Full Outline of Unresponsiveness Score versus Glasgow Coma Scale in Assessing Patients with Isolated Traumatic Head Injury

Ashok Kumar Nayak[1], Srikanta Das[2], Prafullachandra Hoogar[3]

[1, 3] Department of General Surgery, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India. [2] Department of Neurosurgery, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India.

ABSTRACT

BACKGROUND

Traumatic head injury is one of the most common causes of mortality all over the world. Substantial initial assessment of head injury and its intensity in these patients is the primary goal for medical treatment. Hence, there is a necessity for a score better than GCS for the assessment of head injury patients. FOUR score, a new coma scale was published by Wijdicks in 2005. It included 4 components, motor response, eye response, brainstem reflex, and respiration. It precisely assesses the neurological activity as it includes the brain stem reflexes and eliminates the verbal component and identifies locked-in syndromes, temporal lobe herniations and third nerve dysfunctions which GCS fails to do so. We wanted to evaluate the correlation between FOUR score and GCS in evaluating the level of consciousness in patients with head injuries and evaluate the inter-observer reliability of both the above-mentioned scores.

METHODS

This is an observational prospective study conducted on 92 patients with isolated traumatic head injury admitted to Department of General Surgery, VIMSAR, Burla, from November 2018 to October 2020. The parameters that were evaluated were clinical examination at the time of admission, were blood pressure (BP), temperature, pulse, and respiratory rate at the time of admission. Assessment of GCS and FOUR score at the time of admission, at 6th hour, 24th hour and daily assessment till discharge.

RESULTS

A total of 92 isolated traumatic head injury patients were included in the study. Number of females (19.5 %) were significantly less when compared to males. The Pearson correlation coefficient between FOUR score and GCS was calculated to be 0.945, 0.962 and 0.951 respectively at the time of presentation, after 6 hours and isolated traumatic head injury. After 24 hours in patients with isolated traumatic head injury, Cohen's weighted Kappa of GCS and FOUR score inter reliability was 0.956 and 0.985 respectively. Area under receiver operating characteristic curve (ROC) for GCS and FOUR score with Modified Rankins Score was 0.951 and 0.951. Area under ROC for mortality for GCS and FOUR score was 0.974 and 0.997 respectively.

CONCLUSIONS

As per our results, there is an excellent correlation between GCS and FOUR score in head injury patients. The FOUR score aims to overcome these shortcomings with a scale that is both simple to use and comprehensive in its overall neurologic assessment of the isolated traumatic head injury patients. FOUR score might prove to be a better tool to evaluate the consciousness of head injury patients and help in detection and stratification of these patients and in monitoring the efficiency of ongoing treatment.

KEYWORDS

Four Score, GCS, Head Injury

Corresponding Author:
Dr. Prafullachandra Hoogar,
Department of General Surgery,
VIMSAR, Burla, Odisha, India.
E-mail: ph94816@gmail.com

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BACKGROUND

Head injury (HI) is also termed 'traumatic brain injury' (TBI)[1]. A patient coming with road traffic accident or even a self-fall associated with head injury requires fast response in terms of assessment and resuscitation.[2] This is especially significant in India and other developing countries, where such injuries are progressively increasing due to rapid motorization, alcohol abuse etc.[3] Assessing a head injury patient's level of consciousness is a complex affair.[4,5] Several scales have been developed to fulfil this need.[4]

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.

In 1974, the development of a scoring system, so concise and easily comprehendible, was brought to light by Professor Bryan Jennett and Sir Graham Teasdale in the Institute of Neurological Sciences in Glasgow.[6] The paper published in the Lancet on the Assessment of Coma and Impaired Consciousness,[7] proposed a well-structured scoring system for neurological assessment which is now termed as Glasgow coma scale.

Even though the Glasgow Coma Scale has been accepted as the gold standard in neurological assessment of patients,[8] it has come down under scrutiny and many authors have claimed weaknesses in the scoring system.[9] This includes its inability to predict a patient outcome and having variation in its reading amongst assessing individuals. Hence a lot of scoring systems were introduced into the system which would access the consciousness more accurately.[10] One of them was FOUR score that is full outline of unresponsiveness which was developed by Dr. Eelco F.M. Wijdicks and colleagues in Neurocritical care at the Mayo Clinician Rochester, Minnesota.[11] It was in 2005 that Wijdicks and his associates published a new coma scale, the FOUR score of 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.[10] Motor response is obtained preferably at the upper extremities and includes the presence of myoclonus status epilepticus, a poor prognostic sign in comatose survivors after cardiac resuscitation.[12] The motor component also combines decorticate and withdrawal responses.

