A comparison of the diagnostic power of the Full Outline of Unresponsiveness scale and the Glasgow coma scale in the discharge outcome prediction of patients with traumatic brain injury admitted to the intensive care unit

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ABSTRACT

Background and Aim: This study aimed to determine whether the Full Outline of Unresponsiveness (FOUR) score is an accurate predictorof discharge outcome in traumatic brain injury (TBI) patients and to compare its performanceto Glasgow coma scale (GCS). **Materials and Methods:** Thisis diagnostic study conducted prospectively on 53 TBI patients admitted to ICU of education hospitals of Medical Science University of Mazandaran during February 2013 to June 2013. Data collection was done with a checklist including biographic, clinical information and outcome. The FOUR score and GCS were determined by the researcher in the first 24 hours. Outcomes considered as in-hospital mortality and poor neurologic outcome (Glasgow Outcome Scale (GOS) 1-3) in discharge time from the hospital. **Results:** In terms of predictive power for in-hospital mortality, the area under the receiver operating characteristic (ROC) curve was 0/92 (95% CI. 0/81-0/97) for FOUR score and 0/96 (95% CI. 0/87-0/99) for GCS. In terms of predictive power of poor neurologic outcome, the area under the ROC curve was 0/95 (95% CI. 0/86-0/99) for FOUR score and 0/90 (95% CI.0/79-0/96) for GCS as evidenced by GOS 1-3. The cut-off of 6 showed sensitivity and specificity of total four score predicting poor outcome at 0/86 and 0/87 while the cut-off of 4 showed the value of in hospital mortality at 0/90 and 0/90. The total GCS score showed sensitivity and specificity 0/100 and 0/61 at cut-off 7 in predicting poor outcome while in predicting mortality at cut-off of 4 this range was 0/100 and 0/92. **Conclusion:** The FOUR score is an accurate predictor of discharge outcome in TBI patients. Thus, researchers recommend for therapeutic Schematizationto use in neurosurgical patients at admission day.

Key words: *Full outline of unresponsiveness (FOUR) score, glasgow coma scale (GCS), outcome-ICU, traumatic brain injury*

INTRODUCTION

Traumatic brain injury (TBI) is one of the main reasons of mortality in worldwide. It is estimatedthat 1.5 million peoples expire annually due to TBI and million of people need intensive care after TBI. The mortality rate in these patients depends on severity and TBI mechanism although unpleasant outcomes due to TBI can stimulateupto 12% also.[1,2] Preliminary determination of injury in patients with TBI releases the basic guide to help determine the outcome of trauma and treatment program.[3,4] The most common clinical tool for determining the severity of head trauma is the Glasgow Coma Score (GCS).[5] Several studies indicated the efficacy of GCS in providingprimary care and out onpredicting in the case of mortality and morbidity of patients withTBI.[5-8] Although GCS is an appropriate tool to assess the severity index of TBI but it involveslimitations also.[5-9] Vijdik *et al*. designed a new tool called FOUR to overcome these limitations. This provides information such as brainstem reflexes, eye following, and respiratory patterns that are not addressed by the GCS

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provided.[11] It is a more operational tool for critically ill patients with endotracheal tube cause requiring no verbal items.[12] In addition to being able to detect the different stages of brain herniation syndrome, unlike the GCS, it can also detect Locking syndrome state.[13] The relationship between outcomes in patients with TBI and FOUR scores has been proved although rare studies have been conducted to predict the power of FOUR among such patients.[14,15] As per researchers' knowledge, no study has been conducted in Iran up till now as this case; even in other countries also, studies included long-term follow up which can get affectedthrough several factors like physical rehabilitation, pharmacology, and treatment interventions.[16] Therefore, researchers compared the predictive power of FOUR with GCS regarding low limitations of this tool to introduce its application during the first 24 hours of acceptance of patients with TBI.

