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Assessing validity and reliability of glasgow coma scale and full outline of unresponsiveness score: A systematic review

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Abstract---Background: Monitoring accurately the patient's level of consciousness is vital to the management and prognosis. Glasgow coma scale (GCS) the gold standard tool is associated with the discrepancy in scoring eye component and the non-usability of verbal component. The full outline of unresponsiveness (FOUR) score a recently validated tool surpasses the deficits of the GCS tool, examined for its accuracy in assessment, and predicting the outcomes of patients with altered level of consciousness. Aim: To evaluate the predictive value of the GCS and FOUR score tool in relation to the outcomes among patients in altered level of consciousness. Design: A systematic review. Data sources: The MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Cochrane Central Register of Controlled Trials (Cochrane Library), EMBASE, PsycINFO and Web of Science were searched "between" 2011 – 2021 and presented using PRISMA. Review methods: Research studies, which compared the GCS and FOUR score in predicting the outcome of patients with altered level of consciousness, were included. Results: 23 studies, which compared the GCS and FOUR score, were included in this review based on the inclusion criteria. Conclusion: 23 studies included in the review showed that FOUR score could be replaceable

tool for GCS in terms of usability, specificity, accurate assessment of patients with altered level of consciousness and prognostication of poor functional outcomes as morbidity and mortality.

Keywords---validity, reliability, glasgow coma scale.

Introduction

Accuracy in assessing the level of consciousness is paramount to the outcomes of the critically ill patients in altered neurological status ¹. Various scales originated over the past decades but GCS tool has remained as the conventional gold standard for assessing and predicting the outcome of the patients in all kinds of coma^{2,3}. Though the GCS tool has gained familiarity the deficits in areas of brain stem reflexes, indecisive scoring for eye reflexes and inability to score the verbal component on ventilated patients cannot be ignored^{4,5}. Many new validated scales devised to use over the last five decades remained unfamiliar to practice including the Full Outline Of Unresponsiveness (FOUR score) ^{6,7}. The FOUR score well applicable and able to predict precisely the unfavorable outcome in the ICU ventilated and non-ventilated patients in various coma ⁶. FOUR score recognized for its easy to use, assessment of brain stem reflexes, tracking, non-tracking eye movement, and detailed specific grading of the respiration. The validity, reliability, specificity and sensitivity of FOUR score has been similar and better than GCS. ^{4,8}. However, there is limited systematic review studies, which compared the validity of FOUR score and GCS. Therefore, the current review designed to fill this gap in literature with aim of addressing the following question: 1) assess the validity of the GCS with FOUR score; and 2) evaluate the accuracy of FOUR score in predicting the outcome among critically ill patients with altered level of consciousness.

Methodology

Design

This systematic review was guided by the guidelines of Cochrane Collaboration and reported using Preferred Reporting Items for Systematic Reviews PRISMA) .

Search Methods

A comprehensive literature base and search strategy done using PICOT strategy. The MeSH (Medical Subject Heading) key search words used were FOUR Score, GCS, coma scale, outcome, neurological injury, and prospective studies. Two authors had independently searched exclusively for studies using the following databases for the period 2011-2021: MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), CENTRAL (Cochrane Central Register of Controlled Trials - The Cochrane Library), EMBASE, PsycINFO and Web of Science.

Inclusion and Exclusion Criteria

Articles considered for review primarily stood on the objective of the study to evaluate the predictive nature of GCS & FOUR score to outcome measured in terms of morbidity and mortality of the patients. A manual search from all relevant peer-reviewed research trials that fulfilled inclusion criteria as well as related systematic reviews, meta-analyses, review articles and published in English during the 2011-2021 selected. Duplicate records and trials excluded by screening the titles and abstracts.

Participants

Studies which included adult critically ill patients aged 18 and above with altered neurological status and monitored with FOUR score and GCS tool were identified.

Interventions

The studies of the patients monitored with GCS and FOUR Score at the time of admission on non-sedated patients.

