Brain anatomy, physiology, Stroke & Neurological Assessment
Functions of the Brain

FRONTAL
- Personality/Behaviour
- Planning
- Decision making
- Concentration
- Voluntary motor functions
- Primary motor cortex (precentral gyrus)

TEMPORAL
- Understanding speech
- Interpretation and storage of auditory and olfactory sensations

BRAINSTEM (Midbrain, Pons, Medulla oblongata)
- Breathing
- Swallowing
- Heart rate
- Arousal and wakefulness

PARIETAL
- Comprehension and language
- Sensory functions (pain, heat and other sensations)
- Primary somatosensory cortex (postcentral gyrus)

OCCIPITAL
- Primary visual cortex
- Processing visual information
- Storing visual memories

CEREBELLUM
- Coordination
- Balance
- Stores memories of previously learned movement patterns
Contra-lateral Control
Speech centres

- **Broca’s area**: control the muscles of the larynx, pharynx and mouth that enable us to speak.

- **Wernicke’s area**: injury here may result in receptive dysphasia. Controls our understanding of language.
Blood Supply to the Brain
Circle of Willis

- Middle cerebral artery
- Anterior communicating artery
- Anterior cerebral artery
- Ophthalmic artery
- Posterior communicating artery
- Basilar artery
- Superior cerebellar artery
- Pontine arteries
- Anterior spinal artery
- Posterior inferior cerebellar artery
- Anterior choroidal artery
- Posterior cerebral artery
- Vertebral artery

Circle of Willis

Stephanie
1. **Frontal Lobe**
   Controls:
   - Behaviour
   - Emotions
   - Organisation
   - Personality
   - Planning
   - Problem solving
   **Arteries:** ACA, MCA

2. **Parietal Lobe**
   Controls:
   - Judgement of shape, size, texture, and weight
   - The sensation of pressure and touch
   - Understanding of spoken/written language
   **Arteries:** ACA, MCA

3. **Occipital Lobe**
   Controls:
   - Colour recognition
   - Shape recognition
   **Arteries:** PCA

4. **Cerebellum**
   Controls:
   - Balance
   - Muscle co-ordination
   - Posture maintenance
   **Arteries:** Basilar, PICA, AICA, SCA

5. **Brainstem**
   Controls:
   - Alertness
   - Blood pressure
   - Digestion
   - Breathing
   - Heart rate
   **Arteries:** Vertebral, Basilar

6. **Hippocampus**
   Controls:
   - Object recognition
   - Stores meaning of words or places
   **Arteries:** PCA

7. **Temporal lobe**
   Controls:
   - Smell identification
   - Sound identification
   - Short-term memory
   - Hearing
   **Arteries:** MCA, PCA

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ACA = Anterior Cerebral Artery
MCA = Middle Cerebral Artery
PCA = Posterior Cerebral Artery
PICA = Posterior Inferior Cerebellar Artery
AICA = Anterior Inferior Cerebellar Artery
SCA = Superior Cerebellar Artery

Stephanie Drysdale
What is a Stroke?

* Interruption of blood supply to the brain, caused by a blocked or burst blood vessel... Cuts of the supply of oxygen and nutrients, causing damage to brain tissue.

( World Health Organisation 2010)
Ischaemic Stroke

- It an obstruction within the Blood Vessels.
- 84% Strokes are Ischaemic.
Ischemic stroke (Thrombo/embolic stroke)

- hypercholesterolemia
- hypertension
- Atrial fibrillation
- Ischaemic heart disease/angina
- Peripheral vascular disease
- Diabetes
- Previous stroke/TIA
- Smoking
- Increased alcohol intake
- Poor diet/obesity
- Increased age
- Atherosclerosis
- Oral Contraceptive Pill
- Drug misuse
Haemorrhagic Stroke

- Chronic high blood pressure.
- Amphetamine.
- Amyloid angiopathy
- Arterial Venous malformation (AVM),
- inflammation of blood vessels (vasculitis),
- bleeding disorders,
- anticoagulants,
Intracerebral and subarachnoid haemorrhage

Stephanie Drysdale
**A subdural hematoma** (American spelling) or **subdural haematoma** (British spelling), also known as a **subdural haemorrhage** (SDH), is a type of haematoma, usually associated with traumatic brain injury. Blood gathers between the dura mater, and the brain.

- *Usually resulting from tears in bridging veins which cross the subdural space, subdural hemorrhages may cause an increase in intracranial pressure (ICP), which can cause compression of and damage to delicate brain tissue.*
- *Subdural hematomas are often life-threatening when acute. Chronic subdural hematomas, however, have a better prognosis if properly managed.*

Stephanie Drysdale
- Cerebral infarction/ischaemic 84%
- Intracerebral haemorrhage 13%
- Subarachnoid haemorrhage 6%
- Risk of recurrence within 5 years 30-40%

(Stroke Association)
Why perform a neurological assessment?

