Cranial Nerve Examination
Study Guide

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Appendix 2

Appendix

Documentation

Additional Tests / Special Tests

Performing the Inspection

Preparation

Patient safety

Equipment

Inspection

General Inspection

Specific inspection

Performing the examination

Cranial Nerve I, Olfactory

Cranial Nerve II, Optic

Cranial Nerve III, IV and VI (Oculomotor, Trochlear and Abducens)

Cranial Nerve V, Trigeminal nerve

Cranial Nerve VII, Facial nerve

Cranial Nerve VIII, Acoustic (Vestibulocochlear) nerve

Cranial Nerve IX, Glossopharyngeal nerve

Cranial Nerve X, Vagus nerve

Cranial Nerve XII, Hypoglossal nerve

Cranial Nerve XI, Accessory nerve (Spinal Accessory nerve)

Additional Tests / Special Tests

Documentation

Documenting Visual Field Loss

Documenting Eye Movements

Appendix 1

Appendix 2

History 1 findings:
Glossary

Atrophy  Muscle wasting
Bulbar palsy  This is the result of diseases affecting the lower cranial nerves (VII-XII). A speech deficit occurs due to paralysis or weakness of the muscles of articulation which are supplied by these cranial nerves.
Conjugate  Moving together
Contralateral  Occurring on the opposite side of the body
Dextrodepression  Looking down and to the right
Dextroelevation  Looking up and to the right
Dextroversion  Turning eye to the right
Diplopia  Double Vision
Disconjugate  Not moving together
Esodeviation  Inwards deviation of eye from forward gaze
Fasciculation  Spontaneous, involuntary, contraction of a number of muscle fibres, often causing a flickering under skin.
Intortion  Turning the eye inward
Ipsilateral  Occurring on the same side of the body
Laevodepression  Looking down and to the left
Laevoelevation  Looking up and to the left
Laevoversion  Turn eye to the left
Nystagmus  Rapid, repetitive, involuntary eye movement
Phoria  A misalignment of the eye which only appears when binocular vision is broken (the two eyes are not looking at the same object)
Ptosis  Drooping of upper eyelid
Strabismus  Misalignment of eyes
Tropia  A misalignment of the eyes that is always present
Learning Objectives

Year 2

To know the basic anatomy and function of cranial nerves.
To be able to understand and carry out a bed side assessment of cranial nerve function.
To adhere to waste disposal policies including sharps and clinical waste.
Introduction

Cranial nerves have several functions that are crucial for performing activities of daily living, if a patient has a disorder affecting cranial nerve function, you will need to identify which nerves are affected by performing a cranial nerve examination. All 12 pairs of cranial nerves may not need to be examined at once, dependent on the patient’s history and presentation. Cranial nerve assessment is incorporated within a number of neurological examinations.

There are 12 pairs of cranial nerves that arise directly from the brain, each cranial nerve can be described as being sensory (afferent), motor (efferent) or both. The cranial nerves are numbered using roman numerals from I-XII and are listed below:

- I Olfactory
- II Optic
- III Oculomotor
- IV Trochlear
- V Trigeminal
- VI Abducens
- VII Facial
- VIII Auditory (Vestibulocochlear nerve).
- IX Glossopharyngeal
- X Vagus
- XI Accessory
- X11 Hypoglossal

Indications for cranial nerve examination

There are several indications for cranial nerve examination. The following list is by no means exhaustive;

- Sudden paralysis or changes in sensation
- Unexplained muscle weakness
- Trauma
- Malignancies
- Epilepsy
- Glaucoma
- Multiple Sclerosis
- Perforated tympanic membrane

Conscious level must be considered before assessing cranial nerves.
Surface Anatomy / Relevant Physiology

There are twelve pairs of cranial nerves which arise directly from the brain; the first two pairs arise from the cerebrum the rest from the brain stem.
There are a number of mnemonics for remembering the cranial nerves, one example is:

<table>
<thead>
<tr>
<th>Roman Numeral</th>
<th>Word</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>On</td>
<td>Olfactory</td>
</tr>
<tr>
<td>II</td>
<td>Our</td>
<td>Optic</td>
</tr>
<tr>
<td>III</td>
<td>Outing</td>
<td>Occulomotor</td>
</tr>
<tr>
<td>IV</td>
<td>To</td>
<td>Trochlear</td>
</tr>
<tr>
<td>V</td>
<td>The</td>
<td>Trigeminal</td>
</tr>
<tr>
<td>VI</td>
<td>Airport</td>
<td>Abducens</td>
</tr>
<tr>
<td>VII</td>
<td>Fatty</td>
<td>Facial</td>
</tr>
<tr>
<td>VIII</td>
<td>Arbuckle</td>
<td>Auditory or Vestibulocochlear</td>
</tr>
<tr>
<td>IX</td>
<td>Gave</td>
<td>Glossopharyngeal</td>
</tr>
<tr>
<td>X</td>
<td>Vicky</td>
<td>Vagus</td>
</tr>
<tr>
<td>XI</td>
<td>A</td>
<td>Accessory</td>
</tr>
<tr>
<td>XII</td>
<td>Hamburger</td>
<td>Hypoglossal</td>
</tr>
</tbody>
</table>
Below is a full list of the cranial nerves and their functions along with where they exit through:

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Function</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>Sensory function: Controls smell</td>
<td>Cribiform plate</td>
</tr>
<tr>
<td>II Optic</td>
<td>Sensory function (afferent visual component): Controls light / images from the retina transmitted via the optic tract to the lateral geniculate nucleus and on to the visual cortex</td>
<td>Optic canal</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>Motor function (Efferent): Controls constrictor muscles of the iris for dilatation &amp; constriction of pupils, levitator muscle (opening of eye lids), eye muscles: superior rectus, inferior rectus, medial rectus &amp; inferior oblique</td>
<td>Superior orbital fissure</td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>Motor nerve that controls the superior oblique muscle, that is primarily responsible for turning the eye inward (intortion), secondary, depressing the eye and tertiary function to abduct the eye</td>
<td>Superior orbital fissure</td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>Motor &amp; sensory function: Trigeminal has 3 paired tracts on each side of the face. Motor: Controls Temporalis, Masseter &amp; Pterygoid muscles. Sensory: Controls touch sensation on the face, corneal reflex and teeth</td>
<td>Superior orbital fissure / Foramen rotundum/ Foramen ovale</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>Motor function: Controls lateral rectus muscle</td>
<td>Superior orbital fissure</td>
</tr>
<tr>
<td>VII Facial</td>
<td>Motor function: Controls facial muscles and stapedius muscle within the ear, the efferent component in the corneal test (closure of eye lids). Sensory function: Controls the anterior two thirds of the tongue (taste) and the secretomotor function to the salivary gland (with the exception of the parotid) and the lacrimal gland.</td>
<td>Internal acoustic meatus</td>
</tr>
<tr>
<td>VIII Auditory or Vestibulocochlear</td>
<td>Sensory function: This is divided between sensing sound (acoustic) and balance (vestibular).</td>
<td>Internal acoustic meatus</td>
</tr>
<tr>
<td>Nerve</td>
<td>Sensory Function</td>
<td>Motor Function</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IX</td>
<td>Controls the posterior third of the tongue, the tonsils and the pharynx. Also controls the secretions from the Parotid salivary gland.</td>
<td>Controls the stylopharyngeus muscle – elevation of the larynx and pharynx and dilates the pharynx to permit swallowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td>Controls the laryngeal and pharyngeal muscles which control voice &amp; resonance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parasympathetic action to nearly all fibres from the head to the splenic flexure, along with the auditory canal &amp; tympanum (ear drum.)</td>
</tr>
<tr>
<td>XI</td>
<td></td>
<td>Controls the neck muscles, the sternocleidomastoid &amp; trapezius</td>
</tr>
<tr>
<td>XII</td>
<td></td>
<td>Controls the tongue and other glossal muscles and is important for swallowing and voice articulation.</td>
</tr>
</tbody>
</table>
History

Prior to any clinical examination a detailed history should be taken from the patient, this will enable you to tailor the examination to the patient’s presenting complaint and additional symptoms the patient may elude to when you elicit a full history. For guidance on history taking please click MBCHB students – Year 2 – History taking.

