Performing a neurological assessment

Abstract:

Neurological observations are a crucial aspect of patient assessment, which require nurses to collect and analyse information gathered from use of a validated assessment tool such as the Glasgow Coma Scale (GCS). This includes, checking pupil size and reaction, limb movements and vital signs. This article discusses the anatomy and physiology underpinning neurological assessments tools, such as A(C)VPU and GCS, it also explains the rationale for checking pupil size and reaction, limb power assessment and how to correctly record and act on neurological observations.

Keywords: To be drawn from the Nursing Standard taxonomy

Neurological observations provide crucial information on the functional integrity of an individual's central nervous system (Derbyshire and Hill, 2018), forming part of comprehensive assessments based on airway, breathing, circulation, disability (neurological) and exposure (A-E) assessment (Resuscitation Council (UK), 2021). In acute deterioration or acute neurological insults such as a head injury, full assessment is crucial and neurological observations must be continued in all ongoing assessments to identify deterioration and enable early intervention (Oughton and Subramanian, 2023). Neurological observations should only be carried out by an appropriately trained and competent practitioner (National Institute for Health and Clinical Effectiveness [NICE], 2019). Nurses must work within their scope of practice and maintain their knowledge and skills, if they are to deliver safe practice (Nursing and Midwifery Council [NMC], 2018). The NMC (2018b) Standards of Proficiency require nurses in all fields of nursing to be able to undertake and interpret neurological assessments. In consequence, nurses need to understand the indications, types of assessment and actions to be taken once neurological observations have been recorded. This article discusses the anatomy and physiology underpinning the tools used of the commonly used methods, the A(C)VPU and Glasgow Coma Scale (GCS) assessments.

Review of Anatomy and Physiology

Nurses need to have a sound understanding of anatomy and physiology to recognise the possible causes of alterations in an individual's level of consciousness and cognition. The brain is protected by the cranium, which in turn is cushioned by the cerebrospinal fluid (CSF) and is perfused by blood vessels entering via the Foramen Magnum (Waugh and Grant, 2014). Three membranes protect the brain and spinal cord, the dura mater, the arachnoid mater and pai mater. The outer layer (dura mater) is a tough membrane that lines the skill and continues through the foramen magnum lining the vertebral column. Fine blood vessels separate the middle layer (arachnoid mater) from the subdural space. The arachnoid mater, a delicate impermeable membrane, within the subarachnoid space,

separates this layer form the inner most layer (pia mater), which adheres to the brain and spinal cord (Waugh & Grant, 2014).

The Monro-Kellie hypothesis explains how intracranial pressure (ICP) is maintained, stating the skull is a rigid compartment, containing non-compressible contents (brain tissue 10%, intravascular blood 10% and CSF in the ventricles and subarachnoid space, 10%). Cerebral perfusion pressure (CPP) is the difference between the mean arterial pressure (MAP) and ICP (Thomas et al., 2015).

$$CPP = MAP - ICP$$

Autoregulation maintains a constant cerebral blood flow, therefore, any changes in ICP will affect perfusion, for example, when CPP falls there is risk of reduced perfusion to the brain (Waugh & Grant, 2014). Under normal circumstances ICP is maintained by changes in intracranial blood volume and the pressure exerted by the CSF, that circulates around the brain and spinal cord. The normal ICP is estimated to be between 7 and 15mmHg in adults (Canac et al., 2020).

Changes in ICP can be caused by changes in heart rate and blood volume, and by factors such as haemorrhage or sepsis. In addition, nurses need to remember that cerebral trauma or neurological disease affects the normal homeostatic balance controlling ICP and if not recognised or treated, may result in a sustained high ICP (Karakis et al., 2017). Raised ICP impacts on blood flow to the cerebrum, causing hypoxia and a raised carbon dioxide level, this in turn causes arteriolar dilation, further increasing ICP (Waugh & Grant, 2014). The vasomotor centre in medulla oblongata maintains perfusion by increasing blood pressure, however, as ICP rises, the medulla becomes compressed. This is due to the increasing pressure causing cerebellum herniation through the foramen magnum into the upper spinal canal (Waugh & Grant, 2014). This causes cardiorespiratory instability, with signs of hypertension, high pulse pressure, bradycardia, Cheyne-Stoke respirations (abnormal breathing pattern), and reduced level of consciousness. The combination of bradycardia and hypertension is known as Cushing Reflex, a late and terminal sign (Waugh & Grant, 2014).

