International Surgery Journal
*Nair SS et al. Int Surg J. 2017 Feb;4(2):656-662*
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20170209

**Original Research Article**

# Comparison between FOUR score and GCS in assessing patients with traumatic head injury: a tertiary centre study

**Sharath S. Nair[1], Anilkumar Surendran[2], Rajmohan B. Prabhakar[3], Meer M. Chisthi[2]***

[1]Department of of Surgical Oncology, Regional Cancer Center, Trivandrum, Kerala, India
[2]Department of General Surgery, Government Medical College, Trivandrum, Kerala, India
[3]Department of Neuro Surgery, Government Medical College, Trivandrum, Kerala, India

**Received:** 08 November 2016
**Accepted:** 08 December 2016

***Correspondence:**
Dr. Meer M Chisthi,
E-mail: meerchisthi@gmail.com



## ABSTRACT

**Background:** Head injuries are a major cause of mortality and morbidity across the world. Effective initial assessment and early intervention is of importance in patients with traumatic brain injury, so as to ensure the maximum favorable outcome. Glasgow Coma Scale is the widely accepted scale to assess severity in head injury patients, albeit with many inadequacies. The objective of this study was to test the validity of full outline of unresponsiveness score, an alternate tool, in assessing severity in patients with traumatic brain injury.
**Methods:** This was a descriptive study, conducted on 69 patients admitted to the general surgical and neuro-surgical wards of Government Medical College, Trivandrum, India with traumatic head injury. For all these patients, full outline of unresponsiveness score and Glasgow Coma Scale were calculated at the time of presentation and serially thereafter. The predictive value of full outline of unresponsiveness score as well as its correlation with Glasgow Coma Scale was studied.
**Results:** A statistically significant correlation was found between full outline of unresponsiveness score and Glasgow Coma Scale in estimating the severity of head injury. Also Full Outline of unresponsiveness score was able to furnish better details about the neurological status of trauma patients.
**Conclusions:** As per the results, it can be concluded that the full outline of unresponsiveness score can be applied as an ideal tool to evaluate consciousness levels and patients' status in patients with traumatic head injury. It can be used as the ideal replacement for Glasgow Coma Scale.

**Keywords:** FOUR score, GCS, Head injury, Traumatic brain injury

## INTRODUCTION

Head injury (HI), also termed 'traumatic brain injury' (TBI) forms a major contributor towards trauma related mortality and morbidity all over the world. This is especially significant in developing countries India, where such injuries are progressively increasing due to rapid motorization, alcohol abuse and the general indifference by the public towards safety measures. In India, it is estimated that nearly 1 million people get injured, 200,000 people die and another 1 million require rehabilitation services every year due to traumatic brain injury.[1] As per the study undertaken by NIMHANS, it is shown that the incidence, mortality and case fatality rates are 150/100000, 20/100000 and 10%, respectively.[2] The public health burden this causes is not trivial, as most of these patients belong to the young and productive age group.

A head injury survivor has a wide range of brain injuries varying from superficial injuries to a permanent vegetative state. Apart from the physical damage and neurological disabilities of different types, psychosocial problems like depression, anxiety and suffering will affect the individual for a long period even after getting discharged from the hospital. Adequate initial assessment and early intervention is of paramount importance in treating patients with HI, so as to decrease mortality and also to lessen the long term disabilities. However, assessing a patient's level of consciousness is a complex affair, mostly due to the difficulty in finding appropriate terminologies that are truly objective and user-independent. Several scales have evolved over the decades to answer this need.

One of the earliest systems developed was the 'vital sign card' or the Ommaya coma scale, developed by Ommaya, a neurosurgeon at the National Institute of Neurological Diseases and Blindness in Bethesda, Maryland, the USA in 1966.[3] However, the scale never found much use outside of that institution. The Jouvet coma scale, which was published in 1969, evaluates two parameters: perceptivity and reactivity.[4] Another scale, the Moscow coma scale, was developed by the Institute for Research into Neurosurgery at the USSR Academy of Medical Sciences.[5] This scale, which consisted of a quantitative scale for the findings of the neurological examination and a scale for classifying disorders of consciousness, also failed to gain popularity outside the USSR.