As stated previously, there are several indications for a cranial nerve examination, you will need to take a full history and focus to gain clinical diagnostic reasoning. Deciding which nerves need testing will be dependent upon the history and the signs and symptoms that the patient presents with.

Taking a focused history will aid reasoning

**Consider:**

**History of presenting complaint:**
- A description of the symptom, considering numbness/ weakness/ paraesthesia/ headaches/ visual or auditory changes/ changes in speech, sensation or taste and smell/ history of faints or collapse/ dizziness/ problems with gait or coordination, etc.
- How and when it started
- Course of symptom over time
- Pattern to symptoms
- Pain- consider SOCRATES
- Effect on patient
- Previous experience of the same or similar
- Other relevant symptoms

**Past Medical History**
- Take a full history of previous medical problems including surgery or trauma.

**Medication history**
- Ask about medications, and compliance of use, especially consider anti-coagulants
- Discuss allergies

**Social history**
- Ask the patient about lifestyle/ work
- Be clear about alcohol consumption, smoking history and illicit drug use.
- Consider foreign travel
- Does the patient drive- is this affected, should they be driving.

**Family history**
- This should cover all serious medical conditions
- Beware of bleeding disorder, stroke, muscle weakness/ visual problems/ degenerative conditions etc.

**Review of Systems**
- Consider tiredness/ malaise
- Seizure
- Headaches
- Hoarse voice or changes with speech
- Changes in mood
- Recent fall
- Coordination problems
- Increased or decreased hearing
- Changes with taste or smell
- Visual changes, double vision etc.

Below are 2 simple histories, please see the end of the study guide for the findings:

### History 1.

<table>
<thead>
<tr>
<th>Presenting Complaint</th>
<th>2/7 (2 day) history of gradual increasing weakness on the left side of their face.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No nausea</td>
</tr>
<tr>
<td></td>
<td>Complaining of mild headache only (especially around ear)</td>
</tr>
<tr>
<td></td>
<td>No loss of consciousness</td>
</tr>
<tr>
<td></td>
<td>No visual disturbance.</td>
</tr>
<tr>
<td></td>
<td>Has noticed speech has changed slightly (especially for P and B, labial sounds), but similar to after they have been to the dentist.</td>
</tr>
<tr>
<td></td>
<td>No recent history of trauma or infection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Past Medical History</th>
<th>Nil of note, NKA (no known allergies) and is not currently taking any medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family History</td>
<td>Nil to note</td>
</tr>
<tr>
<td>Social History</td>
<td>Works from home, is a little worried and anxious and is hoping that this isn't a stroke.</td>
</tr>
<tr>
<td>Review of Systems</td>
<td>Has noticed that everything seems louder (especially on the left side) and taste has changed. Patient has noticed their left eye is dry also, but no other symptoms.</td>
</tr>
</tbody>
</table>
A 64 year old patient attends GP complaining of double vision

<table>
<thead>
<tr>
<th>Presenting Complaint</th>
<th>Patient noticed a sudden onset of double vision after doing some gardening. Double vision is worse when they look to the left, and the 2 images appear side by side (horizontal). Close up reading isn’t too bad- it is worse when they are looking further away. No history of trauma/ infection, or vomiting, although they feel a bit disorientated with the double vision. Has had a mild headache, treated with Paracetamol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Medical History</td>
<td>Diabetic on insulin, normally fairly well controlled. NKA, and just takes a statin and insulin</td>
</tr>
<tr>
<td>Family History</td>
<td>Nil to note</td>
</tr>
<tr>
<td>Social History</td>
<td>Retired but active</td>
</tr>
<tr>
<td>Review of Systems</td>
<td>Nil of note.</td>
</tr>
</tbody>
</table>
Preparation

Patient safety

- Introduce yourself
- Check the patient’s identity and allergies
- Explain what you want to do
- Gain informed consent
- Consider an appropriate chaperone
- Adequate exposure maintaining dignity
- Position the patient appropriately – consider moving and handling
- Wear Personal Protective Equipment as required.
- Wash your hands before and after you touch the patient (as per WHO guidelines)

- On first meeting a patient introduce yourself, confirm that you have the correct patient with the name and date of birth, if available please check this with the name band and written documentation such as the patient notes and the NHS/ hospital number/ first line of address and check the patient’s allergy status

- Ensure the procedure is explained to the patient in terms that they understand, gain informed consent and ensure that you are supervised, with a chaperone available as appropriate.

- Assist patient into a comfortable position, supported as appropriate. Your explanation of the procedure to the patient should include appropriate detail of the tests you are taking and why they are being taken.

- Don personal protective equipment if required and use sharps in accordance with HSE (2013).

- Be aware of hand hygiene and preventing the spread of disease, WHO (2009)

Equipment

Depending on which nerves are being examined, different equipment may be required, you may have to consider:

- Hand wash
- Ophthalmoscope (For nerves II, III, IV, and VI)
- Otoscope (For nerve VIII)
- Pen torch (For nerves I, II, III, IV, VI, VII, IX, X, and XII)
- Snellen Chart (For nerves II, III, IV, and VI)
- Device/ fingers for assessing rods or cones (For nerve II)
- Sharps bin and tray (For nerve V)
- Neurotips (For nerve V and potentially nerve II)
- Cotton wool (For nerve V and potentially nerve VII)
- Tongue depressor (For nerves IX, X, and XII)
- Tuning fork (For nerve VIII)
- Tendon hammer (For nerve V)
Inspection

General Inspection

As with all examinations, inspection starts as the patient is walking into the room or on first seeing the patient, can they walk, how is their gait and balance? See the study guide on coordination in your resources.

Specific inspection

Is there a specific weakness, observe the face for symmetry and movement, more will be discussed on each specific cranial nerve as each nerve is covered in the study guide.
Performing the examination

Cranial Nerve I, Olfactory
The olfactory nerve is responsible for the sense of smell. Smell is an important component of the appreciation of taste (which may be the principal complaint of a patient). It is only tested in specialist areas.

- It is important to test one nostril at a time by occluding the other nostril.
- Different familiar test smells are used e.g. coffee or orange.
- The patient needs to sniff and signal detection with a prompt response (otherwise the smell can be picked up via the opposite olfactory bulb).

Be aware that strong smells like ammonia are detected through nasal pain fibres, so should not be used. A patient with loss of the olfactory nerve should still be able taste sugar, salt, sour, unless other nerves are damaged.

Potential causes of dysfunction may include: Age, URTI, Malignancies, Chemical Exposure, Facial trauma, Head injury including stroke, Epilepsy (may sense smells prior to or post fitting), Parkinson’s, Alzheimer’s (Odour memory).

Cranial Nerve II, Optic
There are various tests that may be performed to fully assess the integrity of the optic nerve(s). These include:

- ophthalmoscopy (See separate study guide)
- pupillary reflexes
- visual acuity
- visual fields

However if vision is severely affected then not all of them may be performed.

Inspection and pupillary reflexes
Visually check the size and shape of the pupils, the regularity in outline and equality of both sides. Pupils should be round but the size will vary depending on surrounding light. The size of a normal adult pupil varies from 2-4 mm in diameter in a bright light and 4-8 mm in the dark. On the side of some pen torches is a scale of pupil sizes that can be used as a reference.