The FOUR Score is a clinical grading scale designed for use by medical professionals in the assessment of patients with impaired level of consciousness. "FOUR" in this context is an acronym for "Full Outline of Unresponsiveness.[10,13] The FOUR Score is a 17-point scale (with potential scores ranging from 0 - 16). Decreasing FOUR Score is associated with worsening level of consciousness.[14] The FOUR Score assesses four domains of neurological function: eye responses, motor responses, brainstem reflexes and breathing pattern.

The rationale for the development of the FOUR Score constituted creation of a clinical grading scale for the assessment of patients with impaired level of consciousness that can be used in patients with or without endotracheal intubation.[15] Unfortunately, Glasgow Coma Scale (GCS) cannot be administered to patients with an endotracheal tube (verbal component cannot be assessed).[16,17]

Teasdale and Jennett themselves reported a high degree of consistency in eliciting responses by different assessors.[18,6,19] But some degree of errors are reported when the GCS is assessed by both experienced and inexperienced medical care providers.

The objectives were to evaluate the correlation between FOUR score and GCS in evaluating the level of consciousness in patients with head injuries and to evaluate the inter-observer reliability of both the above-mentioned scores.

METHODS

Duration of this observational prospective study was 2 years from November 2018 - October 2020. Cases of isolated head injury that follow the inclusion / exclusion criteria were selected, who presented to casualty in Department of General Surgery, VIMSAR, Burla. A total of 92 cases were included in this study.

Inclusion Criteria

Patients who were hemodynamically stable / readily stabilisable, age more than 12 - 80 years, patient admitted within 24 hours of the alleged head injury and patients radiologically documented with traumatic head injury.[20,21]

Exclusion Criteria

Patients with non-traumatic head injuries, previous history of any central nervous system (CNS) pathology like seizures, tumours, neuro-degenerative disorders, patients with severe pre-existing co-morbidities: cardiovascular, respiratory and haematological disorders, known case of liver pathology / failure, renal failure, cardiac failure, patient on heparin / warfarin. Glasgow Coma Scale[22] and FOUR score were used for assessment of the selected head injury cases at the time of presentation, 6th hour and 24th hour after presentation along with vitals (pulse rate-PR, BP, oxygen saturation-SpO2, temperature). Modified Rankin scale was used to assess the morbidity. Computed tomography (CT) scan of brain was done to diagnose the type of head injury.[23,24,25,26] For quantitative data, appropriate parametric tests will be carried out using SPSS Version 26. The level of the statistical significance is set up at $P < 0.05$.

RESULTS

A total of 92 acute isolated head injury patients were included in our study. Most of the patients presenting with

head injury were between the age group of 20 - 40 years. Mean age was 33 with a standard deviation of 11.62. The number of females were significantly less than the number of males presenting with head injury with former being 18 and later being 74. Road traffic accidents (69.6 %) contributed the most to head injuries followed by assault (16.3 %) and rest of the patients attained head injury due to fall from height (14.1 %)

36.9 % of the patients suffered mild head injury (GCS 13 - 15), 29.34 % patients suffered from moderate head injury (GCS 9 - 12) and 33.6 % of patients suffered from severe head injury. All these patients suffered only from isolated head injuries without any spinal trauma / blunt trauma chest or abdomen.

Among the whole of study population, the highest GCS score of 15 was found in 20.7 %, followed by GCS of 14 (14.1 %) and GCS of 3 seen in 12 %. Among patients with severe head injury, 35.7 % had the lowest possible GCS of 3 at the time of presentation. Maximum patients in the study group had a full FOUR score of 16. Most of the other patients had a FOUR score around 12 to 14. In severe head injury patients, the FOUR score was found to be distributed in a wider range, highest being 3.