MATERIALS AND METHODS

This study was a diagnostic study conducted on 35 patients with TBI who experienced consciousness level disorders and were admitted in the intensive care department of educational hospital in Medical Science University of Mazandaran during November 2012-May 2013. The sample size selected was based on Jenifer *et al.* study[17] and sampling done was based on the convenience method. A recorded sheet was designed to generate the demographic data including age, education, type of head injury, and level of conscious measured by GCS and FOUR. The researcher scored the FOUR and GCS with a 15 minute gap in the first 24 hours of admission of patients in ICU. Then impairment outcome was recorded including mortality in hospital or poor neurologic outcomes at discharge time. GCS tool is a standard and accepted tool worldwide by neurologists and also is the most common clinical measure to determine the TBI severity.[5] It includes 3-15 scores with three eyes, verbal, and motor items by 4,5, and 6 score, respectively.

FOUR tool includes eye response, motor, brain stem reflex, and breathing pattern. The scores ranged from 0 to 16 and each item is 0 to 4. The reliability and validity of FOUR were acceptablein other countries.[8-19] The researcher takes the validation procure by translating the originalLatin version of FOUR[11] to Persian; then the Persian version is translated to English and the twoversions were compared. The validity of content was surveyed by two anesthesia and nursing faculty members of Medical Science University of Mazandaran. All specialists checked and confirmed the content validity. Taiyuan researcher analyzed the internal correlation validity by chronbakh alpha and for reliability, inter-rater reliability was calculated using the kappa qualification.The conscious level of 10 patients who met inclusion criteria but werenot included in sampling selected then to nurses with same job experiences with 30 its gap measured by FOUR. The nurses were blind to the type of injury and were educated already how to fill the FOUR. Instructionshave also been given to them before meeting the patients. Kappa coefficient between 0.4 and 0.6 was considered as poor, 0.6 and 0.8 as moderate,and above 0.8 as great.

In the present study, the outcome considered as mortality in hospital and poor neurologic outcome (GOS = 1-3) in discharge time. For determining outcomes of TBI, this tool is an accepted tool with a high validity and reliability[11] with five levels: Complete recovery = 5, mild disability = 4, sever disability = 3, coma = 2, and expiry = 1.

Inclusion criteria: TBI, age range between 16 and 65 years[20,21] and admitted in ICU for more than 24 hours.[22]

Exclusion criteria: Patients with underlying disorders, addiction, and taking sedative drugs before measurement. This study was approved by ethicalcommittee of Medical Science University of Mazandaran.The consent form was got signed by family of patients.

Analysis

Forthe analysis of data with SPSS software version 17 was used. Logistic regression method with 95% confidence distance was applied. Sensitivity of the total scores of GCS and FOUR in the prediction of outcomes presented by ROC1and cut off was calculated. The amount of AUC and cut off were determined. $P < 0.05$ was considered as meaningful.

Finding

All selected patients (N = 53) were available during the study. The age range was 16-60 years and the mean age was 33.80 ± 12.60 years. Eleven (20.8%) patients were females and remaining (79.2%) were males. In terms of admissions, 13 patients were with epidural hematoma, 4 patients with subdural, 8 patients had a brain hemorrhage, and 22 patients had cerebral edema. In terms of type injury, 30 patients were with motorcycle accident injury, 15 patients with car accidents, and 8 patients had fallen from a height. This shows that the main cause of head trauma is motorcycle accident [Table 1].

Severity of injury 14 patients (4/26%) had mild injuries, 4 patients (5/7%) had moderate injuries, 35 patients (66%) suffered severe damage. It means that most of them suffered from severe injuries. Figures 1 and 2 present the total and subscores of tools. When the internal correlation was calculated, chronbakh alpha was 0.90 and Kappa coefficient was at great level (0.88).