The glasgow coma scale (GCS) was the result of two parallel international studies on coma and prognosis of severe head injuries, which were funded by the National Institutes of Health. In 1974, Teasdale and Jennett published 'assessment of coma and impaired consciousness: a practical scale'.[6] This coma scale utilized the theoretical model of level of consciousness earlier proposed by Plum and Posner in 1972.[7] This got revised in 1976 with the addition of a sixth point in the motor response subscale for 'withdrawal from painful stimulus'. The scale maily assessed only motor, verbal, and eye responses. The first version of this scale was called initially as the coma index but soon became known as the GCS, based on the location of the authors' affiliated institution (Table 1). The GCS was designed mainly to improve the communication between physicians and nurses when describing the state consciousness and to avoid ambiguous terminologies such as "somnolence" and "unresponsiveness".[8]

The GCS was initially developed as an unnumbered system. The assigning of numbers to the responses (using "1" for the lowest score rather than "0") was introduced in a later article that also expanded the motor responses, adding abnormal flexion. Although users of the GCS began creating sum scores for the 3 components (giving a total range between 3 to 15 points), this method was never the primary intention of the originators of the scale. Specific GCS sum scores such as 3, 8, and 15 have acquired immediate familiarity; so much so that use of the sum scores even led to the commonly used directive, "Glasgow 8, intubate."

The Bozza - Marrubini scale was an attempt made in 1983 to better the standardized language of GCS by adding exact descriptions for each clinical level.9 This effort was made to find better ways to assess some items, as in the case of response to a verbal command, where the commands can include the alternatives "close your eyes" and "stick your tongue out", as seen in level 2 of the scale. The Department of Surgical Neurology at the Edinburgh University devised a separate scale, which was further added upon by a Sugiura and his team into the Edinburgh-2 Coma Scale (E2 CS).[10] The E2 CS scale combined sets of commands and orientation to month and age, and used a pain stimulus for grading possible motor responses and hence claimed more sensitivity than the GCS regarding the patient's ability to follow commands. However, this scale rapidly became obsolete.

GCS was modified into the Glasgow-Liege Scale in Belgium by adding a set of tests of brainstem responses that may disappear when the brainstem loses its function in a rostrocaudal direction.[11] In the United States, another derivative scale incorporating brainstem reflexes was introduced and came to be known as the Pittsburgh Brain Stem Score (PBSS).[12] The PBSS was added to the Glasgow Coma score to give a combined Glasgow-Pittsburgh Coma Score to give a combined score with a wider range of 9 - 27. The most comprehensive coma scale till date, the Comprehensive Level of Consciousness Scale (CLOCS), was developed by the Department of Neurosurgery of the University of Tennessee Health Sciences Center.[13] CLOCS was very elaborate and included posture (5 options), eye positioning at rest (67 options), spontaneous eye opening (5 options), general motor functioning (27 options), abnormal ocular movements (76 options), pupillary light reflexes (8 options), general responsiveness (1 option), and best communicative effort (8 options). Though this instrument was more sensitive than the GCS, it turned out to be too elaborate and exhaustive to be useful in a clinical practice. In Europe, all serious challenges to the GCS failed, except in Sweden, where the Reaction Level Scale (RLS85) was adopted.[14] The RLS85 categorized patients as alert, drowsy or confused, very drowsy or confused, or unconscious, while all categories were followed by specific motor responses. The Innsbruck Coma Scale was another tool which included brainstem reflexes and eliminated the verbal response and claimed greater predictive power for mortality than did the GCS.[15]

