

# Full Outline of Un-Responsiveness Scale (FOUR) Versus Modified Glasgow Coma Scale (GCS) in Predicting Discharge Outcomes of Altered Consciousness Patients

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**Abstract Objective:** Altered consciousness level is common in critically ill patients. Neurological assessment of these patients and their outcomes prediction are challenging for critical nurses. This study aimed to compare between Full Outline of Un-Responsiveness Scale and Modified Glasgow Coma Scale in predicting discharge outcomes in altered consciousness patients. **Research Methodology:** A descriptive design was followed in this study which was conducted at Trauma Intensive Care, Neurological Intensive Care and Neurosurgery Intensive Care units in Assuit University Hospital. Three tools were utilized to collect the data. **Results:** Patients' outcomes on discharge were; 3% regained consciousness and discharged to home; around one third regained consciousness and transferred to ward; some of them experienced co-morbidities; and nearly half of them were died after experiencing secondary brain injury. Almost one third of patients who were alive on discharge had physical disabilities and co-morbidities. **Conclusions:** The components of FOUR score and MGCS had different predictive abilities. FOUR score had higher accuracy prediction of in-hospital outcomes and the prognostic power than MGCS in the first three assessment days. Therefore, this study's results would be supported by other studies that recruited a larger number of patients with different acuity levels within more hospitals.

**Keywords:** altered level of consciousness, unconscious patients, coma scales, FOUR score, GCS

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## 1. Introduction

Altered level of consciousness (LOC) is a common acute medical problem frequently encountered both casualty and acute care units. It is defined as every change from full self-awareness to absent or inhibit self-awareness [1]. This alteration is gauged on a continuum from full responsiveness and awareness up to deep coma. Coma is a state of deep sleep, in which the patient is unaware of self or the environment for prolonged periods, cannot be awakened, fails to respond to external stimuli as pain, light or sound [2,3].

Since the majority of critically ill patients have impaired consciousness, sensory deprived and limited mobility due to either disease process or medications [4]. Therefore, assessment of LOC for these patients is a key indicator of the patient's prognosis and outcome. But there is no objective instrument to measure the coma as for temperature or blood pressure [5]. Thus the health care providers should rely on accurate LOC scales for accurate critical decision making.

Altered LOC encompasses a variety levels or disorders include; minimal conscious state, locked-in syndrome,

persistent vegetative state, and coma [6]. Each disorder of consciousness alterations is associated with its own clinical manifestation as well as prognosis. Classification of LOC by accurate assessment has been highly invaluable from a clinical perspective for critical decisions making and plan for therapeutic interventions [7,8,9].

Alterations of LOC represent severe derangement in cerebral function and included metabolic or chemical toxins, seizures, infections, or increased intracranial pressure. However, an impaired LOC is associated with adverse outcomes including increased morbidity and mortality, prolonged duration on Mechanical Ventilation (MV), prolonged intensive care units (ICUs) and hospital lengths of stay, increased risk of transfer to a chronic care facility with higher costs or increased risk of persistent cognitive impairment after hospitalization [10]. About 5% of the patients presented to emergency department experienced LOC alterations [11,12].

The Glasgow Coma Scale (GCS) originally designed for patients with traumatic brain injury (TBI) by Teasdale and Bryan since 1974 and had become widely accepted scoring system for altered LOC patients in the ICUs [13]. It consists of three key components to check the

patient's reactivity status and encompass; eyes opening, verbal response and motor response to painful stimuli. Thus, patient's total score can be calculated by adding patient's scores gained from eye, motor and verbal response and ranged between three and maximum fifteen. On the other hand, GCS scale has some limitations include; inconsistency of inter-observer reliability, inability to assess the verbal response among the intubated patients, and difficulty to assess motor response in certain conditions, such as patients received neuromuscular blocking agents or sedatives and spinal cord injury [14,15,16]. Over the past decades, various alternative scales had been developed, although none of them reached widespread acceptance as they are so complicated and not user-friendly [17,18].

Moreover, a Modified Glasgow Coma Scale (MGCS) was adopted from Tatman and co-authors (1997) to identify the LOC for intubated and non-intubated adult patients and children above 5 years old [19]. This scale consisted of four graded items; eye opening' score from one to four, motor response' score from one to six, and verbal response' score from one to five or grimace responses' score from one to five. Thus, LOC for intubated patient can be assessed by gathering patient's scores gained from eye, motor and grimace response instead of verbal response score in old GCS and similarly to GCS and the total score ranged between three and fifteen as shown in (Figure 1).