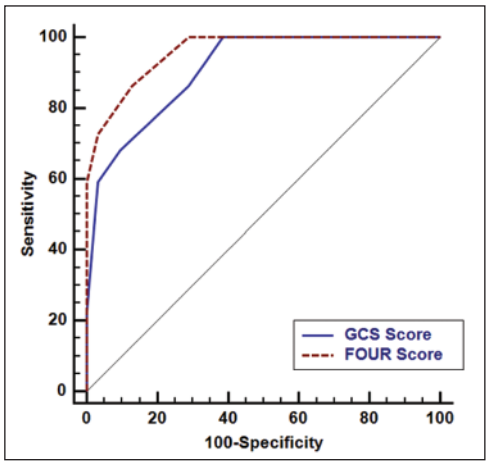

Figure 1: ROC curve to compare FOUR and GCS in the prediction of poor outcomes

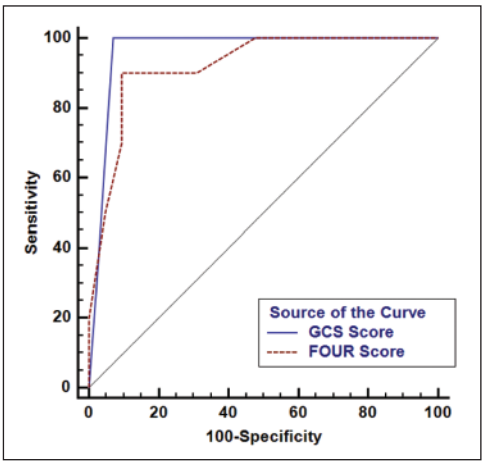

Figure 2: ROC curve to compare predictions of FOUR and GCS in hospital mortality

Table 1: The demographic information of patients

Variable	*N*	%
Gender		
Male	42	79.2
Female	11	20.8
Occupation		
Unemployed	11	20.8
Housewife	7	13.2
Retired	3	5.7
Government	5	9.4
Others	27	50.9
Education		
Illiterate	5	9.4
Elementary	11	20.8
Plus ten	21	39.6
Academic	16	30.2
Marital status		
Single	21	39.6
Married	21	39.6
Widow	1	1.9

Among all the patients, 22 patients (31.6%) showed poor outcomes, GOS (1-3), and 10 patients (18.9%) expired. Logistic regression does not show any relationship between age, gender, and cause of admission with outcome (P > 0.05). The significant relationships exist between GCS and FOUR scores with mortality and poor outcomes. So increasing one score in the FOUR scale leads to 24.8% decrease in mortality and 27.4% reduction in the poor outcomes. In term of GCS increasing one score of GCS leads to 20.7% decreased in mortality and 36.7% reduction in poor outcomes, respectively. We used a ROS curve to compare the power of prediction of outcomes. Overlay the prediction power was good and close together in both FOUR and GCS. Amount of AUC in FOUR for poor outcome prediction (GOS = 1-3) in discharge time was (Cl = 0.95. 0.86-0.99) 0.95 and for hospital mortality (Ci = 0.95. 0.86-0.97) 0.92. In terms of GCS it was (Cl = 0.95. 0.79-0.96) 0.90 and (Cl = 0.95. 0.87-0.99) 0.96. Calculated cut off for FOUR in the case of poor outcome and mortality in hospital were 6 and 4, and for GCS were 7 and 4, respectively. The sensitivity and specificity of FOUR in order to predict the poor outcome (GOS = 1-3), determined to cut off, was (Cl = 0.95, 0.86) and (Cl = 0.95, 0.87), respectively and in terms of mortality it was (Cl = 0.95, 0.90) and (Cl = 0.95, 0.90). In order to predict poor outcomes in GCS, (Cl = 0.95, 0.100) and (Cl = 0.95, 0.61), in terms of mortality in hospital, (Cl = 0.95, 0.100) and (Cl = 0.95, 0.92) [Table 2]. Among the items of GCS, the responses related to motor was highest under curve level in order to predict outcomes (mortality and poor outcome). In FOUR the highest wasfor responses to brainstem reflex and motor items. A comparison of tools according to items, the motor responses had a significant difference with other factors ($P < 0.05$). Brainstem reflex also showed significant differences in comparison to other items involved in prediction of the outcomes. This finding highlights the important role of these two items in the prediction of outcomes.

DISCUSSION

Our samples mostly included young men in active age whoare more vulnerable to comprise risky behaviors.[2] This is similar to Sadaka[22] and Izadi[23] studies. In the current study, the most trauma mechanism was related to vehicles speciallymotorcyclists which is in consonance with Izadi and Juse[24] results.

