7
3: Radial Nerve

Wrist Flexion: “Hold your arms straight out, make a fist.” Hold the forearm and your hand under their fist.

“Push my hand down towards the ground”
1: Flexor Carpi Ulnaris
2: C8
3: Ulnar Nerve

Wrist Extension: “Now cock your wrists back.”
Hold the forearm and use your fist to apply force to their hand.

“Stop me from pushing your wrist down”

1: Carpi Ulnaris
2: C7
3: Radial Nerve
Finger Abduction:

“Spread your fingers”

Use your index and small finger to squeeze their fingers closed.

“Stop me from pushing your fingers together”

1: Interossei muscles

2: T1

3: Ulnar nerve
Thumb Abduction:

“Turn hand palm up, bring thumb towards the ceiling" [to 90 degrees] Use your thumb to push their thumb into their palm.

“Stop me from pushing your thumb down"

1: Abductor pollicus brevis

2: T1

3: Median nerve
Reflexes
Testing deep tendon reflexes is the main way to differentiate between upper and lower motor neuron lesions: present/increased in upper motor neuron lesions and absent in lower motor neuron lesions. To determine whether muscle movement occurs, look at the muscle group involved in the reflex. Many people focus on the foot for the patellar reflex, but a subtle movement of the quadriceps can be missed when looking at the foot.
Ensure a reflex is in fact absent by reinforcing the reflex arc. To reinforce, ask the patient to clench their teeth or grasp hands together and pull apart just as you strike with the tendon hammer (Jendrassik’s manoeuvre)
Tendon hammer technique
Hold the tendon hammer near the tapered tip and let the rubber head fall onto the tendon being tested (the movement is in the wrist). The weight of the tendon hammer head will define the force with which the tendon is struck rather that the strength of the examiner. If the reflex is brisk, the ‘briskness’ can be quantified by repeating the reflex but holding the hammer closer and closer to the head (thus exerting less and less force). Briskness is thus defined as a change in the threshold of the reflex response and not the speed or size of the response.
In the acute setting, if no tendon hammer is available then a stethoscope can be used as a rough stand-in – just do not do this in front of a neurologist.
Unlike power, there is no accepted scoring system for reflexes. Essentially reflexes are either present or absent. When present, a reflex can be described as hyporeflexic (present with reinforcement), normal or brisk. These are often written as +, ++ or +++ respectively. The reflexes tested in the upper limbs are:
Biceps: C5/6

To test the biceps reflex ask the patient to place their hands on their abdomen and let their arms relax. Place a finger over the biceps tendon in the antecubital fossa and strike your finger with the tendon hammer
Triceps: C7/8
To assess the triceps reflex hold the hand/wrist on the abdomen with the elbow in a 90 degree angle and strike the triceps tendon just above the olecranon
Brachioradialis: C6

Test the supinator reflex (brachioradialis muscle) by placing two fingers at the level of the distal radius and striking your fingers with the tendon hammer. Compare left to right before moving on to the next muscle group.
Coordination

In assessing coordination you are testing fine motor skills modulated by higher centres in the brain (i.e. basal ganglia, cerebellum). There are two basic methods of testing coordination in the upper limbs: the finger-nose test and dysdiadochokinesiis
Finger-nose test
Ask the patient to touch their nose with an index finger. Hold your finger at arms-length distance from the patient and ask them to use the same finger to touch your finger. Then ask them to move between their nose and your finger as quickly and accurately as possible. Then repeat the same instructions with the other index finger. Look for past pointing and intention tremor
Dysdiadochokinesis
Ask the patient to clap their right hand on the palm of their left hand, then alternate clapping with the palm and dorsum of the right hand. It always helps to demonstrate this. Then switch hands (clap their left hand on their right hand.) Disorganisation in this alternating movement indicates dysfunction in the cerebellum or associated circuitry. An additional test of coordination is to ask the patient to oppose finger and thumb repeatedly as fast as possible. Slowing of the frequency and amplitude of this movement is a useful sign of bradykinesia.
Lower Limbs
Tone
There are three techniques to use when assessing tone of the lower limbs.
For the first, have the leg fully relaxed, hold the knee to fix the leg to the bed and roll the thigh left and right repeatedly. In a patient with normal tone the foot will flop in the opposite direction as the way the knee is moved. However in the presence of increased tone the foot will remain in line with the knee
In the second technique put your hand under the knee (at the popliteal fossa) and sharply pull the knee up. In a patient with normal tone, the heel will remain on the bed, but with increased tone the foot will leave the bed
The third technique is the test for ankle clonus. The presence of greater than five beats of clonus (or sustained rhythmical contraction while the tendon is stretched) indicates increased tone
Power

