Glasgow Coma Scale versus Full Outline of Unresponsiveness Scale in Predicting Discharge Outcomes of Traumatic Brain Injury

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ABSTRACT

Context: Neurological assessment is an essential element of early warning scores used to recognize and early save the lives of critically ill patients.
Aim: This study aimed to compare the Full Outline of Unresponsiveness Scale and the Glasgow Coma Scale in predicting discharge outcomes in patients with traumatic brain injury
Method: A comparative research design conducted at the Neurosurgery Intensive Care Unit in El Fayoum University Hospital. The Study recruited a purposive sample of 100 adult patients with TBI. They assessed using three tools (Patients Profile Data Form, Level of Consciousness Assessment," and Tool Discharge Data Assessment Record).
Results: GCS is superior to the FOUR score in predicting length of stay and full recovery without any squeal, while they are the same in predicting motor disability and sensory impairment (physical impairment). FOUR score is superior to GCS in the prediction of mortality
Conclusion: The FOUR score provides more neurologic details than the GCS and is a valid predictor of outcome in patients with TBI; thus, it could be considered a future prognostic model. It is recommended to use a FOUR score for predicting outcomes in patients with traumatic brain injuries as a valid predictor of discharge outcomes after traumatic brain injury.

Keywords: Traumatic brain injury, Glasgow Coma Scale, Full Outline of Unresponsiveness Scale, discharge outcomes

1. Introduction

Traumatic brain injury (TBI) remains one of the most complex diseases that continue to be a significant public health problem globally. It is portrayed by high levels of mortality, disability, and undue financial burden on governments and individuals in terms of treatment costs and lost workforce *(Kinyanjui, 2016).*

A survivor of head injury has a wide variety of brain injuries that vary from surface injury to a permanent vegetative state. In addition to physical harm and neurological disabilities of various kinds, psychosocial issues such as depression, anxiety, and pain affect the person for an extended period even after getting discharged from the hospital *(Nair, Surendran, Prabhakar & Chisthi, 2017).* Consciousness is a state of overall self-consciousness and the environment. It includes orienting towards new stimuli *(Mercy, Thakur, Yaddanapudi & Bhagat, 2013).*

Coma or other shifts in the state of awareness could predict outcomes and are, therefore, a vital clinical parameter. Evaluation of consciousness is a crucial component of fundamental nursing skills. Following the correct assessment, the nurse can identify neurological changes in patients and contact the medical team to begin emergency actions to improve survival and outcomes *(Chan, Mattar & Taylor, 2013).* A standard scale for measuring and evaluating the level of consciousness is crucial. Moreover, the prognosis can be determined according to a standard scale for assessing consciousness level *(Sepahvand et al., 2016).*

Adequate initial assessment and early intervention are essential in treating patients with TBI to decrease mortality and lessen long-term disabilities. However, assessing a patient's level of consciousness is a complicated affair, mostly due to difficulty finding appropriate terminologies that are truly objective and user-independent *(Nair et al., 2017).*

Preliminary injury determination in TBI patients releases an essential guide to help determine the outcome of trauma and treatment programs. The most common clinical tool to determine head trauma severity is the Glasgow Coma Scale (GCS). Several studies indicated the efficacy of GCS in providing primary care and predicting the mortality and morbidity of patients with TBI *(Gorji, Gorji, & Hosseini, 2015).*

Despite its extensive use, the GCS has some shortcomings: The inability to test verbal components in patients with intubation, failure to grade respiratory pattern, brainstem reflexes, and inability to detect a subtle change in

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the neurological examination. However, several ICU scoring systems were created to solve the perceived shortcomings in the GCS *(Jalali & Rezaei, 2014).*

In the latest centuries, various alternative scales have been suggested to GCS, which have not found widespread acceptability because of the complexity of use *(Fischer et al., 2010). Wijdicks, Bamlet, Maramattom, Manno, & McClelland (2005)* proposed the Full Outline of Unresponsiveness (FOUR) scale to assess traumatic and non-traumatic impairments of the central nervous system. The FOUR scale consists of four items: eye response, motor response, brain stem reflexes, and respiratory condition, each scoring from 0 to 4 *(Chen, Grothe & Schaller, 2013).*