Comparison

Since this was an observation study, there was no experimental or control group for comparison. Both tools applied on the patients and tested on its predictive value towards the outcomes.

Outcomes

The scales assessed prediction of outcomes in terms of morbidity, evaluating progress of patient at discharge, predicting extubation and mortality.

Design of Selected Studies

All except one study are observation and prospective studies published in English as mentioned in Figure:1.

Search Outcomes

The initial search on GCS and FOUR score identified six hundred forty-three (643) papers as potentially to this review. Based on the inclusion criteria, the titles and abstracts were screened and matched against the inclusion criteria resulting in thirty (43) studies. After examining the methodological quality of the articles, twenty-three (23) identified as relevant to the review. (Figure 1).

Quality Appraisal

Quality appraisal done based on the Cronbach alpha value and the Mixed-Methods Appraisal Tool (MMAT), which used for appraisal of qualitative, quantitative and research studies using mixed methods. The Score on assessment found above 75% out of a maximum score of 100%. The credibility and

methodological quality of the included articles appraised using the data extraction template. Outcomes data extracted listed under themes of assessment, comparison between tools and prognostication to outcome

Result

Research methodology Design

Twenty-three studies except one are observational design (Table 1). The observational studies applied both the scales of assessment on the same patient. One study, retrospectively evaluated the assessment to the outcome of the patient.

Settings and Sample size

The studies globally well represent European, American to Asian countries illustrating the strength of this review. The sample sizes are large ranging from 50- 1645 demonstrates statistical significance of the results.

Patient Characteristics

Studies included adult patients admitted in ICU with neurological specifically traumatic brain injuries. Except for two studies conducted in the emergency department identifies favor among altered sensorium patients with varied etiological origin and beneficial for triaging, to conclude on transportation and for clinical analysis of the patient ⁹. In addition, most studies done The FOUR scale being applicable for intubated and non-intubated patients makes it an ideal replaceable tool for GCS¹⁰.

Effect of interventions

The interventions involved assessment of the patient using the FOUR score and GCS tool earliest from admission and concurrently at different hours until discharge by either single or multiple assessors. Training on FOUR score provided to the assessors involved in the studies towards use and application of the tool. All studies evaluated the predictiveness of the tool towards the outcome except for two studies which evaluated the extubation⁹ and the latter evaluating the interrater reliability of the tool among Health professionals ¹¹. The FOUR score scale paralleled to various outcome tools like APACHE II, NIHSS, mRS and GOS displayed stability and accuracy in predicting the outcome in terms of mortality and morbidity.

Difference between FOUR Score and GCS

Usability of the tools

The effectiveness of tools in terms of its usability favored the FOUR score tool being trustworthy, effective as GCS with high interclass correlation among the assessors¹². FOUR score tool acquires credibility for accuracy, simplicity in

practice and as perfect replacement for the GCS tool¹⁰. The FOUR score used among all types of coma in various studies with similar inter-rater reliability used among different health professionals is advantageous in terms of patient evaluation and clinical decision-making. While evaluating ventilated and non-ventilated patients using FOUR score tool identified as an easy tool and concluding the choice of tool depends on patient's condition^{7,13}.

Assessment of the patients

The detailed component of brain stem assessment and grading of the respiratory system evaluation among the ventilated and non-ventilated patients in the FOUR score stands out as a valuable predictor of the outcome as mortality and functionality of patients^{10,14}. While other studies undeniably identified various advantages in terms of balance of items, identifying locked in syndrome^{7,15} and the FOUR score tool accurately grading the depth of coma especially among the ventilated patients and predicting mortality¹⁶. The enhanced assessment of predicting the risk of developing hematoma, herniation with brainstem compression provides specific clinical details related to patient management and prevention of complication^{7,17,18}.

Most studies identified correlation to the lowest score of the FOUR score to highest mortality^{2,9-11,14,15,17-27}. And highlighted the sensitivity of FOUR score tool in alerting the clinicians in identifying the early signs of brain death²⁸ and measuring the depth of coma among intubated patients¹³. The stark failure of the GCS tool in assessing the verbal component with discrepancy in scores of the eye response among the patients in vegetative state is a major deficit highlighted in all studies^{1,2,4,29}.