Neurological assessment

Neurological assessment is not completed in isolation but should be used as part of the ABCDE assessment, helping to identify and then treat life-threatening conditions (Resuscitation Council, UK, 2021). The ABCDE approach offers a structured assessment tool, which provides more detail than vital signs alone (Smooth & Bowden, 2017. Resuscitation Council, UK, 2021). In addition, medical history, which includes past medical and current conditions, can aid in identifying factors which may have caused or be exacerbating the altered mental state. Therefore, a validated tool such as the Glasgow Coma Scale (GCS), pupil size and reaction, limb movements, vital signs (respiratory rate, blood pressure, temperature, and oxygen saturations) (NICE, 2019. Royal College of Physicians and Surgeons of Glasgow 2023), can help identify the extent of the changes in the neurological status. Increasingly, this assessment includes the use of a "track and trigger", which allows for vital signs to be recorded and 'tracked', and the associated score 'triggers' the nurse to intervene. The National Early Warning Scoring (NEWS-2) tool is an example of a track and trigger tool (Resuscitation Council, UK, 2021). Nurses need to remember that changes in a patient's mental status may be due to a chronic or acute condition. Therefore, when assessing a patient's neurological status, the nurse needs to take account of all aspects of the patient's condition. This includes considering metabolic / systemic, toxins (drugs and medications), hospital acquired e.g. delirium or due to a primary neurological condition (Srikanth, 2022) (Box 1).

Box 1. Altered Mental Status (Srikanth, 2022)	
Metabolic / Systemic	• Pulmonary: hypoxia, hypercarbia • Cardiac: hypoperfusion, heart failure • Renal: uraemia, hypercalcemia, acidosis / alkalosis • Gastrointestinal: hepatic encephalopathy, elevated ammonia, nutritional deficiencies (thiamine, B12) • Infection • Endocrinologic: hypo/hyperglycaemia, hypothyroidism, hypo/hyperthermia • Psychiatric: Catatonia, pseudodementia
Drugs	• Illicit substance intoxication or withdrawal • Carbon monoxide poisoning • Benzodiazepines, opioids, muscle relaxants • Antibiotics e.g. cephalosporins, penicillin's • Antihistamines and anticholinergics

	• Antiepileptic dugs • Steroids
Hospital Acquired / Delirium	• Pain • Delirium
Primary Neurologic Condition	• Vascular: intracerebral haemorrhage, ischaemic stoke, venous thrombosis • Traumatic brain injury • Elevated intracranial pressure • Seizures • Infection e.g. meningitis, encephalitis, brain abscess • Autoimmune • Neoplastic

A(C)VPU Assessment

For a rapid patient's assessment, nurses can use the Alert, responds to Voice, Pain or Unresponsive (AVPU) approach (Royal College of Physicians [RCP], 2012. Williams, 2019). However, the Royal College of Physicians (2017) pointed out that the use of the AVPU scale may underestimate illness, as a patient may be alert but also have new onset confusion, which may be a sign of clinical deterioration. Therefore, they modified the tool creating the revised National Early Warning Scoring (NEWS) tool, into which new onset confusion was added. This addition allows for any deviation from the patient's normal status to be identified, with the assessment now including confusion (C) (A[C]VPU) (RCP, 2017). However, the recent Resuscitation Council (2021) guidelines on management of the deteriorating patient still only refer to the AVPU method. Therefore, nurses must be aware that there may be variations in local and national training programmes. Regardless of whether the AVPU or ACVPU is method is used, pupils must be checked for size and reaction, as outlined below. In addition, if the nurse has any concerns or there are any changes in the patient's neurological status, they must escalate their concerns immediately to the nurse in charge and, if trained, perform a comprehensive neurological assessment using the GCS.

Glasgow Coma Scale

The GCS was developed nearly four decades ago (Teasdale & Jennett, 1974), and is now internationally recognised. By 2014, the GCS was used in 80 countries and translated into the national language in

74% of them (Teasdale et al., 2014. Royal College of Physicians and Surgeons of Glasgow 2023). It has also been incorporated into many national training courses including those of the Resuscitation Council (UK) courses (Resuscitation Council UK, 2021).

The GCS uses a scoring system based on best eye opening, best verbal response, and best motor response, which when added together provides a total score of between 3 and 15 (Mehta et al., 2019) (Table 2). The highest score 15, indicates the patient is alert and orientated, while a score of 3 indicates deep unconsciousness. The GCS score must be documented on a GCS chart, as this helps with recognition of improvement or deterioration from assessing the trends. Nurses need to remember that the score alone, does not explain the cause, for example a total score of 8 could be Eyes = 2, Voice = 2 and Motor = 4 or Eyes =1, Voice = 1 and Motor = 6. These have very different implications for the severity of the patient's condition, which are only evident when charted (Royal College of Physicians and Surgeons of Glasgow, 2023).

Table 2: Glasgow Coma Scale
(Royal College of Physician and Surgeons of Glasgow, 2023).