As opposed to Glasgow Coma Score, eye response in Full Outline of Unresponsiveness and open eyes also assesses their voluntary movements, distinguishing between a vegetative state of patients and minor impaired level of consciousness *(Mercy et al., 2013).*

In comparison to the GCS, the FOUR scores may also be helpful in further subcategorizing patients with severe neurological impairment based on their brainstem function and respiratory pattern, which the GCS is unable to do. It can offer clinicians further information regarding the overall prognosis better. These advantages, combined with its excellent inter-rater reliability, give the FOUR score the potential to replace conventional scoring systems and allow for precise and consistent neurological assessments among health care providers *(Almojuela, Hasen & Zeiler, 2018).*

2. Significance of the study

Traumatic brain injury (TBI) is one of the death reasons worldwide. It is estimated that one and half million people die due to TBI each year, and millions of people need emergency treatment for TBI. Unfavorable consequences of TBI are about 20%. Determining the severity of TBI is the first guideline for treating and predicting the outcome of trauma *(Gorji et al., 2015).* A community-based study undertaken by the Egyptian Ministry of Health and Population and the WHO to assess injury burden showed that road traffic accidents account for 62.9% of injury-related fatalities and 34% of non-fatal injuries. In the economically productive age groups, 70 percent of all road traffic accidents happen. Egypt ranked 41,6 fatalities per 100,000 people among the nations with the most significant mortality rates. *(WHO, 2011).*

Egypt recorded 11,098 traffic accidents in 2017, marking a 24.6 percent decrease, compared to 14,710 accidents in 2016. Those accidents resulted in the death of 3,747 people, the injury of 13,998, and the damage of 17,201 vehicles, according to the 2017 report released by the Central Agency for Public Mobilization and Statistics *(CAPMAS, 2018)*. Awkwardly, there is no national registry for types of trauma.

For decades, researchers have examined predictors of outcome in this population to guide the early decision. Based on GCS deficiencies, It assumed that GCS could be useless in the initial evaluation of traumatic brain injury and that a straightforward scoring scheme such as the Full Outline of Unresponsiveness Scale could show comparable test efficiency. To our knowledge, most of the researches conducted in this area was predicting only mortality versus surviving. So, this study conducted trying to find a comparable alternative to GCS in predicting discharge outcomes in terms of length of hospital stay, mortality, and clinical diagnosis of brain death, motor disability, sensory impairment, and full recovery.

3. Aim of the study

The study aims to compare the full outline of Unresponsiveness Scale and the Glasgow Coma Scale in predicting discharge outcomes in patients with traumatic brain injury.

3.1. Research question

- Which scale can be the most accurate in predicting discharge outcomes in patients with traumatic brain injury, the Glasgow Coma Scale or the Full Outline of Unresponsiveness Scale?

4. Subjects & Methods

4.1. Research design

A comparative research design was utilized for the conduction of this study. Comparative research, simply put, is the act of comparing two or more things to discover something about one or all of the things being compared *(Heidenheimer, Heclo & Adams 1983).*

4.2. Research Setting

This study was conducted at Neurosurgery Intensive Care Unit (ICU) in El Fayoum University Hospital. It consists of four rooms, and each room contains six beds.

4.3. Subjects

According to the following inclusion and exclusion criteria, a purposive sample of 100 adult patients with TBI was tested for their conscious level using the GCS and FOUR scales.

Inclusion Criteria:

Patients aged over 20 and below 65 years, diagnosed with TBI in their first 24 hours of admission.

Exclusion criteria:

- Patients who can not recognize their eye, verbal, or motor GCS components
- Patients with spinal cord injury or undergoing surgical patients were excluded.
- Patients excluded if they were heavily sedated or receiving neuromuscular function blockers.
- Patients with uncontrolled diabetes or have severe uremia, or in the end, stage liver disease also excluded from the study.