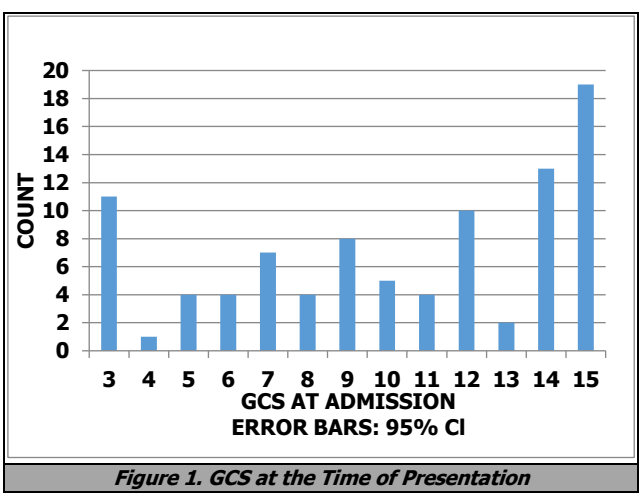

Figure 1. GCS at the Time of Presentation

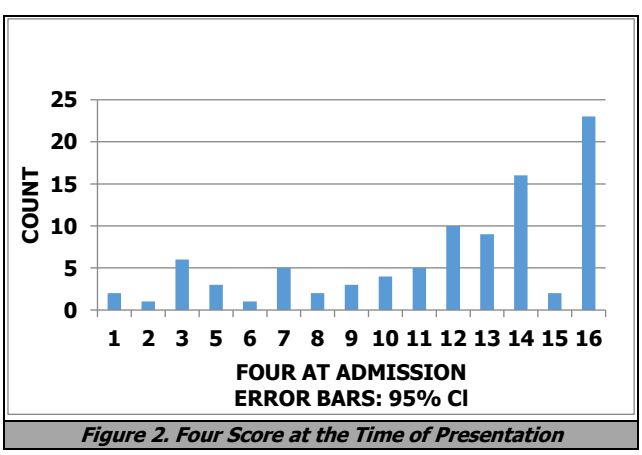

Figure 2. Four Score at the Time of Presentation

There were no significant changes in GCS and FOUR score between 0th hour and 6th hour. (Figure: 1, 2, 3, 4) But GCS and FOUR score was improved slightly after 24 hours in significant number of patients. Among 92 patients, 81 (88 %) patients were treated satisfactorily and discharged whereas remaining 11 (12 %) died during the course of the treatment. GCS and FOUR score was improved slightly after 24 hours in significant number of patients.

The degree of correlation between FOUR score and GCS was calculated using Pearson correlation coefficient. The Pearson correlation coefficient between FOUR score and GCS was calculated to be 0.945, 0.962 and 0.951 respectively at the time of presentation, after 6 hours and isolated traumatic head injury, after 24 hours in patients with isolated traumatic head injury. The Spearman's correlation coefficient between FOUR score and GCS (recorded at the time of presentation) was 0.970 with P < 0.01 resulting to be significant. As derived from the graphs below (Figure: 19, 20, 21), 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.

Correlation Variables	Pearson Correlation	SIG. (2 Tailed)
GCS0 - FOUR0	0.945	< 0.001
GCS 6TH hr. - FOUR 6th hr	0.962	< 0.001
GCS 24TH hr. - FOUR 24TH hour	0.951	< 0.001

Table 1. Correlation of Four Score and GCS

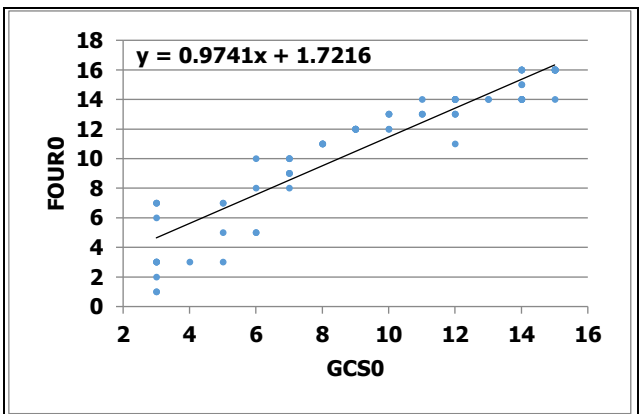

Figure 3. Correlation of Four Score and GCS at the Time of Presentation

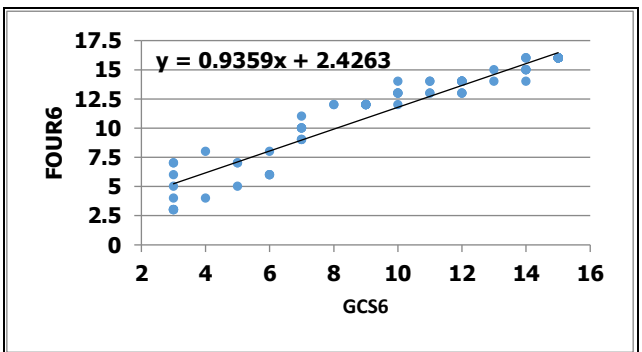

Figure 4. Correlation of Four Score and GCS at 6th Hour after Presentation

Inter observer reliability was tested for GCS score and FOUR score was also calculated. GCS and FOUR score of a particular patient were calculated by two junior residents at the time of presentation. Cohen's weighted Kappa of GCS and FOUR score inter reliability was 0.956 and 0.985 respectively. Cronbach's alpha reliability for GCS and FOUR score was 0.997 and 0.999 respectively. The morbidity of

