Predictive value of full outline of unresponsiveness (FOUR) score and GLASGOW coma scale (GCS) in outcome of children aged 1-14 years admitted with altered sensorium

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Abstract

Background: Evaluation of altered consciousness in children is a challenge and an important aspect of emergency care. There is no objective measure to communicate and document the severity of coma as distinct from vital signs. Various coma scales have been developed for recording depth of consciousness which are widely used in clinical practice in adults and children. Studies are conflicting on the best quick assessment tool for neurologic status. One of the newer tools is the Full Outline of Unresponsiveness (FOUR) score has been developed to assess the depth of coma in a more detailed manner than the Glasgow Coma Scale (GCS) scale.

Objectives: The present study was taken to determine the predictive value of FOUR score and GCS in outcome of children aged 1–14 years presenting with altered sensorium.

Materials and Methods: This prospective observational study was conducted in the teaching hospital of Haryana. A total of 150 children aged between 1 and 14 years were included. FOUR score and GCS were obtained within 1 h of admission. This assessment was repeated at 12th h and 24th h after admission. Children who left against medical advice were telephonically contacted to determine the final outcome, and they were called for 1-month follow-up.

Results: The mean age was 6.64 ± 4.13 years. Seventy-nine (52.66%) patients were male and 71 (47.33%) were female. GCS at admission, 12th h, and 24th h was 7.76 ± 2.91, 7.22 ± 3.60, and 7.22 ± 4.57, respectively. The mean FOUR score was 10.12 ± 3.92 which decreased continuously at 12th h, 24th h, and finally, at discharge, i.e., 10.29 ± 8.13 (P > 0.05). A total of 53 (35.33%) patients expired and 97 (64.66%) were discharged. A total of 69 patients were admitted to the pediatric intensive care unit (PICU). The mean duration of PICU stay was 5.84 ± 5.25. Patients who expired had lesser GCS score as compared to FOUR score at the time of admission and 12th h, i.e., 5.79 ± 2.18 and 6.54 ± 3.40 and 4.20 ± 3.70, respectively. The mean GCS at the time of admission was 5.79 ± 2.8 which decreased significantly to 0.679 ± 2.28 and FOUR score decreased from 6.54 ± 3.40 to 0.35 ± 2.21 at the time in expired (P < 0.001).

Conclusions: FOUR score can be used as good as GCS for predicting the inhospital mortality. GCS and FOUR scores both have a significant correlation with death. The study shows an excellent degree of agreement

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between GCS and FOUR scores at admission, at 12th h, at 24th h, and at discharge. FOUR score has better odds for predicting mortality on admission and at 24th h, whereas GCS at 12th h is better than FOUR score at 12th h in predicting mortality.

**Keywords:** Children, Full Outline of Unresponsiveness score, Glasgow Coma Scale

## INTRODUCTION

Evaluation of altered consciousness in children is a challenge and an important aspect of emergency care. There is no objective measure to communicate and document the severity of coma as distinct from vital signs. Disturbances leading to altered level of consciousness may result from varying causes which include infections of the central nervous system, hypoxic-ischemic encephalopathy, metabolic disorders, cerebrovascular disorders, endocrine abnormalities, exogenous poisons, and structural and degenerative central nervous system.[10] Early recognition of coma in a variety of settings is essential for the assessment and management and to predict the outcome. Various coma scales have been developed for recording depth of consciousness which are widely used in clinical practice in adults and children. Studies are conflicting on the best quick assessment tool for neurologic status. Scales can be used to initially evaluate a patient for critical conditions such as impending airway compromise or brain herniation in a medically ill or trauma patient. Several tools have been designed for assessment and outcome prediction in comatose patients. One of the most widely used tools for examining patients with altered consciousness level and disease outcome prediction is the Glasgow Coma Scale (GCS).[2,3] GCS consists of three components: eye, verbal, and motor responses with the minimum score for each component as 1 and the maximum score of 4 in eye component, 5 in verbal component, and 6 in motor component.[4]