Outcome of the patients

Multiple studies done among the TBI or patients related to cerebral conditions identified that the FOUR score is accurate in evaluating the level of consciousness demonstrating good calibration in terms of specificity, sensitivity and predicting the outcome of the patients regarding mortality and morbidity^{10,14,17,20,21,23-25,27}. FOUR score found to be superior to GCS in terms of efficacy in identifying the need for intubation, predicting extubation and patients requiring ICU admission^{11,15,18}. Several studies concluded that similar lower scores of GCS and FOUR score related to the poor outcome of the patients^{22,23,25,27,30}. It further highlighted that though both tools can be used for predicting^{31,32} the ICU survival FOUR score tool stood beneficial in the areas of the brain stem and grading breathing patterns making it superior to the GCS tool^{14,15,23,32}. It was also reinstated in few other studies displaying that FOUR score was equally effective in predicting the mortality rates and functionality with the high concordance between FOUR SCORE, GCS, APACHE II, KPS, NIHSS, WFNS^{5,12,22}.

The discriminating and calibration power^{3,13} of FOUR was similar and superior^{18,24} in comparison to sensitivity of GCS score¹³. The predictive nature in terms of mortality was seen higher with use of FOUR score stating the tool is more valuable with the calibration power². The FOUR score used among the traumatic brain injury patients identified the ROC similar in comparison to GCS score and

APACHE II in predicting early and late mortality¹³ and the accurate sensitivity of the FOUR score in predicting the outcome specifically identified to hour of admission⁴.

The validity and reliability was greater with the FOUR score when used by the neurologists, nurses, doctors in predicting the In-house mortality, locked-in syndrome and accurate assessment of the eye movement. The study further emphasized the practicability of the tool which can be achieved by simple training promoting a high degree of rigor and confidence¹⁶ and being the most specific and moderately sensitive tool in predicting the mortality³³.

Secondary Outcomes

The secondary outcomes using CT scan showed a close relationship to the disease and prognosis¹⁷. Area under the curve for predicting death or mortality at the time of admission at a confidence level at 95% appraised in these studies favored towards the FOUR Score in various studies as mentioned from the table 2 below:

Publication Bias

The potential for publication bias not assessed in this systematic review due to the limited availability of trials.

Psychometrics

The inter rater reliability of GCS and FOUR score was 0.96 and 0.98¹⁶ used to evaluate outcome measures in included trials was found to be reliable and adequate. The sensitivity and specificity of GCS and FOUR score tools presented in Table 3 highlights higher score for FOUR score.

Quality of evidence

Overall, the quality of evidence illustrated considered good for the estimated primary outcome. The assessment after a well-planned pre intervention like orienting to the FOUR score tool after training and checking the inter rater reliability among the raters, using appropriate study designs and methods of research strengthened with adequate reporting over powers the risks of bias, inconsistency and considerable heterogeneity.

Discussion

Review identified 21 studies relevant to the inclusion criteria and the aim of the study, focusing on predictors of the outcomes^{1-5,7,12,13,32} while two studies focused on the inter-rater reliability, internal consistency,^{28,32}. All the studies excluding one in this review had prospective methodological qualities^{2-5,12,13,28}. The 5 systematic reviews conducted thus far had high or very high risk of bias³⁴⁻⁴⁰ hence this review was done.

The tool must be constant in nature and it should measure what it supposed to measure and it should show the same value irrespective of repeated attempts and

at various settings¹³. From the studies included for this review, regarding accuracy of the tool in predicting the outcomes, FOUR score showed very close accuracy in terms of neurological progress and evaluation than GCS tool^{1-5,7,12,13,28,32}. In addition to this, FOUR score has several advantages such as balance of items, diagnosis of locked-in syndrome⁷, and evaluation of patients with intubation⁷ and the calibration was better for FOUR Score than GCS among ICU^{1,2,12} patients and the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were also better for FOUR Score as compared to GCS^{1,2,7,12}. The review identifies FOUR score has very excellent relationship to in-patient mortality among locking syndrome, intubated and ICU patients which was very authentic among 21 studies.

