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Original Investigation

Glasgow Coma Scale Versus Full Outline of UnResponsiveness Scale for Prediction of Outcomes in Patients with Traumatic Brain Injury in the Intensive Care Unit

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ABSTRACT

AIM: Glasgow Coma Scale (GCS) is the most applied tool for classifying intensity of coma and predicting patient outcomes with traumatic brain injuries. The present study was conducted with the aim of comparing two criteria of Full Outline of UnResponsiveness (FOUR) scale and GCS in predicting prognosis in patients with traumatic brain injuries.

MATERIAL and METHODS: In this prospective study, 198 patients with traumatic brain injuries were investigated. FOUR and GCS criteria for each patient were determined by four well-educated nurses. The area under receiver operating characteristic (ROC) curve was determined for in-hospital mortality outcomes.

RESULTS: Of all patients, 65.2% survived and 34.8% died, and FOUR had correctly predicted 82% of them. FOUR had 0.76 sensitivity and GCS had a sensitivity 0.85. Mean scores for mortality and survival rates were 4.59±2.36 and 10.71±2.24 in GCS, and 3.15±3.52 and 12.77±2.43 in FOUR, respectively. The area under ROC curve was 0.961 for FOUR and 0.928 for GCS. The area under the curve was high for FOUR in scores 6 and 7, and for GCS in scores 5 and 6.

CONCLUSION: FOUR score is a valuable, sensitive and specific diagnostic criterion for predicting outcomes in patients with traumatic brain injuries.

KEYWORDS: Traumatic brain injuries, coma, Full outline of unresponsiveness, Glasgow coma scale

INTRODUCTION

Traumatic brain injuries are a major cause of mortality and severe disability worldwide (19). On average, 1.5 million people die due to traumatic brain injuries annually, and millions require emergency medical treatment after a traumatic brain impact (12). In the United States alone, this type of injury leads to 290,000 hospitalization cases, 51,000 deaths, and 80,000 injuries in survivors (19). Initial assessment of intensity of injury in patients with traumatic brain injuries is the primary guide for medical treatment and contributes to predicting prognosis of trauma (13). Consciousness is a state of general awareness of oneself and the environment and includes the ability to orient towards new stimuli (18). Coma, or any other changes in the state of consciousness predicts outcomes and are therefore a vital clinical parameter (3). Despite technological advances, clinical assessment is still a diagnostic key to minor changes in patients' state of consciousness and the basis for management of neurology

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patients (18). Assessment of consciousness level is a vital part of basic nursing skills. Following correct assessment, the nurse is enabled to identify neurological changes in patients, and contact medical team to begin emergency actions to improve survival outcomes (4). To provide quality patient care, nurses should be able to correctly assess the patient (19). Assessment of coma and damage to consciousness level is essential in monitoring neurology patients in the special care unit (12).

It is essential to have a standard scale for measurement and assessment of consciousness level. Moreover, prognosis can be determined according to a standard scale for assessment of consciousness level (21). There are several methods for assessing impaired consciousness in brain accidents, including the NIHSS scale (National Institute of Health Stroke Scale) (which involves: assessment of consciousness, eye movement ability, visual field, power in lips and facial muscles, lips ataxia, sensory function, aphasia, dysarthria, and patient's impaired recognition and attention and only one of these items assesses level of consciousness. Thus, a precise assessment of patient's consciousness in brain accident cannot be performed) (3), Revised Trauma Scale (RTS), motor, verbal, abdominal, respiratory, circulation scale (CRAMS), Trauma Grading System (TRISS), APACHE II, Ranko scale, Rador scale, and GCS (Glasgow Coma Scale) (11, 20). Among these trauma severity grading systems, GCS that combines above systems has become a gold standard (19). Assessment of severity of injury is essential in clinical management of patients following brain trauma, and design of clinical trials aims to determine new treatments (7).

