Comparative analysis between GCS (Glasgow coma scale) and FOUR (Full Outline of Unresponsiveness) score in preliminary assessment and prognostication of traumatic brain injury

Sri Keerthi[1], Anand Doshi[2], Rajeev Doshi[3], Prashant Khandelwal[4], Mrunal Ketkar[5], Sudhir Sudumbrekar[6]

[1]Resident, Department of General surgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune
[2]Assistant Professor, Department of Neurosurgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune
[3]Associate Professor, Department of General Surgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune-Associate Professor, Department of neurosurgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune
[4]Professor and HOD, Department of General Surgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune
[5]Professor & HOD, Department of Neurosurgery, Bharati Vidyapeeth (DU) Medical College and Hospital, Pune

Date of submission: 19th May 2022 Date of acceptance: 16th February 2023 Date of publication: 30th March 2023

Abstract

Introduction: Head injury is one of the most critical conditions and has a serious neurological outcome if not treated promptly. Effective initial assessment and timely intervention ensures a favourable outcome. To achieve this, many assessment scoring systems have been devised over the years of which Glasgow coma scale (GCS) is the most widely used but it does have a few drawbacks. A newer coma scale, the FOUR score (Full Outline of UnResponsiveness) evaluates four components. The aim of the present study is to compare the GCS and FOUR score in traumatic head injury patients in predicting the better outcome. The outcome scoring is done by GCOS (Glasgow Coma Outcome Scale).

Methods and Materials: One twenty-five patients with traumatic head injury were recruited between September 2019 to September 2021 in a tertiary health care centre. For all these cases, GCS and FOUR score on the day of arrival in emergency department (ED) was calculated by residents attending the case in ED and the outcome was scored using GCOS. The correlation between all three scores was then calculated.

Results: The present study revealed the major cause of traumatic head injury as road traffic accidents and most of them being males. A significant strong positive correlation was found in FOUR score when compared with GCS in the prediction of outcome in traumatic brain injury patients.

Conclusion: It was concluded that the FOUR score is more beneficial to that of GCS and can be used in outcome assessment in traumatic head injury and intubated patients. Thus, FOUR score is a better tool for prognostication.

Key words: FOUR (Full Outline of Unresponsiveness) score, Glasgow coma scale, Glasgow Coma Outcome Scale, traumatic brain injury

Access this article online
Website: https://www.nepjol.info/index.php/NJN
DOI: https://doi.org/10.3126/njn.v20i1.45210
HOW TO CITE
keerthi sri, Doshi A. Comparative analysis between GCS (Glasgow coma scale) and FOUR (Full Outline of Unresponsiveness) score in preliminary assessment and prognostication of traumatic brain injury. NJNS. 2023;20(1):32-38.

Address for correspondence:
Dr. Anand Doshi
Assistant Professor
Department of neurosurgery
Bharati Vidyapeeth (DU) Medical College and Hospital
Pune, India
E-mail: drananddoshi@gmail.com

ISSN: 1813-1948 (Print), 1813-1956 (Online)

Introduction

Traumatic brain injury (TBI) has been one of the major causes of morbidity, disability, and mortality across all ages.[1] To achieve effective initial assessment and timely intervention, many assessment scoring systems have been devised, of which Glasgow coma scale (GCS) is widely used.[2] Professor Graham Teasdale and Professor Bryan Jennett, at the University of Glasgow, published the GCS for the first time in 1974. It was first used to define how severely trauma and acute medical patients' cognition was damaged. The eye-opening, motor, and verbal responses make up the three components of the responsiveness scale.