The reasons to perform a neurological assessment include:
1. Identify the presence of nervous system dysfunction
2. Detect life-threatening situations
3. Establish a neurological baseline for the patient
4. Compare data to previous assessments to determine change, trends and necessary interventions
5. Determine the effects of nervous system dysfunction on activities of daily living and independent function
6. Provide a database upon which nursing interventions will be implemented.
The Glasgow Coma Scale

- It provides a practical method for assessment of impairment of conscious level
The Glasgow Coma Scale

- The GCS evaluates three key categories of behaviour that most closely reflect activity in the higher centres of the brain: **eye opening, verbal response and motor response** (Waterhouse, 2005). These categories enable the MDT to determine whether the patient has cerebral dysfunction.
Within each category, each level of response is attributed a numerical value. The lower the value, the greater the neurological deterioration and resulting brain insult. A Coma Score of 13 or higher correlates with a mild brain injury, 9 to 12 is a moderate injury and 8 or less a severe brain injury. The lowest possible score is 3 which indicates that the patient is completely unresponsive.
The aim of the GCS, is to get a firm baseline for comparison. Without this, you will be unable to recognise deterioration in the patient’s neurological condition and will not be able to react appropriately.

When used correctly, it alerts medics and nurses to a deterioration in a patient’s neurological status.
Illustration of GCS
Motor response - Abnormal Flexion

- Elbow bends
  - Shoulder adduction - arm moves towards the body
  - Wrist flexion
- features clearly predominantly abnormal
Motor response – Extension (2)

- Arm extends at elbow
  - Adduction of the shoulder - arm moves towards the body
  - Wrist flexion • Arm rotates internally
GCS Flow Chart: Eye Opening

1. Does patient open eyes spontaneously when approached?
   - Yes: Score 4
   - No:
     1. Talk to patient in a normal voice. Call patient’s name. ‘Open your eyes’
        - Open Eyes: Score 3
        - No Response: Speak Louder
          - Open Eyes: Score 3
          - No Response: Touch or gently shake patient
            - Open Eyes: Score 2
            - No Response: Apply a central stimulus
              - Open Eyes: Score 2
              - No Response: Score 1
## Eye Opening

<table>
<thead>
<tr>
<th>Score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>RAS, thalamus and cortex function intact CN3 intact</td>
</tr>
<tr>
<td>3</td>
<td>RAS and cortex function intact Motor cortex intact CN3 intact</td>
</tr>
<tr>
<td>2</td>
<td>Reduced function of RAS and cortex</td>
</tr>
<tr>
<td>1</td>
<td>Neurological dysfunction in RAS (brainstem)</td>
</tr>
</tbody>
</table>

- **Score 4**: Spontaneously
  - RAS, thalamus and cortex function intact
  - CN3 intact

- **Score 3**: To speech
  - RAS and cortex function intact
  - Motor cortex intact
  - CN3 intact

- **Score 2**: To pain
  - Reduced function of RAS and cortex

- **Score 1**: None
  - Neurological dysfunction in RAS (brainstem)
Ask the patient the following questions:
- What is your name? (Person)
- Where are you right now? (Place)
- What’s the date today? (Time)

*Do not ask closed ended questions (yes/No questions)*
*Do not ask the names of relatives*

**Answers everything correctly**

- **Score 5**

**No Response**

- **Score 1**

**CONFUSED**
Gives inaccurate responses but still able to respond in context

- **Score 4**

**INCOMPREHENSIBLE SOUNDS**
Responds to the questions but no clear words.
No intelligible words.
Often moans, groans or mumbles.

- **Score 2**

**INAPPROPRIATE WORDS**
Responds to the question but words are random, muddled, or out of context.
No complete sentences.
Repeats the same words.
(Perseveration)

- **Score 3**
## Verbal Response

<table>
<thead>
<tr>
<th>Score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Orientated</td>
</tr>
<tr>
<td></td>
<td>Temporal/parietal, frontal and prefrontal cortex intact</td>
</tr>
<tr>
<td></td>
<td>CN 5, 7, 8, 9, 12</td>
</tr>
<tr>
<td>4</td>
<td>Confused/sentences</td>
</tr>
<tr>
<td></td>
<td>Temporal/parietal, frontal intact</td>
</tr>
<tr>
<td></td>
<td>Reduced activity pre-frontal cortex</td>
</tr>
<tr>
<td>3</td>
<td>Inappropriate Words</td>
</tr>
<tr>
<td></td>
<td>Temporal/parietal, frontal intact</td>
</tr>
<tr>
<td>2</td>
<td>Incomprehensible Sounds</td>
</tr>
<tr>
<td></td>
<td>Temporal/parietal, frontal intact</td>
</tr>
<tr>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td>Neurological dysfunction in cerebral cortex</td>
</tr>
</tbody>
</table>
Questions used to assess best verbal response