With regard to statistical method used in all the review to measure the predictive mortality and other clinical outcomes for FOUR score and GCS was by calculating AUC (Prediction) as well as ROC (Sensitivity and specificity). Most studies used these two AUC-ROC, proving the prediction of neurological outcomes supporting FOUR score^{2-5,7,13}. The same findings is reported in several studies using AUC-ROC in quantifying the performance of FOUR score in predicting the mortality and poor functional outcome³⁵⁻³⁸.

Among patients with mental confusions, sedations and intubation tubes the accuracy of response influences the GCS while the subcategories of FOUR score are easy and specific these barriers and the accuracy is not be questioned³⁴. The authors carefully reviewed studies included in this review to check the inclusion criteria of patients. Many of the studies included patients with difficulty in verbalizing due to sedation and intubation^{1-5,7,12,13,28,32}. Out of 23 studies, eight studies detailed about the sensitivity and specificity of the GCS and FOUR score^{1,2,4,10,16,18,22,33} which displayed equal or higher sensitivity and specificity to FOUR score and the same findings have been reported in other reviews.⁴⁰ The main purpose of the creation of FOUR score was to speed up the evaluation faster and accurate with neurologically challenged components where GCS could not interpret on those challenges. In this review, three studies mentioned about the inter-rater scores by different health care personnel on the same patient. The studies observed different scores by the rater on the same patient while using GCS. Whereas, the FOUR score was consistent with all the raters. The raters are from nursing, physician, neurologist and other allied health care personnel^{8,9,21}. Any instrument should be easy to use, better interpretation, cheaper, non-invasive and faster in speed³⁶. These studies in this review revealed about the consistency in usage and interpretation of FOUR score among various health care personnel than GCS^{11,32}.

Limitation

There are few limitations on this review:

- The population, setting, tests conducted to check the ability to predict the outcome of patients differ from study to study. Hence, the authors unable to provide meta-analysis of the studies reviewed.

- The raters or the users of the tool had different knowledge background. FOUR Score usage and interpretation need some special knowledge background. Hence, there was chance in the error or under reported.
- Most of the studies in this review included patients admitted in ICUs with traumatic brain injury and Aneurysmal subarachnoid hemorrhage. No much variety of non-neurological patients had been included in this review. Further exploration needed to study over other patients with neurological pathology and in different settings.
- Since the studies selected were published in English there is probability of missing high indexed research conducted and published from non English speaking countries

Conclusion

This systematic review clearly concluded the benefits in usage and simplicity of FOUR Score to GCS in ICUs, EMD and wards. The reliability in prediction of mortality among in- hospital patients with depressed level of consciousness using FOUR Score is good and very good than GCS. It demonstrates good inter-rater reliability between primary health care provider and nurses. Finally, the FOUR Score has an overall good and very good relationship among patients with altered level of consciousness on their mortality and poor functional outcome in the clinical setting. Further studies recommended on to compare FOUR Score and GCS among patients included with strict inclusion criteria and with adequate sample size.

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Declaration of interest

No conflict of interest as declared by the author(s)