GCS is a practical tool for classification of intensity of coma in patients with traumatic brain injuries, even though reliability of GCS in predicting patients' outcome is unsatisfactory (19). Incomplete assessment of verbal response in intubated patients and inability to test brain stem reflexes are among failures of GCS (18). The gold standard for detecting signs of consciousness is still behavioral assessment with detailed bedside neurological assessment that can be difficult in intensive care unit (ICU), e.g. presence of orotracheal intubation, tracheotomy or motor impairment (22). Motor response capability is often affected by neuromuscular blocking agents, tranquilizers, or damages to spinal cord, and since the motor response scores the highest in GCS, its ability to correctly assess the patient is therefore impaired. Brain stem reflexes facilitate assessment of midbrain, pons and medulla oblongata functioning (18). This scale assesses various levels of damage to brain stem, and provides more accurate clinical prognosis for patient outcomes (5). Meanwhile, these are not examined in GCS scale. Impaired brain stem reflexes due to brain injuries alter respiratory pattern, and the need for mechanical ventilation can reflect intensity of coma (20). Therefore, neurological changes are not correctly and accurately assessed in GCS scale (5). In recent decades, different alternative scales to GCS have been proposed, which have not found widespread acceptability because of complexity of use (6). Full Outline of UnResponsiveness (FOUR) scale was proposed by Wijdicks et al. for assessment of neurology patients with traumatic and non-traumatic impairments of the central nervous system. FOUR scale consists of 4 items, including: eye response, motor response, brain stem reflexes, and respiratory condition, each scoring from 0 to 4 (Appendix) (5). As opposed to GCS, eye response in FOUR, as well as open eyes, also assesses their voluntary movements, which distinguishes between vegetative state of patients and minor impaired level of consciousness (10,18). Accurate assessment of consciousness level is a major challenge for clinical nurses. Accordingly, it is essential for nurses to have a scale for measuring level of consciousness, so that they can constantly be aware of changes in patients' level of consciousness, and also have the right communication with medical team, using a standard and purposive tool. Thus, the researcher intended to compare FOUR scale and GCS in predicting prognosis of patients with traumatic brain injuries.

MATERIAL and METHODS

In this prospective study, 198 ICU patients with traumatic brain injuries of the major teaching hospital of Khorramabad (Shohada Hospital) from January 2012 to May 2013 were investigated. Study inclusion criteria included over 18 years of age, survival 24 hours after admission to ICU, no intake of tranquilizers or neuromuscular blocking agents, no history of neuromuscular diseases, and no family or hereditary history of neuromuscular diseases (9). To collect data, daily observation and assessments of patients with FOUR and GCS scales were used. Three nurses tested the FOUR score and the GCS. Subsequently, raters were provided with a one-page handout written instruction describing both the FOUR score and the GCS and were asked to grade a few patients using both the GCS and the FOUR score scale. Interrater reliabilities for FOUR score and GCS were 0.98 and 0.96, respectively. In the second 24 hours following admission to ICU, patients were assessed daily by both FOUR and GCS scales, and scores obtained for each scale were recorded. To avoid prejudice, patients were divided into groups A and B, and the first patient in group A was assessed first with FOUR and the second patient, first with GCS. The cut-off point for FOUR was considered 6, and for GCS 5. Scores of 6 or less in FOUR and 5 or less in GCS were considered expected death-risk (14). The four score showed high reliability after translation into Persian (20). Assessment of patients' survival or mortality continued until their discharge or death. Finally, collected data were analyzed using SPSS-18 software. Descriptive statistics were used to analyze data, including: mean, standard deviation, and frequency percentage. To determine the relationship between dependent and independent variables, Chi-square, statistics of both methods (and relevant confidence intervals) were used, receiver operating characteristic (ROC) curve was plotted, and areas under curve for both methods were compared. ROC curve was plotted for every cut-off point. Significance level was set at 0.05.

RESULTS

In this study, 198 patients with mean age 40.88±17.7 years, and age range from 16 years to 80 years were assessed. 80.8% of patients were male, and 19.2% were female. Among

all patients with traumatic brain injuries, 80 (40%) had epidural hematoma, 40 (20%) had subdural hematoma, 5 (2%) had subarachnoid hematoma, and 73 (36%) had hematoma in brain tissue. Of all patients, 65.2% survived, and 34.8% died, and FOUR scale correctly predicted 82% of them (Figure 1A,B). Sensitivity of FOUR was 0.76, and that of GCS was 0.85 (Table I). Mean scores for mortality and survival rates were 4.59±2.36 and 10.71±2.24 in GCS, and 3.15±3.52 and 12.77±2.43 in FOUR, respectively. T-test showed a significant difference between survival and death of patients in the FOUR scale (p=0.000), but the difference in GCS scale was insignificant (p=0.542). The area under ROC curve was 0.961 in FOUR, and 0.928 in GCS (Figure 2). The area under curve was high for FOUR in scores 6 and 7, and high for GCS in scores 5 and 6. The distribution of all ratings of the FOUR score and the GCS score is shown in Figures 3 and 4.

