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Comparison of the accuracy of Glasgow Coma Scale and Full Outline of Unresponsiveness Score in predicting the prognosis of patients with cerebrovascular accidents admitted to intensive care unit

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Original Article

Abstract

BACKGROUND: Vascular-cerebral dysfunction is a sudden decline in brain function as a result of impaired blood supply to the brain. Critical care professionals in intensive care units (ICUs) need highly reliable prognostic scales to determine the degree of neurological dysfunction. The purpose of this study was to compare the Full Outline of Unresponsiveness (FOUR) Score and Glasgow Coma Scale (GCS) in predicting the prognosis of patients with cerebrovascular events.

METHODS: This study was performed on forty patients with cerebrovascular accident (CVA). Researchers used the FOUR Score and GCS for mortality prediction for each patient. Descriptive statistics were used for data analysis. Mann-Whitney test was used for comparison of means. Data were analyzed using Stata software.

RESULTS: In this study, according to FOUR Score, 62.5% of all patients survived and 37.5% died. Mean mortality and survival rates for GCS criterion were 5.37 ± 2.37 and 9.12 ± 2.12, respectively, and for FOUR Score criterion were 5.60 ± 0.81 and 10.64 ± 2.23, respectively.

CONCLUSION: The FOUR Score has higher sensitivity, specificity, and predictive power than GCS in patients with CVA. Therefore, it is recommended to use this scale in ICUs.

KEYWORDS: Glasgow Coma Scale; Intensive Care Units; Cerebrovascular Accident

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Introduction

Cerebrovascular dysfunction is a sudden decline in brain function due to impaired blood supply to the brain.[1,2] This disorder comprises a set of neurological symptoms that last for more than 24 hours: sudden onset, disability, or functional dependence associated with impaired cognitive, emotional, and social skills.[3,4] The disorder is a major health problem worldwide and is the third leading cause of death after heart disease and cancer,[5,6] and also is among the leading causes of disability.[7] Approximately, 85% of these disorders are

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ischemic and 15% are hemorrhagic.[8]

Today, determining the mortality and morbidity of intensive care unit (ICU) patients is one of the research priorities.[9] Thus, the grading prognosis of clinical symptom using specific scales is dramatically increasing.[10] Predicting the prognosis of patients with cerebrovascular dysfunction can be very helpful in decision-making and treatment of these patients.[11]

The purpose of using prognostic tools is utilizing diagnostic and management protocols better. Healthcare workers in ICUs require highly reliable prognostic scales to determine the degree of neurodegenerative dysfunction.[10] There are several different scales for assessing the status of patients with cerebrovascular accidents (CVAs) in the ICU that the most common one is Glasgow Coma Scale (GCS).[9]

The GCS has been adopted worldwide for ease of use and repeatability.[12] However, it has limitations such as frequent changes in the validity and reliability of its results, inability to recognize verbal components in intubated patients, and inability to interpret respiratory patterns and brainstem pattern.[13] Therefore, the Full Outline of Unresponsiveness (FOUR) tool was designed to address GCS restrictions in 2005 and is now widely used in ICUs.[10]

This scale provides complementary information such as brainstem reflexes, visual patterns, and respiratory patterns that are not included in the GCS.[14] In addition, one of the features of FOUR Score that is of interest to its designers is that it does not require a verbal response and is, therefore, more applicable to critically-ill patients.[15] It has four components that examine ocular response, brainstem reflex, respiratory status, and motor response.[13]

Evaluating a patient with cerebrovascular disorders is usually challenging, and neurologic evaluation of these patients is an important part of intensive cares. Careful examination of these patients' consciousness levels is one of the major challenges for nurses and clinical practitioners. Therefore, a scale to assess consciousness level is essential to assess changes in patient consciousness continuously. In addition, by using a standard and purposeful instrument, a correct interaction is established between treatment team. Given the disadvantages of GCS in patient evaluation, another rigorous and practical scale that can be used by physicians and nurses is essential. Therefore, this study aimed to compare the FOUR and GCS scales in their predictive power in patients with CVA admitted to ICU in 2017.

Materials and Methods

This descriptive study was performed on 40 patients with CVA admitted to the ICU of Tohid Hospital in Sanandaj, western Iran, from January 2017 to December 2017. The study population was all patients with CVA aged 12-80 years (hemorrhagic and non-hemorrhagic stroke) admitted to the ICU. Inclusion criteria included: being over 18 years old, surviving 24 hours after being admitted to the ICU, not receiving sedation and neuromuscular blocking agent, and having no history of neuromuscular disease. Injection of neuromuscular blocking drugs at each stage of the study resulted in the exclusion of the patient from the study.

In this study, the accuracy of two scales in predicting patients' prognosis was assessed by sensitivity (ability to correctly detect all who die), specificity (ability to correctly identify all who survive), positive predictive value (PPV) (probability of dying, when the result of the test is positive), and negative predictive value (NPV) (the probability of surviving when the test result is negative).