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Table 1: GCS and FOUR score

Author	Purpose	Outcome Measure	Patients	Research Design	Sample	Intervention	Result	Time	Evidence
[14]	To assess the inter-rater reliability of GCS versus FOUR score [10]	Glasgow outcome scale (GOS) and modified Rankin Scale (mRS) survival measured by duration on ventilator and days in ICU at discharge.	ICU adult patients with altered sensorium	Prospective observational study	111 patients	GCS & FOUR score assessed earliest after admission to ICU among non-sedated patients by senior resident, Junior Resident and Staff Nurse.	The inter-rater observer score of Four Score was not superior to GCS. Both the scores statistically correlated to the survival.	January to December 2015	II
[15]	To assess reliability by comparing the FOUR score and Glasgow Coma Scale (GCS)	The survival of patients in terms of morbidity and mortality rates	Neurosurgery & anaesthesia ICU	Prospective observational study	79 patients	The GCS and FOUR score assessed among non-sedated on day 1 & 7 independently by anesthesiologist & neurosurgeon.	No statistical significant difference in inter-rater observation. Low GCS & Four score was significant to high mortality rate	March 2017 and June 2017	II
[4]	To compare GCS and FOUR score.	Predictive the outcome in terms of mortality rates for trauma patients	Traumatic patients	Prospective observational study	90 patients	GCS and FOUR score assessed on admission, 6, 12 & 24 hours after that by 2 trained ICU nurses in the same time	The predictive of GCS and FOUR score was high for mortality while FOUR score demonstrated good [4]. FOUR score accurately predicts towards ICU admission	February and September 2017	II
[16]	To evaluate the effectiveness and the use of GCS and FOUR score	Follow-up and evaluation of patients mortality rates and functionality of patients	Cranial surgery or head trauma	Cross-sectional prospective	47 patients	The FOUR and GCS scores assessed in the first 24 hours of admission and discharge by two nurses	No difference between the evaluations of two scores and two nurses statistically. The FOUR score is as effective as GCS on the follow-up of patients	July 2012 and July 2015.	II
[17]	To compare the GCS, FOUR and acute physiology and chronic health evaluation (APACHE II)	Predict of the mortality rate	TBI	Prospective observational study	80 patients	The scores of APACHE II, GCS and FOUR assessed in the first 24 hours of admission.	No significant difference among three tools. FOUR score able to identify a locked in syndrome. FOUR score is superior in predicting ICU admission and early mortality.	2012-2015	II
[5]	To compare the predictive value of FOUR score and GCS	In-hospital mortality, clinical diagnosis of brain death, motor disability and full recovery without any sequelae at the time of discharge	Multiple trauma patients	Cross-sectional prospective study	89 patients	The GCS and the FOUR score assessed in the emergency department at admission and 6th and 12th hour	Both the GCS and FOUR scores similar and identified superior predictive outcome from the 6 th and 12 th hour assessment.	May 2014 to October 2014	II
[2]	To compare the GCS, FOUR	To identify the survivors and non survivors	Neurology patients in ICU	Prospective observational study	97 patients	GCS and FOUR score assessed once before 24 h of admission.	The specificity, sensitivity, calibration and predictive value of FOUR score was superior to GCS.	Not available	II
[18]	To compare the FOUR scale and GCS	Predicting the prognosis as in-hospital mortality outcome	Traumatic brain injuries.	Prospective observational study	198 patients	GCS and FOUR score assessed once after 24 h of admission by four registered ICU nurses.	FOUR score accurately predicts the mortality rate with high specificity, sensitivity diagnostic criteria	January 2012 to May 2015	II
[7]	To compare the FOUR score with score of Hunt	To assess the mortality and poor outcome	Aneurysmal subarachnoid	Prospective observational study	75 patients	FOUR score, Hunt and Hess score and World Federation of Neurological Surgeons	FOUR score is highly specific and moderately sensitive in	November 2015 to	II
	and Hess score and World Federation of Neurological Surgeons (WFNS) among		hemorrhage patients			(WFNS) score was assessed on all patients with a GCS of less than 15	predicting the outcome of mortality.	November 2016	
[19]	To assess the usefulness and compare FOUR score with the GCS	In predicting extubation failure at 14 days among intubated patients and prediction of mortality rate on 28 th day and neurological outcome at 3 months	Critically ill intubated patients	Prospective observational study	87 patients	The FOUR score and the GCS assessed within 24 hours of intubation and 24 hours before extubation.	The FOUR score identified is superior to the GCS in predicting the extubation and no statistical significance for 28 th day mortality and 3 months outcome due to small sample size.	December 1, 2014 and May 31, 2015	II
[20]	FOUR score compared with intracranial hemorrhage (ICH) score	Predict the mortality and modified Rankin scale score on day 30 and at 1 year.	Spontaneous intracranial hemorrhage (ICH).	Retrospective Study	652 patients	Medical records assessed for GCS, FOUR score and initial CT scan reports. The FOUR score was replaced with GCS in ICH scoring system in predicting the outcome	FOUR score in easy assessment tool and accurate to identify patients at risk of hematoma and herniation with brainstem compression	2009 to 2012	III
[21]	To validate the FOUR score	Glasgow outcome score (GOS) at 30 days	Spontaneous intracranial hemorrhage (ICH).	Prospective observational study	101 patients	GCS and FOUR score assessed on admission by neurologist.	FOUR score is accurate in evaluation among very low GCS and FOUR score tool is easy to apply and more distinguished in assessment of severely impaired consciousness. The predictive value of FOUR score on day 30 higher than GCS	May 2006 until July 2007	II
[22]	To determine FOUR score an accurate predictor and to compare its performance to GCS	In-hospital mortality and poor neurologic outcome (Glasgow Outcome Scale (GOS) 1-5) in discharge time.	Traumatic brain injury (TBI)	Prospective observational study	55 TBI patients	The FOUR score and GCS assessed by the researcher during the first 24 hours	The FOUR score accurately predicts the outcome among TBI patients with high predictive power. The use of FOUR score during the first 24 hours of admission of patients is advantageous in identification of Locked in syndrome, evaluating intubated patients with equal weightage in components.	February 2015 to June 2015	II
[1]	To compare the performance of GCS with FOUR scale	The survival of patients assessed for two weeks and on hospital discharge.	ICU Head injury	Prospective observational study	104	GCS and FOUR score assessed on ICU admission by three trained nurses and accuracy checked by researcher.	FOUR score identified as better predictive tool of mortality and accurate replaceable tool for GCS that is easy to use and accurate for comprehensive neurological assessment	Not available	II
[23]	To assess the inter-rater reliability, concurrent validity and assess doctors' &	Outcome on discharge	Emergency Department	Prospective observational study	217 observations from 203 patients	The study based on the number of observations. The GCS and FOUR score assessed on admission and a second participant independently reassessed	The FOUR Scale demonstrated higher reliability in assessing altered sensorium with higher inter-rater reliability score and exceptional for assessing all levels of consciousness and	October 2007 to February 2008	II