4.4. Tools of data collection

Three tools used to collect the data as follows:

4.4.1. Patients Profile Data Form

It is developed by the researcher to collect personal and clinical patients' data. It consists of two parts:
Part one was designed to collect data about the study subjects' socio-demographic characteristics as age, gender, occupation, education, and marital status.
Part two intended to collect data about the clinical presentation among studied patients as the reason for referral, mechanism of trauma. The investigator develops it.

4.4.2. Level of Consciousness Assessment

It consisted of two scales.

4.4.2.1. Glasgow Coma Scale

The GCS was adopted by *Teasdale & Jennett (1974)* and revised *(Teasdale & Jennett, 1976)* and used to assess the level of consciousness of patients. The GCS is divided into three assessment parameters: eye-opening, verbal response, motor response. The score from each category is summed to provide a total GCS score (range = 3-15).
Scoring system

Eye-opening, (score 1 to 4): when the patient spontaneously opens his eyes, he receives a score of 4. A score of 3 is given when the eye opens by verbal stimulus using simple commands such as "open your eyes." When the patient needs a painful stimulus to open his eyes, a score of 2 is given. If there is no eye-opening even after applying all previously described stimuli, a score of 1 is given**.**

Verbal response (score 1 to 5): if the patient is oriented to time, place, and answer simple questions, the score given is 5. When the patient can answer questions but incoherently, he/she is disoriented and confused; the score given is 4. A score of 3 is given for patients whose answers do not match questions. If the patient needs a painful stimulus to answer, he will receive a score of 2. When there is no response even after applying all previously described stimuli, he will take a score of 1**.**

Motor response (score 1 to 6): score of 6 is given for a patient who obeys simple commands, such as "raise your arm or leg." If the patient does not obey simple commands and needs a painful stimulus to find the origin and try to remove what is causing the pain, the score given is 5. After a painful stimulus, the patient can find the pain and move the limb by flexion. However, he/she cannot remove the source of pain; the score given is 4.

A score of 3 is given for the patient whose motor response is by flexion movement, evidenced by decortication response, therefore, presenting arms flexed or bent inward on the chest, hands clenched into fists, and legs extended and feet turned inward. A score of 2 is given for patients whose motor response is by extensor movement and decelerate posture in which neck is extended, arms are rigidly extended close to elbows, legs are extended on knees level, and feet in plantar flexion. A score of 1 is given for a patient who presents no motor response even after applying all previously described stimuli**.**

4.4.2.2. Full Outline of Unresponsiveness

It is a clinical grading scale designed for use by medical professionals to assess patients with an impaired level of consciousness. It was adopted from *Wijdicks et al. (2005)* in Neurocritical care at the Mayo Clinic in Rochester, Minnesota. It comprises four categories eye response, motor response, brain stem reflexes, and respiration, where patients are assigned a score ranging from 0 to 4 for each category. Total scores from each category summed (range = 0-16).
Scoring system

For eye response (score 0 to 4): A score of 4 indicates eye tracking of a finger or object and at least two blinks on command. If eyelids are closed, the examiner should open them and examine the tracking of a finger or object. Tracking with the opening of one eyelid is sufficient in cases of eyelid edema or facial trauma.

A score of 3 indicates the absence of voluntary tracking with open eyes. A score of 2 indicates eyelids opening to a loud voice. A score of 1 indicates eyelids open to pain stimulus. A score of 0 indicates no eyelid opening to pain.

For motor response (score 0 to 4): almost all of the examination was done on the upper limbs because of easy observation. A score of 4 indicates that the patient demonstrated at least one of three hand positions (thumbs-up, fist, or peace sign) with either hand. A score of 3 (localization) indicates that the patient touched the examiner's hand after a painful stimulus and try to keep the painful stimulus away. A score of 2 indicates any flexion movement of the upper limbs after exposure to a painful stimulus. A score of 1 indicates an extensor response to pain. A score of 0 indicates no motor response to pain or myoclonus status epileptics.