the patient was scaled using Modified Rankins Score. A score of 3 - 6 was considered to be of poor neurological outcome. 44.6 % of the patients had a poor neurological outcome. Magnetic resonance spectroscopy (MRS), 3 - 6 which includes the patients who succumbed and 55.4 % had an excellent prognosis. Area under ROC for GCS and FOUR score with Modified Rankins Score was 0.951 and 0.951. Area under ROC for mortality for GCS and FOUR score was 0.974 and 0.997 respectively.

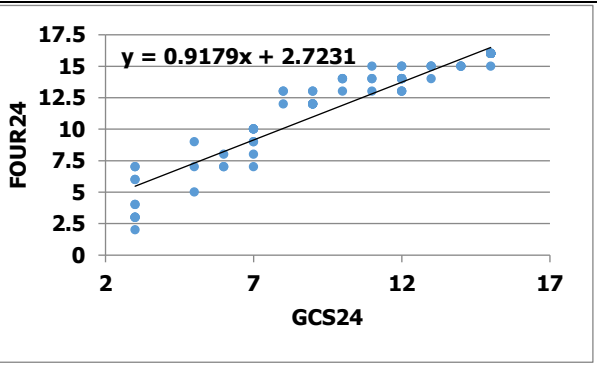

Figure 5. Correlation of Four Score and GCS at 24th Hour after Presentation

	Action	Score
Eye response	Opens eyes spontaneously, tracks, blinks to command	4
	Opens eyes, does not track or blink to command	3
	Eyes closed; open to loud voice	2
	Eyes closed; open to painful stimulation	1
	Eyes remain closed following painful stimulation	0
Motor response	Obeys, makes sign, e.g., "thumbs up"	4
	Localises painful stimulus	3
	Flexes to painful stimulus	2
	Extends to painful stimulation	1
	No response	0
	Myoclonic status epilepticus	0
Brainstem reflexes	Pupils +, corneas +, cough +	4
	1 pupil unreactive, corneas +, cough +	3
	Pupils -, corneas +, cough NA	2
	Pupils +, corneas -, cough NA	2
	Pupils -, corneas -, cough +	1
	Pupils -, corneas -, cough -	0
Intubation	Not intubated, normal respirations	4
	Not intubated, Cheyne-Stokes respiration	3
	Not intubated, irregular respirations	2
	Not intubated, apnoeic	0
	Intubated, breathes above ventilator settings	1
	Intubated, breathes below ventilator settings	0

Table 2. Four Score

Legend: + = present, - = absent. Each category has a maximum of 4 and a minimum of O. The results of each category are added together for the total FOUR score.

DISCUSSION

Since the 1970s, when Teasdale and Jennett established the Glasgow Coma Scale, the scale has been the subject for numerous papers. The assessment of outcome in head injury patients have been compared to many variables of which GCS has outstood them all. Some of these studies have even been dated before the use of CT scans and other advancements of medicine, revealing how accurate it is as a scale of quantifying impaired consciousness in an individual with head injury.[27]

Various scales were introduced over the course of time to asses impaired levels by Dr. Eelco F.M. Wijdicks and colleagues in Neurocritical care at the Mayo Clinic in Rochester, Minnesota.[13] The FOUR Score is a 17-point scale. (FOUR score purpose assessment of patients with impaired level of consciousness, worsening level of consciousness). The rationale for the development of the FOUR Score constituted creation of a clinical grading scale for the assessment of patients with impaired level of consciousness that can be used in patients with or without endotracheal intubation. The main clinical grading scale in use for patients with impaired level of consciousness has historically been the Glasgow Coma Scale [22], which cannot be administered to patients with an endotracheal tube. Overall, FOUR score has better bio-statistical properties than Glasgow Coma Scale in terms of sensitivity, specificity, accuracy and positive predictive value.