Note if there are any defects in the iris or foreign bodies in the anterior chamber. Does the patient have any obvious cataracts or do they have a history of glaucoma? The pupillary responses will be affected if the answer to the previous question is yes.
• Assess if the pupillary light reflexes are present by asking the patient to look at a distant object.
• Then shine a light onto one eye by bringing it in from the side, or switch the light on from in front.
• Ensure that the stimulus is abrupt, and shield the other eye from the light as there are two responses being assessed – direct and consensual.

A **direct response** is when there is constriction of the pupil when light is shone into that eye.

A **consensual response** is when there is constriction of the pupil to light shone in the opposite eye.

The next part of the assessment is to assess for **accommodation**.

Accommodation changes with age normally, it is lost with age, especially after 50 years of age. Accommodation is an adjustment of the eye for near vision.

• You need to ask the patient to focus on a distant object
• And then focus when an object is brought into view and held at about 10 cm from their face (a pen torch / finger etc.).

It is important to keep the pen or finger at a high level or the patient’s eyelids may obscure the pupil. If accommodation is intact the patient’s eyes should converge and the pupils should constrict equally, when focusing on the object close to their eyes.

**P.E.R.L.A** (Pupils Equal and Reactive to Light and Accommodation) can be documented in the patient records when all of the above responses are normal. The acronym PERLA can also help remind you what tests should be performed. When documenting, it is permissible to write PERLA in the case notes as it signifies that all elements were checked and functioning normally. However, if any of the tests were negative you would need to write this in long hand you cannot just omit the letter e.g. if accommodation was not present you cannot write PERL you need to write each element individually.

**Relative afferent pupillary deficit:**

Another test that is often performed is the swinging light test. The test compares direct and consensual response to stimulation.

• Light stimulus should be shined in each eye for 2-4 seconds and quickly moved from one pupil to the other repeatedly (Wilhelm 2011),
• The light source should be held 5 – 10 cm away (Elliot 2013).
• The examiner observes for pupils which dilate and constrict during the procedure, both pupils should dilate and constrict equally.

The test may detect abnormalities of the retina and the optic nerve up to the optic chiasm. An abnormal finding is when both pupils do not show a similar response to the light stimuli, the
patient will then be diagnosed with RAPD or Marcus Gunn pupils. You can search on line for videos of this.

Abnormal pupillary reflexes may be due to: Optic nerve disorders, Age, Macular degeneration, Glaucoma, Retinopathies, Corneal, Iris or Lens conditions, Optic neuritis including MS, Malignancies, Head injury including stroke or Drugs.

**Visual Acuity**

Visual acuity is the ability to see objects clearly. To assess visual acuity we use a Snellen’s chart. A Snellen’s chart has a series of different sized characters, which are viewed from a distance of 6 metres away, (half sized charts are available and should be viewed at 3 metres). For each line there is a number below it that represents the distance in metres from which that size letter would be visible to someone with normal eyesight. For example a line with a small 9 should be readable from 9 metres by someone with normal vision.

- The patient should cover each eye in turn and determine the smallest print size that can be read comfortably.
- If they are unable to see any of the characters at 6 metres they can move forward 1 metre at a time until they can see a character clearly e.g. if they could only read the 60 print size from 3 metres then the documentation would be recorded as 3/60.
- Each eye is recorded separately and charted with the distance from the chart followed by the size of the smallest letters they can read e.g. R = 6/6 L = 6/9, these results would indicate that this patient can read the smallest text with their right eye and therefore has normal vision. However, with their left eye from 6 metres they can only read what people with normal vision are able to read at 9 metres.
- If the patient is short-sighted their glasses should be worn (their lens prescription should be documented), if their glasses are not available reading through a pin-hole will help to compensate as we are assessing a sudden deterioration in vision.
- For patients unable to read the chart as close as 1 metre acuity is recorded based on their ability to:
  - Count fingers (CF) at 0.5 metre,
  - Perceive hand movement (HM),
- Perceive light (PL) or document NPL if the patient has no perception of light.
- For patients with NPL this can be confirmed by a “blink to threat test” in which the examiner’s fingers are moved rapidly towards the patient’s eyes from each quadrant to see if a blink occurs.

For patients and children who cannot recognise the alphabet there are charts showing shapes or pictures rather than letters.

It is difficult to determine if the optic nerve is the root cause for visual acuity problems but causes may include: Age, Macular degeneration (The receptor sites for central acute vision), Glaucoma (increased pressure within the eye), Retinopathies (affecting the light sensitive cells), Corneal, iris or lens conditions (affecting the passage of light or the ability to focus), Optic neuritis including Multiple Sclerosis (affecting the transmission of information), Malignancies (within the eye, CN II or the brain), Head injury including stroke.

Visual Field

The visual field refers to the total area in which objects can be seen in the side (peripheral) vision as you focus your eyes on a central point. If there is damage to the nerve fibres then your vision may alter.

Assessing visual fields is a simple “bedside” test to assess a patient’s peripheral vision and evaluate their blind spot. To carry out this test you should

- Face the patient at a distance of about 1 metre.
- Keep the patient’s visual background uncluttered, with light behind the patient.
- To test the right eye close or cover your right eye and ask the patient to cover their left eye and ask them to look at the bridge of your nose, this ensures you are both looking at the same visual fields.
- Ensuring the patient doesn’t look away from your nose and keeping a white pin in a plane midway between you and the patient
- Bring the white pin head from the extreme of vision (arm’s length) in towards the midline. A white pin head is used due to rods being in abundance on the periphery of the retina hence a light / dark colour is used.
- As the pin head is moved in ask the patient to indicate when they first see it entering their visual field and compare this to your own detection.
Test each quadrant moving diagonally bisecting each quadrant.

Establish rough boundary then define areas of loss with slower target movements (see Fig. 1&2) thus producing a more detailed “map” of a defect.

The field of vision is limited superiorly by the supra-orbital ridge and medially by the nose. Any defect to the patient’s vision should be assessed formally.

**Blind spot**

As the optic disc contains neither cones nor rods it is an area of the retina which is unable to perceive light and therefore creates a blind spot in which a visual field deficit is present. This is found at an angle of approximately 15 – 20 degrees lateral to forward gaze and is perceived only when one eye is closed.

For this test sit opposite the patient ensuring you are both at the same eye level. As with peripheral vision you are comparing your right eye with the patient’s left eye and vice versa closing one eye at a time.

- You need to use a 1cm red pin / object, this is because we are assessing central vision and there are more cones, which pick up colour, than rods present.
- Move the pin head slowly from the midline outwards.
- Ask the patient to report any distortion of the pinhead or when it disappears and reappears due to the blind spot.
- The pinhead should disappear and reappear within approx 1cm (width of the pin head). Compare the patient’s blind spot with your own, if there is a difference in the size of the blind spot, this could indicate many things including a scotoma or optic disc oedema. A scotoma is a small visual field deficit due to conditions which affect the passage or perception of light within the eye.

**Interpretation of Visual Field**

The following images show the possible areas of damage to the nerve and how this could affect the patients vision along with the name of the visual loss. The arrows at the top indicate the
passage of light (light travels in a straight line) and it is important to note that images perceived by the temporal pathway are traveling from the nasal area i.e. the green and purple arrows and conversely images perceived from by the nasal pathway are travelling from the temporal area i.e. the blue and red arrows.

It is important to remember that visual loss can be partial or complete for a variety of reasons and the basic patterns of damage are listed below, each clinical case could present differently and neurology patients present with slightly more challenging cases than most due to the numerous pathways.

In this first image there is damage to the optic nerve on the left hand side. If you follow the green and blue pathway they both lead to the left eye, so in this condition the patient would not be able to see anything from their left eye. This would be the same for the right eye if the damage was to the nerve on the right side.

Unilateral blindness – The lesion or damage is anterior to the optic chiasm so causing total blindness to that eye. This may be caused if the optic nerve is severed due to trauma.