Table I: Diagnostic Value of FOUR and GCS in Predicting Death

Scale/indicator	FOUR scale	Glasgow coma scale
Sensitivity	76%	85%
Specificity	90%	83%
Positive prediction value	83%	64%
Negative prediction value	86%	94%
Rigor	85%	83%
Likelihood ratio	7.6	5

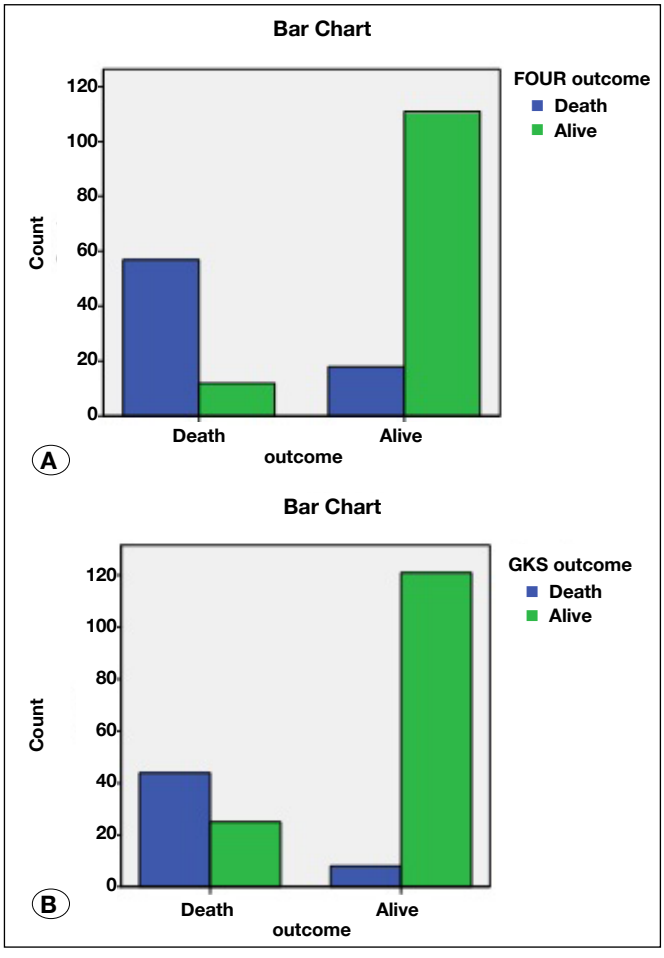

Figure 1: Prediction of survival and death outcomes by FOUR **(A)** and GCS **(B)** scales.

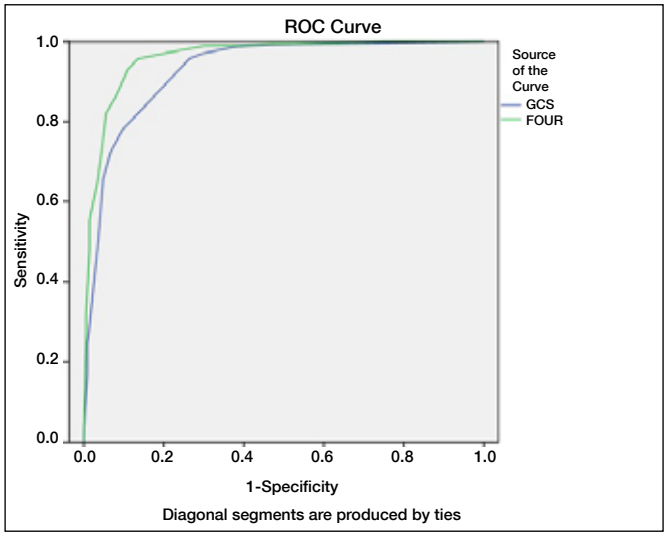

Figure 2: Area under curve for FOUR and GCS scales.

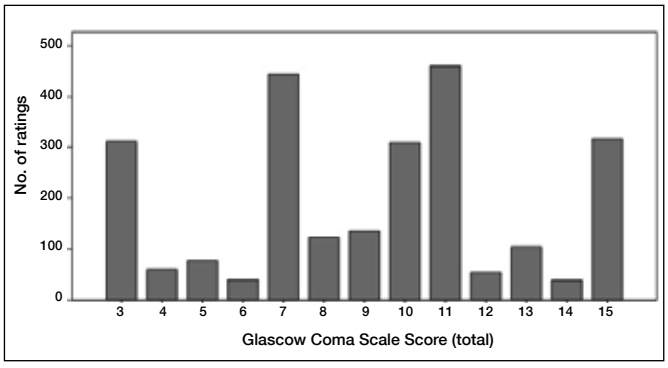

Figure 3: Distribution of total Glasgow Coma Scale Score.