Ask patient the following questions:

* Tell me your name? (personal details)
* Where are you? Or what is this place? What do you think my job is? (hospital, nurse)
* Tell me the month and year (the current month, year or season)
* Do not ask closed questions (i.e. those with yes/no answers)
* Do not ask the names of relatives
* Do not ask who the current prime minister is or other irrelevant questions (these are context specific e.g. if it is a visitor to the UK, they might not be able to answer)
GCS Flow Chart: Best Motor Response

Ask patient to follow 2 simple commands. Give verbal commands only. (eg. Lift up both of your arms, bend both of your knees) Avoid asking to squeeze your hands. If you ask patient to squeeze your hand, make sure the patient releases your hand on command too.

Obeys commands

Score 6

Does not obey command but tries to remove an oxygen mask or a nasogastric tube

Score 5

LOCALISES TO PAIN

Tries to remove stimulus. Arm moves across the midline towards the level of the chin.

Score 5

EXTENSION

In response to the painful stimulus, straightens arm at the elbow and rotates the arm inwards. Legs are often extended and the feet are plantarflexed.

Score 2

No commands obeyed

Score 1

Apply a central stimulus

No response

ABNORMAL FLEXION

In response to painful stimulus, flexes the arm and rotates the wrist.

Score 3

NORMAL FLEXION

In response to the painful stimulus, flexes the arm towards the source of pain but fails to localise or remove the source/stimulus.

Score 4
### Motor responses

<table>
<thead>
<tr>
<th>Score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Obeys commands</td>
</tr>
<tr>
<td>5</td>
<td>Localising pain</td>
</tr>
<tr>
<td>4</td>
<td>Flexion to pain</td>
</tr>
<tr>
<td>3</td>
<td>Abnormal flexion</td>
</tr>
<tr>
<td>2</td>
<td>Extension</td>
</tr>
<tr>
<td>1</td>
<td>none</td>
</tr>
</tbody>
</table>
Physical stimulus

Central Stimulus
- Can be used to assess eye opening response and motor response
- If the patient does not obey commands or is not trying to pull off oxygen facemask or nasogastric tube (if applicable)- central painful stimulus needs to be applied
- Trapezius squeeze

Always explain to the patient and relatives what you are about to do and why
The trapezius squeeze targets the spinal accessory nerve (cranial nerve XI) and is documented as the most suitable method.

- Apply pressure by grasping approximately 3 cm of the muscle between the thumb and forefingers and squeezing with gradually increasing intensity for up to 15 seconds.
- Do not squeeze for more than 15 seconds even if the patient does not react.
- This method could be difficult on a large or obese patient but can be done.
Estimate the size in mm using pupil scale and record the size numerically on the chart

Move the torch from the outer aspect of the eye towards the pupil, the pupil should constrict quickly (direct light response)

Repeat the previous procedure but observe the reaction of the opposite eye (consensual light response)

Repeat point 3 and 4 for the opposite eye
# Pupillary Responses

<table>
<thead>
<tr>
<th>feature</th>
<th>action</th>
<th>interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Equality</td>
<td>Resting assessment</td>
<td>Normal 2-6mm, Pinpoint- opiates Large- atropine Fixed Dilated- sudden CN3 compression, rising ICP</td>
</tr>
<tr>
<td>• Normal pupils are round, equal and react briskly and simultaneously to light</td>
<td>equality</td>
<td>Rising ICP, Cataract, Orbital injuries</td>
</tr>
<tr>
<td>shape</td>
<td>Ovoid</td>
<td>Rising ICP</td>
</tr>
<tr>
<td></td>
<td>Keyhole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Irregular/ jagged</td>
<td></td>
</tr>
<tr>
<td>Reaction to light</td>
<td>Sluggish</td>
<td>rising intracranial pressure compression of CN3 at brainstem</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>Coordination of CN3, unilateral compression</td>
</tr>
<tr>
<td></td>
<td>Consensual response</td>
<td></td>
</tr>
</tbody>
</table>
Assessing the pupils

Acutely widely dilated pupil on one side may be due to a unilateral space occupying lesion

Bilateral abnormally constricted pupils may be due to opiates

Bilaterally dilated pupils could be an intracranial catastrophe or due to sympathetic over activity i.e fear
Limb assessment

- Evaluation of the limbs provides the nurse with detail of the geographical distribution of dysfunction and is important when performing a full neurological assessment of the patient.