It was in 2005 that Wijdicks and his associates published a new coma scale, the FOUR score.[16] It involved assessment of the following four components, each on a scale with a maximum score of four: eye response, motor response, brainstem reflexes and respiration (Table 2). Motor response is obtained preferably at the upper extremities and includes the presence of myoclonus status

epilepticus (persistent, multi segmental, arrhythmic, jerk like movements), a poor prognostic sign in comatose survivors after cardiac resuscitation. The motor component also combines decorticate and withdrawal responses. The hand position tests (thumbs-up, fist and peace sign) have been validated previously as being reliable to assess alertness. Three brainstem reflexes which test the functions of mesencephalon, pons, and medulla oblongata are used in different combinations. The clinical sign for acute third nerve dysfunction (unilateral dilated pupil) is also included. The cough reflex mostly remains absent when both corneal and pupillary reflexes are absent. Cheyne - stokes respiration and irregular breathing can represent bi-hemispheric or lower brainstem dysfunction of respiratory control. When all the four categories are graded 0, the examiner is alerted to consider brain death evaluation.

The GCS is criticized for its failure to incorporate brainstem reflexes which are considered strong indicators of brainstem arousal systems' activity. Examination of some brainstem reflexes which includes rapid neck movements to obtain oculovestibular reflexes and eyeball pressure to obtain oculocardiac reflexes were incorporated in the modified GCS (Glasgow - Liege Coma Scale).[17] Also, the GCS does not incorporate the size and reactivity to light of pupils. This would be certainly helpful, since a dilated pupil or unequal pupils not reacting to light would suggest temporal lobe herniation.[18] The pain stimulation techniques are of outmost importance as the response elicited is directly dependent on this. Pressure on the finger nailbed with a pencil as was first proposed by Teasdale and Jenett, falsely lowers the level of responsiveness and might throw up spurious scores.[19] Though various modifications of the anatomical location of pain application have been tested including the earlobe, sternum, supra-orbital ridge, finger nail-bed, retro-mandibular and trapezius regions, none of them have been proved to be superior.

There are several confounding conditions that have great impact on GCS rating. Some authors designate a "P" for administration of paralyzing agents, "S" for administration of sedatives, and a "U" for un-testable components.[20] Besides, high levels of blood alcohol (> 240 mg / 100 ml) are associated with a 2-3 point reduction in GCS. The scale has a numerical skew towards motor response: there are only 4 points for eye response, as compared to 5 for verbal and 6 for motor responses. Summing the three subscales assumes an equal weightage for each one, thus leading to skewed information. Teoh et al. in 2000 reported that it was possible for patients to have the same total score, but significantly different mortality risks due to differences in the GCS profile.[21] Some other authors also have found that in the intermediate levels of consciousness (GCS scores 7 to 11) the discriminative power of GCS was reduced very much.[22] Even a very low GCS does not always predict the outcome of severe TBI accurately. Another retrospective study of children with head injuries admitted to an ICU showed that in the absence of ischemic-hypoxic injury, subjects with GCS scores of even 3 to 5 could recover adequate independent function.[23]

Scoring in intubated patients also has been an Achilles' heel of GCS for too long. When intubated, some trauma centers give 1 point for verbal component, some give points for total GCS, while some others give 15 points for total GCS and a few assigned a "T" for the verbal component. Some authors mention the pseudo-scoring technique, i.e. replacing missing values with an average value of the testable score or assigning a score of 5 if patients seem able to talk, of 3 if there is questionable ability to talk and of 1 if patients are generally unresponsive.[24] With such approaches, the significance of verbal portion to the predictive value of GCS is reduced and may account for the disparity in mortality rates between different centers.[25] Teasdale and Jennett themselves reported a high degree of consistency in eliciting responses by different assessors. But some degree of errors are reported when the GCS is assessed by both experienced and inexperienced medical care providers.[26]

Currently, GCS is being widely used to assess patients with head injury across the world. With no serious challenges raised in the last 15 years, it has certainly withstood the test of time. Yet, by comparison, the FOUR score seems simple to use, provides substantial additional information regarding neurological status of the patient, includes the minimal necessities of neurological testing in impaired consciousness and specifically recognizes certain unconscious states. This idea formed the basis of our study. The primary objective was to evaluate the correlation between FOUR score and GCS in evaluating the level of consciousness in patients with head injury.

