A Comparison of Glasgow Coma Scale Score with "Full Outline of Unresponsiveness Scale" to Predict Outcome of the Patients with Traumatic Brain Injury Presenting to Emergency Medicine Department

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Abstract

Introduction: In patients presenting to Emergency Department(ED) with traumatic brain injury, it is important to evaluate the neurological status to determine the present clinical status and to predict outcome of the patient. GCS is the most widely used score,but it has some drawbacks which led to the development of other scores such as the Full Outline of Unresponsiveness (FOUR) score. In our study, we compared the GCS and the FOUR scores in patients presenting with traumatic brain injury. **Aims:** 1) To compare the FOUR score with the GCS score in traumatic brain injury (TBI) patients. 2) To understand the effectiveness of FOUR score as an assessment tool. 3) To assess whether FOUR score is an alternative tool in TBI patients or could be complimentary. **Methods:** We conducted a prospective observational study at a trauma centre of a tertiary care hospital during January 2019 to March 2019 after taking institutional ethical committee approval. All patients presenting with clinical diagnosis of TBI were evaluated and given a GCS and FOUR score by the emergency physician. Relevant investigations were done and findings were noted. We tabulated all information in Microsoft Excel 2019 and statistical analysis was done with SPSS software. **Results:** The mean age of study population was 38.295+/- 15.33 years. Male patients were 79% and 21% were female patients. Road traffic accidents contributed highest percentages of causes of TBI (60%). By comparing the median value of FOUR score with mortality and the median value of GCS score with the mortality by using the Mann-Whitney test showed a p-value of $\geqslant 1$, which is statistically non-significant. **Conclusions:** FOUR score is equally reliable with GCS score. Both have their own significance.

Keywords : Glasgow Coma Scale score, Full Outline of Unresponsiveness Scale score, Traumatic brain injury

Introduction:

The Glasgow Coma Scale is an objective measurement of clinical status, as it correlates with outcome; it is a reliable tool for inter observer measurements and is also effective for measuring patient recovery or on-going response to treatment. Minimum score is 3 (deep coma or death) and maximum score is 15 (no neurological deficit). Three aspects of behavioral response namely eye opening, verbal and motor response are examined: The motor response is considered a good indicator of the ability of central nervous system (CNS) to function properly due to variety of possible motion patterns. The assessor records the best response from any limb when assessing the altered consciousness and the worst one when focal brain damage is in question.[1–3] According to other studies, it is the best response that should be also scored in focal brain damage.

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All the above responses are tested after the application of painful stimulus (pressure to the fingers- nail bed with a pencil). Stimulation follows in head, neck, and trunk. Arms are more useful to test since they present a wider range of responses, while a spinal reflex may cause flexion of legs if pain is applied locally [1] yet, one should keep in mind that peripheral stimuli may elicit a spinal reflex response, while pressure on the sternum or the supraorbital ridge may causes injury to the patient.[4] These techniques do not accurately leg the motor response. Instead, it is advisable to pinch the pectoralis major or the trapezius muscles.[5,6] A drawback of GCS is failure to incorporate brainstem reflexes. The scale also includes a numerical bias towards the motor response and an important concern of issue is appropriate application in intubated patients who cannot manifest a verbal response. Several approaches have been used to assign the verbal score to such patients. Withdrawal from pain, which is easily misinterpreted as flexion response to pain, is another cofounder for GCS. Lastly GCS doesn't signify subtle changes in neurological examination.[7] Despite its drawbacks, the Glasgow Coma Scale is popular universally for management of unconsciousnessscore. Mayo clinic, which evaluates 4 components, developed a new scale: eye, motor responses, brainstem reflexes, and respiration, this is called the Full Outline of Unresponsiveness (FOUR) Score. [8]