The same principles of examination apply in the lower limbs as in the upper limbs. The table below contains the instructions for testing power in the legs, which is done with the patient lying down. Test each side individually before moving to the next muscle group.
Testing power in the lower limbs

**ACTION**  
INSTRUCTION  
ANATOMY

(1 Muscle;  
2 Nerve Root;  
3 Nerve)  

Hip Flexion “Keeping your knee straight, lift your leg off the bed”  
Hold their thigh with your hand.
“Stop me from pushing your leg down”
1: Psoas
2: L2
3: Femoral
Hip Extension  “Push your leg down” Hold underneath their thigh.
“Push your leg into the bed”
1: Gluteus Maximus
2: L5/S1
3: Inf. gluteal nerve
Knee Flexion
“Bend your leg at the knee and rest your foot flat on the bed.”
Hold their leg around the back of the calf. “Don’t let me straighten your leg/Pull your heel in towards your bottom”
1: Hamstrings
2: L5
3: Sciatic
Knee Extension  

Holding their leg on the shin.

“Try to straighten you leg, push against my hand away with your leg”

1: Quads

2: L3/4

3: Femoral
Dorsiflexion Place leg straight again: point toes toward face. Place your hand on the dorsum of foot. “Stop me from pulling your foot down”

1: Tibialis anterior (and others)
2: L4/5
3: Deep Peroneal
Plantar flexion

Place your hand on the sole of the foot. “Push down against my hand”

1: Gastronemeus (and others)
2: S1/2
3: Tibial nerve
Reflexes

The reflexes tested in the lower limbs are:

Patellar (L3/4)

Place your hand underneath the knee and slightly flex the knee for the patellar reflex then strike the patellar tendon just above the tibial tuberosity
Ankle (S1)
For the ankle jerk, bend the knee and open the leg out, flex the foot slightly and strike the Achilles tendon looking for plantarflexion
Plantar reflexes
Finally the Babinski reflex or plantar response: use a smooth but rigid instrument and apply steady pressure starting at the heel and moving towards the big toe (never use the sharp end of a tendon hammer)
Do not scratch the sole of the foot so hard as to leave a visible mark on the skin. Watch the toes for upward or downward movement (predominantly the big toe)
Upper motor neuron lesions will cause the big toe to dorsiflex (an ‘upgoing plantar’), and the other toes spread out
Positioning and comparison between left and right again, are key. You must have the muscle group being tested relaxed in order to see the contraction.

Knowing the nerve roots that supply each muscle group and reflex being tested will help identify the location (level) at which the motor nervous system is affected. For example if the ankle reflex is brisk but the patellar reflex is normal then the lesion must lie in the spinal cord at L3/4.

Below the level of the lesion there are upper motor neuron signs (brisk reflex) and at the level there may be lower motor neuron signs (loss of the reflex) or no change in reflex. In addition the patient will have decreased power in the muscles groups below L3/4 and thus will have weakness of dorsi- or plantar flexion of the foot.
Coordination

The heel-shin test assesses coordination in the lower limbs.

Ask the patient to “place your left heel on your right knee. Then slide your heel down your shin to the ankle. Now lift your foot in the air and place your heel back on the knee. Slide your heel once again down to your ankle. Please repeat this movement.”

Look for the heel sliding off the shin as the patient tries to slide it down towards the ankle. If this is difficult another technique is to ask the patient to tap their foot repeatedly on your hand.

