

Examination of the head-injured patient

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MILITARY DOCTORS CAN expect to encounter patients with head injuries both in deployment for combat or humanitarian missions and in peacetime practice. Management is often undertaken in less than ideal conditions. The limited access to computed tomography (CT) and specialist neurosurgeons makes the clinical assessment of these patients even more important. Decisions to operate, evacuate or even not to treat at all will often depend on the result of repeated clinical assessment. It is therefore vital that the assessment be competent and reproducible and also readily transmitted to and understood by medical support teams further down the line.

Whether the head injury is open or closed, penetrating or blunt, the initial assessment is performed at the same time as resuscitation following early management of severe trauma principles. Application of these principles will ensure that secondary brain injury due to hypoxia and ischaemia is minimised. It is important to ensure that the sight of a dramatic open head wound or anxiety about managing severe brain injury does not distract one's attention from the more important tasks of securing an airway and maintaining adequate cerebral oxygenation and perfusion.

As part of the primary survey, the pupillary size and reactions are noted and the conscious state is assessed. Disturbances of consciousness may follow focal damage to the reticular formation, which extends from the rostral midbrain to the caudal medulla. It receives input from all sensory pathways and projects widely to the cerebral cortex and limbic system. Focal cortical lesions do not affect consciousness, but coma may result from general depression of the cerebral cortex.

Using purely descriptive methods to assess conscious state



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Synopsis

- ◆ Repeated clinical assessment is vitally important in the management of patients with severe head injury.
- ◆ The presence of a head injury should not distract one from performing the usual primary survey and resuscitation.
- ◆ The Glasgow Coma Scale provides a simple and relatively reproducible assessment of level of consciousness.
- ◆ A more detailed neurological examination is performed as part of the secondary survey. Even in an unconscious patient, useful information can be obtained.
- ◆ Early neurosurgical consultation is to be encouraged, particularly when neurological deterioration occurs.

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is problematic. One observer's "somnolent" is another's "drowsy". When is a person stuporous and when are they obtunded? What is semi-conscious and when does a clouded conscious state become coma? Consciousness is a continuum and we use the Glasgow Coma Scale (GCS) as a measure (albeit crude) of level of consciousness.

Glasgow Coma Scale

A thorough understanding of the GCS is vital for all health care workers involved in the management of head-injured patients, as changes in GCS are the basis for many management decisions. An assessment of the GCS at the earliest possible time after the injury should be obtained from those transporting the patient, as changes in GCS over time are more relevant than any single observation.

This scale was developed as a simple and reproducible measure of conscious level. It has both interobserver and intraobserver consistency, allowing it to be used as a measure of a patient's progress, despite recordings being made by many different staff members.

There are three components of the Glasgow Coma Scale. These are assessed separately and charted to give a visual representation of a patient's progress over time (Figure 1).

It is important to note that it is the *best* score that is recorded. The reason for this is obvious if one considers what is being assessed. This is a measure of conscious state, not focal deficit. Someone who had a stroke many years ago may

have abnormal flexion in their affected arm, even though they are wide awake and will obey commands with their good arm. As they are fully conscious, using their best motor score (“obeys commands”) is much more appropriate than their worst motor score (“abnormal flexion”). The best score also implies the best of all four limbs and, although assessment of the lower limbs is more difficult, it may be relevant in patients with bilateral upper limb fractures or other injuries.

Each response on the GCS is given a number, up to 4 for eyes, 5 for speech and 6 for motor response. Note that these start from 1, not 0, so a patient scores 3 points just for attending, even if they have already expired!

The total is 15 and a score can be given out of this total (eg, 6/15). This is more meaningful if it is broken up into its component parts (eg, E1, V2, M3, 6/15).

1. Eye opening

This is quite straightforward. If the patient’s eyes are open, “spontaneous” is recorded. If the eyes are closed initially, say the patient’s name or ask him or her to open their eyes. If they do, record “to speech”. If the eyes remain closed, apply a painful stimulus (a rub to the chest or pressure over the supraorbital margin). If the eyes open, record “to pain”, otherwise record “none”.



