ORIGINAL ARTICLE

Comparison of GCS and four scoring system in prediction of mortality in ICU admitted patients.

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ABSTRACT… Objective: To determine diagnostic accuracy of GCS and FOUR score in predicting mortality keeping actual mortality as gold standard. **Study Design:** Cross Sectional (valudation) study. **Setting:** Department of Pediatrics, Children Hospital Faisalabad. **Period:** September, 2024 to March 2025. **Methods:** We included three hundred fifteen children with neurological disorders who were admitted to the pediatric intensive care unit (PICU). The GCS and FOUR score findings were documented as clinical examination evidence in the PICU. The FOUR score and GCS score were calculated for each patient. Responses were documented using clinical examination of ocular, motor, verbal and brain stem reflexes. Mortality was assessed over a 7-day follow-up period. **Results:** Patients' mean GCS and FOUR score at admission were 8.66±1.6 and 11.69±2.37, respectively, and the mean PICU stay was 6.57±2.33 days. The mean age 6.77±2.84 years. The proportion of male patients (54%) was greater than that of female patients (46%). One hundred one patients (32.1%) died. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy rate in predicting mortality using the Full Outline of Unresponsiveness Score (FOUR score) in children admitted to the PICU were 67.33%, 88.79%, 73.91%, 85.2%, and 81.9% respectively. On the other hand, GCS sensitivity, specificity, PPV, NPV, and accuracy rate are 63.37%, 84.58%, 65.98%, and 83.03%, respectively. **Conclusion:** The FOUR and GCS show good results with respect to mortality within a week after admission to the pediatric intensive care unit.

Key words: Brain Stem, Children, Eye, Glasgow Coma Scale, Mortality, Motor, Neurological Disorder, Pediatric Intensive Care Unit, Verbal.

INTRODUCTION

The most fundamental and important metric needed to analyze and appraise the neurological condition of patients in critical condition is their level of consciousness.[1] According to research conducted in the West, there are 30 hospital admissions for every 100,000 children each year as a result of non-traumatic causes of low awareness. Unintentional injury continues to be the greatest cause of pediatric mortality in developed nations, with estimated rates of severe traumatic brain damage from nonaccidental and accidental causes being comparable.[2] By assessing a patient's degree of consciousness, a number of grading systems have been developed that can be useful in forecasting their outcome. In addition to being a measure of patient outcome, the ideal coma scale should be valid, dependable, simple to use, and easy to remember.[3]

The Glasgow Coma Scale (GCS), which was created in 1974, is used to objectively characterize neurological condition. Despite being the gold standard for assessing awareness, this score has limits in terms of predictive validity and reliability, as noted multiple times in the literature.[4] Furthermore, the GCS was unable to identify variations in respiratory patterns and brainstem reflexes and did not help assess verbal response in ventilated or aphasic patients.[5]

The Full Outline of Unresponsiveness (FOUR) score, created in 2005 by Wijdicks et al. at the Mayo Clinic, is one of the more recent instruments.[6] In addition to the three GCS components, the FOUR score takes into account breathing patterns

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and brainstem reflexes. More information about neurological disabilities and brain function is captured by this broader perspective. The multifaceted approach of the FOUR score may enhance patient outcomes and death prediction.[7]

When comparing GCS and FOUR scores to predict outcomes, there are conflicting results. While some research indicated that the FOUR score outperformed the GCS, others indicated that the two scores were equally effective.[8] GCS had a sensitivity of 55.76% and a specificity of 83.89% in predicting death, while the FOUR score had a sensitivity of 63.46% and a specificity of 86.44%. 30.59% was the mortality rate.[9]

A comparison of FOUR score with GCS in predicting morbidity and mortality was performed by some researches in adult populations, and a few researches were performed in the pediatric population. But local data in this topic is scarce. In this study, we want to investigate whether the FOUR score is better than the GCS in predicting morbidity and mortality in children aged 1-14 years presenting to the emergency department (ED). The better score will be recommended to manage the children more vigilantly who are at risk of mortality. The objective of the study is to determine diagnostic accuracy of GCS and FOUR score in predicting mortality keeping actual mortality as gold standard.

METHODS

From September 2024 to March 2025, the Department of Pediatrics at Children Hospital Faisalabad conducted this cross-sectional (validation) study after approval from ethical committee (No.27-4/09/23) GCS sensitivity of 55.76%, specificity of 83.89%, mortality rate of 30.59%[9], 95% confidence level, and absolute precision of 10% were used to calculate the sample size. 315 children with neurological disorders, aged 1–13 years, of both sexes, who were admitted to the PICU were recruited by non-probability consecutive sampling. The following patients were not included: those on sedative medications and neuromuscular blockers: midazolam, fentanyl, sufentanil, morphine, pancuronium bromide, atracurium, nesdonal,

and propofol. The study also did not include children with known visual, hearing, speech, or limb paralysis issues.