Remember that coordination can be affected by weakness and lack of sensory perception and may necessarily indicate a lesion in the basal ganglia or cerebellum. This is especially true in the lower limbs where a patient may have sensory loss in the stocking distribution, such as in diabetes.
Gait
Gait can be the first clue to an underlying diagnosis and is best examined when the patient is unaware of the observer. Many neurologists call their own patients into clinic so that they can observe the patient stand and walk. There are only a limited number of pathological gaits that you must commit to memory: Look for posture, arm swing, step size, width of base and inability to walk on toes or heels.
Ataxic or broad-based gait (due to a cerebellar lesion, or alcohol)
The patient will also be unable to walk heel-to-toe, a more sensitive test of ataxia
Shuffling or festinating gait ("gait apraxia")
Classically seen in extra-pyramidal disease
Tilted gait
May be indicative of inner ear disorder
High-stepping gait
Ocurs in foot drop, a person will lift their foot far above the ground in order to avoid catching their toes on the ground while walking. The patient will also have difficulty walking on their heels
Video on gait disturbances  
Romberg’s Test  
Romberg’s test is a method of assessing proprioception and can be positive in sensory ataxia (peripheral neuropathy) and in tabes dorsalis caused by syphilis (affecting the sensory pathways of the spinal cord).  
Ask the patient to stand with their feet close together and stretch out their arms. Make sure you position the patient so that if they did fall you can catch them or that they fall onto a bed. After giving reassurance that you will catch them if they fall, ask the patient to close their eyes.  
In a positive Romberg’s test the patient will fall with their eyes closed but not with their eyes open, as the visual input that was compensating for the lack of proprioceptive input is removed.  
In cerebellar dysfunction the patient will be just as unsteady with their eyes open as closed.
Sensation: Upper and Lower Limbs
There are three principals in testing sensation: compare left to right, compare distal areas to proximal areas and finally test dermatomes (when indicated)
It can be helpful to ask the patient if they have any numbness or tingling
Start by touching the patient’s upper chest lightly with your finger or a piece of cotton wool and ask them if it feels like a finger/cotton touching them
Ask them to close their eyes and each time you touch their limb ask them which side you have touched, left or right. Ask them if it feels the same on both sides.
Dermatomes

Upper limb

Outer shoulder/regimental badge area: axillary nerve C6

Outer forearm: lateral cutaneous C5

Thaumb: median nerve C6

Middle finger: median nerve C7

Little finger: ulnar nerve C8

Back of the hand – radial side: radial nerve C5-T1

Medial antecubital fossa: medial cutaneous T1
Lower limb
  Inner thigh: upper L1, mid L2
Medial side of knee: L3
Medial malleolus: L4
Big toe: L5
Heel: S1
Popliteal fossa: S2
Anal sensation/tone needs to be tested if concern about spinal cord lesions: S3 and S4

In determining the sensory level remember that the pain and temperature pathways decussate at the level of entry at the spinal cord (spinothalamic tract) while the pathways for fine touch and proprioception ascend the spinal cord and decussate at the level of the brain stem (dorsal columns)
Other sensory modalities

To test sensation thoroughly the above routine should be repeated, testing the rest of the sensory modalities.

Pain
Alternate using the sharp and blunt ends of the neurotip.

Temperature
Can be tested with the metal tuning fork as it tends to be cold.

Vibration
Tested on a bony prominence looking for when the patient stops feeling the vibration.

Proprioception
Start at the most distal joint in the limb, such as the distal interphalageal joint. Place your fingers on either side of the digit to isolate the joint. Move the joint upwards and say “this is up” and then move the joint down and say “this is down”. Ask the patient to then close their eyes and tell you which way they feel you are moving their joint. If they are unable to tell you move to the next more proximal joint.

Beware of the subjective nature of the sensory exam. If you suspect that the patient is giving spurious answers, or trying to disguise a lack of sensation, instruct them to close their eyes and ask them which side you are touching without touching them at all. Patches of sensory loss that do not follow a dermatomal or nerve distribution are likely to be non-organic in aetiology.
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