Several studies have indicated that GCS provides the guideline for primary care and disease outcome prediction (mortality and morbidity). Despite the widespread use of GCS, it has its own limitation, including variation in inter-rater reliability and predicting validity.[5] One of the newer tools is the Full Outline of Unresponsiveness (FOUR) score that was designed by Wijdicks *et al.* at the Mayo Clinic in 2005.[1] FOUR score has been developed to assess the depth of coma in a more detailed manner than the GCS. This scale includes four components: eye responses, motor responses, brainstem reflexes, and breathing pattern. Each component receives a score between 0 and 4 (the lowest and highest scores being 0 and 4, respectively).[6] The FOUR score has some advantages over the GCS; it provides more neurological details, identifies different stages of herniation, facilitates the detection of locked-in syndrome, does not include verbal response, and thus may have a high prognostic value for intubated patients in the intensive care unit (ICU).[7]

Some of the studies showed that FOUR score is better than GCS and some showed that both scores performed equally. Most of the studies included one group of the study population, i.e., traumatic brain injury. The present study was conducted to predict the value of FOUR score and GCS in subgroup of population which affected the assessment and outcome.

## MATERIALS AND METHODS

The present prospective observational study was conducted in the Department of Pediatrics, Pt. B. D. Sharma PGIMS, Rohtak, Haryana, India. A total of 150 children aged between 1 and 14 years were included. Written informed consent was obtained from all the enrolled parents. Further patients were subgrouped into traumatic, nontraumatic, infectious, noninfectious, with vascular disorders and electrolyte disorders. The primary outcome variable was all-cause hospital mortality within 1 month of onset of illness and the secondary outcome variable was morbidity in terms of the Modified Rankin Scale (MRS) at discharge and at 1-month follow-up.

### Study procedure

All study participants were enrolled in the study based on eligibility criteria. Detailed clinical history and examination was performed and recorded in the study pro forma. Initial hemodynamic stability and treatment was initiated as per department protocol. An investigator had no role in deciding the management plan of admitted children. Details of treatment records were obtained. FOUR score and GCS were obtained within 1 h of admission. This assessment was repeated at 12th h and 24th h after admission. Children who left against medical advice were telephonically contacted to determine the final outcome, and they were called for 1-month follow-up. Outcome of children was recorded as death or survival. Among those who survived, MRS was administered at the time of discharge and at 1-month follow-up.
Training for Full Outline of Unresponsiveness score administration
Training for 3 days was provided by thesis supervisors to the candidate for administration of FOUR scores. Subsequently, a written instruction for administration of FOUR scores was provided and then handed on training on the first 20 patients provided to the candidate. All the scoring done was supervised by thesis supervisors.

Full Outline of Unresponsiveness score
FOUR score included four components: eye responses, motor responses, brainstem reflexes, and breathing pattern. Each component received a score between 0 and 4 (the lowest and highest score being 0 and 4, respectively).

Glasgow Coma Scale
GCS consisted of three components: eye, verbal, and motor responses with the minimum score for each component as 1 and the maximum score as 4 in eye component, 5 in verbal component, and 6 in motor component. For intubated patients, the minimal score for verbal component was considered 1.
0. No symptoms at all
1. No significant disability despite symptoms: Able to carry out all usual duties and activities
2. Slight disability: Unable to carry out all previous activities but able to look after own affairs without assistance
3. Moderate disability: Requiring some help but able to walk without assistance
4. Moderately severe disability: Unable to walk without assistance and unable to attend to own bodily needs without assistance
5. Severe disability: Bedridden, incontinent, and requiring constant nursing care and attention dead
6. Modified Rankin Score 0–2 indicated good recovery for the patients: A poor outcome reflected by a score between 3 and 6.

Statistical analysis
All data were entered into Microsoft Excel. Data were analyzed using IBM® SPSS Statistics 17.0 Version. Categorical data were expressed as numbers (proportions) and continuous variables as mean (standard deviation [SD]). Logistic regression analysis was performed to determine the odds ratio (OR) of GCS and FOUR scores in predicting the primary and secondary outcome measures. To compare GCS and FOUR scores in at various time durations, one-way analysis of variance was used. For inter-class comparison, correlation of coefficient was used. $P < 0.05$ was considered as statistically significant.