Then Wijdicks and co-authors developed the Full Outline of Un-Responsiveness (FOUR) score as a new coma scale with accurate snapshot of patient's neurological status and to overcome the limitations of the GCS and had been found to be useful in ICUs [20,21]. FOUR score consists of four main components: eye response, motor response, respiratory patterns and brainstem reflexes; each component scored from zero to four with maximum total of sixteen as shown in (Figure 2). On contrary to the GCS, FOUR score does not rely on a verbal response [22,23].

There has been widespread increased use of the FOUR score in evaluating patients in the medical, Neurology and Pediatric ICUs in addition to emergency settings in comparison to the GCS [24,25]. In these settings some conditions including intubation, sedation, or delirium, which hinder the patients' verbal response and make the FOUR more applicable than GCS [26,27].

Since critical care nurses now play a pivotal role in assessing and interpreting the LOC of critically ill patients [28,29]. Nurses should rely on accurate assessment scale with no limitation to determine the patient LOC, which influences both planning and implementing appropriate care and consequently affecting the patients' outcomes [30,31]. Therefore, this study was conducted to compare between FOUR score and MGCS in predicting discharge outcomes of altered consciousness patients.

Category	Responses	Scores
Eye opening (E)	E4 spontaneous	4
	E3 to verbal stimulus	3
	E2 to pain	2
	E1 no response to pain	1
Verbal (V)	V5 orientated	5
	V4 confused	4
	V3 inappropriate words	3
	V2 incomprehensible sounds	2
	V1 no response to pain	1
Grimace (G)	G5 spontaneous normal facial/oromotor activity, as sucks tube, coughs	5
	G4 less than usual spontaneous ability or only responds to touch	4
	G3 vigorous grimace to pain	3
	G2 mild grimace or some change in facial expression to pain	2
	G1 no response to pain	1
Motor (M)	M6 obeys commands	6
	M5 localizes to pain stimulus	5
	M4 withdraws from pain	4
	M3 abnormal flexion to pain	3
	M2 abnormal extension to pain	2
	M1 no response to pain	1
Total	E+V+M for non-intubated patient, and E+G+M for intubated patient	15

Figure 1. Modified Glasgow coma scale (MGCS)