For brainstem reflexes (score 0 to 4): it depends on examining pupillary and corneal reflexes. Preferably, corneal reflexes are tested by instilling two or three drops of sterile saline onto the cornea from a distance of 4 to 6 inches (this minimizes corneal trauma from repeated examinations). Sterile cotton swabs can also be used. The cough reflex to tracheal suctioning is tested only when both of these reflexes are absent.

A score of 4 indicates that pupil and corneal reflexes are present. A score of 3 indicates one pupil wide and fixed while the other pupil and corneal reflexes are present. A score of 2 indicates that either pupil or cornea reflexes are absent. A score of 1 indicates that both pupil and corneal reflexes are absent. A score of 0 indicates that pupil, cornea, and cough reflex (using tracheal suctioning) are absent.

For respiration (score 0 to 4): determine spontaneous breathing pattern in a non-intubated patient and grade simply as a score of 4 is given if the patient breath is regular, but if the patient is irregular breath he will take 2, patient with Cheyne-Stokes respiration (an abnormal pattern of breathing characterized by progressively deeper, and sometimes faster, breathing followed by a gradual decrease that results in a temporary stop in breathing called

apnea. The pattern repeats, with each cycle usually taking 30 seconds to 2 minutes) take a score of 3, but if the patient has irregular breath, the patient scored as 2.

In mechanically ventilated patients, when there is a pressure waveform of spontaneous respiratory pattern or the patient triggering on the ventilator, a score of 1 is given.

The ventilator monitor displaying respiratory patterns can be used to identify the patient-generated breaths on the ventilator. No adjustments are made to the ventilator while the patient is graded, but grading is done preferably with PaCO 2 within normal limits. When a patient breathes at a ventilator rate, the score given will be 0.

4.4.3. Discharge Data Assessment Record

The researcher developed it. It used to assess outcomes of patients with TBI, and it includes recording for the length of stay in the hospital, mortality, clinical diagnosis of brain death, motor disability, sensory impairment, and full recovery without any squeal at the time of discharge that studied over two weeks of evaluation.

4.5. Procedures

Official permission to carry out the study was submitted from the Dean of the Faculty of Nursing Ain Shams University, issued to El Fayoum University Hospital director to access sample subjects and start the data collection process. The purpose of the study and its procedure included were in the letter. Official permission to conduct the study is secured from relevant authorities.

Preparatory Phase: The tools of data collection are prepared based on reviewing the literature. A panel of three experts evaluated the tools' content validity. They were from the nursing faculty at Ain Shams University (3 of them were professors, and one was an assistant professor). Besides, a professor from the Faculty of Medicine, El Fayoum University, ensures content validity regarding comprehensiveness, accuracy, clarity, and relevance of the tool. Based on the jury's opinion, a minimum modification has done, and the final form was developed.

A pilot study was conducted on ten TBI patients representing (10%) of the sample. The pilot study aimed to test clarity, applicability, the relevance of the designed tool, and the feasibility of the study process and determining the time needed for filling the studied tools. The patients of the pilot study excluded later from the study sample.

The actual fieldwork of data collection has consumed six months, starting from January 2018 to the end of June 2018. Data collected by the researcher within 24 hours of patient admission. GCS and FOUR scores were measured at 24 hours and 72 hours of admission. The patients were followed up by the researcher till discharge to find out the outcomes. Data were collected four days per week in the morning and afternoon shifts. The researcher takes about 10 minutes to assess the cases using the GCS and FOUR scales. The researcher assured that the collected information was treated confidentially and used only for the study.

Approval obtained from the Research Ethics Committee of Faculty of Nursing, Ain Shams University. Official permissions were obtained from the El Fayoum University Hospital. The aim of the study was explained to the studied group, and verbal consent was obtained from the guardian if the patient was unconscious. All patients have the right to withdraw from the study at any time, and their data were kept confidential. Data collection tools did not touch religious, cultural, or ethical issues among patients, and the patient's dignity was considered.