	nurses' knowledge attitudes in using the FOUR Scale					after five minutes. Assessment done by Doctors and nurses.	patient presentations as compared to GCS.		
[24]	To compare the FOUR score with National Institutes of Health Stroke Scale (NIHSS) and GCS	In-hospital or 30 days mortality and Modified Rankin Scale (mRS) at 3 months	Acute ischemic stroke	Prospective observational study	127 adult patients	NIHSS, GCS, and FOUR score assessed at 24 and 72 h	The mortality Predictive value of FOUR score is accurate to NIHSS and GCS. While the NIHSS more accurate in predicting the poor neurologic outcome	March to the 30th of September 2015	II
[25]	To evaluate the reliability between the FOUR score and GCS score while evaluating intubated patients in the emergency room.	Evaluate intubated patients in Emergency Room and predict in-hospital mortality	Emergency Room	Observational study	Eighty patients	Each patient evaluated by random pairs of raters using both the FOUR and the GCS scores. The FOUR and GCS scores assessed by two personnel. The participants involved in assessing are emergency medicine residents, nurses and externs	The FOUR score identified to be reliable tool for ED in assessing patients in varied altered state of consciousness for triaging, transportation, critical clinical analysis and better predictive tool to assess the in-hospital mortality.	May 2011 to November 2011	II
[26]	To compare the GCS and FOUR score at 24hrs and 72 hours of admission.	Functional and cognitive status at 3 months post-injury and in-hospital mortality.	Traumatic Brain Injury	Prospective cohort study.	136 Patients	The GCS and FOUR score assessed at 24 and 72 hours	FOUR score is similar to GCS in predicting the functional, cognitive and in-hospital mortality.	Not Available	II
[27]	To test the validity of FOUR Score versus GCS.	To evaluate and monitor the progress of the patient and outcome on discharge	Traumatic Brain Injury	Descriptive study	69 patients	The FOUR score and GCS assessed on admission, 1 hour, 6 hour and concurrently by the same assessor.	FOUR score superior and an ideal replacement tool of GCS. It is strong to detect, classify and evaluate patients with head injury and has high prediction towards outcome on discharge.	January 2015 to December 2015.	II
[28]	To determine FOUR score as an alternate tool for GCS.	Outcome on Mortality.	Traumatic Brain Injury	Descriptive study	55 TBI patients	The patient FOUR score and GCS assessed after stabilization from admission and the APACHE II and TISS score evaluated within 24 hours.	The FOUR score is similar to GCS in predicting early mortality and an ideal tool, simple & valid for use in ICU. The deficits of GCS overcome in FOUR score.	January 2015 to June 2015	II
[29]	To compare the predictability of FOUR score and GCS	Predict early mortality at the end of 2 weeks of injury	Traumatic Brain Injury	Prospective observational study	158 patients	The FOUR and GCS scores assessed on admission until 2 weeks.	The FOUR score is similar to GCS in predicting the early mortality while the individual components of FOUR score not significantly varied from GCS among severe coma patients	Not Available	II
[30]	To compare the predictability of FOUR score and GCS	Predicting ICU mortality	Critically ill patients in ICU	Prospective observational study	Thirteen ICUs at five U.S. hospitals & 1,645 patients	FOUR score alternating with GCS assessed within the first of admission and compared against APACHE II and GCS score by trained ICU attendants.	The FOUR score identified as an accurate prognostic tool to predict in-house mortality with incorporation of brain stem reflexes and respiration [24]	6-month period.	II
[31]	To evaluate the use of FOUR score among aneurysmal SAH patients	To predict the mortality using the GCS and mRS scale at 1- and 6-month	Aneurysmal SAH	Prospective observational study	Sixty-four patients	FOUR score calculated upon admission and repeated concurrently at day 7 and 14. The outcome of patients assessed at 6 months.	The FOUR score assessed on admission, day 7 predicts accurately the mortality, GCS, and mRS while the day 14 score is associated to 6 months outcome. While the brain stem score was not statistically significant due to high probability of time lag in EVD and variation in time of assessment.	January 2013 to July 2015	II