- A difference in responsiveness in one limb compared to another indicates focal brain damage. Hemiparesis or hemiplegia usually occurs in the limbs on the opposite side to the lesion (due to the crossing over of nerve fibres in the medulla). However, it may also affect the limbs on the same side as the lesion due to the pressure on the contra lateral hemisphere.
Each limb should be assessed separately. The patient should be awake, able to co-operate and understand what you are asking them to do.

Have the patient flex and extend their arm against your hand, squeeze your fingers, lift their leg while you press down on their thigh, hold her leg straight and lift it against gravity, and flex and extend her foot against your hand. A peripheral stimulus needs to be applied to limbs that you have not seen move.

As part of the motor assessment, also check for arm pronation or drift. Have the patient hold her arms out in front of her with her palms facing the ceiling, eyes closed. If you observe pronation—a turning inward—of the palm or the arm or the arm drifts downward, it means the limb is weak.
Grade each extremity using a motor scale like the one below.

- **+5** - full ROM, full strength
- **+4** - full ROM, less than normal strength
- **+3** - can raise extremity but not against resistance
- **+2** - can move extremity but not lift it
- **+1** - slight movement
- **0** - no movement
Vital signs

**Temperature**
* Regulation may be disrupted due to damage to the hypothalamus
* In the acute phase of brain injury hyperthermia should be treated as it will exacerbate cerebral ischaemia and adversely affect outcome

**Heart rate**
* ECG changes may occur in the acute stage following cerebral insult as a result of catecholamine release
* These can include peaked P waves, prolonged QT interval, heightened T waves, ST segment elevation or depression
* Bradycardia is present in the later stages of raised ICP (compensatory phase – Cushing’s response) or when there is an associated cervical spine injury.
* Tachycardia is present in the terminal stage of raised ICP
* Arrhythmias are seen in posterior fossa lesions or when there is blood in the CSF
Blood pressure

* In a normal brain a fall in blood pressure does not cause a drop in cerebral perfusion pressure since autoregulation results in cerebral vasodilation to protect brain tissue.
* However, following cerebral insult/injury, when autoregulation may be impaired, hypotension may lead to brain ischaemia.
* Hypotension (systolic BP <90mmHg) has been identified as a predominant factor in secondary brain injury and is related to morbidity and mortality.
* Hypotension is associated with a rising ICP and is part of the Cushing’s response – rising BP with a widening pulse pressure, bradycardia and decreasing respirations.
* This is a late response and may not appear in some patients and is invariably preceded by a drop in GCS.
Respiration

* Changes in the respiratory pattern are common following cerebral insult and patients often require advanced respiratory support in the acute stage. Initially an acute rise in ICP will cause slowing of the respiratory rate indicating loss of all cerebral and cerebellar control of breathing, with respiratory function at only brain stem level.

* As ICP continues to rise the rate becomes rapid indicating that the brain stem is affected too.

A decreased level of consciousness may compromise respiratory function, therefore observe for potential airway problems.

* Irregular pattern
* Noisy or snoring respirations
* Use of accessory muscles
* Tachyphoea/dyspnoea/apnoea
Raised Intracranial Pressure

**Early Signs**
- Agitation
- Vomiting
- Headache
- Dilated pupils

**Later Signs**
- Increased systolic blood pressure
- Bradicardia
- Abnormal respiratory pattern
# Causes and Treatment

<table>
<thead>
<tr>
<th>Causes</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oedema</td>
<td>Steroids</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>Manitol</td>
</tr>
<tr>
<td>Tumour</td>
<td>Hyperventilation</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td>Hemicraniectomy</td>
</tr>
</tbody>
</table>

Stephanie Drysdale
Hemicraniectomy

Stephanie Drysdale
• Score the patient as you see them – no guessing or backdating the results

• If they do not meet one criteria move down the score to the next one

• Always start the assessment with the patient as awake as possible (even at 2am)
• If patient looks different to the GCS scoring do a set of obs together at hand over
• Consistency with using the neuro. Obs is vital to detecting changes in the patients
• Don’t forget to spot other changes like increasing confusion even if the GCS hasn’t yet changed
Patterns of change in GCS

• Dropping obviously!
• Fluctuating widely – could it represent seizure (sub-clinically)
• Increasing difficulty in obtaining the same GCS
• Small changes within the category – e.g. confused but worsening confusion, obeys some commands but not others
http://www.glasgowcomascale.org/
References

- Care of the neurological patient. Caroline Pollington, 2013
- Glasgow coma scale flow chart: a beginner’s guide. K. Okamura, 2014