Similar to the Izqadi[23] study, there was norelationship found between injury type and attending cause with

Table 2: The AUC values of FOUR and GCS in prediction of outcomes

		Mortality in hospital			Poor outcome		
	Items	AUC	SD	CL = 95%	AUC	SD	CL = 95%
FOUR	Eye response	0.69	0.05	0.55 to 0.81	0.82	0.04	0.69 to 0.91
	Motor	0.92	0.03	0.81 to 0.97	0.89	0.04	0.77 to 0.96
	Brain stem reflex	0.90	0.06	0.78 to 0.96	0.88	0.04	0.76 to 0.95
	Breathing pattern	0.82	0.05	0.69 to 0.91	0.90	0.03	0.079to 0.97
	total	0.92	0.04	0.81 to 0.97	0.95	0.02	0.86 to 0.99
GCS	Eye response	0.69	0.05	0.55 to 0.81	0.79	.04	0.66 to 0.89
	Motor	0.95	0.02	0.85 to 0.99	0.89	0.04	0.77 to 0.96
	Verbal response	0.77	0.03	0.63 to 0.87	0.81	0.04	0.68 to 0.91
	Total GCS	0.96	0.02	0.87 to 0.99	0.90	0.03	0.79 to 0.96

outcomes. Although in the Gan[25] study, a relationship was observed between injury mechanism and outcome. It is explainable with elimination of people above 60 years old in this study. On the other hand, GCS and FOUR scores showed a meaningful relationship with trauma outcomes so one score increasing in GCS = 15% reduction ofmortality and 18% poor outcomes, respectively. One score increase in FOUR scores = 13% reduction of mortality and 15% poor outcomes, respectively. Internal correlation of FOUR wasat very high level ($\alpha = 0.09$) and the examiner agreement also was very high (Kappa coefficient = 0.88).

The prediction of outcomes in discharge time was at very high level in either GCS or FOUR; their efficacy was close together as in mortality prediction in hospital: It was (AUC = 0.92) for FOUR and (AUC = 0.96) for GCS, in prediction of poor outcomes (GOS = 1-3), for FOUR it was (AUC = 0.95) and for GCS (AUC = 0.90) which was in consistence with Avakist study. Although AUC in the Farid study protection amount for poor outcomes, it was lower in both tools. This inconsistency may be related to timeframe of research plan and difference in injury severity in two studies. In the current study, the calculated AUC in outcomes was higher than other studies like Bruno,[26] Ekan,[27] Wijdick (2006),[13] Vijidic and Iyer (2009),[19] which can explained with the following reasons. The study population in the Bruno study included all traumatic and non-traumatic patients with brain injury who had GCS lower than 8 and tools were examined 1 month after injury but in our study examination of tools started in the first 24 hours of study and only included traumatic patients who followed up for 3 months after injury. Ekan (2009) also reported that the patients with mild neurologic signs in the normal levels of consciousness included in the study which comprised traumatic and non-traumatic samples which followed patients mortality for 3 months and poor outcome or 3-6 months. Our study recorded outcomes at discharge time only in trauma patients (27). Wijdick (2006) and Iyer (2009) also included heterogeneous samples from internal ad surgery sections on the patients who experienced consciousness disorder. The proper cut-off point of GCS in the prediction of mortality was 4 and in prediction of poor outcomes it was 7, in FOUR scores it was 6 which is inconsistent with the Avakist and Vijidic study as Avakist reported 10 and 14 for prediction of mortality and poor outcomes, respectively in FOUR which is explainable with higher severity of injury in samples of the current study. In the Sancer study of mortality during 3 month score was 5 for GCS and 9 for FOUR; in the case of mortality inside of hospital, score was equal to 4 for both tools which is in harmony with our findings. In the Vijidic study, the cut-off point for mortality in hospital was equal to 7 by GCS and 9 for FOUR which is related to differences of severity of injury in patients and hetrogeniouse sampling in their study.

CONCLUSION

The finding of the current study revealed that FOUR is an applicable tool forhigh predictive power of outcomes in discharge time for patients with TBI. The authors suggest FOUR to use in the first 24 hours of admission of patients with TBI or the patients'consciousness fluctuationtime. Considering this tool included some advantages such as equal weight of items, diagnosis of Locking syndrome, evaluation ofintubated patients. The current study involved some limitations due to small sample size regarding most patients excluded cause of using sedative medicines. Therefore, the authors suggest to future researchers conducting studies with a greater sample size for long time and for comparing with other tools.

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