RESULTS
A maximum number of patients were below 5 years with a range of 1–14 years. The mean age of the study population was $6.64 \pm 4.13$ years. A total of 79 (52.66%) patients were male and 71 (47.33%) were female. Alert, verbal, pain, and unresponsive examination of the patients demonstrated verbal in 46 (30.66%), pain response in 64 (42.66%), and unresponsiveness in 40 (26.66%). Among 150 enrolled patients, meningoencephalitis was found to be the most common disease in 91 (60.66%) patients, followed by hepatic encephalopathy in 26 (17.33%) and tubercular meningitis in 17 (11.33%) patients.

Mean scores in eye opening, verbal response, motor response, and total scores increased significantly when compared at admission, 12th h, 24th h, and at discharge [Table 1]. The total score of all these three variables at the time of admission, 12th h, 24th h, and at discharge/death, i.e., 7.76 ± 2.91, 7.22 ± 3.60, 7.22 ± 4.57, and 8.56 ± 6.89 respectively, which also found to be statistically significant.

There was a significant incremental response in eye opening, motor response, brainstem reflexes, and respiration when these scores were compared at admission, 12th h, 24th h, and at discharge. Table 2 shows the FOUR score of all the patients observed using all four responses, i.e., eye response, motor response, brainstem reflexes, and respiration. At the time of admission, the mean total score was $10.12 \pm 3.92$ which decreased continuously at 12th h, 24th h, and finally at discharge/death, i.e., $10.29 \pm 8.13$, but statistically found to be insignificant ($P > 0.05$).

A total of 53 (35.33%) patients expired during the study period and 97 (64.66%) patients were discharged. Of total 150 patients, we observed meningoencephalitis as the most common disease, i.e., in 91 (60.66%) patients, tubercular meningitis in 17 (11.33%), hepatic encephalopathy in 26 (17.33%), bacterial meningitis in 7, dengue encephalopathy in 6, and vascular cause in 3 patients. The mean score of meningoencephalitis was $7.55 \pm 2.86$ at the time of admission, $6.88 \pm 3.61$ at 12th h, $6.54 \pm 4.57$ at 24 hrs. The mean score at discharge was increased to $8.08 \pm 6.97$, but statistically found to be

| Table 1: Mean±standard deviation Glasgow Coma Score of all three variables |
|-----------------------------|------------------|--------------------|------------------|
| Duration                  | Eye opening     | Verbal response   | Motor response   |
| On admission               | 2.5±1.03        | 1.88±0.97         | 3.37±1.28        |
| 12th h                     | 2.43±1.10       | 1.89±1.01         | 3.35±1.45        |
| 24th h                     | 2.66±1.19       | 2.23±1.36         | 3.56±1.53        |
| At discharge               | 3.96±0.31       | 4.26±1.18         | 5.66±0.74        |
| Statistical                | 52.60 <0.001    | 105.55 <0.001     | 73.57 <0.001     |
| significant $(F, P)$        | (significant)   | (significant)     | (significant)    |
insignificant ($P = 0.13$ NS). Similarly, tubercular meningitis, bacterial meningitis, dengue encephalopathy, and vascular cause also showed no significant relationship with GCS except hepatic encephalopathy which was $7.96 \pm 2.73$ at the time of admission and significantly increased to $12 \pm 5.53$ ($P < 0.001$). There was no significant change in FOUR score from admission till discharge when all individual diseases were analyzed separately.

The final outcome of the patients according to their disease demonstrate meningoencephalitis as the main disease during which 39 (73.58%) patients expired of total 53 deaths ($P < 0.01$, significant), followed by hepatic encephalopathy in which 6 (11.32%) patients expired, 3 (5.66%) expired due to tubercular meningitis, and 2 each with bacterial meningitis and dengue encephalopathy. Only 1 (1.88%) patient died due to vascular etiology. The mean GCS score of patients who died due to meningoencephalitis was $5.58 \pm 2.13$, 4 $\pm 2.49$, 2.48 $\pm 2.18$, and 0.38 $\pm 1.11$ which was found to be statistically significant. Similarly, the FOUR score of patients who died due to meningoencephalitis was $6.12 \pm 3.18$ which decreased significantly to $3.82 \pm 3.40$, $2.07 \pm 2.29$, and $0.07 \pm 0.35$ at 12$^{th}$ h, 24$^{th}$ h, and at discharge/death ($P < 0.001$). A patient with poor FOUR score died.