Each element on its own offers a clear, understandable picture of a patient's condition.[3,4]

Even though GCS is widely used across the world, there are few drawbacks including inability of interpretation of verbal component in intubated patients, inability to assess brain stem reflexes and inability to grade breathing pattern. Adding these mentioned components to GCS could provide better information about prognosis.[5] Hence, the "Full Outline of Unresponsiveness (FOUR) score," a newer scale created to provide a more thorough assessment, was published by Wijdicks et al. in 2005.[6] The FOUR score offers extra details that the GCS cannot estimate, such as brainstem reflexes, visual tracking, breathing patterns, and respiratory drive. As it does not rely on a judgement of the vocal response, it is also more useful for evaluating severely ill intubated cases. The FOUR score assesses four factors—Eye reaction, Motor response, Brain stem reflexes, and Respiratory pattern—each of which is given a maximum value of four.[7]

In a 2016 study by Nair SS et al., 69 patients with TBI were admitted to general surgery and neurosurgery wards. The FOUR score and GCS were calculated for each patient, and it was discovered that there was a statistically significant correlation between the two scores in determining the severity of head injury. Additionally, the FOUR score was a perfect alternative for GCS and was able to provide better findings when estimating the neurological assessment in TBI patients.[2]

In research done in 2015 on 138 patients, Saika et al. examined the prediction of the FOUR score and the GCS for early death. They discovered that the FOUR score's ability to predict the admission of patients with TBI was no better than the GCS score.[8]

Khajeh et al evaluated 200 patients admitted to Paediatric Intensive care unit (PICU). They came to the conclusion that the FOUR score is more effective than GCS at predicting death and discharge in PICU admission cases.[9]

Based on GCS deficiencies and difference of opinion to predict the outcome, a recalibration of study needs to be done to demonstrate a similar test performance with a better outcome. Therefore, the present study was undertaken to evaluate the efficacy of FOUR score in comparison with GCS score on the day of arrival of traumatic head injury patients and the prediction of outcomes was assessed by performing a follow up study on day one and on day five using Glasgow coma outcome scale (GCOS).

Materials and methods:

Design:

A prospective observational study was carried out in our tertiary care centre over a period of two years from September 2019 to September 2021

Population and Criteria of selection:

The selected population was 125 consecutive traumatic head injury patients who presented to Emergency Medicine Department (ED)

The inclusion criteria were:

1. Traumatic head injury
2. Age group of 18 to 60 years
3. History of loss of consciousness with or without CT findings

The exclusion criteria were:

1. Intoxicated patient
2. Known psychiatric disorder
3. Patients transferred from elsewhere- post-stabilisation
4. Duration of injury more than 24 hours on arrival
5. Associated polytrauma

Collection of Data:

Patients were assessed by trained surgical post-graduate (PG) residents. A specially designed proforma is filled for each patient which includes demographic data, mode of injury, duration of trauma, vital parameters, GCS and FOUR scores. The proforma also contains the outcome assessment scores on day one and day five of admission which were assessed by Glasgow outcome score.

The GCS was interpreted using the sum of the scores for these three components, with a maximum score of 15 and a minimum score of three. Similar to this, the FOUR score components—Eye response, Motor response, Brainstem reflexes, and Respiratory pattern—were assessed. Each category is scored from zero to four, with zero being the worst and four being the best.

The lower the value in both scoring systems, the poorer is the prognosis. The prognosis of the patient was assessed on day one and five by assessing the patient using Glasgow outcome scale (GCOS) by the same doctor who carried out the patient's initial assessment. GCOS consists of five categories: Dead, Vegetative State, Severe Disability, Moderate Disability or Good Recovery.

Analysis of Data:

The comparison between GCS and FOUR score was done by analysing the outcome of the patient by using GCOS. Thus, the better scale in the prediction of better outcome is assessed. Complete record of the case was entered in the standardised data collection form (proforma of the study).

All statistical analysis was done by using SPSS software with version 25.0. Quantitative variable was represented by descriptive statistics and qualitative variable were represented by frequency and percentages. Non-parametric Mann Whitney U test was used to compare the score between GCS and FOUR score. Area under the ROC curve (AUC) was calculated for both scores.