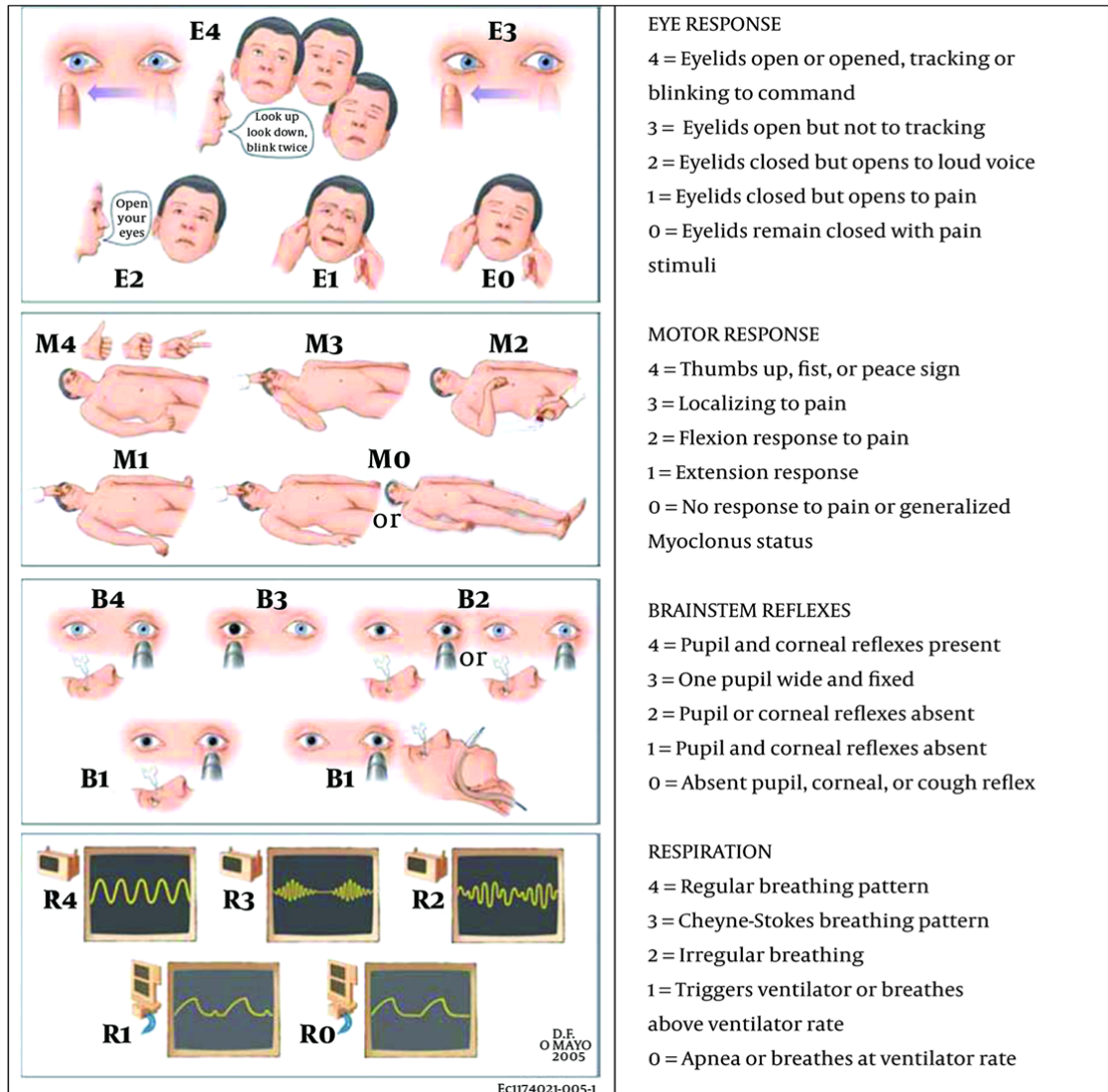


Figure 2. Full Outline of Un-Responsiveness (FOUR) score

## 2. Materials and Methods

### 2.1. Settings

This study was conducted at Critical Care Units affiliated to Assuit University Hospital namely Trauma ICU, Neurological ICU and Neurosurgery ICU. The Trauma ICU admitted only post traumatic patients with a total capacity of 12 beds and contained 39 technical nurses (two years study) and 21 bachelor nurses (four years study) with no difference in their assigned work and a nurse-patient ratio was one to one. Neurological ICU admitted only neurological cases as stroke with a total capacity of ten beds and contained 23 diploma nurses and three bachelor nurses with a nurse-patient ratio was one to two. While Neurosurgery ICU admitted postoperative neurosurgery patients with a total capacity of ten beds and contained 8 diploma nurses and one bachelor nurse with a nurse-patient ratio was one to two.

### 2.2. Subjects

A convenience sampling of 100 adult critically ill patients newly admitted to three ICUs with altered LOC

and available at the time of data collection was included in this study. Patients who received hypnotic, narcotic or neuromuscular relaxant medications and/or had hearing impairment, paraplegia or quadriplegia were excluded from the study.

### 2.3. Tools

Data were collected using a data collection sheet, which was divided, into three parts: demographic data, LOC assessment and discharge assessment. Demographic data developed by the researcher after reviewing related literature [14,32,33]. Demographic data included: unit, age, gender, date of admission, diagnosis, mechanism of trauma, and past medical-surgical history. Also it included the primary assessment on admission such as airway, breathing, circulation, hemodynamic status, and MV data, and the occurrence of secondary insults such as hypoxemia, hypotension or hyperthermia. The second part was LOC assessment which comprised two elements; the first one titled “Full Outline of Un-Responsiveness (FOUR) Scale”, developed by Wijdicks et al., since 2005 [20]. The second element namely “Modified Glasgow Coma Scale (MGCS)” was adopted from Tatman et al., to identify the LOC for

the intubated and non-intubated patients [19]. The third part was discharge data assessment record which developed by the researcher after reviewing the relevant literature to record the patient's condition and outcomes on discharge [34,35,36]. It included both scores of FOUR and MGCS at discharge and the discharge criteria included; regaining consciousness, discharge to home or transfer to step down unit, experienced co-morbidities, mortality, MV dependency days, and ICU length of stay.

## 2.4. Ethical Approval

A written approval was obtained from Assuit University hospital administrative authorities to conduct the study after providing explanation of the aim of the study. Also, the researcher assessed the studied patients after obtaining written consent from their family who were informed about the research objectives and their right to withdraw from the study at any time. Confidentiality was ensured in the current study. Ethical approval was obtained on 30th May 2013.

## 2.5. Data Collection

Seven experts in the related fields did the content validity for the developed tools and the necessary modifications were done. A pilot study was carried out on five patients to test the feasibility and applicability of the tool and the necessary modifications were done accordingly. These patients were excluded from the study. Reliability of part one and part three of the tool were tested using Cronbach's Alpha and were 0.85 and 0.84 respectively. Demographic data were collected. Patients were assessed using the FOUR score and MSCS upon admission, 24 and 48 hours post ICU admission. Finally, the researchers assessed the studied patients on ICU discharge using part three of the tool.