## METHODS

This study was carried out at Government Medical college, Trivandrum, India which is one of the biggest health care institutions in the state of Kerala and caters to a large number of patients with major traumatic head injuries. Institutional Review Committee clearance was obtained before starting the study and Ethics Committee approval was obtained before data collection. The study was done as a Descriptive study, at the General Surgery and Neurosurgery departments of Government Medical College, Trivandrum from January 2013 till December 2013. Patients aged 12 - 80 years, who were admitted within 24 hours of injury with a radiologically documented traumatic brain injury, were included in the study. Patients with non-traumatic injuries to the brain were excluded from the study. The sample size was set at 69 based on values available from similar studies.

On admission, the patients' detailed history was noted. Data was collected using a structured performa, after obtaining consent from the immediate relatives. After

recording general survey, patients were managed according to the ATLS protocol. Subsequently, they underwent definitive evaluation and management by the Neurosurgery department. Management included antiepileptics, antibiotics, sedatives and in some cases mechanical ventilation or neurosurgical procedures.

At the time of admission, the patients were assessed to chart out their GCS and FOUR scores. This was done by the same person to reduce observer variation and a standard scheme of testing was followed. This was repeated at 1 hour and 6 hours after admission and on a daily basis. Regular follow-up was done to continue the neurological monitoring. Daily assessment of temperature, pulse rate, blood pressure, respiratory rate, input and output, biochemical parameters was also done. All statistical analyses were performed using SPSS ver. 17.0 (SPSS Inc., USA). The level of statistical significance was set at $p < 0.05$. Data was statistically analysed by applying Pearson coefficient correlation to check the correlation between GCS and FOUR scores.

## RESULTS

In this study, a total of 69 patients were included. Most of the patients presenting with head injury were between the age group of 20-50 years. Among these a major bulk of the patients fell within the sub group of 20-30 years. The number of females presenting with head injury was found to be far less than the number of males. Road traffic accidents contributed to the majority of head injuries (78.3% in all subjects studied and 82.6% in severe head injuries). Falls from a height seconds the list. (14.5% in all subjects and 17.4% in severe head injuries).

**Table 1: Glasgow coma scale.**

| Component tested | Score |
|---|---|
| **Eye response** | |
| Eyes open spontaneously | 4 |
| Eye opening to verbal command | 3 |
| Eye opening to pain | 2 |
| No eye opening | 1 |
| **Motor response** | |
| Obeys command | 6 |
| Localises pain | 5 |
| Withdraws from pain | 4 |
| Flexion response to pain | 3 |
| Extension response to pain | 2 |
| No motor response | 1 |
| **Verbal response** | |
| Oriented | 5 |
| Confused | 4 |
| Inappropriate words | 3 |
| Incomprehensible sounds | 2 |
| No verbal response | 1 |