As per the results of this study, most of the patients presenting with head injury are young, between the age group of 20 - 40 years with a mean age of 33 years. This might be attributed to the fact that the most common mechanism of injury happens to be motor vehicle accidents[22], 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 of 4.1:1. The other causes of head injury were assault and fall from height. There were no sports related head injury in the study.

Majority of the patients suffered from mild head injury (all these patients suffered from isolated head injury without any co-morbidities). Most of the patients suffered from mild head injuries. Among patients with severe head injury, 35.7 % had the lowest possible GCS of 3 at the time of presentation. Maximum patients in the study group had a full FOUR score of 16. Most of the other patients had a FOUR score around 12 to 14. In severe head injury patients, the FOUR score was found to be distributed in a wider range from 1 – 6, highest being 3.

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. Among 92 patients, 11 patients died during the course of treatment and rest received satisfactory treatment till discharge. Among the patients who died FOUR score ranged from 1 - 6 and GCS ranged from 3 - 5 which shows a good relation with mortality.

Our study showed an excellent correlation between FOUR score and GCS. Pearson's correlation coefficient between FOUR score and GCS was calculated to be 0.945, 0.962 and 0.951 respectively at the time of presentation, after 6 hours and after 24 hours in patients with isolated traumatic head injury. These values prove excellent correlation between FOUR score and GCS. In a study of Nair SS et al,[28] 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.[28] 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 was 0.94, at 1 hour 0.96 and 0.98 after 6 hours. Our study values are similar to the above study which goes to show excellent correlation between FOUR score and GCS. As derived from the graphs below, 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 study also conducted inter observer reliability test for GCS and FOUR score which was calculated by two junior residents at the time of presentation. Cohen's weighted Kappa of GCS and FOUR score inter reliability was excellent that is 0.956 and 0.985 respectively. In fact, FOUR score has slightly better inter observer reliability when compared to GCS in our study. Hence, FOUR score is more reliable scale when compared to GCS. In Sepahv and E. et al. study,[29] interrater reliabilities for FOUR score and GCS were 0.98 and 0.96 respectively which is quite similar to our study.

We also studied the correlation of GCS and FOUR score in assessing the mortality and morbidity of the patients. We used modified Rankins scale to assess the morbidity of the patients. Modified Rankins scale of 3 - 6 was considered as poor neurological outcome. Area under ROC for GCS and FOUR score with Modified Rankins Score is 0.951 and 0.951. Area under ROC for mortality for GCS and FOUR score was 0.974 and 0.997 respectively. This shows that both the scores have good morbidity and mortality predictability values. Although predive values of both scores are same for morbidity but FOUR score has slightly better than GCS in terms of predicting mortality of the patient. In Vivek N Iyer et al. study,[30] In terms of the predictive power for poor neurologic outcome (Modified Rankin Scale score, 3 - 6), the area under the receiver operating characteristic curve was 0.75 for the FOUR score and 0.76 for the GCS score.[30] The mortality rate for patients with the lowest FOUR score of 0 (89 %) was higher than that for patients with the lowest GCS score of 3 (71 %).

On summarizing our study, there is an excellent correlation between FOUR score and GCS at the time of presentation, 6th hour and 24th hour. Both FOUR score and GCS have excellent inter-observer reliability with FOUR score having slightly better reliability compared to GCS. Both GCS and FOUR score have excellent morbidity and mortality prediction in isolated traumatic head injury patients. In all, there is excellent statistical correlation between the two scoring systems. Additionally, FOUR score furnishes better details regarding the neurological status of the patient. The only drawback of the study is that the sample size was not very high and hence, may not be representative enough. But the results can be taken to be clinically relevant, because of the strong statistical association obtained as well as the literature agreement. Our results echo the findings from similar studies which compared FOUR score with GCS. Hence, it is 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.

CONCLUSIONS

As per our results, there is an excellent correlation between GCS and FOUR score in head injury patients. Hence, 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.

The FOUR score aims to overcome these disadvantages with a scale that is both simple to use and comprehensive in its overall neurologic assessment of the isolated traumatic head injury patients and has an added advantage in intubated patients. Both GCS and FOUR score are excellent predictors of outcome of the head injury patients in terms of mortality and morbidity which will help in the management of treatment. FOUR score has aided in providing more detailed information on the prognosis of head injury patients when compared to GCS.

Although further studies on FOUR score are required to prove the validity of the FOUR score on a larger scale of samples, FOUR score certainly has the potential to replace GCS in assessing the patients with isolated traumatic head injuries.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

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