Higher score indicates a better prognosis.[9,10] Singounas proposed the addition of the score 2 to GCS as symbolic expression of brain death and designated a score of -1 in absence of brainstem reflexes. The initial score should be assigned six hours after head trauma had been sustained to avoid over estimation of brain damage produced by transient factors, such as hypoxia, hypotension, or alcohol intoxication.[11] The GCS is inapplicable to infants and children below the age of 5years. The response of children changes with development therefore the GCS requires modification for pediatric use.[12,13] The need to incorporate the brainstem reflexes when evaluating patients in coma led to the development of other scales such as the Bouzarth Coma Scale and the Maryland Coma Scale,[4,14] and the Full Outline Of Unresponsiveness (FOUR) which includes four components (eye, motor, brainstem and respiratory functions) each rated with a maximum score of four. Wijdicks et al [2] recently presented a new coma scale named the Full Outline of Unresponsiveness (FOUR) as an alternative to the GCS in the evaluation of consciousness in severely brain injured patients. The FOUR score, contrary to the GCS, avoids assessing verbal function. We here aimed to compare the FOUR score with the GCS, in assessing and comparing outcome prediction and diagnostic accuracy of the different coma scales (i.e., identification of vegetative/ unresponsive vs minimally conscious states.

Methods:

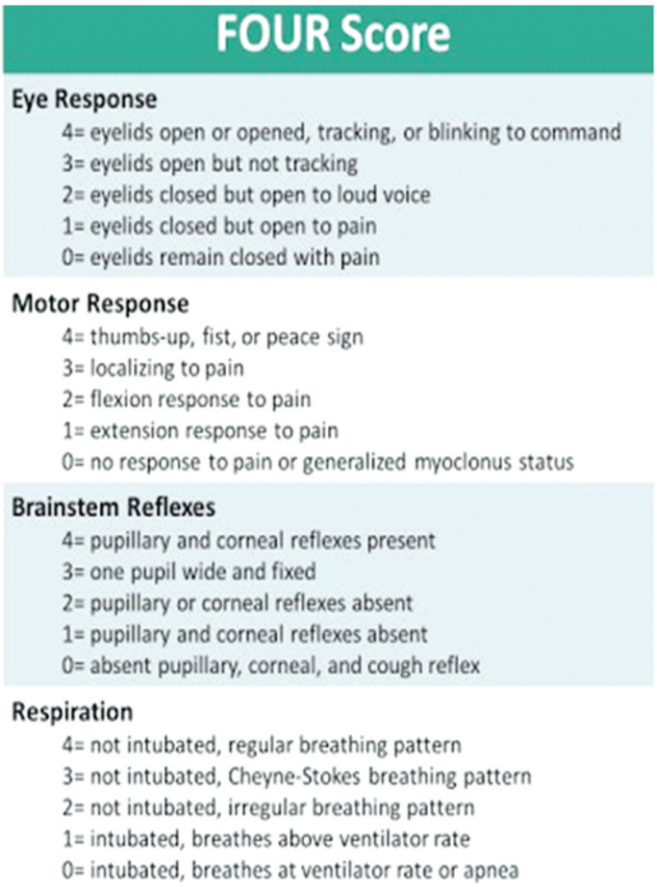
This was a single center, prospective, observational, and descriptive study.From all the patients who were admitted to emergency department with history of traumatic brain injury, during the period between January 2019 to June of 2019, 200 patients with clinical diagnosis of traumatic brain injury were selected based on the following inclusion and exclusion criteria:

Inclusion criteria: All patients of either gender with the clinical history of traumatic brain injury, presenting to emergency department of Civil Hospital Ahmedabad, BJMC.

Exclusion criteria:

1. Patients whose eye, verbal or motor GCS components were inaccessible for evaluation.
2. Patients with spinal cord injury.
3. Patients who were heavily sedated and intubated and or received neuromuscular blockers or patients under the alcohol influence.