Table 2: The ROC of GCS and FOUR score

Name of the study	GCS- ROC	FOUR- ROC
Sepahvand E. et al:	0.961	0.928
Alireza Baratloo et al:	0.91	0.93
Kishor Khanal, et al:	0.79	0.82
Parisa Ghelichkhani et al:	0.87	0.88
Jamileh Ramazani et al:	0.826	0.873
Chen, Grothe et al.	0.699	0.768
Ghelichkhani, Esmaeili et al.	0.78	0.84
Gorji, Hoseini et al.	0.90	0.95
Hosseini, Ayyasi et al	0.95	0.89
Mishra, Mahajan et al.	0.7855	0.8002
Mansour, Megahed et al.	0.975	0.977

Table 3: Specificity and Sensitivity of GCS and FOUR score

Names of Instruments	GCS	FOUR score
Sepahvand E. et al:		
Sensitivity	85	76
specificity	83	90
Alireza Baratloo et al:		
Sensitivity	84.2	86.9
Specificity	88.6	88.4
Kishor Khanal, et al:		
Sensitivity	75.86	79.31
Specificity	77.94	79.41
Jamileh Ramazani et al:		
Sensitivity	79.76	78.31
Specificity	68.98	78.24
Jalali and Rezaei		
Sensitivity	68.4	68.4
Specificity	63.6	77.3
Mishra, Mahajan et al.		
Sensitivity	75%	75%
Specificity	72.55%	86.27%
Said, Chaari et al		
Sensitivity	73%	92.3%
Specificity	61.7%	85%
Mansour, Megahed et al.		
Sensitivity	84	84
Specificity	93	94