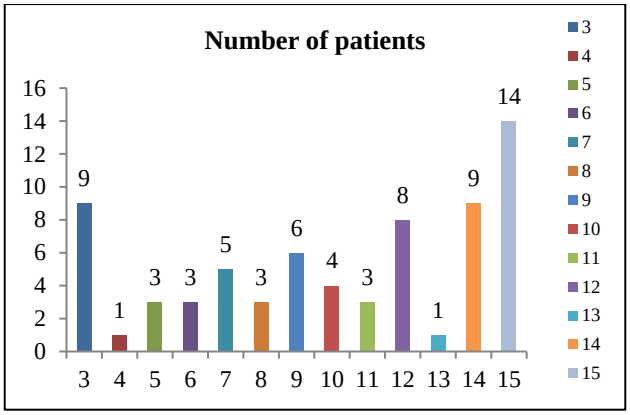


**Figure 1: GCS score at presentation.**

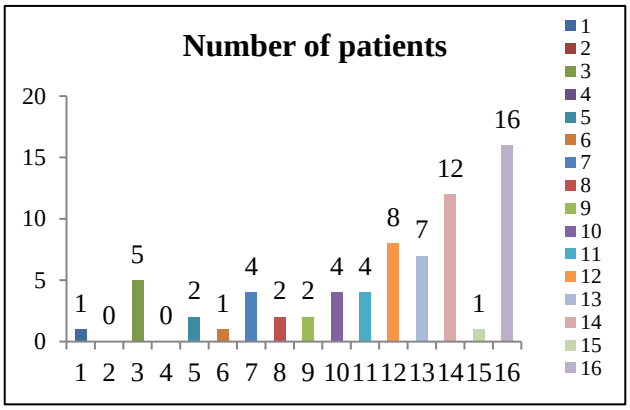


**Figure 2: FOUR score at presentation.**

5.8% the subjects studied had sustained head injury due to assault. One patient studied had sustained a sports related injury.

The most frequently seen associated injuries were facial bone fractures and long bone fractures. (25% each among severe head injury patients and 30% and 22% among all subjects respectively). Around 18% of the severe head injury patients and 20% of all subjects had associated injuries to the chest wall like fractured ribs, hemo/pneumo thorax or lung contusions/lacerations. Blunt trauma abdomen was seen in 6% of the severe head injury patients compared to 9% among all subjects. Spine injury was seen in 2 patients one of whom had severe head injury. 18.5% of the subjects had no other injuries.

When the whole of study population is taken, the highest GCS score of 15 was found in 20%, followed by GCS of 3 and GCS of 14 seen in 13% (Figure 1). Among patients with severe head injury, 39% had the lowest possible GCS of 3 at the time of presentation. Most of the patients in the study group had a full FOUR score of 16 (Figure 2). Most of the other patients had a FOUR score around 12 to 14. Among severe head injury patients, the FOUR score was found to be distributed in a wider range.

