



## Glasgow Coma Scale: Technique and Interpretation

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### Abstract

The Glasgow Coma Scale (GCS) was designed to objectively, easily, methodically evaluate the neurological status of patients with impaired consciousness especially after traumatic brain injury. The score is used to grade and plan treatment of patients with head injury. It can also be used to monitor neurological status of critically ill patients.

There are three parameters used- eye opening, verbal response and best motor response with the score ranging from 3-15. The technique, interpretation and certain practical issues concerning the GCS are discussed.

**Keywords:** Glasgow coma scale; Head injury; Interpretation

### Introduction

The Glasgow Coma Scale was introduced in 1974 [1]. The acronym stands for both Glasgow Coma Scale (individual components) and Score (total). The scale is used to decide the management issues of individual patients. The total is used to group patients into various categories so that management protocols can be designed and outcome measured. It has three components for assessment that are totalled and a combined score is given. The total score is used in classifying head injuries into mild (3-8), moderate (9-12) and severe (13-15) [2]. The GCS has made a subjective assessment of head injury (coma, semi coma, drowsy, stupor, altered sensorium, locked in state) into an objective method [3,4]. It has significant advantages and also certain drawbacks that need to be understood when applying it. The basic techniques of how to perform the GCS and the issues involved in its interpretation are discussed.

### Technique

Key Messages (Provide appropriate messages of about 35-50 words to be printed in centre box).

There are three parameters that are assessed

**Eye opening (E):** used as a reflection of the intensity of impairment of activating functions.

**Verbal response (V):** Index of higher cortical function.

**Best motor response (M):** Knowing the integrity of the nervous system in patients who are not speaking.

The original score had total score of 14, which was increased to 15 (Table 1).

#### GCS assessment method [5,6]

**Check:** To check for any factors that might interfere with the assessment like sedation, muscle relaxants, metabolic disturbances, fever, hemodynamic disturbances, eye swelling, airway injuries, limb injuries, intoxicants

**Observe:** To see for spontaneous patient actions (eg: eye opening).

**Stimulate:** Once it is decided that there is no spontaneous response then to stimulate and check for responses.

**Rate:** After the stimulation for various parameters the score is recorded and totalled to arrive at the GCS score.

#### Eye opening

**E4 (Spontaneous):** The patient will be opening his/her eyes without any external stimulus and this indicates that arousal mechanisms in the brainstem are intact. In the rare case of persistent vegetative state the patient will have a spontaneous opening without awareness.

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**Table 1:** The original score had total score of 14, which was increased to 15.

Original GCS-14	Expanded GCS-15
Eye Opening Spontaneous-4 To sound-3 To pain-2 Absent-1	Eye Opening Spontaneous-4 To sound-3 To pain-2 Absent-1
Verbal Response Orientated-5 Confused-4 Inappropriate words-3 Incomprehensible sounds-2 Absent-1	Verbal Response Orientated-5 Confused-4 Inappropriate words-3 Incomprehensible sounds-2 Absent-1
Best motor Response Obeys commands-5 Localizes to pain-4 Flexion to pain-3 Extension to pain-2 None-1	Best motor Response Obeys commands-6 Localizes to pain-5 Normal flexion (withdrawal) to pain-4 Abnormal flexion-3 Extension to pain-2 None-1

**E3 (Eye opening to command):** Next a verbal stimulus is given; this includes any loud sound that will make the patient open eyes and not necessarily a command to open eyes. The sound should be loud enough to evoke a response.

**E2 (Eye opening to pain):** The painful stimulus is given at either the nail bed with a pen/pencil or pinching the trapezius muscle or rubbing the sternum. The sternal region has just skin over the periosteum and hence is very sensitive. The stimulus has to be a firm rubbing movement and not excessive downward force that may fracture ribs or even the sternum in undiagnosed chest wall injuries. The stimulus is sustained for 10 seconds (if required) before concluding that there is no response to pain.

**E1 (None):** No Eye Opening to even painful stimulus: Patient might have closed the eyes as a result of the stress due to the trauma or at times even sleeping after the exhaustion following the event! So one should not give a painful stimulus before a verbal one. Pressing over the supraorbital notch is not recommended for eye opening as it may elicit an erroneous response by a grimace reflex. The body's natural reflex to any painful stimulus in the facial region is to close eye and protect them from that stimulus! Another issue to be noted is to make sure that there are no facial injuries that might exacerbate by applying a stimulus in the facial region. If there is extensive periorbital swelling that precludes eye opening then it can be written as Not Assessed or Ep or E<sub>edema</sub>. Whatever is the format it should be uniformly followed by all caregivers in a given institution? Any confusion, then it should be explicitly communicated as to what state the patient is in. This would avoid any confusion in assessment and subsequent management.