A total of six patients died due to hepatic encephalopathy. The mean GCS score of patients who died due to hepatic encephalopathy was $7 \pm 2.60$, 6 $\pm 2.75$, $6.33 \pm 3.77$, and $3.5 \pm 5.82$ which decreased statistically significant ($P < 0.001$). Similarly, the FOUR score of patients who died due to hepatic encephalopathy was $8 \pm 4.14$ which decreased significantly to $7.33 \pm 4.41$, $5.66 \pm 4.67$, and $2.66 \pm 6.53$ at 12$^{th}$ h, 24$^{th}$ h, and at discharge/death ($P < 0.001$). In hepatic encephalopathy, both GCS and FOUR scores were poor.

A total of 69 patients were admitted to the pediatric ICU (PICU). A total of 38 patients were admitted up to 5 days, 22 between 6 and 10 days, and 6 between 11 and 20 days. Only three patients were admitted for >20 days. The mean duration of PICU stay was $5.84 \pm 5.25$.

We found that patients who expired had lesser GCS score as compared to FOUR score at the time of admission and 12$^{th}$ h, i.e., $5.79 \pm 2.18$ and $6.54 \pm 3.40$ and $4.20 \pm 2.62$ and $4.30 \pm 3.70$, respectively. However, at 24$^{th}$ h and at the time of discharge, GCS was slightly higher as compared to FOUR score. The mean GCS at the time of admission was $5.79 \pm 2.8$ which decreased to 0.679 $\pm 2.28$ and FOUR was $6.54 \pm 3.40$ which also decreased to 0.35 $\pm 2.21. (P < 0.001)$.

In the present study, GCS of survived cases was $8.82 \pm 2.57$ at the time of admission, $13.73 \pm 2.47$ at the time of discharge, and found to be statistically significant. In comparison to GCS, FOUR score performed better. The FOUR score at the time of admission was $11.90 \pm 2.64$ which increased to $15.75 \pm 3.78$ at the time of discharge/death with a statistically significant difference ($P < 0.001$). There was a significant rise in both GCS and FOUR scores among children who survived ($n = 97$).

All those who survived were evaluated according to the Modified Rankin Score, and they were categorized as per MRS 0–2 (good recovery) and poor outcome (scores 3–6). A total of 79 patients were assessed as good recovery and 18 with poor recovery. We found that in patients with good recovery, the mean GCS was $9.07 \pm 2.44$ which increased significantly to $9.21 \pm 2.61$, $10.25 \pm 3.18$, and $14.17 \pm 2.01$ at the time of admission, at 12$^{th}$ h, 24$^{th}$ h, and finally, at discharge, respectively. With regard to FOUR score, it was better than GCS, i.e., $12.10 \pm 2.46$, $11.92 \pm 3.06$, $12.60 \pm 3.47$, and $16.05 \pm 4.11$ at the time of admission, 12$^{th}$ h, 24$^{th}$ h, and finally, at discharge, respectively ($P < 0.001$).

In patients of poor recovery, the mean GCS was $7.72 \pm 2.86$ which increased significantly to $7.77 \pm 2.83$, $7.77 \pm 3.38$, and $11.77 \pm 3.31$ at the time of admission, at 12$^{th}$ h, 24$^{th}$ h, and finally, at discharge, respectively. With regard to FOUR score, it was better than GCS, i.e., $11.05 \pm 3.26$, $11.05 \pm 3.26$, $10.72 \pm 4.02$, and $14.38 \pm 1.03$ at the time of admission, 12$^{th}$ h, 24$^{th}$ h, and finally, at discharge, respectively ($P < 0.001$).