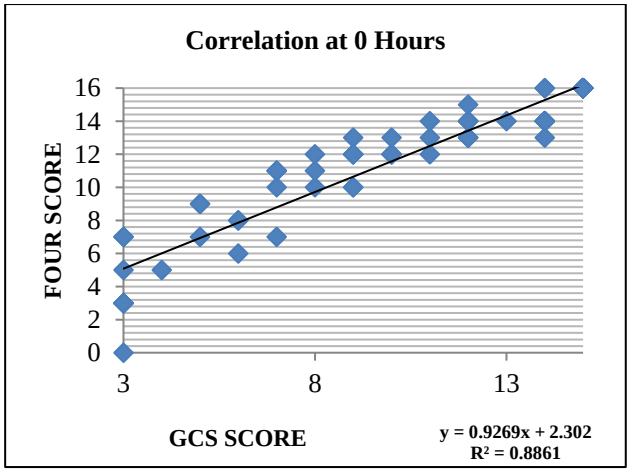


**Figure 3: Correlation between GCS and FOUR score at presentation.**

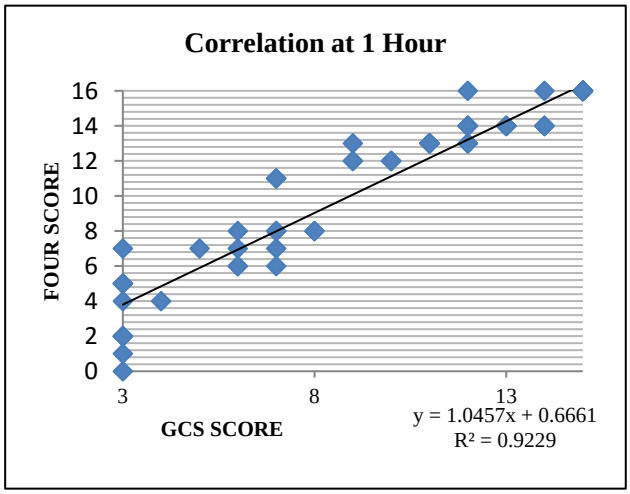


**Figure 4: Correlation between GCS and FOUR score at 1 hour.**

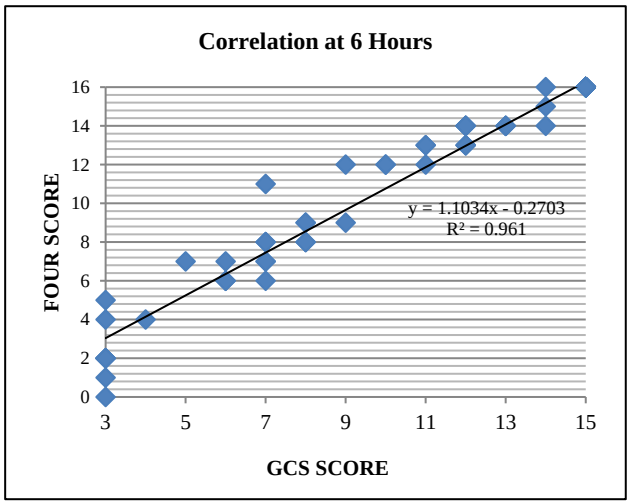


**Figure 5: Correlation between GCS and FOUR score at 6 hours.**

**Table 2: FOUR score.**

| Component Tested | Score |
|---|---|
| **Eye response** | |
| Eyelids open or opened, tracking or blinking to command | 4 |
| Eyelids open but not tracking | 3 |
| Eyelids closed, but open to loud voice | 2 |
| Eyelids closed, but open to pain | 1 |
| Eyelids remain closed to pain | 0 |
| **Motor response** | |
| Thumbs-up, fist or peace sign | 4 |
| Localizing to pain | 3 |
| Flexion response to pain | 2 |
| Extension response to pain | 1 |
| No response or generalised myoclonus status | 0 |
| **Brain stem reflexes** | |
| Pupil and corneal reflexes present | 4 |
| One pupil wide and fixed | 3 |
| Pupil or corneal reflexes absent | 2 |
| Pupil and corneal reflexes absent | 1 |
| Absent pupil, corneal and cough reflex | 0 |
| **Respiration** | |
| Not intubated, regular breathing pattern | 4 |
| Not intubated, cheyne stokes breathing pattern | 3 |
| Not intubated, irregular breathing | 2 |
| Breathes above ventilator rate | 1 |
| Breathes at ventilator rate or apnea | 0 |

## DISCUSSION

This was a descriptive study undertaken to find whether FOUR score can be an effective tool in assessing patients with head injury. As per the results of this study, most of the patients presenting with head injury are young, between the age group of 20-30 years. This might be attributed to the fact that the most common mechanism of injury happens to be motor vehicle accidents, wherein younger people are the ones very often involved. This association of head injuries with motor vehicle accidents might also explains the fact why males outnumber females by a large ratio. In patients with head injuries, the most frequently associated injuries are facial bone fractures and long bone fractures.

The FOUR score hovered around the maximum of 16 in most of the studied patients. Among severe head injury patients, the FOUR score was found to be distributed in a wider range. It was found that higher the consciousness level based on GCS score the higher also the levels obtained by FOUR score and vice versa. When the GCS score improved over a period of time, a similar improvement in FOUR score was also noted. Also, it was quite evident that the FOUR score could furnish out more details about the neurological status of the patients and thus turn out to be more informative.

The Pearson correlation coefficient between FOUR score and GCS was calculated to be 0.83, 0.78 and 0.91 respectively at the time of presentation, after 1 hour and after 6 hours in patients with severe head injury. The Pearson correlation coefficient between FOUR score and GCS for moderate head injury at presentation was 0.76, at 1 hour 0.85 and 0.98 after 6 hours whereas that between FOUR score and GCS for mild head injury at presentation was 0.80, at 1 hour 0.87 and 0.69 after 6 hours. Overall the Pearson correlation coefficient between FOUR score and GCS for all subjects studied at presentation is 0.94, at 1 hour 0.96 and 0.98 after 6 hours (Figure 3, 4, 5). As derived from the graph, there is excellent correlation between the two scores. In all cases the p values were calculated to be less than 0.05, which shows that the correlation is not due to chance, but is of statistical significance. Our results echo the findings from similar studies which compared FOUR score with GCS. A research conducted in 2014 on head injury patients, revealed that FOUR is an applicable tool for high predictive power of outcomes in discharge time for patients with TBI.[27] The authors suggested that FOUR score could be used in the first 24 hours of admission of patients with TBI. They concluded that this tool included some advantages such as equal weightage of items, diagnosis of locking-in syndrome and the ability to evaluate intubated patients.