## 2.6. Data Analysis

The collected data were analysed using the appropriate statistical test using the Statistical Package for Social Science software (SPSS version 20) software. Descriptive data were used to present patients' characteristics using frequency and percentage for categorical variables and mean and standard deviation for normally distributed continuous variables. Statistical analyses were performed using the chi-square test ( $\chi^2$ ) for identifying the relationship between the patients' discharge outcomes and their characteristics, while a two-way Analysis of Variance (ANOVA) (F-test) was used to identify the relationship between the studied patients' outcome in each of: MV dependency days (MVDDs) and ICU length of stay. Multiple regression analysis was used to evaluate the ability of FOUR and MGCS to predict the patients' discharge outcomes based on the first three assessment days. All statistical analyses were performed using two-tailed tests and an alpha of 0.05.

## 3. Results

Table 1 presents the distribution of the studied patients according to their characteristics. In relation to the

socio-demographic data, it was found that 42% (n=42) of the patients aged between 18 to 29 years old, and 74% (n=74) of the patients were males. Most patients had TBI as a cause of their neurological injury.

**Table 1. Distribution of the studied patients according to their characteristics**

Socio-demographic Characteristics	No. (n = 100)	% (100%)
-Age		
18 ≤ 30 years old	42	42.0
30 ≤ 50years old	33	33.0
50 ≤ 65 years old	25	25.0
-Gender:		
Male	74	74.0
Female	26	26.0
-Admission diagnosis:		
Trauma brain injury	75	75.0
Non-traumatic brain injury	25	25.0
DKA	2	2.0
Brain Tumor	4	4.0
Poisoning	6	6.0
Aspiration pneumonia post arrest	2	2.0
Stroke	10	10.0
Myocardial infarction	1	1.0

**Table 2. Distribution of the studied patients according to their assessment data on admission**

Patients' assessment data		No.	%
Primary assessment	Airway alterations	52	52.0
	Breathing alterations	67	67.0
	Circulation alterations	60	60.0
Vital signs	Temperature		
	Hypothermia	12	12.0
	Normal	36	36.0
	Hyperthermia	52	52.0
	Pulse		
	Normal	29	29.0
	Tachycardia	71	71.0
	Blood pressure		
	Hypotension	15	15.0
	Normal	78	78.0
Hypertension	7	7.0	
Respiration			
Bradypnea	10	10.0	
Normal	67	67.0	
Tachypnea	23	23.0	

Table 2 reveals the distribution of the studied patients according to their assessment data on admission. In relation to the primary assessment 52% (n=52) of the studied patients had airway alterations, 67% (n=67) had breathing patterns alterations and 60% (n=60) had circulation alterations. In relation to the vital signs, 52% (n=52) of the patients had hyperthermia, 71% (n=71) experienced tachycardia.

**Table 3** demonstrates the comparison between the FOUR and MGCS in relation to the assessment scores during the first three days. Regarding to FOUR in the first assessment day, it was found that 47% (n=47) patients' had score of (0-7) which means high mortality rate, 53% (n=53) patients had score of (8-14) with moderate mortality rate compared to 48 % (n=48) patients' had score of (0-7) with high mortality rate, 28% (n=28) patients had score of (8-14) score with moderate mortality rate, and 24% (n=24) patients had Score of (15-16) with low mortality rate on the third assessment day.

Regarding to MGCS in the first assessment day, it was found that 59 % (n=59) patients had score of (3-8) with high mortality rate, and 41% (n=41) patients had score of (9-13) with moderate mortality rate compared to 41% (n=41) patients had score of (3-8) with high mortality rate, 49% (n=49) patients had score of (9-13) with moderate mortality rate, and 10% (n=10) patients had Score of (14-15) with low mortality rate on the third assessment day.

Moreover, this table shows that that the prediction power by multinomial logistic regression of the FOUR scores in the first three assessment days were 92.3%, 96.3%, and 94.9% respectively. While the predicted power of the MGCS scores in the relation to discharge outcomes in the first three assessment days was found to be 46.50%, 62.9%, and 74.2% respectively. This means that the FOUR score on admission better matched the patients' discharge outcomes and better prediction power than MGCS.