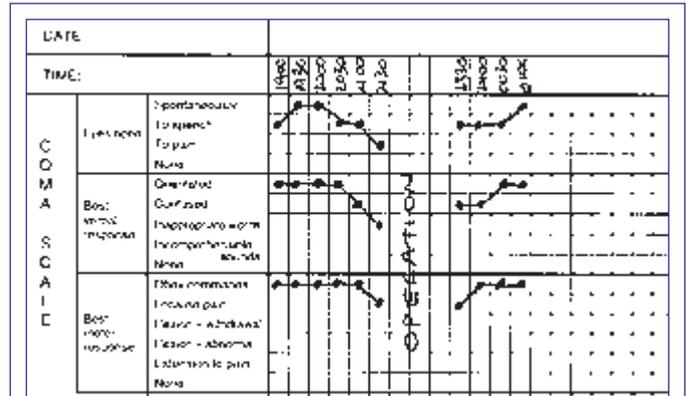
2. When the eyes are too swollen to open, a “C” is placed in the appropriate square on the GCS chart. This image shows bilateral periorbital haematomas or “raccoon eyes” which are typical of an anterior fossa fracture.

If the eyes are too swollen to open, a “C” for closed is placed in the box and this part of the scale becomes invalid (Figure 2).

2. Best verbal response

Each level on the verbal response section represents an increased level of complexity in communication. Starting at the bottom is “none”, which should not cause too many difficulties. Next is “incomprehensible sounds”, which means groans or other noises which do not make a word. One level higher is “inappropriate words”, which are words that do not make a sentence. Stringing words together to make sentences comes next. If these sentences are incorrect (eg, Q: “Where are you?” A: “At the supermarket”), the patient is recorded as “confused”, whereas if the answers are correct and the patient knows where they are they are recorded as “oriented”.

If the patient is intubated or has a tracheostomy tube they will not be able to talk and are recorded as “T” for tube. They should not be recorded as “none”. Dysphasia can also complicate assessment of the verbal component of the GCS.



1. A Glasgow Coma Scale chart, showing recordings made at half-hourly intervals in a patient who developed an extradural haematoma. The patient’s decline can be seen graphically, followed by surgery and subsequent recovery.

3. Best motor response

This section is the most difficult, but with a little practice it can be done quickly and reproducibly. It is also the most reliable indicator of conscious level and is not affected by intubation, dysphasia or swollen eyelids. It will be affected by paralyzing agents and their use should be noted in the clinical record.

“Obeying commands” means just that. The patient is asked to perform a task (eg, “Lift up your arm”). It is important to be wary of using “Squeeze my fingers”, as this may be confused with a grasp reflex. One needs to be confident that the patient has understood the command, processed it and then produced the appropriate response.

“Localises pain” implies that the upper limb is brought up above shoulder level when a stimulus is applied to the supraorbital margin (Figure 3). If a stimulus is applied to a nail bed on one hand and the other hand comes across the midline to push it away, this is also “localising” (Figure 4). A stimulus applied to the sternum will not reliably distinguish between “localising” and “normal flexion” (Figure 5).

“Normal flexion” (withdrawal) implies that the upper limb is flexed when a stimulus is applied to the supraorbital area but does not go above shoulder level (Figure 6). A similar response can be produced using nail bed pressure, but it is important to try supraorbital stimulation first to distinguish localisation.

“Abnormal flexion” is a more primitive reflex response. It can be distinguished from normal flexion by the presence of initial extension followed by flexion or any two of the following:

- stereotyped flexion posture (Figure 7)
- extreme wrist flexion (Figure 8)
- abduction of the upper arm (Figure 9)
- flexion of the fingers over the thumb (Figure 8).

“Extension” is easily recognised and is accompanied by

pronation of the forearm and flexion of the wrist (Figure 10).

“None” implies no response at all to painful stimuli, which should include a stimulus in a cranial nerve territory in case of spinal cord injury.

Using the GCS, coma is defined as not speaking words, not obeying commands and not opening eyes. Using this definition, most patients with a GCS of 9 and all with a GCS of 8 or less are unconscious (in coma). Patients who are unconscious (GCS <9) from a head injury should be intubated and ventilated, as they will not be able to protect their airway or maintain normal oxygen and carbon dioxide levels.

The GCS is also used to categorise head injuries as mild (GCS 14–15), moderate (GCS 9–13) or severe (GCS 3–8).

Despite the length of the description above, assessing GCS should take only a matter of seconds. It is not a complicated neurological examination and requires only observation, a few words and sometimes the application of a painful stimulus.