FOUR score has four testable components, in contrast with the GCS. The number of components and the maximal grade in each of the categories is four (E4, M4, B4, R4), which is easier to remember than the GCS with its varying number of scores and is reinforced by the acronym. Another study concluded that the FOUR score appears to be an easier tool to use and it provides a more comprehensive neurological assessment.[28] A study on pediatric patients indicated that the FOUR score is more capable than GCS in predicting the mortality and discharge of patients admitted to the PICU.[29] Another study found that the inter-rater agreement of FOUR score results was excellent among medical intensivists.[30] Also, all components of the FOUR score could be rated even when patients were intubated.

As per the study results of this study, GCS and FOUR scores show comparable results in the assessment of patients with Traumatic Brain Injury. There is excellent statistical correlation between the two scoring systems. Additionally, FOUR score furnishes better details regarding the neurological status of the patient. The own drawback of the study is that the sample size was not very high and hence may not be representative enough. Nevertheless, the results can be taken to be clinically relevant, because of the strong statistical association obtained as well as the literature agreement.

## CONCLUSION

The FOUR score can be applied as an effective reference to evaluate consciousness status in management of head injury. It can be a strong ally for the clinician in detecting and stratifying patients with severe head injuries and also in monitoring efficacy of treatment. With further clinical research, this tool can supersede GCS as the monitoring tool of choice in head injury.

## ACKNOWLEDGEMENTS

Authors would like to thank the Departments of General Surgery and Neurosurgery, Government Medical College, Trivandrum, India for providing necessary support in carrying out the study.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the institutional ethics committee*

## REFERENCES

1. Gururaj G, Kolluri SVR, Chandramouli BA, Subbakrishna DK, Kraus JF. Traumatic Brain Injury. National Institute of Mental Health and Neuro Sciences. 2005;61.
2. Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. Neurological Research. 2002;24:24-8.
3. Ommaya AK. Trauma to the nervous system. Ann R Coll Surg Engl. 1966;39:317-47.
4. Jouvet M. Coma and other disorders of consciousness. Handbook of Clinical Neurology. P. Vinken J, Bruyn GW. North-Holland Publishing Company. Amsterdam, 1969.
5. Shakhnovich AR, Mamadaliev AM, Abakumova Lla. The prognosis of the outcomes of comatose states in the first 24 hours following craniocerebral trauma. Zh Vopr Neirokhir Im N N Burdenko. 1991;6:11-2.
6. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. a practical scale. Lancet.1974;2:81-4.
7. Posner JB. Clinical evaluation of the unconscious patient. Clin Neurosurg. 1975;22:281-301.
8. Sternbach GL. The Glasgow Coma Scale. J Emerg Med. 2000;19:67-71.
9. Marrubini M. Classifications of coma. Intensive Care Med. 1984;10:217-26.
10. Sugiura K, Muraoka K, Chishiki T, Baba M. The Edinburgh-2 coma scale: a new scale for assessing impaired consciousness. Neurosurgery. 1983;12(4):411-5.
11. Born JD. The glasgow-liege scale. prognostic value and evolution of motor response and brain stem reflexes after severe head injury. Acta Neurochir. 1988;91:1-11.
12. Brain resuscitation clinical trial ii study group. A randomized clinical study of a calcium entry blocker (lidoflazine) in the treatment of comatose survivors of cardiac arrest. N Engl J Med. 1991;324:1225-31.