4.7. Data analysis

The collected data were organized, categorized, tabulated, and statistically analyzed using the statistical package for social science (SPSS) version (20) to assess patients' socio-demographic data, clinical characteristics, level of consciousness, and traumatic brain injury outcomes at discharge. Data presented in tables. The statistical analysis included: percentage (%), the arithmetic mean ($\bar{x}$), standard deviation (SD), and chi-square (X^2).

Receiver Operating Characteristic (ROC) curve analysis was used to compare the Full Outline of Unresponsiveness Scale and the Glasgow Coma Scale in predicting outcomes in patients with traumatic brain injury. The statistical analysis included; sensitivity, specificity, positive predictive value (PPV), negative predictive (NPV), accuracy, and cut-off-point.

5. Results

Table 1 describes the socio-demographic characteristics of the studied traumatic brain injury patients. 51% of the traumatic brain-injured patients aged between 20-40 and 35% aged above 60 years old. 65% of them were males. Unemployed patients were 50%, with 35% of them not reading and writing, and 56% were married. The table also shows that 43% of the studied traumatic brain injury patients were referred to the hospital because of severe head trauma. Among them, 58% were referred due to road traffic accident, while referral due to falling was 30% of cases.

Table 2 shows a comparison of diagnostic accuracy of GCS and FOUR scales in predicting hospital length of stay in traumatic brain injury patients. The table shows the diagnostic accuracy of GCS in predicting hospital length of stay 0 .725, 0.748 at 24, 72 hours, respectively, compared to the diagnostic accuracy of FOUR scales in predicting hospital length of stay as 0.721, 0.741 at 24, 72 hrs, respectively. The GCS was more sensitive at 24 and 27 hrs, 91.7 and 91.7 compared to the FOUR scale of 87.5 and 87.5 at 24 and 72 hrs.

Table 3 shows a comparison of GCS and FOUR scales diagnostic accuracy in predicting hospital mortality in traumatic brain injury patients. The table shows a sensitivity of 85.7, 96.4 at 24, 72 hrs respectively compared to 92.9 and 100 at 24 and 72 respectively of FOUR scale. The table also shows less diagnostic accuracy of GCs with 0.981 and 0.985 at 24 and 72 hrs compared to 0.988 and 0.997 of FOUR scale at 24 and 72 hrs.

Table 4 shows a comparison of GCS and FOUR scales diagnostic accuracy in predicting hospital length of stay in traumatic brain injury patients. The table shows equal sensitivity of both tests 100, 97.1 at 24, 72 hrs respectively and more diagnostic accuracy of FOUR scale compared to GCS of 0.513 and 0.556 versus 0.499 and 0.507 respectively at 24 and 72 hrs.

Table 5 shows a comparison of GCS and FOUR scales diagnostic accuracy in predicting sensory impairment in traumatic brain injury patients. The table shows the sensitivity of 100 at 24, 72 hr. for both with comparable diagnostic accuracy in sensory impairment of both scales 0.514, 0.535 versus 0.532 and 0.520 at 24, 72 hrs respectively.

Table 6 shows a comparison of GCS and FOUR scales diagnostic accuracy in predicting full recovery without any squeal in traumatic brain injury patients. The table shows more sensitivity of FOUR score at 24 hr and the same sensitivity at 72 hrs with a more diagnostic accuracy of GCS in predicting the full recovery at 24 and 72 hrs.

Table (1): Frequency and percentage distribution of sociodemographic characteristics and clinical presentation among traumatic brain injury patients under study (n=100).