Following the parents' or attendees' informed consent, information about the patient's demographics, diagnosis, and duration of illness was gathered. At the time of admission, a complete clinical history and neurological evaluation were performed on every patient. All patients' ocular, motor, and verbal responses were evaluated using the GCS, and their brainstem reflexes, breathing, and eye and motor responses were evaluated using the FOUR score. As required by ward procedure, patients got routine treatment until they passed away or were released. If a person died within seven days after being admitted to the hospital, their actual mortality was noted. FOUR score < 11 and GCS ≤ 8 were used to predict mortality.

SPSS version 16 was used to transfer and analyze all of the gathered data. For every quantitative variable, the mean and standard deviation were determined, and for every qualitative variable, the frequency and percentage were determined. By creating a 2x2 table, the following metrics were computed: sensitivity, specificity, PPV, NPV, diagnostic accuracy, and likelihood ratio. Quantitative variables were compared using the independent sample t-test, and qualitative variables were compared using the chi-squared/Fisher exact test. A P-value of less than 0.05 was considered significant.

RESULTS

The current study included 315 children in total. The patients' average age was 6.77±2.84 years, and their average length of stay in the intensive care unit was 6.57±2.33 days. Of the patients, 46% were female and 54% were male. Of the patients, 51.4% had non-traumatic neurologic conditions and 48.6% had traumatic neurologic conditions. 32.1% was the in-hospital death rate. At admission, the patients' mean GCS and FOUR scores were 8.66±1.6 and 11.69±2.37, respectively. A statistically significant difference (p-value=0.0001) exists between survivors' and non-survivors' GCS and FOUR scores (Table-I).

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy rate in predicting mortality using the Full Outline of Unresponsiveness Score (FOUR score) in children admitted to the PICU were 67.33%, 88.79%, 73.91%, 85.2%, and 81.9% respectively (Table-II).

GCS sensitivity, specificity, PPV, NPV, and accuracy rate are 63.37%, 84.58%, 65.98%, and 83.03%, respectively (Table-III).

Table-IV shows diagnostic accuracy of the GCS and FOUR score according to the stratification of age, gender and neurologic condition.

DISCUSSION
Making decisions about the patient's management and treatment in a timely manner to avoid complications depends heavily on accurately monitoring the patient's degree of consciousness.[10] Improving mortality and treatment for pediatric patients is a really difficult problem right now. Using the GCS and FOUR scores, early detection and management will assist improve the result in the PICU and emergency room.[8] Although it has a few drawbacks, the Glasgow Coma Scale is the most often used and approved measure for assessing unconsciousness in critically ill patients.[11]

Variables		Total patients (n = 315)	Non Survivors (n = 101)	Survivors (n = 214)	P-Value
Age (years)	1-6 years	6.77±2.84	6.44±2.73	6.93±2.87	0.145
		144 (45.7%)	51 (50.5%)	93 (43.5%)	0.242
	7-13 years	171 (54.3%)	50 (49.5%)	121 (56.5%)	
Gender	Male	170 (54%)	58 (57.4%)	112 (52.3%)	0.398
	Female	145 (46%)	43 (42.6%)	102 (47.7%)	
Neurologic condition	Trauma	153 (48.6%)	42 (41.6%)	111 (51.9%)	0.088
	Non trauma	162 (51.4%)	59 (58.4%)	103(48.9%)	
PICU stay (days)	≤ 7 days	6.57±2.33	5.42±1.52	7.12±2.44	0.0001
		234 (74.3%)	101 (100%)	133 (62.1%)	0.0001
	>7 days	81 (25.7%)	0	81(37.9%)	
GCS at admission		8.66±1.6	7.22±1.8	9.35±0.88	0.0001
FOUR score at admission		11.69±2.37	9.4±2.5	12.77±1.32	0.0001
Table-I. Baseline characteristics of the children (n = 315)					

		Mortality		Total
		Yes	No	
FOUR score at admission	≤ 11	68	24	92
	> 11	33	190	223
Total		101	214	315
Table-II. Diagnostic accuracy of FOUR score (n = 315)				

Sensitivity = 67.33%   Specificity = 88.79%   PPV = 73.91%   NPV = 85.2%
+ve Likelihhod ratio = 6.003   -ve Likelihhod ratio = 0.37   Diagnostic accuracy = 81.9%

		Mortality		Total
		Yes	No	
GCS at admission	≤ 8	64	33	97
	> 8	37	181	218
Total		101	214	315
Table-III. Diagnostic accuracy of GCS (n = 315)				

Sensitivity = 63.37%   Specificity = 84.58%   PPV = 65.98%   NPV = 83.03%
+ve Likelihhod ratio = 4.109   -ve Likelihhod ratio = 0.43   Diagnostic accuracy = 77.78%