13. Stanczak DE, White JG, Gouview WD. Assessment of level of consciousness following severe neurological insult a comparison of the psychometric qualities of the glasgow coma scale and the comprehensive level of consciousness scale. J Neurosurg. 1984;60:955-60.
14. Starmark JE, Stalhammar D, Holmgren E. The reaction level scale (RLS85). manual and guidelines. Acta Neurochir. 1988;91(1-2):12-20.
15. Benzer A, Mitterschiffthaler G, Marosi M. Prediction of non-survival after trauma. Innsbruck Coma Scale. Lancet. 1991;338:977-8.
16. Wijdicks EFM, Kokmen E, O'brien PC. Measurement of impaired consciousness in the neurological intensive care unit: a new test. J Neurol Neurosurg Psychiatry. 1998;64:117-9.
17. Born JD, Albert A, Hans P, Bonnal J. Relative prognostic value of best motor response and brain stem reflexes in patients with severe head injury. Neurosurgery. 1985;16(5):595-601.
18. Lowry M. Emergency nursing and the Glasgow Coma Scale. Accid. Emerg Nurs. 1998;6:143-8.
19. Prasad K. The glasgow coma scale: a critical appraisal of its clinimetric properties. J Clin Epidemiol. 1996;49:755-63.
20. Fischer J, Mathieson C. The history of the glasgow coma scale : implications for practice. Crit Care Nurs Q. 2001;23(4):52-8.
21. Teoh LSG, Gowardman JR, Larsen PD, Green R, Galletly DC. Glasgow coma scale: variation in mortality among permutations of specific total scores. Intensive Care Med. 2000;26(2):157-61.
22. Bastos PG, Sun X, Wagner DP, Albert WW, Knaus WA. Glasgow coma scale score in the evaluation of outcome in the intensive care unit: findings from the acute physiology and chronic health evaluation III study. Crit Care Med. 1993;21:1459-65.
23. Lieh LMW, Theodorou AA, Sarnaik AP, Meert KL, Moylan PM, Canady AI. Limitations of the glasgow coma scale in predicting outcome in children with traumatic brain injury. J Pediatr. 1992;120(2):195-9.
24. Meredith W, Rutledge R, Fakhry SM, Emery S, Kromhout SS. The conundrum of the glasgow coma scale in intubated patients: a linear regression prediction of the glasgow verbal score from the Glasgow eye and motor scores. J Trauma. 1998;44(5):839-45.
25. Jagger J, Jane JA, Rimel R. The glasgow coma scale: to sum or not to sum? Lancet. 1983;2(8341):97.
26. Rowley G, Fielding K. Reliability and accuracy of the glasgow coma scale with experienced and inexperienced users. Lancet. 1991;337:535-8.
27. Gorji MA, Hoseini SH, Gholipur A, Mohammadpur RA. A comparison of the diagnostic power of the Full Outline of Unresponsiveness scale and the Glasgow coma scale in the discharge outcome prediction of patients with traumatic brain injury admitted to the intensive care unit. Saudi J Anaesth. 2014;8(2):193-7.
28. Jalali R, Rezaei M. A comparison of the glasgow coma scale score with full outline of unresponsiveness scale to predict patients' traumatic brain injury outcomes in intensive care units. Crit Care Res Pract. 2014;10:289-93.
29. Khajeh A, Fayyazi A, Miri AG, Askari H, Noori N, Khajeh B. Comparison between the ability of glasgow coma scale and full outline of unresponsiveness score to predict the mortality and discharge rate of pediatric intensive care unit patients. Iran J Pediatr. 2014;24(5):603-8.
30. Iyer VN, Mandrekar JN, Danielson RD, Zubkov AY, Elmer JL, Wijdicks EF. Validity of the FOUR score coma scale in the medical intensive care unit. Mayo Clin Proc. 2009;84(8):694-701.

**Cite this article as:** Nair SS, Surendran A, Prabhakar RB, Chisthi MM. Comparison between FOUR score and GCS in assessing patients with traumatic head injury: a tertiary centre study. Int Surg J 2017;4:656-62.