Demographic characteristic	No. 100	%
Age		
20-40	51	51
>40-60	14	14
More than 60	35	35
Gender		
Male	65	65
Female	35	35
Occupation		
Employed	11	11
Unemployed	50	50
Retired	39	39
Education		
Cannot read and write	35	35
Primary	22	22
High school	18	18
Graduated	25	25
Marital status		
Married	56	56
Single	33	33
Widow	10	10
Divorced	1	1
Clinical presentation		
Reason for referral		
Minor head trauma	34	34
Moderate head trauma	23	23
Severe head trauma	43	43
Mechanism of trauma		
Direct trauma	12	12
Road traffic accident	58	58
Falling	30	30

Table (2): Comparison of diagnostic accuracy of the Glasgow Coma Scale and FOUR Scale in predicting the length of stay of Traumatic brain injury patients at 24 hrs and 72hrs from admission.

ROC curve length of stay in hospital as regard GCS						
	Cut off	**Sens.**	**Spec.**	**PPV**	**NPV**	**Accuracy**
24 hrs.	≤ 8	91.7	68.1	48.9	96.1	0.725
72 hrs.	≤ 10	91.7	65.3	46.8	95.9	0.748
ROC curve length of stay in hospital as regard FOUR score						
24 hrs.	≤ 11	87.5	68.1	47.7	94.2	0.721
72 hrs.	≤ 11	87.5	70.8	50.0	94.4	0.741

Table (3): Comparison of diagnostic accuracy of Glasgow Coma Scale versus FOUR scales in predicting in-hospital mortality of Traumatic brain injury patients at 24 hrs and 72hrs from admission.

ROC curve in-hospital mortality as regard GCS						
	Cut off	Sens.	Spec.	PPV	NPV	Accuracy
24 hrs.	≤ 4	85.7	98.6	96.0	94.7	0.981
72 hrs.	≤ 5	96.4	97.2	93.1	98.6	0.985
ROC curve Mortality as regard FOUR score						
24 hrs.	≤ 6	92.9	97.2	92.9	97.2	0.988
72 hrs.	≤ 7	100.0	98.6	96.6	100.0	0.997

ROC: Receiver Operating Characteristic Curve, Sens.: Sensitivity, Spec: Specificity, PPV: Positive Predictive Value, NPV: Negative Predictive Value,

Table (4): Comparison of diagnostic accuracy of the Glasgow Coma Scale and FOUR Scale in predicting motor disability of Traumatic brain injury patients at 24 hrs and 72hrs from admission.

ROC curve motor disability as regard GCS						
	Cut off	Sens.	Spec.	PPV	NPV	Accuracy
24 hrs.	≤4	100.0	38.5	46.7	100.0	0.499
72 hrs.	≤4	97.1	40.0	46.6	96.3	0.507
ROC curve motor disability as regard FOUR score						
24 hrs.	≤4	100.0	35.4	45.5	100.0	0.513
72 hrs.	≤7	97.1	43.1	47.9	96.6	0.556

Table (5): Comparison of diagnostic accuracy of the Glasgow Coma Scale and FOUR Scale in predicting sensory impairment of Traumatic brain injury patients at 24 hrs and 72hrs from admission.

ROC curve sensory impairment as regard GCS						
	Cut off	Sens.	Spec.	PPV	NPV	Accuracy
24 hrs.	≤ 4	100.0	31.6	28.0	100.0	0.514
72 hrs.	≤ 6	100.0	41.8	31.3	100.0	0.535
ROC curve sensory impairment as regard FOUR score						
24 hrs.	≤ 4	100.0	29.1	27.3	100.0	0.532
72 hrs.	≤ 7	100.0	36.7	29.6	100.0	0.520

Table (6): Comparison of diagnostic accuracy of the Glasgow Coma Scale and FOUR Scale in predicting full recovery without any squeal of Traumatic brain injury patients at 24 hrs and 72hrs from admission.