Results

A total of 125 patients admitted with traumatic head injury were recruited. The mean age was 38.73 ± 15.09 ranging between 18 to 60 years, among which 34 (27.2%) were females and 91 (72.8%) were males. Road traffic accident being the major cause (85.6%).

There was a significant ($p<0.0001$) positive correlation found between GCOS, FOUR score and GCS among the patients with traumatic head injury.

The corresponding correlation coefficient 'r', and 'p' values are graphically presented in scattered diagram below.

Table 2 shows on the day of injury, GCS and FOUR score both have strong positive correlation with GCOS in view of outcome. But on day five post injury, FOUR score has shown better positive correlation with the outcome when compared to GCS.

The Receiver operative characteristic (ROC) curve analysis was done to find out the efficacy of GCS and FOUR score among the patients with traumatic head injury.

The area under the ROC curve (AUC) was significantly ($p<0.0001$) high for GCS, it was 0.974 with 95% confidence interval of 0.947 to 1.000. The AUC was also significantly ($p<0.0001$) high for FOUR score it was 0.989 with 95% confidence interval of 0.974 to 1.000 (mentioned in the table below). In the ROC curve, the area of FOUR score was found to be high, which signifies it as the better predictive tool in outcome assessment.

The ROC curves for GCS and FOUR score are presented in the graph 2.

The results of ROC curve analysis with respective AUC ± SE (standard error), p values and 95% confidence interval are presented in the table 3 below.

The cut-off values of GCS and FOUR score in patients of traumatic head injury are presented in the table 4 with highest sensitivity and specificity. Based on the above ROC analysis, the cut off value obtained for GCS was 6.5, while for FOUR score it was 10.50.

Table 1: Description of FOUR score and GCS

Full Outline of UnResponsiveness Score		Glasgow Coma Scale	
Eye response		Eye opening	
E4	Eyelids open or opened, tracking or blinking to command	E4	Spontaneous
E3	Eyelids open but not tracking	E3	To verbal command
E2	Eyelids closed but open to loud voice	E2	To pain
E1	Eyelids closed but open to pain	E1	None
E0	Eyelids remain closed with pain		
Motor response		Verbal response	
M4	Thumbs-up, fist or peace sign	V5	Oriented
M3	Localizing to pain	V4	Confused
M2	Flexion response to pain	V3	Inappropriate words
M1	Extension to pain	V2	Incomprehensible sounds
M0	No response to pain or generalized myoclonus status	V1	None
Brainstem reflexes		Motor response	
B4	Pupil and corneal reflexes present	M6	Obeying commands
B3	One pupil wide and fixed	M5	Localizes pain
B2	Pupil or corneal reflexes absent	M4	Withdraws from pain
B1	Both Pupil and corneal reflexes are absent	M3	Flexion to pain
B0	Absent pupil, corneal and cough reflex	M2	Extension to pain
		M1	None
Respiration			
R4	Not intubated, regular breathing pattern		
R3	Not intubated, Cheyne–Stokes breathing		
R2	Not intubated, irregular breathing		
R1	Breathes above ventilator rate		
R0	Breathes at ventilator rate or apnea		

Table 2: GCOS, GCS, and FOUR score correlation at presentation

		Correlations			
		GCS-(15)	FOUR score- (16)	GCOS-(5) Day 1	GCOS-(5) Day 5
GCS-(15)	**Pearson Correlation**	1	.973**	.892**	.697**
	p-value		0.000	0.000	0.000
	N	125	125	125	120
FOUR score- (16)	Pearson Correlation	.973**	1	.881**	.722**
	p-value	0.000		0.000	0.000
	N	125	125	125	120
GCOS-(5) Day 1	Pearson Correlation	.892**	.881**	1	.669**
	p-value	0.000	0.000		0.000
	N	125	125	125	120
GCOS-(5) Day 5	Pearson Correlation	.697**	.722**	.669**	1
	p-value	0.000	0.000	0.000	
	N	120	120	120	120