Eyes Opening	4	Spontaneously
	3	To sound
	2	To pressure
	1	None
Verbal Response	5	Orientated
	4	Confused
	3	Words
	2	Sounds
	1	None
Motor Response	6	Obeys commands
	5	Localises
	4	Normal Flexion / withdrawal to pain
	3	Abnormal flexion
	2	Extension
	1	None

Eye Response

Best response has a maximum score of 4 points, given if the patient opens their eyes spontaneously and unprompted. It is important to note, this is a measure of arousal and not awareness (Derbyshire

and Hill, 2019). If the patient opens their eyes to speech which can be achieved by calling the patient's name or asking them to open their eyes, they are scored 3 points. If the patient does not their eyes, then a painful stimulus should be applied to the supraorbital notch or trapezius pressure to assess response (figure 1) (Royal College of Physicians and Surgeons of Glasgow, 2023. Resuscitation Council UK, 2021). The lowest score is one which indicates no eye opening to verbal and painful stimuli. If the patient cannot open their eyes due to swelling, then 'C' for 'closed' is recorded with the score. However, particularly with older patients, other factors which could affect the score, such as loss of hearing.

Figure 1: Supraorbital notch and trapezius pressure to assess response

Verbal Response

Assessment of verbal response determines higher cerebral function. For the maximum points of 5, the patient must be able to correctly respond to all component parts, which include orientation to time, place, and person (Derbyshire and Hill, 2019). If the patient is disorientated, they may use sentences that have a logical sequence in terms of words and phrases, however, they may be confused as to time, place, or person, and therefore score 4 points. If they use inappropriate or disorganised words, random audible words that are not relevant to the context, they score 3 points. If the patient makes sounds such as groaning, this would score 2 points and if there were no audible responses, they would score 1 point (the minimum score). If the patient has an artificial airway in place, such as an endotracheal or tracheostomy tube, the letter 'T' for 'tube' is recorded. Also, If the patient lacks awareness of cognitive function due to a known condition, such as dysphasia, it may be appropriate to use the letter 'D' (Derbyshire and Hill, 2019).

Motor Response

While all elements of the GCS are seen as crucial, motor response indicates motor cortex responses (Derbyshire and Hill, 2019), two decades ago this was identified as the most likely predictor of the motor cortex being undamaged (Healey et al., 2003). However, this element of assessment is the most difficult component of the GCS (Royal College of Physicians and Surgeons, 2023). For completion of this aspect, nurses must check the patient is able to understand language and simple commands (Derbyshire and Hill, 2019).

If the patient is able to obey one stage commands, for example, raise their arms, they score the maximum 6 points. However, if they are unable to do this, then the patient should be assessed using a painful stimulus. The location of where to apply painful stimuli remains controversial. For example, rubbing the knuckles on the sternum (previously accepted practice) is no longer recommended as it can cause bruising and responses can be difficult to interpret (Royal College of Physicians and Surgeons, 2023). The Resuscitation Council (UK) (2021) now recommends applying supra-orbital pressure at the supraorbital notch. However, other suggested locations include the trapezius pinch (using your thumb, index, and middle finger, squeeze at least two inches of the trapezius muscle at the base of the neck and twisting it) or the nail bed. Therefore, nurses must know and follow local policies, applying clinical judgement, for example, in a patient with facial injuries, it would not be advisable to use the supraorbital notch.

When a painful stimulus is applied, if the patient can localise to pain, they will move their hand above their shoulder in the direction of the pain, this scores 5 points. It is important to note that only one limb needs to move for scores of 5 or less. If the patient attempts to extend or withdraw from pain, where a limb moves away from the peripheral stimulus this scores 4 (figure 2). Abnormal flexion to pain, involves adduction (movement of a limb or other part towards the centre of the body) and internal rotation of the arms and extension of the legs, termed ‘decorticate’ movements (figure 2). This indicates damage above the level of the red nucleus in the midbrain, such as cortical or thalamic injury (Derbyshire and Hill, 2019) and scores 3. Extension to pain is an abnormal response, through

which the elbow and wrist extend, usually with leg extension, referred to as ‘decerebrate’ posturing, suggesting damage at or below the level of the red nucleus, such as in brainstem injury, indicating more severe brain damage. Decerebrate movements score 2 points. The final score of 1 point is given when there is no response.

Figure 2: Extension and Flexion to pain

Limb power and movement are also part of motor assessment, providing an indicator of motor response and extent of neurological dysfunction. Starting with the arms, the assessment involves testing each limb for strength, as each side of the brain controls the opposite limbs. Therefore, when recording power the letters ‘L’ and ‘R’ are used to identify left and right respectively.