In this second image there is damage to the optic chiasm. If you follow the red and blue pathways it will show that the patient’s right eye will not be able to perceive images from the temporal region - as the left side of the retina (red in the image) is picking up images from the temporal region. Similarly the patient will not be able to see to the left side with their left eye (again the temporal side). This will give them a bi-temporal hemianopia.
The third image shows damage to the optic radiation on the right side (blue and purple lines). These fibres come from the right side of each eye (purple from the right eye and blue from the left eye). As the damage affects the right side of each eye, the patient would not be able to see anything to the left side. This is called a left homonymous hemianopia. If the damage had been to the opposite side of the optic radiation then the result would be a right homonymous hemianopia.

Homonymous hemianopia – visual loss on the same side of both eyes i.e. if it were a right sided hemianopia there would be visual loss in the right side halves of both eyes. This can be caused by strokes, traumatic brain injury, tumours, aura phase of migraine (although this would be transient).

Bi Temporal Hemianopia – More commonly referred to as tunnel vision. Light from the temporal fields picked up on the nasal fibres are not transmitted to the visual cortex, so causing blindness of peripheral vision. This can be caused by a pituitary tumour - the tumour enlarges and compresses the optic nerve at the chiasm causing peripheral visual field loss.
The final image is damage to the optical cortex. In the image the damage has occurred at the red and green line so the patient would not be able to see anything from the right side. However, due to the collateral blood supply in this area central vision is preserved.

Causes of an abnormally large blind spot, the presence of scotoma or loss of visual field may include: CN II Lesions, Optic neuritis (affects the passage of information), Glaucoma, Diabetes (affects the retina), Macular degeneration, Arteriosclerosis or tumour.

Cranial Nerve III, IV and VI (Oculomotor, Trochlear and Abducens)
Eye movements are controlled by cranial nerves III, IV and VI. Read through your HARC notes to learn more about the anatomy and physiology of eye movements.

Which nerves govern which muscles?
A way to remember which muscle is controlled by which nerve is SO⁴ LR⁶ & EE³.

- SO⁴ means that the superior oblique muscle is controlled by the 4th nerve which is the trochlear nerve, this muscle also goes through a bony prominence called a trochlear.
- LR⁶ means that the lateral rectus muscle is controlled by the 6th nerve which is the abducens. To abduct means to move away from the body.
- EE³ means that everything else is controlled by the 3rd nerve which is the oculomotor.
Image 3

The arrows indicate the direction of movement of the eyes and not necessarily the position of the muscles.
Testing eye movements

Known as testing the angle of movement in the 9 cardinal positions of gaze.

- Ensure that the patient's glasses are removed, and inspect the position of the eyes in their primary position before you start.
- Hold a pen torch 50 cm from the patient Danchaivijitr & Kennard (2004) in the midline and on a level with the patient's eyes.
- Ask the patient to follow the object ("with their eyes"), keeping their head still, and to tell you if they experience any double vision (diplopia).
- Move the pen torch slowly and smoothly as per the arrows in Image 4, watching the movement of the patient's eyes.
- You will need to observe the range, smoothness and speed of the movement, as well as noting whether the eyes move together (conjugate) or if there is a nystagmus present (see 8th nerve for details).

Please be aware that you may occasionally see clinicians performing the “Double H” in practice, current research and best practice recommend the 9 cardinal positions of gaze and this is what the CSTLC will be practising. (Snell 2013 and Lim et al 2014)

Diplopia – which eye and muscle

If the patient is suffering from diplopia, you will need to establish which muscle(s) is affected. Monocular diplopia is double vision in one eye, binocular diplopia is double vision in both eyes. With monocular diplopia, the double vision occurs even when the other eye is covered and continues when looking in different directions, this can be caused by; astigmatism (abnormal curvature of the front of the cornea), cataracts (the lens becomes less transparent), dry eye, infections like shingles or herpes or retinal problems etc.

Binocular diplopia is double vision related to the misalignment of the visual axis, and the double vision disappears if either eye is covered. This can be affected by palsy (Lateral rectus) the eye will misalign medially.

You will need to initially determine if it is monocular or binocular, if it is monocular, the patient will need an ophthalmological assessment.
For binocular diplopia, a full history will be required, covering speed of onset, location of double vision, ie; is it horizontal or vertical, is there separation between the images? Horizontal binocular diplopia tends to be damage to or affecting the medial or lateral rectus muscle. Danchaivijitr & Kennard (2004)

- Cover each eye in turn and confirm binocular diplopia (present only with both eyes looking).
- If you cover one eye and the 2nd image away from the centre of vision disappears, the covered eye and the muscle turning it that way are the abnormal ones.
- This can be cross-checked by covering the other eye, in which case the central image should disappear.

Here are some examples of nerve palsy’s:

6th (Abducent) nerve palsy

- patients complain that they get double vision on the stairs or reading. Often they report that tilting the head helps with double vision or closing one eye.

4th (Trochlear) nerve palsy

- patients often complain that their double vision is worse in the distance.
Cover test for latent squint

The cover/uncover test, is used to identify strabismus (misalignment of eyes), specifically a tropia or a phoria. A tropia is a misalignment of the eyes that is always present, a phoria is a misalignment of the eye which only appears when binocular vision is broken (the two eyes are not looking at the same object) and tends to occur when the patient is tired. The cover/uncover test is when each eye is covered and then uncovered in turn, this is a sensitive test and should be able to demonstrate the deviated eye by observing for return to alignment (fixation) immediately after being uncovered. If there is a return to alignment then there is evidence of deviation.

- Ask the patient to look with both eyes at the bridge of your nose.
- Cover the patient’s left eye, then uncover it and rapidly cover their right eye.
- You should look to see if the left eye corrects to fix on your nose, repeat for the patient’s right eye.

If there is no shift in fixation then it can mean the patient has no misalignment, however it needs to be confirmed with the findings of the opposite eye. If the eye does shift in fixation then it is an indication that there is a form of strabismus.

In addition to CN III, IV and VI dysfunction, causes of diplopia may include: Thyroid condition, Diabetes, Myasthenia Gravis, Multiple Sclerosis, Tumour, Trauma including stroke.
Cranial Nerve V, Trigeminal nerve

The trigeminal nerve has both sensory and motor supplies. The sensory division supplies three branches of the face: the ophthalmic (V1), maxillary (V2), and mandibular (V3), and the motor division supplies the muscles of mastication.

To test the sensory function you can use light touch or pain.

- For light touch use a wisp of cotton wool, although fingers are sometimes used instead if cotton wool is not available.
- For pain use the sharp end of a neuro tip, you can use the blunt end to act as a discriminator if the patient is unable to readily sense pain.
- You should test in at least two places for each of the regions, more if there is any sensory loss, when you should map out the area of loss.
- Remember to compare the right side with the left as you go along. Also be careful, when assessing pain, not to rest your fingers on the patient's face, or the edge of the neuro tip as this will not give a sharp sensation.

The corneal reflex can also be assessed as it is also governed by the trigeminal nerve. Be aware that it may naturally be dulled in someone who wears contact lenses, which should be removed, if present, before assessment.

- This reflex is elicited by using a wisp of cotton wool and asking the patient to look up and inwards, as this will remove usual stimuli.
- Gently touch the lateral cornea and both eyes should blink.
- Be careful to touch the peripheral cornea and not the conjunctiva and avoid the central cornea.
- Be careful not to drag the cotton across the cornea.

The trigeminal nerve senses the presence of the cotton wool, but it is the 7th cranial nerve (the facial) that closes the eyelid.

To assess the motor function of the trigeminal nerve:

- Place your fingers on the temporalis muscles and then the masseter muscles.
- Each time you should ask the patient to clench their teeth and you should be able to feel the muscles contracting.
- Next ask the patient to open their mouth to the left, and stop you trying to gently push the open jaw back to midline.
- Repeat this for right side; this is testing power of lateral and medial pterygoids, note any weakness.