Figure 1: Full Outline of Unresponsiveness Scale



4. Refusal for consent by relatives.

The institutional ethical committee approval was obtained before commencing the study. Investigations performed were electrocardiography, computed tomography, and chest radiography. All patients presenting with clinical diagnosis of traumatic brain injury due to different mechanisms of injury like road traffic accidents, fall from height, assault or other modes were evaluated. Primary survey (Airway with cervical spine stabilization, breathing and circulation) was done initially. Vitals of the patients were taken, and resuscitation started. Simultaneously a GCS and a FOUR score were recorded by the emergency physician. All patients were evaluated in terms of TBI and relevant investigations were done, and findings were noted. Patients who were requiring surgery were consulted by neurosurgeon and immediate surgical management was done. Statistical analysis was done with SPSS software and information was noted and tabulated in Microsoft Excel.

Results:

The most common age group involved was above 55 years followed by 29-30 years. The mean age is 38.295+- 15.33 years. Thirty-one patients were above 55 years and 29 patients were from the 26-30 age group. Age distribution of TBI in Percentages: The patients of age above 55 years accounted for 15.5%.The age group of 21-25 years and 26-30 years accounted 13.5% and 14.5% of the cases in this study respectively. In our present study, out of the 200 patients 158 (79%) were male patients and 42(21%) were female patients. Males are the most common victims in the road traffic accident.

Road traffic accidents mainly due to motor vehicle accidents contribute higher percentage of causes of

Table 1: Age distribution in numbers

Age (in completed years)	No. of Patients	%
0-14	2	1
15-20	21	10.5
21-25	27	13.5
26-30	29	14.5
31-35	23	11.5
36-40	22	11
41-45	22	11
46-50	15	7.5
51-55	8	4
>55	31	15.5
Total	200	100 %

Table 2: Patterns of injury among study participants

Patterns of Injury	No. of Patients	%
RTA	120	60
Assault	40	20
Fall from Height	32	16
Others	8	4
Total	200	100 %

Table 3: FOUR score -eye response, motor, respiratory and brain-stem components among study participants

FOUR-eye	No. of Patients	FOUR - motor	No. of Patients	FOUR-Respiratory	No. of Patients	FOUR - Brain Stem	No. of Patients
0	28	0	8	0	9	0	3
1	70	1	8	1	13	1	10
2	23	2	42	2	13	2	38
3	35	3	60	3	26	3	61
4	42	4	82	4	126	4	88
Total	200	Total	200	Total	200	Total	200

TBI (60%). Next leading cause was assault injury which contributes (20%) followed by fall from height (16%) and other causes (4%) for traumatic brain injury. Most of the patients have scored low in eye component of FOUR score. Most of the patients scored 4 in motor component of FOUR score while most of the patients scored 4 in respiratory component of FOUR score. Survivor patient who scored low in GCS scored high in brainstem component of FOUR Score. (Table 3) Most of the patients scored 4 in EYE component of GCS. (Figure 2). Patients with high mortality had low verbal component. (Figure 3). Most of the patients scored 6 in motor component of GCS. (Figure 4).