Secondary survey

Once the primary survey is complete, the secondary survey should include a more thorough neurological examination, starting with a reassessment of the GCS, and an examination of the head, face and neck. The head and face should be examined for lacerations and fractures. Scalp lacerations can be palpated with a gloved finger. If there is an underlying depressed fracture, surgery will be required. Profuse bleeding may occur from a scalp laceration and this can be controlled with a pressure dressing or by a few temporary full-thickness sutures.

With missile injuries, the entry wound may be quite small (Figure 11), but high velocity missiles may cause massive brain injury. If there is an exit wound it will generally be larger than the entry wound and accompanied by major fracturing of the skull (Figure 12). Low velocity missiles do not



3. If the upper limb is brought above the clavicle in response to a supraorbital stimulus, this is coded as “localising”.



4. With nail bed pressure, movement of the opposite limb across the midline is considered as “localising”.



5. Sternal pressure will not reliably distinguish between “normal flexion” and “localisation”.



6. If the upper limb is flexed to supraorbital stimulation but does not go above the clavicle, it is recorded as “normal flexion”.



7. Stereotyped flexion posture is seen in “abnormal flexion”.



8. This shows two components of abnormal flexion, namely extreme wrist flexion and flexion of the fingers over the thumb.

always produce an exit wound and may cause only focal injury without significant depression of consciousness. The nose and ears are inspected for leaks of cerebrospinal fluid (CSF). This is usually mixed with blood and results in a thinner discharge that will separate on blotting paper. If this is not available, the separation can also be observed on a sheet or pillowcase. If there is CSF rhinorrhoea or otorrhoea, a basal skull fracture is present (regardless of whether it can be seen on radiographs).

Bilateral periorbital haematomas (raccoon eyes) (Figure 2) and sub-conjunctival haemorrhages where the posterior margin cannot be seen are both indicators of anterior fossa fracture. Haemotympanum or bruising over the mastoid (Battle's sign) suggests a middle fossa fracture. Battle's sign usually takes several hours to develop. The nose, mid-face and orbits should also be palpated for fractures that may require treatment later. When the patient is log-rolled, the back of the head and cervical spine should also be examined.

The neurological examination will be limited because of the lack of cooperation of the patient, but it should still be possible at least to determine if there are lateralising signs such as a hemiparesis or a third cranial nerve palsy.

Higher functions

Higher functions are assessed first. Most often this will be limited to level of consciousness and, in particular, the "voice" component of the GCS. In a relatively cooperative patient with a focal injury it may be possible to assess lan-



9. Abduction of the upper arm as part of "abnormal flexion".



10. Extension of the arm.

guage further, but in the early period after a head injury it will be difficult to differentiate dysphasia from confusion. Memory becomes important later and the period of post-traumatic amnesia is used as an indicator of injury severity.

Cranial nerves

Many of the cranial nerves can be assessed even in the unconscious patient.

I (olfactory): Assessment obviously requires cooperation, but this nerve should be examined when possible, as it is the most commonly affected cranial nerve after head injury and is often ignored. Anosmia may seem trivial but it has significant effects beyond enjoyment of food and wine. Anosmic patients will not be able to smell smoke from a fire or leaking gas, both of which may potentially put them at risk.



11. A small entry wound in the right temporal area from a .22 calibre weapon fired at close range (suicide attempt).



12. The exit wound in the same patient shown in Figure 11. There is extensive fracturing of the skull with dural tearing and cerebral herniation.

II (optic): The pupillary reactions to light depend on the integrity of the optic and oculomotor nerves, as well as their connections. Normally both pupils should constrict when light is shone in either eye or when the patient looks at a near object (accommodation reflex). A pupil that responds to direct light implies that the ipsilateral optic and oculomotor nerves are intact. If it responds to direct light, but not consensually, this implies damage to the contralateral optic nerve. A pupil reacting only consensually suggests ipsilateral optic nerve damage. An oculomotor nerve injury will produce an ipsilateral dilated pupil which does not respond directly or consensually, but the contralateral pupil will constrict when light is shone in either eye.

One must remain aware that the commonest cause of a dilated pupil after head injury is traumatic mydriasis due to local ocular trauma. This should be suspected if the dilated pupil was present right from the time of injury and there is local trauma to the globe or orbit.

During examination of the eyes the fundi are assessed. One would not expect to see papilloedema in the early hours after a head injury, and funduscopy is done more for the purpose of assessing the integrity of the eye itself (checking for retinal detachment or haemorrhage, vitreous haemorrhage, corneal laceration, etc). Contact lenses should be looked for and removed.