The **jaw jerk** is a reflex that is also governed by the trigeminal nerve.

- You should assess it by asking the patient to relax their jaw so the mouth is slightly open,
- You then place a finger on their chin and percuss your finger with a tendon hammer,
- Observe and feel for jaw movement, which will be noticed by the mandible jerking upwards.

In addition to CN V dysfunction potential causes of trigeminal nerve problems may include: Trauma, MS, Arteriovascular Malformation or Tumour. If the patient is displaying signs of sensory loss on either side of the face, you will need to determine the extent of the loss, ie; is it a single trigeminal nerve or, could it be a single dermatone or a cutaneous nerve or does it follow a bizarre pattern (eg; the corneal reflex is present in a patient with sensory loss in an ophthalmic branch)? Once you have mapped the extent of the sensory loss you should report this to your supervisor.

**Cranial Nerve VII, Facial nerve**

(Don’t forget we looked at VI before the trigeminal nerve which is why we are jumping to VII)

The facial nerve supplies the muscles of facial expression and the stapedius muscle in the ear. Additionally the sensory aspect supplies taste to the anterior 2/3rd of the tongue and the parasympathetic fibres to the lacrimal gland. Lower motor neuron (LMN) lesions affect all facial muscles on that side of the face, whereas unilateral upper motor neuron lesions (UMN) spare the forehead, as it is dually innervated by the right and left facial nerve.
To test the motor function, ask the patient to
- show their teeth
- purse their lips,
- blow out their cheeks
- close their eyes tightly and
- open their eyes as wide as they can.

It is better for you to demonstrate each action first to the patient.

- Once you have assessed that the patient is able to do these movements, you need to assess them against resistance.
- To do this, with the patients eyes tightly shut attempt to gently pull the eyelids apart.
- With their eyebrows raised, attempt to pull eyebrows downwards.
- With their lips pursed tightly, attempt to pull their lips apart.
- With their cheeks blown out, press against the cheek to assess strength.

Remember to document any weakness.

When considering facial nerve dysfunction think:
Is the whole side of the face affected including the forehead?
If so causes include: Ipsilateral LMN causes – Parotid Tumour, Bell’s Palsy & Trauma. See NICE (2019) on management of Bell’s Palsy.

Is the whole side of the face affected excluding the forehead?

If so causes include: Contralateral UMN causes – Cerebral Vascular Accident (CVA), Epilepsy (Todd’s Paresis) & Trauma.

Bilateral weakness is unusual and is only seen in less than 3% of presentations.

Cranial Nerve VIII, Acoustic (Vestibulocochlear) nerve

The acoustic nerve has two functions – Auditory (hearing) and Vestibular (balance).

Tests for auditory function

The first test is a simple gross test:

- use a watch or rub your fingers together (in a quiet environment), and judge how far away the sound can be detected.
- You should test each ear, one at a time and block the opposite ear.

If hearing is impaired in either ear then you should perform Rinne’s and Weber’s test. These tests use a 512 Hz tuning fork which you should set vibrating by gently tapping on your knee or wrist or by squeezing the ends together and sliding your finger and thumb off the prongs.
Rinne’s test can be done in two ways the short and the long way.

- For the short way you should place the base of the vibrating tuning fork on the mastoid process, and confirm that it can be heard.

- Once the patient confirms they can hear it, immediately place prongs in front of external auditory meatus,
- Explain that it is in front of the ear and ask the patient which is louder - “behind the ear or in front?”

In normal conductive hearing the patient should hear it louder in front of the ear as the sound is travelling through air.

For the longer method:

- Place the vibrating tuning fork behind the ear,
- Once you have confirmed that the patient can hear the sound ask them to tell you when they can no longer hear the sound.
- When they can no longer hear the sound place the fork in front of ear directly over the auditory meatus and ask the patient again if they can hear the sound.

If the conductive pathway is normal the patient should be able to hear the sound again.

If the patient is suffering from conductive deafness (the sounds cannot conduct from the external to the inner ear) the sound will not be heard, or will be reduced, when the tuning fork is placed in front of the ear.

In partial sensorineural deafness (due to damage to the cochlea, auditory nerve or auditory centres of the brain) the sound may be heard when the tuning fork is placed in front of the ear (but at a higher pitch than normal hearing).

In complete sensorineural deafness no sound will be heard when the tuning fork is placed in either position as the nerve pathway has been severed.
Weber's test is performed by

- Holding the base of the vibrating tuning fork on the top of the patient's head or forehead.
- Ask the patient to tell you if the sound is louder in either ear or is the sound equal in both ears?

In normal conductive hearing the sound of the tuning fork will be heard equally in both ears or the patient will say they can't hear it at all.

In unilateral conductive deafness the sound will be heard loudest in the affected ear this is due to the vibration passing through the bone only and not through the air.

In bilateral conductive deafness the sound will be heard loudly in both ears.

In unilateral sensorineural deafness the sound will be heard loudest in the unaffected ear as again the affected ear has had the pathway blocked.

**Interpretation of Hearing tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Normal</th>
<th>Conductive Loss</th>
<th>Partial Sensorineural Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross, (Rubbing Fingers)</td>
<td>Heard at a distance</td>
<td>Not heard in the affected ear</td>
<td>Not heard in the affected ear</td>
</tr>
<tr>
<td>Rinne</td>
<td>Sounds are heard through air greater than bone</td>
<td>Sounds are conducted through bone greater than air</td>
<td>Sounds are conducted through air greater than bone</td>
</tr>
<tr>
<td>Weber</td>
<td>Equal</td>
<td>Increased hearing in affected ear than normal ear</td>
<td>Increased hearing in normal ear than affected ear</td>
</tr>
</tbody>
</table>

In addition to CN VIII dysfunction, hearing may be affected by number of conditions: blockage of ear canal, perforated eardrum, disarticulation of ossicles, inner ear infections, MS or tumour.

**Tests for vestibular function**

There are a number of tests to assess the vestibular function.

- Firstly assess gait by asking the patient to walk heel to toe.
- Observe to see if the patient veers to the affected side and is unsteady.
- You need to observe for nystagmus (involuntary rhythmic eye movements) which may be caused by peripheral or central vestibular, or cerebellum problems.
A nystagmus takes one of the 3 forms and may be rotary or linear:

**Jerk nystagmus**: slow drifting movement followed by fast corrective movement.

**Pendular nystagmus**: drifting & corrective movements occur slowly.

**Mixed nystagmus**: there is a pendular movement in the primary position of gaze (straight ahead) but a jerk nystagmus on lateral gaze.

When examining the patient a note is made of which position of gaze the nystagmus occurs in.

The primary position is when the patient is looking straight ahead.

The secondary position is looking straight up or down & straight right or left.

The tertiary position is the four oblique positions; up & right, down & right, up & left and down & left.

Cardinal positions include the right & left (secondary) positions and all tertiary positions.

- To examine for nystagmus you use the same double star and a cross pattern (as described previously – Cranial nerves III, IV and VI).
- Ask the patient to comment on any visual symptoms e.g. “vision has gone blurry towards the left side,” “I can see two fingers when looking up and right.”
- Enquire about the patient’s ‘null’ point: This is the gaze position of least eye movement and tends to be where vision is best. Abnormal head posture is usually observed, as tilting or turning the head into this direction, where the movements are least, can optimise vision.

If a nystagmus is present there are some points to note.

- What is the eye position and gaze direction when nystagmus occurs?
- Note the direction of the fast movement and the plane is it horizontal, vertical, rotatory.
- Is the abducting eye affected more than the adducting?
- Does it occur in other directions of gaze? A typical description could be; “a linear nystagmus, fast phase to the left, in both eyes on left lateral gaze.”

In addition to CN VIII dysfunction, balance may be affected by number of conditions: Inner ear infections, Labyrinthitis, MS, Diabetes, Cardiovascular conditions, Alcohol Misuse, Migraine, Anxiety or Tumour.