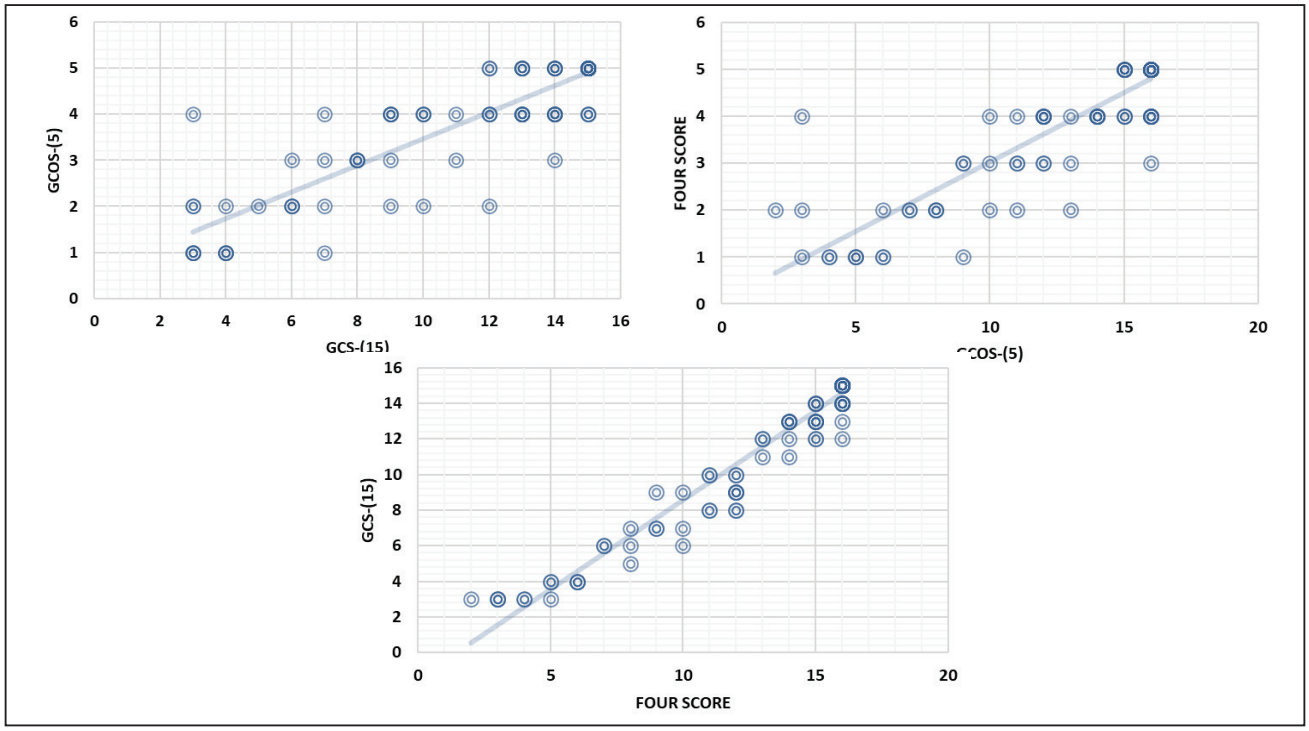
**. *Correlation is significant at the 0.01 level (2-tailed).*

Table 3: Receiver operative characteristic (ROC) curve analysis of GCS and FOUR score