Table 3 shows a comparison of GCS and FOUR scores with regard to prediction of mortality. In our study, 53 patients died and 97 discharged during the study period. Table 3 clearly shows that GCS at 0 h (on admission) and at 12$^{th}$ h and FOUR score at 0 h and at 24$^{th}$ h are a good

### Table 2: Mean Full Outline of Unresponsiveness score of all four variables

| Duration       | Eye response | Motor response | Brainstem reflexes | Respiration |
|----------------|--------------|----------------|--------------------|-------------|
| On admission   | 1.82 ± 1.27  | 2.09 ± 0.99    | 3.17 ± 1.10        | 3.03 ± 1.47 |
| 12$^{th}$ h    | 1.77 ± 1.33  | 2.05 ± 1.04    | 3.12 ± 1.17        | 2.81 ± 1.64 |
| 24$^{th}$ h    | 2.11 ± 1.43  | 2.13 ± 1.12    | 3.14 ± 1.24        | 2.88 ± 1.61 |
| At discharge   | 3.97 ± 1.33  | 3.70 ± 1.44    | 4.08 ± 1.30        | 4.06 ± 0.43 |

Statistical significant ($F, P$) 91.19, <0.001 (significant) 72.25, <0.001 (significant) 22.70, <0.001 (significant) 26.82, <0.001 (significant)
predictor for mortality. However, GCS at 12\textsuperscript{th} h is the best mortality predictor. The odds of predicting mortality is 2.78 times the odds of survival when GCS is performed at 12\textsuperscript{th} h. We also found that OR 0.32 of GCS at admission was much lower than FOUR score at admission, i.e., 1.85. Overall, GCS at 24-h OR was also found to be lower, i.e., 0.83 as compared to 1.85 OR of FOUR score, which clearly indicates that chances of predicting mortality are much better, i.e., 1.83 times as compared to 0.83. Hence, FOUR score has better odds for predicting mortality on admission and at 24\textsuperscript{th} h, whereas GCS at 12\textsuperscript{th} h is better than FOUR score at 12\textsuperscript{th} h in predicting mortality.

Table 4 shows that both GCS and FOUR scores both have a significant correlation with death.

Table 5 shows a comparison of GCS and FOUR scores with regard to poor outcome on MRS. In the present study, a total of 79 patients had a good recovery and 18 had a poor recovery. It is clear that both GCS and FOUR scores at any time do not predict poor outcome.

Table 6 shows an excellent degree of agreement between GCS and FOUR scores at admission, 12\textsuperscript{th} h, 24\textsuperscript{th} h, and at discharge.

**DISCUSSION**

The result of the current study indicated that the predictive value of FOUR score is as good as GCS in predicting inhospital mortality. GCS at 0 h and 12\textsuperscript{th} h and FOUR score at 0 h and 24\textsuperscript{th} h were a significant predictor of mortality. Among children presenting with acute encephalopathy, it was found that GCS at 12\textsuperscript{th} h was the best predictor of mortality. The correlation between GCS and FOUR scores was excellent. Morbidity at discharge in terms of the MRS was not predicted by GCS and FOUR scores. We found that both GCS and FOUR score variables show a significant increment from the time of admission till discharge and a decrease in expired patients.

Jamal et al.\textsuperscript{[10]} conducted a study in 63 children 5–12 years of age group. They reported that FOUR score was as good as GCS in prediction of inhospital. The area under the curve (AUC) for inhospital mortality for GCS was 0.83 (confidence interval [CI]: 0.7–0.9) and FOUR score was 0.8 (CI 0.7–0.9, difference between areas: −0.0250 [95% CI: 0.0192–0.0692], \(P = 0.2674\)). A similar study was conducted by Kochar et al.\textsuperscript{[11]} to compare the FOUR score with GCS among 70 children aged 5–18 years admitted with impaired consciousness, and ROC curves were used to compare the two scores. The AUCs for GCS and FOUR scores were 0.916 and 0.940, respectively. However, the difference between the AUCs for the two scores was not statistically significant (0.023, 95% CI: −0.0115–0.058). Thus, the study indicates that both the scores were good predictors for inhospital mortality and functional outcome. These findings are consistent with our study showing good correlation of GCS and FOUR scores at 0 h (\(r = 0.52\), at 12\textsuperscript{th} h (\(r = 0.66\)), at 24\textsuperscript{th} h (\(r = 0.73\)), and at discharge (\(P < 0.001\)).