**Cranial Nerve IX, Glossopharyngeal nerve**

There is a sensory component that affects the posterior 1/3rd of tongue, the pharynx and middle ear. There is also a motor component affecting the stylopharyngeus muscle. An autonomic response affects the parotid salivary gland and the carotid baroreceptors.
To test for glossopharyngeal function, the gag reflex is bilaterally assessed only when clinically appropriate, for example in patients with suspected brain stem pathology, impaired swallowing or reduced consciousness. This will not be tested in your clinical skills session at the CSTLC. The glossopharyngeal has the afferent effect and senses that there is something present, the Vagus nerve (Cranial nerve X) creates the motor response.

- Using a cotton tipped swab briefly touch the pharyngeal wall behind the pillars of the faucets and ask if patient can feel it, while also observing for a gag response.

If there is no feeling or gag it may mean an ipsilateral 9th nerve dysfunction.

Another assessment is to ask the patients to

- say “Ahh” while observing their uvula for any deviation.

If there is a deviation one way, it indicates weakness on the opposite side as shown above.

Cranial Nerve X, Vagus nerve
This is also a mixed nerve with both sensory and motor aspects. The tympanic membrane, external auditory canal are external ear sensory components, whereas, the muscles of the palate, pharynx and larynx are motor components. Additionally the parasympathetic supply to and from thorax and abdomen is an autonomic response.

To test the vagus nerve,

- ask the patient to say “Ahh”,
- observing for any deviation, as mentioned previously with the glossopharyngeal.

If there is no movement on saying “Ahh” or no gag there is a bilateral palatal muscle paresis.
Cranial Nerve XII, Hypoglossal nerve
We have skipped XI for now as IX, X and XII can be tested together. The hypoglossal innervates the extrinsic and intrinsic muscles of the tongue (except for the palatoglossus), which is innervated by the vagus nerve.

The hypoglossal nerve is tested by:

- asking the patient to open their mouth and examine the tongue resting inside the mouth.
- observing for fasciculation and / or wasting (atrophy) as this is one of the indications of a LMN lesion. If it is unilateral it is a nerve problem, if it is bilateral it is usually a bulbar palsy.
- Ask the patient to stick out their tongue and you should observe for any deviation to one side, which indicates a weakness on that side, as tongue muscles “push”.
- Ask the patient to waggle their tongue, which you should demonstrate to them first. You should see normal smooth bulk, however, poor movement control, usually bilateral indicates an UMN lesion (“pseudobulbar” palsy).
- To test the power of the tongue, ask the patient to push their tongue against the inside of their cheek and you should press against the patient’s skin, where the tongue is pushing the cheek outwards. This should then be repeated for the other side.

Cranial Nerve XI, Accessory nerve (Spinal Accessory nerve)
This is a motor nerve. Each side of the brain supplies the ipsilateral sternocleidomastoid muscle and the contralateral trapezius muscle, therefore, a lesion on one side can give rise to signs on both sides.

**Right accessory nerve governs the ipsilateral (same) sternocleidomastoid and the contralateral (opposite) trapezius**
To test for the sternocleidomastoid:

- Ask the patient to turn their head to one side.
- Stabilise the patient with shoulder counter pressure
- Then put your hand against patient’s chin and cheek and ask patient to resist you *rotating* their head back to the midline.
- Watch the opposite sternocleidomastoid contract while testing its power.

To assess the trapezius muscles

- Ask the patient to shrug their shoulders and push down against the movement.
- This should be done one side at a time.

Weakness of sternocleidomastoid and trapezius on the same side indicates a lower motor neuron nerve lesion on the affected side. Weakness of sternocleidomastoid and trapezius on the other side indicates an upper motor neuron lesion on the side of the affected sternocleidomastoid.

In addition to CN XI dysfunction, causes of weakness may include: Myasthenia Gravis, MS, Motor Neurone Disease, Tumour or Trauma including stroke.
Additional Tests / Special Tests

Glasgow Coma Scale (GCS) or GCS-P (pupils)
The GCS is a global neurological assessment, where the conscious state of a patient is recorded, based on eye, verbal and motor responses. In 2018, GCS-P was introduced also observing for pupillary response.

How to assess a patient using this scale can be found in the further reading on GCS along with a tutorial. A score of 15/15 indicates a patient who is orientated, opens their eyes spontaneously and can obey commands (and with bilateral reactive pupils). Accurate assessment of cranial nerve function may be impaired by a decreased conscious level. Conscious level must be considered before assessing cranial nerves.
Documentation

Be sure to report any abnormal findings to your supervisor and document in the notes.

Documenting Visual Field Loss

An example of visual field loss documentation:

![Visual Field Loss Diagram]

Documenting Eye Movements

The information should include:
- If the movement is full, limited or excessive
- The grade of abnormality (usually -4 to + 4 described on the next page)
- Direction of abnormality (this may be related to the muscle affected if known)
- Any associated signs e.g. lid changes or presence of nystagmus

Nine cardinal positions of gaze

The nine cardinal positions are listed below. The position on the page represents the patient’s eyes as they face the examiner. These are the terms that should be used if writing a descriptions of eye movements.

<table>
<thead>
<tr>
<th>Dextroelevation</th>
<th>Elevation</th>
<th>Laevoelevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dextroversion</td>
<td>Primary position</td>
<td>Laevoversion</td>
</tr>
<tr>
<td>Dextrodepression</td>
<td>Depression</td>
<td>Laevodepression</td>
</tr>
</tbody>
</table>
Grading

Zero represents normal movement and limitation of movement is usually graded on a scale of 1 to 4.

- -4 indicates no movement beyond midline (no movement beyond midline)
- -3 indicates 25% movement remains (marked)
- -2 indicates 50% movement remains (moderate)
- -1 indicates 75% movement remains (slight)

If the eye cannot reach the midline, the extent of limitation should be recorded as -5 or higher if necessary.

Documentation graphically

Below is an example of how this can be drawn. These shapes can be drawn out by hand in the clinical notes.

The — indicates where a grading needs to be inserted to indicate if the movement is full or abnormal. As above, the diagram represents the patient’s eyes as they face the examiner.

A minus number and a hatched area indicates a restriction

Other documentation you may see on eye movement documentation may include:

- A minus number without hatching indicates an underaction
- A positive number indicates an overaction

If eye movements are complicated – say what you see!
An example:

* Graphically when testing eye movements:

```
  0  0  0  0  0  0  0  -4
  0  0  0* 0  0  0  -4
  0  0  0  0  0  -4
```

* Nystagmus seen in right eye on laevoversion

Descriptive
No movement of left eye beyond midline in laevoversion and nystagmus seen in right eye on laevoversion.
## Appendix 1