**Verbal response**

**V5 (Oriented):** Patient is asked who, where and what time (at least in terms of year, month and day of the week) if the response to all three questions are correct then it is V6. The thing to be remembered is some patients are not told that they have been admitted to that particular hospital, so if they tell the name of some other health centre then it should be corroborated with the relatives about the correctness. It might be the case that the patient was taken to that centre before being shifted to the current place of evaluation! If the patient only answers some of these questions and not all correctly then can be sub categorized into sub groups based on the number answered correctly. This will only be useful for research purposes and should not influence management decisions.

**V4 (Confused):** Patient does engage in conversation that includes

appropriate sentences and words but is not answering appropriately the above three questions.

**V3 (Inappropriate Speech):** Here it is a few exclamatory words (more often swearing) and does not result in sustained conversation.

**V2 (Incomprehensible sounds):** The patient moans and groans, most often to painful stimulus.

**V1 (Absent):** No verbal response.

The patient who is intubated or tracheostomized cannot be assessed for an appropriate verbal response. Patients with focal damage to speech areas (eg: Broca area) can have an impaired speech response but may otherwise be alert.

Many centres give a score of 1 in the verbal response to patients whose airway is secured by a definitive airway. All caregivers in that institution should uniformly apply this. Otherwise it will create an error in the evaluation. For example if a patient has been intubated for a faciomaxillary injury (eg mandibular fracture) that is compromising the airway, the GCS will be E4V1M6. This becomes moderate head injury whereas it might not be so. It is advisable to use the abbreviation of V<sub>ET</sub> or V<sub>T</sub> to denote an intubated or tracheostomized patient respectively. This way the confusion stated in the previous scenario would be avoided. This drawback with the GCS has become more in the recent times as the intubation and ventilation care has significantly increased.

**Best Motor response**

The motor response becomes very important in a person who is not conversing or at least is at a confused level.

**M6 (Obeying commands):** This is tested by asking the patient to move fingers, wriggle toes, show tongue/open or close eyes (especially in suspected spinal injury). This response ensures that there is an intact arc of receiving stimulus (command), processing at the cortical level and executing via motor function (response). The stimulus should be loud and clear before inferring lack of response and proceeding to painful stimulus. One should remember that some motor response might be elicited by simple grasp reflex, startle response or even to postural changes. These should not be interpreted as M6. If in doubt then specificity of the response should be crosschecked eg: ask to release hand in case of suspected grasp reflex, holding limbs to verbal command. Once it is decided that the patient does not respond to verbal command then a painful stimulus is given in a standardized manner and maintained for appropriate time to see for motor response. The sites for a painful stimulus are- pinch the trapezius, firm rubbing movement (not pressing) over the sternum or press over the supra-orbital notch. These stimuli are sustained for a period of 10 seconds to make sure that the stimulus is adequate. The nail bed stimulus is not applied in this situation because the other upper limb has to reach over and localize plus it will be erroneous in case of focal brain injuries and spinal cord injuries.

**M5 (Localizing to painful stimulus):** This response will be when the hand reaches the site of stimulus i.e. the sternum or trapezius. In the case of the supra-orbital area the patient's hand even goes above the level of the clavicle not necessarily reaching the site of stimulus. A common misconception about the GCS is the equation of abnormal flexion and extensor response to decorticate and decerebrate rigidity respectively (these are based on the Sherrington experiments corresponding to the level of lesion, mid-brain or brainstem) [7]. In head injury the severity correlates with the GCS score irrespective of

the site. A poor motor response can be as a result of severe cortical or hemispheric lesions.