ROC curve full recovery as regard GCS						
	Cut off	Sens.	Spec.	PPV	NPV	Accuracy
24 hrs.	≥ 9	92.9	69.4	54.2	96.2	0.863
72 hrs.	≥ 9	100.0	65.3	52.8	100.0	0.880
ROC curve full recovery without any squeal as regard FOUR score						
24 hrs.	≥ 11	100.0	63.9	51.9	100.0	0.849
72 hrs.	≥ 11	100.0	61.1	50.0	100.0	0.838

6. Discussion

Traumatic brain injury (TBI) is a common cause of mortality and disability universal. Deciding on an appropriate diagnostic tool is critical in the early stage for appropriate judgment about primary diagnosis, medical care, and prognosis *(Hosseini, Ayyasi, Akbari, & Gorji, 2017).* Consciousness evaluation is an essential and vital part of neurological consideration. Grading the level of consciousness creates powerful and effective communication between the health care provider. GCS and FOUR score are the most used scales for this purpose *(Baratloo, Shokravi, Safari, & Aziz, 2016).* The present study aimed to compare the Full Outline of Unresponsiveness Scale and the Glasgow Coma Scale in predicting outcomes in patients with traumatic brain injury.

Regarding socio-demographic characteristics of traumatic brain injury patients, the present study reveals that more than half of traumatic brain injury patients were in the age group between 20 and 40, who are more vulnerable to comprise risky behaviors, and more than one-third of the studied subjects were more than 60 where they are vulnerable for falling. *Taha and Brakat (2016)* reported a similar finding in a hospital-based study entitled "Demographic characteristics of traumatic brain injury in Egypt" on 2124 TBI patients admitted to the neurosurgical trauma unit. They reported that traumatic brain injury affects mainly young male Egyptians with a mean age of 26.57±18.4 years.

Related to gender, the present study reveals that the incidence of TBI in males was higher than in females. This finding may be due to the male gender being a risk factor for TBI due to the higher incidence of a road traffic accident (RTA), which mainly affects males who are the primary workers and drivers in Egypt.

This finding concurs with *Montaser and Hassan (2013)*, whose study entitled " Epidemiology of moderate and severe traumatic brain injury in Cairo University Hospital in 2010," who reported that male sex was predominantly affected and represented 79% of cases. *Taha and Barakat (2016)* reported that males constituted 82.7% of TBI patients admitted to the neurosurgical trauma unit.

As for occupation, fifty percent of cases were not employed. This percentage exceeded the 2018 first-quarter statistics reported by the Central Agency for Public Mobilization and Statistics (CAPMAS) of 10.6% male, and 22% female were unemployed *(CAPMAS, 2018).*

These findings may be due to our place of data collection at Al Fayoum governorate, a terminal/remote governorate compared to Cairo. This finding is evidenced by the CAPMAS report for unemployment at Al Fayoum governorate that slightly exceeds the national statistics of 13% distributed as 9.6% among males and 24% among females in 2016 *(CAPMAS, 2016),* but matched with more than half of the study subjects were either cannot read and write or had a primary education which much reduces their employment chances. It also causes them to work as temporary laborers in mechanical work that might increase their TBI incidence.

This result concurs with *Aenderl, Gashaw, Siebeck, and Mutschler (2014)* in a study entitled " head injury-a neglected public health problem: A-month prospective study at JIMMA University Specialized Hospital, Ethiopia" and reported that the odds of sustaining head injury among daily laborers and the unemployed were 3.94 and 4.16 times more likely when compared with civil servants respectively.

This finding goes with *Wui Shaun, Ramalingam, and Wai (2014)*, whose study entitled "Epidemiology of trauma in an acute care hospital in Singapore," who found that being illiterate means the person is 2.74 times more likely to head injury as compared to literate.

Concerning the diagnostic accuracy of GCS and FOUR scores for predicting the hospital length of stay (LOS), the study revealed that GCS was superior to the FOUR score for LOS prediction with higher sensitivity and moderate accuracy.

LOS is an essential measure of health care utilization and determinant of hospitalization costs. Although many reports in the literature are available that determine risk factors for mortality and unfavorable outcome after TBI, little is published on factors influencing ICU LOS. *Frontera et al. (2011)*, whose study was about "Trend in the outcome and financial impact of subdural hemorrhage," a study of 216 subdural hemorrhage patients, the study reported that hospital and ICU LOS were independently associated with poor GCS.