Pupil Response

Pupil size and reaction to light are important component parts of neurological assessment because they assess the third cranial nerve (oculomotor) function. The normal pupil size is 3-5mm, with pupils constricting briskly, with changes in light. Prior to assessing pupil reaction, the nurse must first look at the pupils to check if they are equal, as medications and conditions such as eye surgery can change the pupil size, shape and reaction and are not associated with raised ICP (Waugh & Grant, 2014).

Using a bright pen torch, each pupil is assessed separately, by shining the light from the side of the eye being assessed to observe for its reaction. This is crucial because the pupil will constrict to a nearing object termed the ‘accommodation response’ affecting the accuracy of response (Waugh & Grant, 2014). Pupil size is recorded in millimetres and if the reaction is brisk, is charted as positive (+), if the reaction is slow or sluggish the letter ‘S’ is used and if there is no reaction, or the pupil is fixed, it is recorded as negative (-). The observation chart or pen torch may have the pupil sizes to help with

the assessment. If a pupil is fixed, dilated and unreactive to light, this could indicate injury or pressure on one side of the brain and the patient needs urgent review.

Figure 3: Size of pupils in mm

Frequency of Neurological Observations

NICE (2019) recommend any patient presenting to an emergency department with a head injury must be assessed within 15 minutes of arrival, using a validated neurological assessment tool such as the GCS. They suggest that any patient with a GCS of less than 15/15 requires observations to be performed and recorded every 30 minutes until the GCS of 15/15 is achieved. If the initial GCS is 15/15, neurological observations should be recorded every 30 minutes for 2 hours, then 1 hourly for 4 hours and then 2 hours thereafter (NICE, 2019). However, if there are any concerns or signs of deterioration the nurse should revert to 30-minute observations and an urgent medical review requested. Clinicians may request neurological observations to be recorded every 15 minutes depending on the clinical situation (Derbyshire and Hill, 2019). In addition, the nurse should also observe for other signs such a as new onset agitation, confusion or abnormal behaviour, any changes in GCS, development of severe or increasing headache or persistent vomiting, new or evolving neurological symptoms or signs such as pupil inequality or asymmetry of limb or facial movement (NICE, 2019). However, a limitation to using the GCS is inter-observer reliability which may over or under assess. In consequence, NICE (2019) recommends a second practitioner who is competent to perform neurological observations should assess the patient before escalating concerns. It is also good practice, when handing over patients, for the nurse going off shift to perform a set of neurological observations together with the nurse coming on shift, so that they can compare findings and consistency can be maintained.

While few studies are available on the accuracy of recording neurological observations, it is important to point out that an ongoing challenge is inaccurate recording of vital signs, incomplete observations,

and a failure to escalate early (Downey et al., 2017). While NICE (2019) have identified strategies to improve assessments, it is important to note that every effort must be made to maintain accuracy when performing neurological observations and documenting in the patient's records. To try to address this, some organisations are now using electronic systems. These have been identified as supporting consistency and accuracy of recording vital signs, making the practitioner perform full sets of vital signs, then the system automatically calculates scores and, in some instances, refers on (Watson and Carberry, 2021. Vincent et al., 2018). Using an electronic documentation system has the advantage that it may highlight and prompt the nurse if vital signs are missed, alerting them to the need to perform vital signs assessments, which in turn reduces missing data and improves compliance. However, as Watson and Carberry (2021) identified, availability of IT infrastructure may limit the effectiveness of this approach, increasing the risk of missed or delayed recording of vital signs, thereby delaying recognition of the deteriorating patient.

As outlined above, patients requiring neurological observations need to be closely monitored and have regular recordings of all observations. However, staffing levels can be a cause for concern, as Redfern et al's (2019) retrospective observations study of surgical and acute general wards in England found. They identified that late or missed vital signs were frequent, particularly in high-risk patients where nurse to patient ratios were high, and that better Registered Nurse staffing levels resulted in a lower rate of missed or delayed vital sign recording. The current nurse staffing crisis in the UK may affect monitoring of patients at risk of deterioration (Mitchell, 2022. Royal College of Nursing 2022). Nurses must recognise the importance of prioritising patients requiring neurological observations. If care for these patients is delegated to a junior colleague or student, supervision and monitoring of their practice is essential.

Conclusion

Nurses are required to complete neurological assessments in a range of settings. In consequence, neurological assessment is a crucial skill for nurses in all fields of practice, as a range of conditions and

co-morbidities may cause altered mental status, and a timely and effective response is essential. As this article shows, the role of the nurse is key because nurses spend more time at the bedside than any other healthcare professional and are the most likely practitioner to see changing levels of consciousness. However, it is not enough to observe, accurate documentation to corroborate these changes, facilitates early escalation and promote early intervention and effective treatment are essential.

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