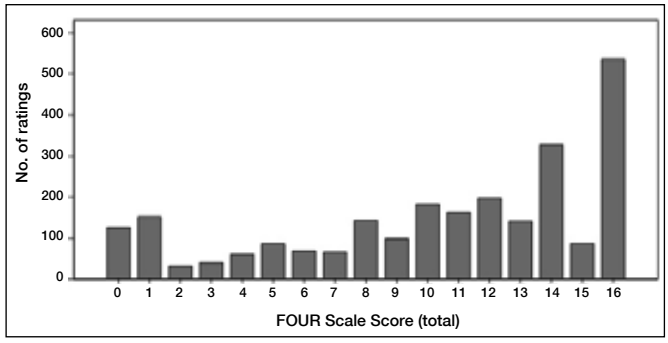

Figure 4: Distribution of total FOUR scale scores.

DISCUSSION

Neurological impairments are a major challenge for ICU patients and those with neurological damage. In line with other studies, the present study results indicate that FOUR is a correct predictor of mortality in ICU patients with traumatic brain injuries (1,14,19). FOUR is easy to use, and provides better information, particularly in intubated patients, and shows depth of coma in greater details compared to GCS, since it assesses brain stem reflexes and respiratory pattern (18). Considering failures of GCS in assessing patients' level of consciousness, Sadaka et al. recommended the FOUR scale (19). FOUR better classifies level of consciousness damage in emergency patients (15,16), cardiac arrest patients (8), and ICU patients (12) compared to other scales. Furthermore, FOUR has greater validity and reliability among nurses, neurologists, and doctors (5,6,11, 20). In the present study, FOUR showed high predicting value for in-hospital mortality, which agreed with Sadaka study (19). Mercy et al. study indicated minor differences between FOUR and GCS scales in prediction value for in-hospital deaths, and argued that, FOUR and GCS are equally able to predict mortality in neurological patients (18).

In the present study, area under ROC curve showed that both FOUR and GCS were excellent predictors of in-hospital mortality, which concurs with other studies (2, 14, 17). In the present study, likelihood ratio was higher in FOUR scale than in GCS, which indicates greater ability of this scale in better identifying patient outcomes (17). This scale also assesses neurological status of patients with greater accuracy. High sensitivity of FOUR scale in clinical assessment has eased treatment and monitoring of patients for the medical team.

The originator of FOUR considers cut-off point of 9 valid for in-hospital mortality, while cut-off point in the present study was 6-7, and 10, in Akavipat study (1). The difference could be due to patient's conditions and the environment where the patient is hospitalized.

FOUR assesses locked-in syndrome more accurately and faster by examining voluntary eye movements (18). This is a valid and practical scale, which can be used after simple training of medical team, and has a high degree of practical confidence, and high rigor as a diagnostic indicator in determining level of consciousness (10). Yet, due to global acceptability, GCS is still used to assess patients with neurological injuries (5).

CONCLUSION

According to the present study results, FOUR is a new, valuable, sensitive and specific scale for predicting outcomes in patients with traumatic brain injuries. Using brain stem reflexes and respiratory pattern, this scale provides an accurate and correct assessment of patients in coma, and has the ability to assess minor changes in neurological status of patient. Therefore, FOUR is recommended as a tool for assessment of neurological patients with changes in consciousness levels. It is also recommended that medical team be trained to use this scale beforehand.

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APPENDIX

Full Outline of UnResponsiveness (FOUR)

A.2.1. Eye Response. One has the following:

4 = eyelids open or opened, tracking, or blinking to command

3 = eyelids open but not to tracking

2 = eyelids closed but open to loud voice

1 = eyelids closed but open to pain

0 = eyelids remaining closed with pain stimuli.

A.2.2. Motor Response. One has the following:

4 = thumbs up, fist, or peace sign

3 = localizing to pain

2 = flexion response to pain

1 = extension response

0 = no response to pain or generalized myoclonus status.

A.2.3. Brain Stem Reflexes. One has the following:

4 = pupil and corneal reflexes present

3 = one pupil wide and fixed

2 = pupil or corneal reflexes absent

1 = pupil and corneal reflexes absent

0 = absent pupil, corneal, or cough reflex.

A.2.4. Respiration. One has the following:

4 = regular breathing pattern

3 = Cheyne-Stokes breathing pattern

2 = irregular breathing

1 = triggering ventilator or breathing above ventilator rate

0 = apnea or breathes at ventilator rate.