Kim (2011), whose study entitled "The impact of time from ED arrival to surgery on mortality and hospital length of stay in patients with traumatic brain injury," Kim found that TBI patients with GCS scores ranging from 3 to 8 had a longer average hospital LOS than did those with a GCS of 13-15 (18.2 vs. 9.2 days, $p < 0.01$).

To our knowledge, this study is the second to report the prediction of ICU LOS from admission coma scores after *Okasha, Fayed, and Saleh* (2014), whose study entitled "The FOUR Score predicts mortality, endotracheal intubation and ICU length of stay after traumatic brain injury" and reported FOUR score and the GCS were moderately predictive of ICU LOS. It is essential to mention that, although the type and severity of patients' illnesses can directly affect LOS, there are structural and managerial factors that influence ICU LOS. However, these factors are difficult to control in predictive models *(Gruenberg et al., 2006).*

Concerning the diagnostic accuracy of GCS and FOUR scores in predicting mortality, the present study revealed that the FOUR score was superior to GCS in predicting in-hospital mortality with greater accuracy and higher sensitivity.

This finding concurs with the study *Jalali and Rezaei (2014)*, whose study was about "A comparison of the Glasgow Coma Scale (GCS) score with Full Outline of Unresponsiveness (FOUR) scale to predict patients' traumatic brain injury outcomes in intensive care units." While *Mercy et al. (2013)*, whose study was about "Can FOUR Score replace GCS for assessing the neurological status of critically ill patients," 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.

The higher accuracy of the FOUR for prediction of in-hospital mortality compared to the GCS score may be explained by: first, pupil reactivity (a significant component of the brainstem reflexes and a sub-score of the FOUR scores) was found to be a strong predictor of TBI mortality in previous studies *(Hoffmann et al., 2012).* Second, varying mortality rates have been reported for patients with the lowest GCS score of 3 *(Demetriades et al., 2004).*

Concerning GCS and FOUR scores predictive ability for motor disability and sensory impairment, no studies reported the predictive ability of motor disability and sensory impairment as outcomes after traumatic brain injury from admission coma scores. The current study revealed that both the GCS and FOUR score equally predicted motor disability and sensory impairment; however, with high sensitivity and poor accuracy. This finding is similar to *Okasha et al. (2014)*, whose study was about "The FOUR Score predicts mortality, endotracheal intubation and ICU length of stay after traumatic brain injury" as he found both the GCS and the FOUR score equally predicted unfavorable outcomes.

Concerning the predictive ability of GCS and FOUR score for full recovery without any squeal, the study revealed that the GCS score is superior to the FOUR score in predicting full recovery without any squeal at 24 and 72 with high sensitivity and accuracy. *Sepahvand et al. (2016)* reported that 65.2% of TBI patients survived, and the FOUR scale had correctly predicted 82% of them with a sensitivity of 0.76 and GCS sensitivity of 0.85. The area under the 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 GCS in scores 5 and 6.

7. Conclusion

In the light of the study findings, it concluded that GCS is superior to the FOUR score in predicting length of stay and full recovery without any squeal, while they are the same in the prediction of motor disability and sensory impairment (physical impairment). FOUR score is superior to GCS in the prediction of mortality. The FOUR score provides more neurologic details than the GCS and is a valid predictor of outcome in patients with TBI; thus, it should be considered for future prognostic models, and this finding answers the research question.

8. Recommendations

Based on the findings of this research, the following recommendations suggested:

- It is suggested to train ICU nurses on how to assess traumatic brain injury patients.
- It is suggested to train ICU nurses on how to use GCS and FOUR scores.
- It is suggested to put FOUR score instructions into the ICU procedure book.
- Further research is suggested to validate the predictive power of both scores in predicting the discharge outcomes other than morbidity and mortality.

9. References

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