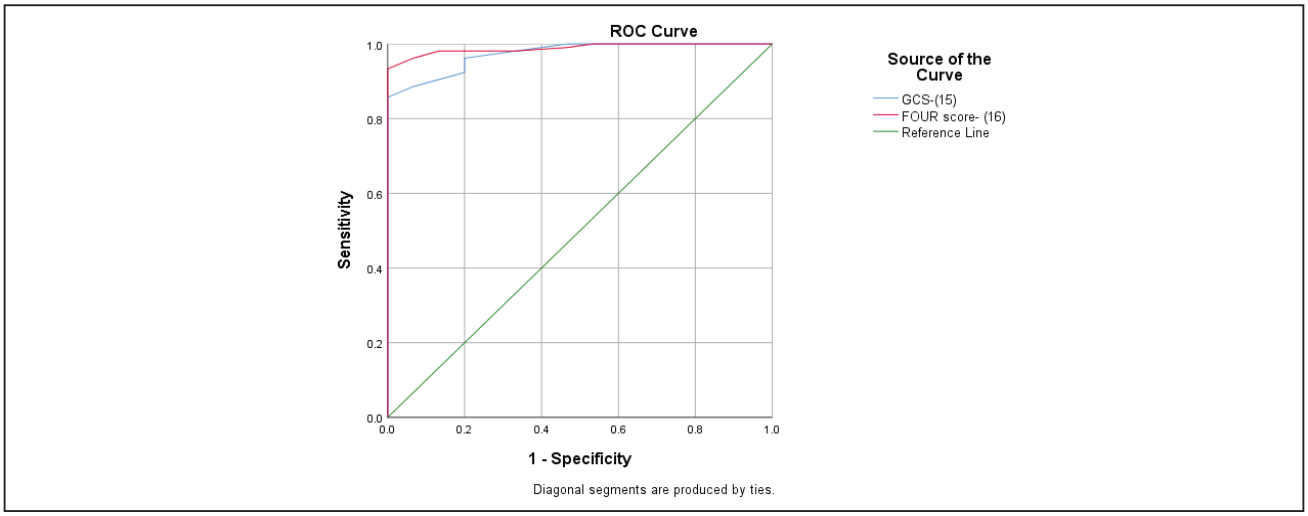
Parameters	AUC	SE	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
GCS-(15)	0.974	0.014	<0.0001*	0.947	1.000
FOUR score- (16)	0.989	0.008	<0.0001*	0.974	1.000

Table 4: Cut-off values with respective sensitivity and specificity of GCS and Four score

	Cut-off value	Sensitivity	Specificity
GCS-(15)	6.5	98.1	33.3
FOUR score- (16)	10.50	96.2	6.7



Graph 1: GCOS, GCS, and FOUR score correlation at presentation



Graph 2: Receiver operative characteristic (ROC) curve of GCS and FOUR score

Discussion

This study was performed to compare the efficacy between GCS and FOUR score in assessing the outcome in patients with traumatic head injury.

According to the study that we conducted, a total of 125 patients with traumatic head injury were assessed, of which majority were young patients in active age group (mean 38.73 ± 15.09) and who were more vulnerable to risky behaviours. Among which almost 3/4th population comprised of males and road traffic accident was the major cause of trauma (85.6%).

Similar to present study, the mean age reported by Gorji MA et al was 33.80 ± 12.60 years, with male predominance (79.2%) over females (20.8%). 45 patients had road traffic accident while eight had history of fall from height.[10]

Kodliwadmath, H et al also reported similar results with predominantly males (87.8%) having brain injury with most of the cases belonging to middle age group.[11]

The mechanisms of injury reported by Chamoun RB et al was motor vehicle accidents (40.7%), auto-pedestrian accident (22.2%), fall (15.9%), assault (9.5%), and unknown (11.6%).[12]

All study patient's GCOS was documented, compared with GCS and FOUR score, and interpretated. The results of Wilson JT et al indicated GCOS and GOSE had consistent relations with other outcome measures including subjective reports of health outcome; they thus remain useful in overall summary assessments of outcome of head injury.[13]

GCOS score has been found to be reliable and, in some cases, better predictor of disability as per study done by Pettigrew LE et al.[14]

In the present study there was a significant positive correlation found between GCOS, FOUR score and GCS in the study population. It was observed that the higher the consciousness level determined by the GCS score, the higher levels attained by the FOUR score, and vice versa.