A study by Wijdicks et al.\textsuperscript{[1]} in 1645 critically ill patients reported FOUR score to be better than GCS in predicting...
ICU mortality ($P = 0.001$). In a recent study, of the 200 children admitted to the PICU, Khajeh et al.[9] showed that FOUR score is a good predictor of inhospital mortality (FOUR score = OR: 0.13, 95% CI: 0.06–0.29, $P < 0.001$; GCS = OR: 2.49, 95% CI: 1.44–4.32, $P < 0.001$). In the research by Büyükcam et al.[2] in 100 children aged 2–17 years, no significant difference was observed between these tools for predicting the mortality of children admitted to the ICU.

In a study comparing GCS and FOUR scores in emergency setting, Eken et al.[12] enrolled 185 patients older than 17 years who presented with an altered level of consciousness after head trauma or with neurologic complaints. AUC values in predicting hospital mortality for GCS and FOUR scores were 0.735 and 0.788, respectively. The AUC value of brainstem and respiration components was 0.598 and 0.585, respectively. No statistical difference was observed between the AUC values of total FOUR score and GCS. The subunit analyses of FOUR score and GCS revealed that the eye and motor components of FOUR score had AUC values higher than GCS and lower than the complete FOUR score, but these differences lack statistical significance. Furthermore, brainstem reflexes and respiratory pattern had significantly lower AUC values than eye and motor components of the FOUR score.

The results of the present study are consistent with previous studies demonstrating a good correlation between GCS and FOUR scores. Nair et al.[18] in their study recruited 69 patients with head injury, and FOUR score and GCS were calculated at the time of presentation and serially thereafter. Pearson's correlation coefficient between FOUR score and GCS for all participants studied at presentation was 0.94, 0.96 at 1 h, and 0.98 after 6 h. A statistically significant correlation was found between FOUR score and GCS ($P < 0.05$). In our study, a correlation coefficient at 0, 12th h, at 24th h, and at discharge was 0.81 (0.07–0.93), 0.87 (0.57–0.94), 0.87 (0.57–0.94), and 0.94 (0.91–0.96), respectively, and found significant ($P < 0.001$).

Büyükcam et al.[2] observed moderate correlations between GCS and FOUR scores and inhospital mortality ($r = -0.489$ for GCS, $r = -0.512$ for FOUR score; $P = 0.000$), GOS at discharge ($r = -0.511$ for GCS, $r = -0.510$ for FOUR score; $P = 0.000$), and GOS after 3 months ($r = -0.489$ for GCS, $r = -0.512$ for FOUR score; $P = 0.000$). Similar result Wijdicks et al.[11] and Iyer et al.[14] found in their study.

MRS is one of the most commonly used tools to assess functional neurological outcome in adults.[19] Despite the lack of formal validation in children, this scale has been used in several pediatric studies to allow for direct comparison with adult studies. Cohen[16] reported for poor outcome at the end of hospitalization, the AUC for the FOUR was 0.78 (95% CI = 0.65–0.88) and that for the GCS was 0.76 (95% CI = 0.64–0.86). Difference was not significant. In our study, MRS was used to assess the morbidity at the time of discharge and found that GCS or FOUR score could not predict the morbidity. Eken et al.[12] reported that moderate correlation was observed between the MRS at the end of the 3 months both for GCS and FOUR scores.

In the previous study by Kochar et al.,[1] 70 patients with eligible criteria were included in the study. The median age of the patients was 8 years (range: 5–16 years). Of 70 patients, 46 (65.7%) were boys and 24 were girls (34.3%). Central nervous system infections accounted for 38 (54.3%) of cases of that 12% meningoencephalitis and 7% tubercular meningitis. Among the other 32 children, the most common diagnoses were fulminant hepatic failure and intracranial bleed secondary to underlying bleeding diathesis. The mortality rate for central nervous system infections was 37% and for toxic-metabolic group was 45%.