Visual fields can be checked by confrontation in a cooperative patient or by menace in an uncooperative patient. They are not clinically assessable in the unconscious patient.

III, IV and VI (oculomotor, trochlear and abducens): The pupils are assessed as above. Ptosis (III) is difficult to assess in patients who are unconscious. Ocular movements can be observed and any dysconjugate movements noted. If the patient is cooperative this is easy. An alert but uncooperative patient can be made to look at objects quite readily by placing them in their field of vision. This also applies to children.

Oculocephalic reflexes test the third, fourth and sixth cranial nerves and their connections. Movement of the head from side to side or up and down will be accompanied by movement of the eyes in the opposite direction, resulting in a constant point of fixation.

The term "doll's eyes" is often used to describe oculocephalic reflexes but this frequently leads to confusion. Whether doll's eyes are normal or abnormal depends on the sophistication of the doll. One with eyes painted on would describe the abnormal and one with eyes free to rotate would better approximate the normal situation. It is preferable to avoid the term altogether and describe oculocephalic reflexes as being normal or abnormal.

It is not usually recommended to test oculocephalic reflexes in a head-injured patient owing to the high risk of associated cervical spinal injury. If it is important to know if these reflexes are intact (eg, in assessing brain death), caloric testing is usually undertaken.

V (trigeminal): The motor component of the trigeminal nerve can be tested in a cooperative patient, but the sensory part can be assessed even in the unconscious. Painful stimuli applied to the supraorbital nerve should usually produce a response and the corneal reflex tests trigeminal function as well as facial nerve function.

VII (facial): Facial movements are readily assessed in the cooperative patient, but can also be observed when painful stimuli are applied and as part of the corneal reflex. Facial nerve palsies are often seen with middle fossa fractures and this nerve should be assessed early in any patient with CSF otorrhoea or Battle's sign.

Taste is not usually tested. Patients often complain of loss of taste after a head injury but this is usually due to anosmia.

VIII (acoustic): This is hard to test clinically in the unconscious patient. An alert but uncooperative patient can be observed for reaction to sudden noises. Assessment in the unconscious usually requires brainstem auditory evoked potential monitoring. This nerve is also often injured in middle fossa fractures.

IX (glossopharyngeal), X (vagus): There is usually little more to do than observe swallowing and test the gag reflex, either directly or by moving an endotracheal tube.

XI (accessory): Sternomastoid and trapezius function can be tested, but it is unusual for the accessory nerve to be injured intracranially.

XII (hypoglossal): A hypoglossal nerve injury will force the protruded tongue to the ipsilateral side. Over time the ipsilateral side of the tongue becomes wasted.

Motor function

The sophistication of motor testing depends on the level of cooperation of the patient. At the least, it is possible to detect asymmetry in movement or responses to pain as described above in assessing the GCS. Reflexes are often brisk but may be absent with associated spinal cord injury (spinal shock). Plantar reflexes will usually be extensor after a significant head injury. Priapism and loss of anal tone are other indicators of spinal cord injury that should be sought.

Sensory function

The same applies as for motor function. If there is a response to pain, this can be compared in different areas. This is important when a spinal cord injury is suspected and one is attempting to determine at what level. Sometimes there can be movement of limbs through local spinal cord reflexes; hence, when assessing a patient for brain death, it is mandatory that the painful stimulus is applied to a cranial nerve distribution.

Summary

The neurological examination of the head-injured patient is limited to pupils and level of consciousness (GCS) during the primary survey. Further information can be gleaned during the secondary survey, even in unconscious patients. The most important aspects are GCS and lateralising signs, including pupillary abnormalities and hemiparesis.

The key to neurological observation is to detect a trend and the GCS therefore becomes more useful with increasing observations. A GCS of 9 may be a good sign in someone whose GCS was 5 an hour ago, or an indication for urgent treatment in someone whose GCS was 14 an hour ago.

An attempt must be made to determine the level of consciousness at the earliest possible time after the injury and then to assess and chart it repeatedly at regular intervals. A decrease of 2 or more points on the GCS suggests significant

deterioration and should be reported to the surgeon or neurosurgeon as a matter of urgency.

More detailed criteria for consultation and transfer in the civilian situation can be found in reference 4.