Given the reported sensitivity of 0.63 for both methods in the study of Jalali and Rezaei[13] and with considering a 15% error and 95% confidence interval (CI), the sample size was calculated using the following equation for 40 patients:

$$n = \left(\frac{Z_{1-\frac{\alpha}{2}}}{d^*}\right)^2 p(1-p)$$

Which is valid where n0 is the sample size, Z2 is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired, confidence level e.g., 95%) 1 e is the desired level of precision, p is, the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve.

The study data were collected after obtaining the code of ethics. The Ethics Committee of Kurdistan University of Medical Sciences, Sanandaj, approved this study (no. IR.MUK.REC.1394.291), and the consent form was signed by the patients' family.

Demographic data checklists and two FOUR and GCS scales were used for data collection. Patients were evaluated in the second 24 hours, first week, second week, third week, and fourth week after admission by using both scales. One person for both scales evaluated all patients, and all patients were screened with both of the scales. The cut-off point of 6 was considered for the FOUR Score and 5 for the GCS. A score of 6 or less for FOUR Score and a score of 5 or less for GCS was considered as expected risk of death. At the end, collected data were entered into Stata software (version 12, Stata Corporation, College Station, TX, USA) to be analyzed.

Descriptive statistics were used for data analysis and estimation of sensitivity, specificity, PPV, and NPV along with CIs. These indices were used to evaluate the predictive power of FOUR and GCS scales in patients' prognosis. The prognosis in this study is predicting the survival or death rate of a patient with CVA within one month after hospitalization in the ICU.

In order to compare the mentioned indices for the two scales of FOUR and GCS, Mann-Whitney test was used. After calculating the Kappa coefficient of agreement for the two scales, the conclusions were made based on comparing the area under the receiver operating characteristic (ROC) curve for the two scales. The significance level was considered as less than 0.05 at all stages.

Results

In this study, 40 patients with mean age of 69.25 ± 12.43 years, and age range from 34 to 86 years were assessed. Among all patients, 26 (65%) were men and 14 (35%) were women.

Mean and standard deviation (SD) for mortality and survival rates were 5.93 ± 2.37 and 9.12 ± 2.12 in GCS, and 5.60 ± 3.81 and 10.64 ± 2.23 in FOUR Score, respectively. Mann-Whitney test showed a significant difference between survival and death of patients in both FOUR Score (P = 0.0001) and GCS (P = 0.0001).

The area under the ROC curve was 0.880 in FOUR, and 0.928 in GCS (Figure 1). According to the ROC curves, the best cut-off points for FOUR and GCS scales to predict death outcome were 8.5 and 7.5, respectively.

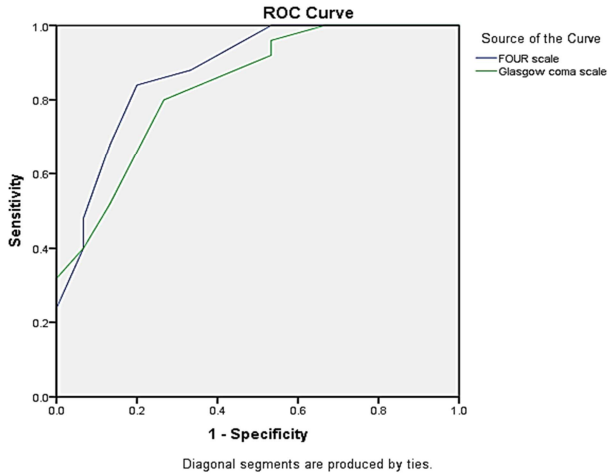

Figure 1. Receiver operating characteristic (ROC) curve of Glasgow Coma Scale (GCS) and Full Outline of Unresponsiveness (FOUR) Score

According to these cut-off points, the calculated sensitivity of FOUR Score was 0.84 and for GCS was 0.80 (Table 1).

Table 1. Comparison of Glasgow Coma Scale (GCS) and Full Outline of Unresponsiveness (FOUR) Score in the prediction of early mortality in intubated patients

Scale/indicator	FOUR Score	GCS
Sensitivity	0.840	0.800
Specificity	0.800	0.733
PPV	0.875	0.833
NPV	0.750	0.687
LR	4.200	3.000

FOUR: Full Outline of Unresponsiveness; GCS: Glasgow Coma Scale; PPV: Positive predictive value; NPV: Negative predictive value; LR: Likelihood ratio

Of all patients, 62.5% survived, 37.5% died, and FOUR Score correctly predicted 80% of them (Figure 2, A and B).