The comparable results to present study were found by Nair S et al with strong association between FOUR score and GCS, reported at presentation, after one hour and after six hours in patients with mild, moderate and severe head injuries.[2]

Zeiler et al. documented FOUR score at admission and day seven in 64 cases presented with subarachnoid bleed with aneurysm. The mean age was 54.2 years (26–85). A significant association was noted between FOUR score and mortality ($P < 0.05$).[15]

In 2016, Sepahvand et al. conducted a prospective study in 198 brain injury patients. FOUR score and GCS was evaluated and prognostics were compared. 65.2% survived and 34.8% died, and FOUR scoring predicted 82% of them. In the GCS, the average scores for death and survival rates were 4.59±2.36 and 10.71±2.24, separately the FOUR score recorded 3.15±3.52 and 12.77±2.43. For FOUR and GCS separately, the area under the ROC curve was 0.961 and 0.928. The area under the curve was high for FOUR in scores 6 and 7, and for GCS in scores 5 and 6. Both FOUR and GCS had sensitivities of 0.76 and 0.85. They found that the FOUR score is an effective diagnostic criterion for predicting outcomes in cases with TBIs since it is sensitive, specific, and useful.[16] In present study the area under the ROC curve (AUC) were significantly higher for GCS and FOUR score, with cut off values of 6.5 and 10.50 respectively.

Gorji MA et al reported a close prediction in both FOUR score and GCS. The sensitivity and specificity of FOUR in order to prognosticate the poor outcome (GOS = 1-3), determined to cut off, was (Cl = 0.95, 0.86) and (Cl = 0.95, 0.87) respectively and in terms of mortality it was (Cl = 0.95, 0.90) and (Cl = 0.95, 0.90). In order to predict poor outcomes in GCS, the sensitivity and specificity was (Cl = 0.95, 0.100) and (Cl = 0.95, 0.61) respectively

and in terms of mortality it was (Cl = 0.95, 0.100) and (Cl = 0.95, 0.92). They came to the conclusion that the FOUR score is a useful instrument with a high degree of prediction of outcome for individuals with traumatic brain injuries. Similar to present study, scoring tools were applied within 24 hours of injury, only traumatic head injury were included and FOUR score has shown better positive correlation with the outcome when compared to GCS.[10]

The FOUR score, unlike the GCS, doesn't include a verbal response, and therefore is more important in ICU practices that generally have a large number of intubated patients. Intubation is a common procedure in the field, emergency department, and ICU that invalidates one of the three components of the GCS.[17]

In their study, Jalali R et al. came to the conclusion that the FOUR score appears to be a simpler tool to use and that it offers a more thorough neurological assessment.[18] Inconsistent with present study, the proper cut-off point of GCS in the prediction of mortality was 4 and in prediction of poor outcomes it was 7, in FOUR scores it was 6. This inconsistency may be related to timeframe of research plan and difference in injury severity in two studies.

The present study therefore concluded that the FOUR score outcomes are better in outcome prediction in intubated patients when compared to GCS.

Conclusion

The present study was conducted to know the association between GCS and FOUR score and also to find the efficacy of these scores. FOUR score can be used among the patients intubated as opposed to GCS, and it also correlates well with poor outcomes with cut-off value of 10.50. The FOUR score has shown better positive correlation with the outcome when compared to GCS. Thus, FOUR score is a better tool for prognostication.

Acknowledgement: Nil.
Conflict of interest: Nil
Funding: No funding sources
Ethical approval: The study has been approved by institutional ethical committee