In a similar study, 157 children with altered consciousness were assessed for eligibility, and of these, 63 children (33 boys, mean age 7.4 ± 2.1 years) meeting study criteria were enrolled. The suspected cause for impaired consciousness was neuroinfection in 34 children and noninfection in 29 children.[10] Similar to previous studies, in the present study, most of the children with impaired consciousness admitted in emergency had encephalopathy secondary to neuroinfection. Thus, it depicts a true representation of population.

In a study conducted in the PICU by Khajeh et al.,[9] 200 patients were enrolled, of which 55% ($n = 110$) were males and 45% ($n = 90$) females. The mean age of patients was 4.4 years. The cause of patients’ admission to ICU was mostly intracranial hemorrhage.

The mean score of the FOUR and GCS at the time of ICU admission for all patients was 10.5 ± 4.1 (range: 0–16) and 10.4 ± 3.9 (range: 3–15), respectively. Mean of the FOUR score at the time of admission was 12.5 ± 2.1 and 5.1 ± 2.8 for discharged and dead patients, respectively (cutoff point: 8).[16]

In PICU, 60 patients ranging in age from 2 to 18 years with a mean age of 9.4 years (SD = 5.12 years) were enrolled in the study by Cohen.[18] Patient diagnoses included brain tumors ($n = 25$), hydrocephalus ($n = 7$),
traumatic brain injury (n = 5), spinal surgery (n = 5), seizure disorder (n = 4), arteriovenous malformations (n = 4), cranial remodeling (n = 3), moyamoya disease (n = 2), encephalitis (n = 2), subdural hematoma (n = 2), and near drowning (n = 1).

In our study, 150 cases were recruited and mean (SD) age of study population was 6.64 (4.13) years. In that, the most common disease was meningoencephalitis (n = 91, 60.66%) followed by hepatic encephalopathy (n = 26, 17.33%), tubercular meningitis (n = 17, 11.33%), bacterial meningitis (n = 7, 4.66%), dengue encephalopathy (n = 6, 4%), and vascular etiology (n = 3, 2%).

The strength of this study was that we have an adequate sample size of patients when compared to the previous study. In addition, FOUR score has been evaluated in nontraumatic coma patients, whereas majority of the previous studies were on traumatic coma. Inhospital mortality was primary outcome measured akin to other studies studies. Children <2 years of age enrolled were in this study. No study had enrolled in children below 2 year age groups. The study design in this study was robust and different from previous studies. This study had prospective design and well-defined inclusion and exclusion criteria. A single researcher had analyzed all scores, thus reducing the bias of inter-observer variability. All the patients could not be admitted to PICU owing to logistic limitation. In this study, long-term outcome could not be assessed.

Assessment of respiration, brain stem reflexes, and pupillary reactions using FOUR score may help in recognition of possible brain death, herniation syndromes, and prompt urgent medical and surgical intervention in emergency. The possible areas of exploration could be an assessment of each scale in different settings (ER and ICU, intubated vs. nonintubated), various etiologies, and severities of coma (e.g., for GCS <5). Another important aspect that needs careful comparison is how absolute scores and serial changes in scores impact management at bedside. The FOUR score has to show unequivocal advantage over GCS in more than one aspect to become the new gold standard coma scale. Thus, we can consider using FOUR score for serial assessment and management of children with coma/ altered consciousness.

CONCLUSIONS

It is concluded that FOUR score can be used as good as GCS for predicting the inhospital mortality. GCS and FOUR scores both have a significant correlation with death. The study shows an excellent degree of agreement between GCS and FOUR scores at admission, at 12th h, at 24th h, and at discharge. FOUR score has better odds for predicting mortality on admission and at 24th h, whereas GCS at 12th h is better than FOUR score at 12th h in predicting mortality.

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Conflicts of interest

There are no conflicts of interest.

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