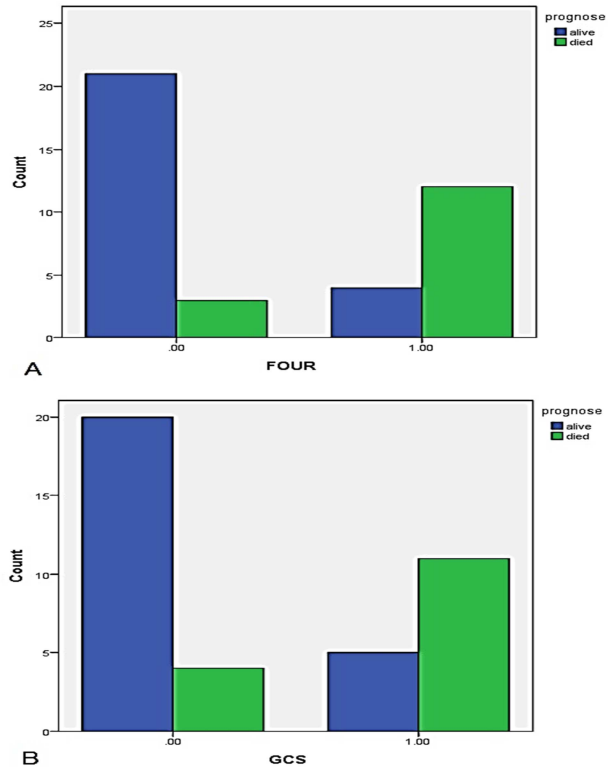

Figure 2. Comparison of predictive power of Full Outline of Unresponsiveness (FOUR) Score (A) and Glasgow Coma Scale (GCS) (B)

Discussion

Follow-up and treatment of patients with cerebrovascular events require extensive neurological observation and examination, which requires group work and a common language. There is also a need for simple and rational evaluation criteria that allow the healthcare workers to predict the patient's prognosis. The aim of this study was to compare the accuracy of GCS and FOUR Score in predicting prognosis of patients with cerebrovascular events. An ideal coma criterion must be reliable (it measures what to be measured), valid (it will show one result if repeated), linear (all its components are of equal weight), and finally, easy to use.[16]

The results of our study based on the Mann-Whitney test did not show a significant difference between survival and mortality rate in both FOUR ($P < 0.0010$) and GCS ($P < 0.0010$) scales. In fact, the FOUR and GCS scales showed the mortality and survival rate with an equal accuracy. The area under the ROC curve indicates that both the FOUR and GCS scales have high predictive power, but the FOUR Score is more capable of predicting patients' prognosis. Besides, figure 2 (A and B) shows that the FOUR Score correctly predicted 80% mortality of the studied patients. Abdallah et al. in 2019 showed that according to the area under the ROC curve, the FOUR Score predicted the mortality status of patients better than the GCS, but they recommended further statistical studies to confirm it;[17] that is consistent with our study. Jalali and Rezaei also stated in their study that FOUR Score was more predictive of mortality than GCS, and predicted overall survival more accurately in these patients.[13] However, in another study, Saika et al. in 2015 reported that although the FOUR Score showed more details about neurological status than GCS, no significant differences were found between the two scales in terms of accuracy and predictability of mortality and they were similar.[18] The results of this study were in line with our results, but they were not in line with our study according to the area under the ROC curve.

Moreover, based on table 1, the results of

the study revealed that the FOUR Score had higher sensitivity and specificity than GCS. This means that the ability of the FOUR Score is more reliable in both correctly identifying all those who die and all those who do not die in comparison to GCS. Nyam et al. also showed higher specificity of the FOUR Score than the GCS, and stated that this high specificity could assist healthcare workers in explaining the patient's condition to their family.[19] In addition, the results of Silvitasari et al. study conducted in 2017, which aimed at evaluating the sensitivity and specificity of both FOUR and GCS scales in ICU patients, showed that the FOUR Score had higher sensitivity and specificity than the GCS and they recommended that this scale could replace the GCS in ICUs.[20]

The results of this study revealed that the FOUR Score was better for assessing the state of consciousness of patients with CVA admitted in ICU. A study by Nair et al. found that FOUR Score compared to GCS could provide more details on patients' neurological status and appeared more applicable.[14] Bledsoe et al. also stated that the GCS was overall inaccurate, since it measured the neurological status objectively, and its value varied with each use and suggested that better scales be developed and validated.[21] Sacco and Carolei in 2015 also found in their study that FOUR Score was a more reliable scale than GCS in patients with CVA.[12] On the other hand, since the FOUR Score, unlike the GCS, does not require a verbal examination of the patient, is more valuable and suitable for use in the ICU, where most patients are intubated.[10,22]

Finally, the researchers confirm that the FOUR Score is highly sensitive and specific, and is more suitable for assessing the consciousness of patients with CVA admitted to ICU, but for use in other wards and other patients with different diagnoses, more research with more samples is required.

One of the limitations of this study is the small population of the study. There are also many different mechanisms which can affect the prognosis of patients that could not be controlled in this study, and this study has investigated the validity of both FOUR and GCS scales in a homogeneous group. Therefore, it is suggested that in future studies, the environmental factors and factors affecting the prognosis of the patients be controlled.

Conclusion

FOUR Score is a simple and valid scale that provides more details of the patients with CVA. It also has greater mortality sensitivity and predictive power than GCS. Finally, we propose that the FOUR Score is more appropriate for predicting the prognosis of patients with CVA, because it is not dependent on verbal response and provides valuable information on brainstem reflexes. It is recommended that healthcare providers use FOUR Score in ICUs to evaluate the prognosis of patients with cerebrovascular events.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

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