Further reading

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Military anaesthesia

MILITARY ANAESTHESIA in Australia dates from January 1864, when an immigrant Scottish “etherist”, John Henry Hill Lewellin (1818–1886), was commissioned as an Assistant Surgeon in the Prahran and South Yarra Corps of the Victorian Volunteer Force (Rifles), in Melbourne.¹ His foundation appointment occurred 18 years after Dr William Morton, the Boston dentist, had first used modern surgical anaesthesia on 16 October 1846.

Since the earliest days of the discipline, anaesthetists have been subjected to military risk, sometimes even after their death (the memorial to John Snow, pioneer English anaesthetist, was destroyed by bombing in World War II).

Besides Lewellin, Australia’s other pioneering anaesthetists were Belisario,² Pugh^{3,4} and Buchanan.²

Since the Vietnam War, Australia’s operational health commitments have been built around the concepts of (a) the forward surgical team with its support and (b) major preventive medicine endeavours. The forward surgical team can provide Level Three surgical care, and can carry out definitive surgery in the theatre of operations. Such teams are built around a surgeon and an anaesthetist (as in the Peace Monitoring Group on Bougainville); or a general surgeon, an orthopaedic surgeon, an anaesthetist and an intensivist-physician (as in the UNAMIR II deployment in Rwanda, and in both INTERFET and UNTAET deployments to East Timor). The military anaesthetist is pivotal to these operations.

Since 1998, the Defence Health Service within the Australian



The memorial commemorating the life and work of Dr John Snow (1813-1858), in Brompton Cemetery, London (restored after the original was destroyed by German bombing in 1941). Snow first used chloroform anaesthesia, and delivered Queen Victoria of two of her children (in 1853 and 1858) under general anaesthesia. His work, *On chloroform and other anaesthetics*, published in 1858, is one of the milestones in the history of medicine.



Dr William Russ Pugh was a pioneer Australian anaesthetist who, on 7 June 1847, administered ether at St John's Hospital, St John's Square (190 Charles Street, today), in Launceston. This lifesize bronze statue by the sculptor, Peter Corbet, stands on the steps leading to Prince's Park (formerly St John's Square) in central Launceston, and was unveiled in June 1997. Dr Pugh lived on the corner of Frederick and St John Streets, in central Launceston. He compounded many of his drugs in the laboratory attached to his house. Dr Pugh (with Dr James Grant) opened St John's Hospital (the Morton House of today) on 1st September, 1845, as a self-supporting hospital and dispensary.

Defence Force has instituted a formal policy of developing Discipline (or Craft) Groups to promote and foster specialty disciplines within the profession of military health. One such key discipline is military anaesthesia. In March 2000 the first two Australian national workshops on military anaesthesia were held in Launceston. They were convened under the auspices of Wing Commander George Merridew (Consultant Anaesthetist, Launceston General Hospital) and Squadron Leader Haydn Perndt (Royal Hobart Hospital).

These pioneering "hands on" clinical workshops brought together 40 of the 60 Reserve officers who serve as anaesthetists in the Australian Defence Force.

Military anaesthetists require resilience, resolution, the ability to work to exhaustion, flexibility and widespread skills in many aspects of anaesthesia (from life-saving resuscitation of patients with massive limb avulsion, through the spectrum of specialty anaesthetic subdisciplines, to paediatric anaesthesia during humanitarian deployments). The challenges are great, and the spearhead example of the military anaesthesia discipline group has done much to meet these in the context of the great international demands of the future.

Major General John H Pearn
Surgeon General ADF

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4. Crowther WE. The Introduction of surgical anaesthesia in Van Diemen's Land. *Med J Aust* 1947; 2: 561-570. □

Faculty and postgraduate students of the second National Workshop of Military Anaesthesia held in Australia, conducted at the Department of Anaesthetics, Launceston General Hospital, Tasmania, 30-31 March, 2000. Front row (left to right): LTCOL Stuart Inglis, GPCAPT Roger Capps, LEUT Patrick Liston, LEUT Douglas Fahlbusch, LEUT Christopher Scarff, LTCOL Jan Wrobel and LEUT Fabian Purcell. Back row (left to right): Dr Jeremy Wallace (Demonstrator), SQNLDR Haydn Perndt (Lecturer), COL Brian Pezzutti, WGCDR David Schuster, Mr Andy Roussos (ULCO), WGCDR Doug McEwan, MAJ Gerry Meijer, Dr Richard Zacks (Demonstrator) and WGCDR George Merridew (Convenor).