**M3 & 4 (Normal/Abnormal flexion):** What is important to document among these responses is if the patient demonstrates any degree of flexion. The patients who show any degree of flexion response on a persistent basis do well overall than those who have extensor posturing. One can also see a flexion response in the lower limbs. Experienced personnel can make the distinction between the two responses but inexperienced staffs particularly in the field have difficulty in differentiating between these responses. It is not of clinical importance to make a definite diagnosis between M3 and M4 as decisions like intubation, CT scan etc are unlikely to be influenced only on this parameter. Patient who is not localizing to painful stimulus is more likely to be in the severe than moderate head injury group. A range of movement is possible in a patient who is not localizing to painful stimulus. It can vary from a "Normal Flexion" which is rapid withdrawal, abduction of shoulder with external rotation. In "Abnormal Flexion" there is adduction, internal rotation of shoulder (classical decorticate posture). Between these two extremes of movements there may be varied patterns and also both types of movements may be seen at the same time in a patient. One simple and practical way to sort out between the two responses is done by observing the position of the forearm. If the forearm is in pronation then it is labelled as M3. The forearm is in supination without localizing to the painful stimulus then it is labelled as M4. In the situation of a difference in the motor score, it is best to manage as per the lower score. When there is a difference of 1, a moderate head injury may be diagnosed as severe (GCS- 8 or 9). It is only a mathematical probability and an unlikely clinical situation that the patient has E4V5M4. Such gross differences in the individual parameters can occur with focal brain injuries. This way the management will not be hampered by this difference in eliciting motor response. Depending on the patient's response to the treatment initiated one can decide the future course of action. One needs to take into account that a patient's response can be varied when tested by two different people or at different times. It is not always a stereotyped response that is uniformly seen in these patients.

**M2 (Extension response):** The classic "decerebrate" posturing. Shoulder adducted, elbow extended, wrist hyperpronated, hip and knee extended with ankle plantar flexed.

**M1 (None):** This is when there is no response to a painful stimulus. One should be very careful when deciding this response especially in spinal injuries with quadriplegia. The patient if conscious can be asked to show his/her tongue to document a M6 response. One should take into account of any muscle relaxants or sedative agents before concluding that there is no motor response. What is important during the assessment is that patients, who localize to painful stimulus and those who do not, should be identified without ambiguity at the earliest. It is possible that a patient is M5 but falls in the severe head injury. The GCS of E1V1M5, E2V1M5 or E1V2M5 are not commonly encountered in clinical scenario. More often than not, patients who are M5 fall in the moderate head injury group. When GCS scale like E1V1M6 is encountered, it is likely to be due to observer error rather than a real clinical situation. In situations like hypotension, hypoxia, intoxicants, sedation/relaxants and other confounding factors it is important to document these at the time of GCS assessment. Later when these are corrected one can correlate the GCS with that. The low GCS may be entirely due to this factor eg: hypotension which

once corrected the GCS improves. It may also be that this is just one of the elements involved. One should also document the neurological status, pupils at the time of intubation so that a follow up can be done to see the progress. GCS should be calculated of the full score including all 3 parameters and not of two. For example GCS-9 out of 10 in an intubated patient will convey an inaccurate picture than E4V<sub>ET</sub>M5.

### How much change is significant?

On clinical monitoring a change in GCS of 1 is a sign that after some time it is to be checked. Further decrease in the score merits an investigation and intervention if indicated. A drop in the GCS of 2 or more means that one needs to reevaluate the patient, plan a repeat investigation and medical or surgical intervention as and when indicated.

### How frequently should it be assessed?

The issue of how frequent should the assessment be done can be resolved by using common sense on a case-by-case basis. There cannot be fixed criteria for this. A simple measure is a patient who comes sooner after the injury and is a poorer grade should be monitored more closely than a patient who has reported after a significant time after injury and is in a good grade. The frequency of monitoring also depends on the number of personnel and number of patients being monitored.

### How to communicate GCS?

The acronym stands for both Glasgow Coma Scale (individual components) and Score (total). The scale is used to decide the management of individual patients. The score will help in measuring outcome of group of patients with same score. It is always advisable to mention the complete score with its individual parameters than just the total score. If one parameter is not assessable due to any cause (periorbital swelling precluding eye opening response assessment) then this should be mentioned as such and the total should not be made excluding this parameter. A GCS of 9/10 when Verbal response cannot be assessed will not convey the right meaning and can cause errors in management. When in serious doubt, the actual response can be described verbatim so that the message is not lost in translation.

Confounding factors that make testing of GCS parameters untenable [8,9]

Drugs- anaesthetics, sedatives, neuromuscular blockades, anti psychotics

Cranial nerve injuries

Spinal cord injuries

Intoxicants (alcohol or drugs)

Hearing impairment

Limb injuries with or without splints

Dysphasia

Pre-existing illnesses eg: dementia, psychiatric conditions

Ocular injuries

Language and Cultural barriers

## Conclusion

The GCS is a very simple, fast, easy and objective method of assessment of neurological condition especially in head injury. One

needs to be aware of the fact that the GCS assessment does have certain lacunae in terms of overall picture of the patient. There is no mention of vitals, pupils or any other parameters. One needs to look at the GCS in context to the overall clinical picture of the patient. Adding too many other parameters to circumvent this, will take away the simple objective nature of GCS assessment.

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