Figure 2: GCS - eye opening among study participants

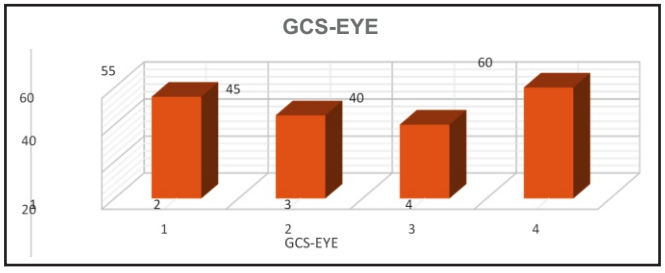


Figure: 3 GCS- verbal response among study participants

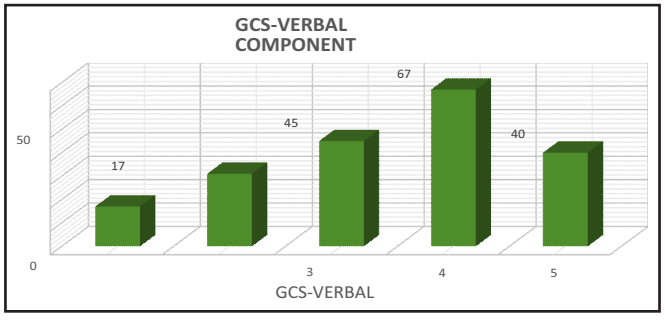


Figure 4: GCS- motor component score among study participants

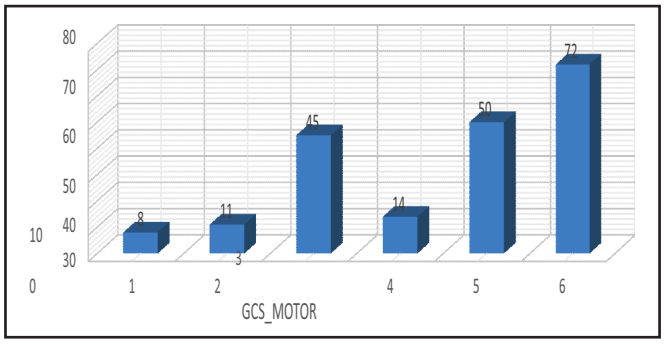


Table 4: Comparison of the Glassgow coma scale with mortality

	Mortality	
	Deceased	Not Deceased
GCS	Count	Count
3	2	0
4	5	0
5	4	0
6	9	0
7	7	1
8	2	3
9	4	28
10	0	30
11	0	36
12	0	23
13	0	22
14	0	20
15	0	4

Road traffic accidents mainly due to motor vehicle accidents contribute higher percentage of causes of TBI (60%). Next leading cause was assault injury which contributes (20%) followed by fall from height (16%) and other causes (4%) for traumatic brain injury. Most of the patients have scored low in *eye* component of FOUR score. Most of the patients scored 4 in motor component of FOUR score while most of the patients scored 4 in respiratory component of FOUR score. Survivor patient who scored low in GCS scored high in brainstem component of FOUR Score. (Table 3) Most of the patients scored 4 in EYE component of GCS. (Figure 2). Patients with high mortality had low verbal component. (Figure 3). Most of the patients scored 6 in motor component of GCS. (Figure 4).

Patients who were deceased had low GCS score and when GCS 8 was taken as the cut off value, sensitivity of GCS was 87.88% and specificity of GCS was 97.60% with a positive predictive value of 87.8%. Positive likelihood ratio was 36.69%. Patients who were deceased had very low FOUR score and when FOUR Score of 8 was the cut off value, sensitivity of FOUR score was 100% and Specificity was 97.52%, with a positive predictive value of 89.19%. Positive likelihood ratio was 40.25%. In our study, FOUR score had higher sensitivity than GCS, whereas specificity was comparable. In terms of outcome in this study, patients with low GCS and low FOUR score on initial presentation were more prone to prolonged length of stay in the hospital. Initial score of < 8 of GCS and < 8 of FOUR score are showing high incidence of mortality.

By comparing the median value of FOUR Score with the Mortality by using the Mann – Whitney test it showed a p value of 1, which is not statistically significant.

FOUR Score is equally reliable with the GCS score. Both have their own significance.

Table 5: Comparison of the FOUR score with mortality

	Mortality	
	Deceased	Not Deceased
FOUR	Count	Count
0	1	0
1	2	0
2	4	0
3	0	0
4	6	1
5	5	0
6	7	0
7	7	2
8	1	1
9	0	3
10	0	23
11	0	27
12	0	23
13	0	32
14	0	3
15	0	34
16	0	18

Table 6: Comparison of median values of the GCS with the mortality (Two Sample Wilcoxon Rank Sum (Mann- Whitney) Test)

By comparing the median value of the GCS with the survivors by using the Mann- Whitney test it showed a p value > 1, which is not statistically significant.