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Function</th>
<th>Exit</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I Olfactory</strong></td>
<td>Sensory function: Controls smell</td>
<td>Cribiform plate</td>
<td>Usually not tested. Patient may complain of loss of taste sensation. Essence of vanilla, damp coffee or other recognisable pungent smells. Not Ammonia – painful. (Test one nostril at a time.)</td>
</tr>
<tr>
<td><strong>II Optic</strong></td>
<td>Sensory function (afferent visual component): Controls light / images from the retina transmitted via the optic tract to the lateral geniculate nucleus and on to the visual cortex</td>
<td>Optic canal</td>
<td>Ophthalmoscopy, direct light reflex, consensual light reflex &amp; accommodation. (P.E.R.L.A.) Snellen’s chart. Distance and near visual testing. Visual field test. RAPD</td>
</tr>
<tr>
<td><strong>III Oculomotor</strong></td>
<td>Motor function (Efferent): Controls constrictor muscles of the iris for dilatation &amp; constriction of pupils, levitator muscle (opening of eye lids), eye muscles: superior rectus, inferior rectus, medial rectus &amp; inferior oblique</td>
<td>Superior orbital fissure</td>
<td>Direct light reflex, consensual light reflex &amp; accommodation. Testing of eye movement. 9 Cardinal positions of gaze Checks for co-ordinated eye movements and notes double vision due to the inability of the eyes to co-ordinate. Cover test</td>
</tr>
<tr>
<td><strong>IV Trochlear</strong></td>
<td>Motor nerve that controls the superior oblique muscle, that is primarily responsible for turning the eye inward (intortion), secondary, depressing the eye and tertiary function to abduct the eye</td>
<td>Superior orbital fissure</td>
<td>Testing of eye movement. 9 Cardinal positions of gaze and cover test</td>
</tr>
<tr>
<td><strong>V Trigeminal</strong></td>
<td>Motor &amp; sensory function: Trigeminal has 3 paired tracts on each side of the face. Motor: Controls Temporalis, Masseter &amp; Pterygoid muscles. Sensory: Controls touch sensation on the face, corneal reflex and teeth</td>
<td>Superior orbital fissure / Foramen rotundum / Foramen ovale</td>
<td>Motor = Palpate the temporal &amp; masseter muscles whilst the patient clenches their jaw. Pterygoids, ask the patient to deviate the jaw to the left and right, ask the patient to return their jaw to the midline whilst you apply opposing force to assess muscle power. Sensory = Sharp &amp; blunt discrimination test. Sensory component of the corneal reflex (explained in study guide) Motor aspect is Facial nerve and oculomotor. Tooth sensation not tested.</td>
</tr>
<tr>
<td><strong>VI Abducens</strong></td>
<td>Motor function: Controls lateral rectus muscle</td>
<td>Superior orbital fissure</td>
<td>Testing of eye movement. 9 Cardinal positions of gaze and cover test</td>
</tr>
<tr>
<td><strong>VII Facial</strong></td>
<td>Motor function: Controls facial muscles and stapedius muscle within the ear, the efferent component in the corneal test (closure of eye lids). Sensory function: Controls the anterior two thirds of the tongue (taste) and the secretomotor function to the salivary gland (with the exception of the parotid) and the lacrimal gland.</td>
<td>Internal acoustic meatus</td>
<td>Motor = Ask the patient to “pull faces” Assess their ability to do so. Ask them to repeat pulling faces and apply counter pressure to oppose their muscle action. Assess their muscle strength. Note eye lid closure as part of corneal reflex test. Sensory = Taste seldom tested</td>
</tr>
<tr>
<td><strong>VIII Auditory or Vestibulo-</strong></td>
<td>Sensory function: This is divided between sensing sound (acoustic) and balance (vestibular).</td>
<td>Internal acoustic meatus</td>
<td>Acoustic = Rinne’s &amp; Weber’s test. Diagnose sensorineural or conductive hearing loss. Vestibular = Observe the patient walking with their eyes closed. Observe gait / balance.</td>
</tr>
<tr>
<td><strong>cochlear</strong></td>
<td>Romberg’s test may be performed. (Coordination study guide - They are separate tests, testing different things.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
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<td></td>
</tr>
</tbody>
</table>
| **IX Glosso-pharyngeal** | Sensory function:  
| | Controls the posterior third of the tongue, the tonsils and the pharynx. Also controls the secretions from the Parotid salivary gland.  
| | Motor function:  
| | Controls the stylopharyngeus muscle – elevation of the larynx and pharynx and dilates the pharynx to permit swallowing  
| | Jugular foramen  
| | Sensory = Afferent component of eliciting a gag reflex.  
| | Taste test for the posterior ⅓ of the tongue very rarely performed. |
| **X Vagus** | Motor function:  
| | Controls the laryngeal and pharyngeal muscles which control voice & resonance.  
| | Sensory function:  
| | Parasympathetic action to nearly all fibres from the head to the splenic flexure, along with the auditory canal & tympanum (ear drum.)  
| | Jugular foramen  
| | Ask the patient to say “Ahhhhhhhhhhhhhhhhhh!” Observe for flattening of the tongue, elevation of the palate and the symmetrical elevation of the uvula. If the uvula deviates then the lesion is on the opposing side to which it deviates.  
| | The patient will also exhibit a hoarse voice and difficulty swallowing. |
| **XI Accessory** | Motor function:  
| | Controls the neck muscles, the sternocleidomastoid & trapezius  
| | Jugular foramen  
| | Sternoceleidomastoid. Ask the patient to turn their head to one side with the examiner applying gentle pressure to oppose this manoeuvre. If there is weakness or an inability to perform this then the lesion is in the contra lateral (Opposite) portion of this nerve.  
| | To test the trapezius muscle. The examiner places his hands on the patient’s shoulders and asks the patient to lift their shoulder whilst the examiner bears down. Any weakness is ipsilateral in origin. (Same side.) Remember to test both sides. This is an example of upper motor neurone lesion. (UMN)  
| | Lower motor neurone problem (LMN) would be as follows. Ask the patient to turn their head to the right whilst applying gentle pressure to prevent them returning to the midline. If they are unable to comply and additionally display weakness of the left shoulder then this characterises LMN |
| **XII Hypoglossal** | Motor function:  
| | Controls the tongue and other glossal muscles and is important for swallowing and voice articulation.  
| | Hypoglossal canal  
| | Observe for tongue fasciculation. May indicate a peripheral lesion.  
| | Ask the patient to move their tongue through a range of movements. Then oppose these movements by applying gentle pressure to prevent them from moving their tongue in the indicated direction.  
| | Ask the patient to “stick” their tongue out. If there is a weakness then it will deviate to the side of the weakness as the unaffected side pushes it over. |
Appendix 2

History 1 findings:

| Presenting Complaint | 2/7 (2 day) history of gradual increasing weakness on the left side of their face. No nausea Complaining of mild headache only (especially around ear) No loss of consciousness No visual disturbance. Has noticed speech has changed slightly (especially for P and B, labial sounds), but similar to after they have been to the dentist. No recent history of trauma or infection |
| Past Medical History | Nil of note, NKA (no known allergies) and is not currently taking any medication |
| Family History | Nil to note |
| Social History | Works from home, is a little worried and anxious and is hoping that this isn’t a stroke. |
| Review of Systems | Has noticed that everything seems louder (especially on the left side) and taste has changed. Patient has noticed their left eye is dry also, but no other symptoms. |

**On examination:**

| General inspection | Right side of face looks scrunched up compared to left. Right shows active movement on communication. |
| Specific Inspection | Examine face, mouth and tongue: Asymmetry apparent when patient raises eyebrows, smiles, puffs out cheeks and closes eyes tightly. |
| Palpation | Reduced power on left side when performing facial nerve testing including forehead weakness |
| Clinical Diagnostic Reasoning | 48 hour history of facial weakness with no history of trauma or infection. Patient has forehead weakness, therefore it is a lower motor neurone lesion, commonly a left ipsilateral Bell’s palsy. |

Further tests and investigations are required and the patient will need referral.
A 64 year old patient attends GP complaining of double vision

| Presenting Complaint | Patient noticed a sudden onset of double vision after doing some gardening. Double vision is worse when they look to the left, and the 2 images appear side by side (horizontal). Close up reading isn't too bad- it is worse when they are looking further away. No history of trauma/ infection, or vomiting, although they feel a bit disorientated with the double vision. Has had a mild headache, treated with Paracetamol. |
| Past Medical History | Diabetic on insulin, normally fairly well controlled. NKA, and just takes a statin and insulin |
| Family History | Nil to note |
| Social History | Retired but active |
| Review of Systems | Nil of note. |

On examination:

<p>| General inspection | Head turned slightly to left on arrival, no drooping of eyelid/ pupillary change. |
| 1. Specific Inspection | 1. No drooping of eyelid/ pupillary change. |
| 2. Ophthalmoscopy | 2. No signs of papilloedema |
| 1. When Testing Eye Movements | 1. When testing eye movements, the patient complains of double vision. There is a slight deviation of left eye inwards (esodeviation) on forward gaze |
| 2. Cover Test | When the patient is asked to follow an object to the left, left eye remains predominantly in forward gaze. The left eye moves slowly and does not move smoothly, yet all other movements are fluid. |
| | 2. Esodeviation noted in left eye when right eye is covered, which is greater when the patient is focused in the distance. |</p>
<table>
<thead>
<tr>
<th><strong>Clinical Diagnostic Reasoning</strong></th>
<th>Sudden onset of horizontal double vision no other significant symptoms noted, lateral rectus muscle appears weak in left eye - which could suggest 6th nerve palsy. The patient has diabetes, which is a risk factor for an isolated 6th nerve palsy. Consider differentials: myasthenia gravis, temporal arthritis etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Further tests and investigations are required and the patient will need referral.</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Appendix 3**  
Further clinical cases

**History A**

<table>
<thead>
<tr>
<th>Presenting Complaint</th>
<th>Patient noticed a sudden onset of double vision while reading, the images appear to be one on top of the other. Double vision is relieved by closing one eye and also improves when tilting head over to one side.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Medical History</td>
<td>Nil of note</td>
</tr>
<tr>
<td>Family History</td>
<td>Nil to note</td>
</tr>
<tr>
<td>Social History</td>
<td>Retired</td>
</tr>
<tr>
<td>Review of Systems</td>
<td>Nil of note</td>
</tr>
</tbody>
</table>

**On examination:**

<table>
<thead>
<tr>
<th>General inspection</th>
<th>Head tilted to the right side and chin slightly dipped.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Inspection</td>
<td>No eyelid or pupillary changes</td>
</tr>
<tr>
<td>Cover test</td>
<td>Left eye moves downwards when the right eye is covered, and the right eye moves upwards when the left eye is covered.</td>
</tr>
<tr>
<td>Ocular movements</td>
<td>When testing eye movements, the patient complains the double vision is worse when their head is straight.</td>
</tr>
</tbody>
</table>

![Diagram of ocular movements](image)

**Clinical Diagnostic Reasoning**

Sudden onset vertical double vision improving with a head tilt to the right, superior oblique muscle appears weak in the left eye, which could suggest 4th nerve palsy. The most common cause of an isolated 4th nerve palsy remains ‘undetermined’. Consider differentials: trauma, vascular etc.

Further tests and investigations are required and the patient will need referral.
### A 44-year-old attends GP complaining of changes to vision

<table>
<thead>
<tr>
<th>Presenting Complaint</th>
<th>Patient noticed a sudden change to vision, has been bumping into door frames and has been finding it hard to read. Does not normally wear glasses for any activity. Last vision test 8 months ago. No other symptoms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Medical History</td>
<td>Nil of note, no known allergies, no medications</td>
</tr>
<tr>
<td>Family History</td>
<td>Nil to note</td>
</tr>
<tr>
<td>Social History</td>
<td>Nil of note</td>
</tr>
<tr>
<td>Review of Systems</td>
<td>Nil of note.</td>
</tr>
</tbody>
</table>

**On examination:**

<table>
<thead>
<tr>
<th>General inspection</th>
<th>Nil of note</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Visual acuity</td>
<td>3. Good equal vision 6/6 right and left eyes</td>
</tr>
<tr>
<td>4. Ophthalmoscopy</td>
<td>4. No ocular pathology</td>
</tr>
</tbody>
</table>

**Visual field**

![Visual field diagram](image)

**Clinical Diagnostic Reasoning**

Sudden onset visual change. Left homonymous hemianopia present on visual field assessment with good visual acuity and no ocular pathology therefore likely a posterior circulation stroke.

Further tests and investigations are required, and the patient will need referral.
### History C

<table>
<thead>
<tr>
<th>Presenting Complaint</th>
<th>Complaining of pain when moving their eyes. Have noticed their eyes have changed in appearance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Medical History</td>
<td>Radioiodine treatment eight years prior and is currently taking levothyroxine for her hypothyroid status post treatment.</td>
</tr>
<tr>
<td>Family History</td>
<td>Nil to note</td>
</tr>
<tr>
<td>Social History</td>
<td>Ex-smoker</td>
</tr>
</tbody>
</table>

**On examination:**

<table>
<thead>
<tr>
<th>General inspection</th>
<th>Both upper lids appear retracted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Inspection</td>
<td>Bilateral widening of palpebral fissures and both globes appear proptosed.</td>
</tr>
<tr>
<td>Cover test</td>
<td>No manifest deviation seen.</td>
</tr>
<tr>
<td>Ocular movements</td>
<td>When testing eye movements complaining of pain on all movements. Also notices double vision while testing when looking in elevation, depression and to the right.</td>
</tr>
</tbody>
</table>

| Clinical Diagnostic Reasoning | Presentation with lid retraction, proptosis, and multiple eye movement limitations associated with pain and diplopia on movement. History of hyperthyroid and radioiodine treatment. Likely thyroid eye disease. |

Further tests and investigations are required and the patient will need referral.
Appendix 4

Clinical Skills sharps management for the School of Medicine, Liverpool

If you sustain a sharps injury in clinical practice, please also adhere to Trust policy, if you sustain an injury in CSTLC, such as in The Learning Zone please also adhere to the CSTLC policy.

- **Remove**
  - Remove sharp
  - Sharps with unknown contaminants may need to be retained for analysis

- **Squeeze it**
  - Squeeze the site to make it bleed

- **Wash it**
  - Wash the site thoroughly with soap under running water
  - Do not scrub

- **Dry it**
  - Dry the site thoroughly

- **Dress it**
  - Apply a dressing to the site

- **Report it**
  - Report the injury to your supervisor and manager of the clinical area
  - Dr Beddoes(ebeddoes@liv.ac.uk) must be emailed with all injuries sustained in clinical practice.

- **Document it**
  - Complete an incident form
  - Attend Occupational Health or Accident and Emergency Department
Bibliography & Further Reading

Ataxia: https://www.ataxia.org.uk/
For details of the anatomy look at Aclands Video Atlas, Volume 4


Eye movements;
https://www.liverpool.ac.uk/elearning/orthoptics-project/


NICE (2019); Bell’s Palsy; https://cks.nice.org.uk/bells-palsy#Iscenario

NICE (2019); Brain tumours (primary) and brain metastases in adults; NICE guideline [NG99]: https://www.nice.org.uk/guidance/ng99

NICE (2019); Trigeminal neuralgia; https://cks.nice.org.uk/trigeminal-neuralgia

Paul Rea (2014)


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**Image 1** - View from below of the brain and brainstem showing the cranial nerves, This file is licensed under the Creative Commons Attribution 2.5 Generic license. By Brain_human_normal_inferior_view_with_labels_en.svg:
*Brain_human_normal_inferior_view.svg: Patrick J. Lynch, medical illustrator
derivative work: Dwstultz (talk) - Brain_human_normal_inferior_view_with_labels_en.svg, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=15108118

**Image 2** – The Brainstem, with cranial nerve nuclei and tracts: By CFCF - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=31097174


**Image 5** - Photographer Simon Robben https://www.pexels.com/photo/face-facial-hair-fine-looking-guy-614810/

**Image 6** - By Lars Chittka; Axel Brockmann - Perception Space—The Final Frontier, A PLoS Biology Vol. 3, No. 4, e137 doi:10.1371/journal.pbio.0030137 (Fig. 1A/Large version), vectorised by Inductiveload, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=5957984

**Image 7** – Permission for image kindly granted from Charlie Goldberg M.D. U CSD School of Medicine https://meded.ucsd.edu/clinicalmed/neuro2.htm

**Image 8** - By RobertB3009 - Own work, CC BY-SA 4.0