Variable		Diagnostic Tool	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Age	1-6 years	GCS	62.75%	83.87%	68.09%	80.41%	76.39%
		Four	70.59%	86.02%	73.47%	84.21%	80.56%
	7-13 years	GCS	64%	85.12%	64%	85.12%	78.95%
		Four	64%	90.91%	74.42%	85.94%	83.04%
Gender	Male	GCS	62.07%	84.82%	67.92%	81.2%	77.06%
		Four	63.79%	90.18%	77.08%	82.79%	81.18%
	Female	GCS	65.12%	84.31%	63.64%	85.15%	78.62%
		Four	72.09%	87.25%	70.45%	88.12%	82.76%
Neurologic condition	Trauma	GCS	45.24%	78.38%	44.19%	79.09%	69.29%
		Four	52.38%	86.49%	59.46%	82.76%	77.12%
	Non trauma	GCS	76.27%	91.26%	83.33%	87.04%	85.8%
		Four	77.97%	91.26%	83.64%	87.85%	86.42%
Table-IV. Diagnostic accuracy of GCS and FOUR score (n = 315)							

Since it addressed the deficiencies of GCS, the Full Outline of UnResponsiveness (FOUR) score—which evaluates visual, motor, brainstem reflexes, and breathing pattern—attracted interest.[10]

In accordance with Kundan et al.[6], Ajeetkumar et al.[8], Zahid et al.[9], and Pabbati et al.[12], our study found that the majority of patients (54.3%) were between the ages of 7 and 13 with a mean age of 6.77±2.84 years. Male predominance (54%) was noted in our study, which is in line with prior research findings.[10,13]

32.1% of patients experienced mortality, and every patient passed away within seven days of their PICU hospitalization. Similar hospital death rates within 7 days were also reported in other studies by Zahid et al.[9], Pabbati et al.[12], and Kundan et al.[6] The majority of deaths in our sample happened at a mean GCS of 7.22±1.8, which is comparable to the Pabbati et al. study. They found that a GCS score between 3 and 8 was a reliable indicator of death.[12] A study by Ghelichkhani et al. revealed a similar finding: a GCS score between 4 and 7.1 was highly correlated with death.[14] Our analysis of the FOUR score revealed a substantial correlation between mortality and a mean score of 9.41±2.5. This is somewhat greater than the results that Pabbati et al. found. A mean FOUR score of 8.47 was shown to be linked to mortality.[12] Our study is similar to one by Jamal et al. that found a substantial correlation between mortality and a GCS of 4.25–7 and a FOUR score of 7.25–11 at admission.[15]

In contrast, the accuracy of GCS ≤ 8 demonstrated 63.37% sensitivity, 84.58% specificity, and 77.78% accuracy rate, while the accuracy of FOUR score ≤ 11 for mortality prediction showed 67.33 sensitivity, 88.79% specificity, and 81.9% accuracy rate. Zahid et al. found that when it came to predicting child mortality, the FOUR score outperformed the GCS.[9] In a related study, Pabbati et al. discovered that the FOUR scale was more accurate than the GCS at predicting child death.[12] Higher accuracy was observed with a FOUR score, although other research by Ramazani et al.[16], Fahad et al.[17], and Keerthi et al.[18] demonstrated acceptable discrimination power. Mahmoud et al. found that when it came to predicting death, GCS and FOUR scores were identical.[19] In their systematic review and meta-analysis, Ahmadi et al.[20] and Sankhyan et al.[21] also discovered that the FOUR score was identically effective as the GCS in predicting in-hospital death.

Only one pediatric unit was used for this investigation; larger sample sizes from multiple centers are required to assess the diagnostic accuracy of the GCS and FOUR scores in predicting pediatric in-hospital mortality. Additionally, bias may arise from variations in the

quality of care as well as observer bias brought on by disparities in scores from various assessors.

CONCLUSION

In this study it was found that both GCS and FOUR score significantly varies among survivor and non-survivor groups of unconscious patients but while comparing them regarding predicting mortality there is no significant differences in both score. Finally we conclude that both GCS and FOUR score equally good at predicting in hospital mortality among unconscious patients admitted in MICU In this study it was found that both GCS and FOUR score significantly varies among survivor and non-survivor groups of unconscious patients but while comparing them regarding predicting mortality there is no significant differences in both score. Finally we conclude that both GCS and FOUR score equally good at predicting in hospital mortality among unconscious patients admitted in MICU The GCS and FOUR scores in this study were found to differ significantly between alive and deceased patients; however, when comparing them in terms of predicting mortality, we came to the conclusion that both scores were equally effective at predicting in-hospital mortality among pediatric patients admitted to the PICU.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1	**Syed Muhammad Naveed Zafar Zaidi:** Manuscript writing.
2	**Iram Javed:** Critical review.
3	**Zahid Mehmood Anjum:** Data analysis.
4	**Farah Iqbal:** Data collection.
5	**Huma Rubab:** Final Proof read.
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