Variable	Observed Value	Median (75%, 25 %)	P value
Recovered	167	12 (14,9)	P value > 1
Not recovered	33	4.5 (7,2)	

Table 7: Comparison of median values of Four score with the mortality (Two Sample Wilcoxon Rank Sum (Mann- Whitney) Test)

Variable	Observed Value	Median (75%, 25 %)	P value
Recovered	167	12.5 (15,10)	P value > 1
Not recovered	33	4 (7,1)	

Discussion:

Neurological disturbances pose a greater challenge in the critically ill patients and patients with neurological disorders. The GCS has been the gold standard for assessment in LOC in patients with significant brain injury since it was developed in1974. The GCS is widely used and accepted but gives relatively limited information about brainstem function eye opening and tracking, and respiratory patterns. Since its introduction in 2005, FOUR score has been refined in clinical use, and its usefulness has been confirmed by hundreds of neurosurgical patients and dozens of doctors. FOUR Score maintains simplicity and provides far better information, particularly for intubated patients. The FOUR score is a good predictor of the prognosis of critically ill patients and has important advantages over the GCS in the ICU setting. The FOUR score has been developed to assess the depth of coma in a more detailed mannerthan the GCS.

The FOUR score is simple to use, includes the minimal necessities of neurological testing in impaired consciousness, and specifically recognizes certain unconscious states.[2] In order to overcome deficiencies of theGCS, the FOUR score has been designed to provide further neurological details in coma patients, recognize certain unconscious states, and predict outcome.[2] The FOUR score, unlike the GCS, doesn't include a verbal response, and thus is more valuable in ICU practices that typically have a larger number of intubated patients. In contrast, the GCS, which uses a verbal score as one of the three components, was less useful in some patients because they were intubated. This would be expected because the verbal component has been recognized as the least reliable component of the GCS. Examination of some brainstem reflexes has been incorporated in the modified GCS (Glasgow-Liege Coma Scale). These reflexes included rapid neck movements to obtain oculovestibular reflexes and eyeball pressure to obtain oculocardiac reflexes.

In line with previous studies, FOUR score and GLS/GCS total scores were comparable in predicting outcome.[2] In addition, no patients with a FOUR score of 0 or 1 survived, while 20% of patients with a GCS total score of 3 were alive. Althoughthis finding doesn't reach statistical significance, it corroborates previous studies. It is important to stress that the FOUR score, unlike the GLS/GCS score, assesses eye tracking, one of the first signs heralding recovery of consciousness after coma and the vegetative/ unresponsive state. Based on GLS/GCS Score and FOUR Score assessments, vegetative/ unresponsiveness state was defined by GLS/GCS Score of E> 1,V3, M< 5, and FOUR Score showing E<4,M<3. Our finding supports previous reports on the ability of FOUR Score to predict mortality. We incorporated a larger sample size and included up to 24 hrs. coma scale scores. When controlling for age and gender, odds ratio for FOUR Score remained comparable to those for GCS.

Limitations of the study:

- The study is limited by the fact that the subjects were taken fromthe convenient sample (usually when investigators were on duty in the ED), raising the possibilities of selection bias.
- The sample may not have covered enough severely injured patients. GCS and FOUR scores were determined within 24 hr. of admission to the ED by only one investigator.
- Another limitation was that the target enrolment cohort was not reached, and approximately 35% of the studied patient population included alert patients. This increases the chance of

interobserver agreement because no neurologic abnormality will have to be identified. A study of a larger group of stuporous or comatose patients would be desirable. This was a single centre study, so the generalizability to other ED has not been proved yet.

Conclusion:

The present study we found that FOUR score is reliable, easy to use, reproducible gives more clinical information and takes less time to perform and can be useful alternate to GCS in the ER settings. The study findings point that the FOUR score is comparable with the GCS scale. It is also suggested that the health care team can be trained and made proficient in using the FOUR score. A similar study can be undertaken with large sample size under reproducible environment for Meta analytical approach. In conclusion, our prospective study comparing the GCS with FOUR score in patients with TBI showed that the FOUR Score is a valid tool with prognostic value comparable and equally reliable to GCS. The FOUR score may offer the additional advantage to be performable in intubated patients and to identify nonverbal signs of consciousness by assessing visual pursuit.

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