References

1. Ng SY, Lee AYW. Traumatic Brain Injuries: Pathophysiology and potential therapeutic targets. Front Cell Neurosci. 2019 Nov 27;13:528. DOI: https://doi.org/10.3389/fncel.2019.00528
2. 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 Jan 25;4(2):656. DOI: http://dx.doi.org/10.18203/2349-2902.isj20170209
3. Jain S, Iverson LM. Glasgow Coma Scale. [Updated 2022 Jun 21] [Internet]. Vol. In: StatPearls [Internet]. Treasure Island (FL). StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513298/
4. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. The Lancet. 1974 Jul;304(7872):81–4. DOI: https://doi.org/10.1016/S0140-6736(74)91639-0
5. Laureys S, Piret S, Ledoux D. Quantifying consciousness. Lancet Neurol. 2005 Dec;4(12):789–90. DOI: https://doi.org/10.1016/S1474-4422(05)70230-1
6. Wijdicks EFM, Bamlet WR, Maramattom BV, Manno EM, McClelland RL. Validation of a new coma scale: The FOUR score. Ann Neurol. 2005 Oct;58(4):585–93. DOI: https://doi.org/10.1002/ana.20611
7. Sadaka F, Patel D, Lakshmanan R. The FOUR score predicts outcome in patients after traumatic brain injury. Neurocrit Care. 2012 Feb;16(1):95–101. DOI: https://doi.org/10.1007/s12028-011-9617-5
8. Saika A, Bansal S, Philip M, Devi BI, Shukla DP. Prognostic value of FOUR and GCS scores in determining mortality in patients with traumatic brain injury. Acta Neurochir (Wien). 2015 Aug;157(8):1323–8. DOI: https://doi.org/10.1007/s00701-015-2469-6
9. Khajeh A, Fayyazi A, Miri-Aliabad G, 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 Oct;24(5):603–8. PMID: 25793069; PMCID: PMC4359415.
10. Hoseini S, Gholipur A, Mohammadpur R, Gorji MA. 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. DOI: https://doi.org/10.4103/1658-354X.130708
11. Kodliwadmath H, Koppad S, Desai M, Badiger S. Correlation of Glasgow outcome score to Glasgow coma score assessed at admission. Int Surg J. 2016;1959–63. DOI: http://dx.doi.org/10.18203/2349-2902.isj20163172
12. Chamoun RB, Robertson CS, Gopinath SP. Outcome in patients with blunt head trauma and a Glasgow Coma Scale score of 3 at presentation: Clinical article. J Neurosurg. 2009 Oct;111(4):683–7. DOI: https://doi.org/10.3171/2009.2.JNS08817

13. Wilson JTL. Emotional and cognitive consequences of head injury in relation to the Glasgow outcome scale. J Neurol Neurosurg Psychiatry. 2000 Aug 1;69(2):204–9. DOI: https://doi.org/10.1136/jnnp.69.2.204.
14. Pettigrew LEL, Wilson JTL, Teasdale GM. Assessing disability after head injury: improved use of the Glasgow Outcome Scale. J Neurosurg. 1998 Dec;89(6):939–43. DOI: https://doi.org/10.3171/jns.1998.89.6.0939
15. Zeiler FA, Lo BWY, Akoth E, Silvaggio J, Kaufmann AM, Teitelbaum J, et al. Predicting outcome in Subarachnoid Hemorrhage (SAH) utilizing the Full Outline of UnResponsiveness (FOUR) Score. Neurocrit Care. 2017 Dec;27(3):381–91. DOI: https://doi.org/10.1007/s12028-017-0396-5
16. Sepahvand E, Jalali R, Mirzaei M, Ebrahimzadeh F, Ahmadi M, Amraii E. Glasgow coma scale versus Full Outline of Unresponsiveness scale for prediction of outcomes in patients with traumatic brain injury in intensive care unit. Turk Neurosurg [Internet]. 2015 [cited 2023 Feb 11]. DOI: https://doi.org/10.5137/1019-5149.JTN.13536-14.0
17. Iyer VN, Mandrekar JN, Danielson RD, Zubkov AY, Elmer JL, Wijdicks EFM. Validity of the FOUR score coma scale in the medical intensive care unit. Mayo Clin Proc. 2009 Aug;84(8):694–701. DOI: https://doi.org/10.1016/S0025-6196(11)60519-3
18. 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;2014:1–4. DOI: https://doi.org/10.1155/2014/289803