**Table 3. Comparison between FOURS and MGCS in relation to assessment scores during first three days**

Scale	Day	0-7 High mortality		8-14 Moderate mortality		15-16 Low mortality		MLR
		No.	%	No.	%	No.	%	
FOUR	Day 1	47	47	53	53	0	0	92.3%
	Day 2	45	45	51	51	4	4	96.3%
	Day 3	48	48	28	28	24	24	94.9%
		3-8 High mortality		9-13 Moderate mortality		14-15 Low mortality		
		No.	%	No.	%	No.	%	
MGCS	Day 1	59	59	41	41	0	0	46.5%
	Day 2	46	46	52	52	2	2	62.9%
	Day 3	41	41	49	49	10	10	74.2%

MLR: Multinomial logistic regression

**Table 4** shows the outcomes of studied patients according to their assessment data on discharge. Regarding the patients' status on discharge, it was found that only 43% (n=43) of patients regained their consciousness, 12% (n=12) patients experienced co-morbidities and transferred to step down unit, and 45% (n=45) of the studied patients were died.

Furthermore, this table illustrates outcomes and co-morbidities of the studied patients on discharge whereas patients who developed secondary brain insult experienced; hypoxemia, hypotension, Coagulopathy, acidosis and hyperthermia were 50% (n=50), 68% (n=68), 2% (n=2), 24% (n=24), and 68% (n=68) respectively.

**Table 4. Outcomes of the studied patients according to their assessment data on discharge**

Discharge outcomes	No.	%
<b>Discharge status</b>		
Regaining consciousness and discharge to home	3	3.0
Regaining consciousness and transferred to step down units	40	40.0
Experienced co morbidities and transferred to step down unit	12	12.0
Death	45	45.0
<b>Secondary brain insult</b>		
Hypoxemia	50	50.0
Hypotension	68	68.0
Coagulopathy	2	2.0
Acidosis	24	24.0
Hyperthermia	68	68.0
<b>Co-morbidity</b>		
Tracheostomy	15	27.2
Infection	12	21.8
Decubitus ulcer	9	16.3
Anemia	9	16.3
Splenectomy	4	7.2
Hemiplegia	2	3.6
Unilateral leg amputation	3	5.5
Muscles contracture	6	10.9

**Table 5** shows the relationship between patients' discharge outcomes and their characteristics. From the studied patients who regained their consciousness, it was found that 72.1% (n=31) of them were males, nearly half of them (n=21) aged in the 18 -29 year age group most of them 86% (n=37) were admitted with TBI which reflects the high incidence of trauma among young adult male population. There was highly significant relationship between patient's age, gender, admission diagnosis and the patients' discharge outcomes where the age, gender and TBI are considered risk factors for deaths in the ICU (P <0.001, 0.004 and 0.001 respectively).

**Table 5. Relationship between the patients' outcomes and their characteristics**

Patients' characteristics	Patients' outcomes						P value
	Regain conscious (43)		Comorbidity (12)		Death (45)		
	No.	%	No.	%	No.	%	
<b>Age</b>							
18 -29 (n= 42)	21	48.8	6	50	15	33.3	<0.001* *
30 -49 (n=33)	11	25.6	6	50	16	35.6	
50-65 (n=25)	11	25.6	0	0.0	14	31.1	
<b>Gender</b>							
Male (n=74)	31	72.1	6	50	37	82.2	<0.004* *
Female (n=26)	12	27.9	6	50	8	17.8	
<b>Admission diagnosis</b>							
Traumatic	37	86.0	9	75.0	29	64.4	<0.001* *
Non traumatic	6	14.0	3	25.0	16	35.6	

Chi-squared test of significance, \*\*Significant difference (p<0.01)

Table 6 reveals the relationship between patients' discharge outcomes and MV dependency days (MVDD). It was found that the highest mean value of MVDD was  $21.3 \pm 6.5$  days among patients who experienced co-morbidities. Also this table shows the relationship between patients' discharge outcomes and the ICU length of stay (LOS). It can be seen that the highest mean value of the ICU LOS was  $31.0 \pm 9.5$  days among patients who experienced co-morbidities. There is highly significant relationship between patients' ICU LOS, MVDD and the patients' discharge outcomes where the ICU LOS and MVDD considered risk factors for deaths in the ICU ( $P < 0.001$ ). This means those who experienced comorbidities had an increased number of MV days and a longer ICU LOS.

**Table 6. Relationship between patient's outcomes and mechanical ventilation dependency days (MVDD) and ICU length of stay**

Outcomes	MVDD	ICU length of stay
	Mean $\pm$ SD	Mean $\pm$ SD
Death	12.7 $\pm$ 10.8	15.0 $\pm$ 13.1
Co-morbidities	21.3 $\pm$ 6.5	31.0 $\pm$ 9.5
Regaining consciousness	8.8 $\pm$ 9.5	14.7 $\pm$ 11.0
ANOVA	F	13.839
	P	0.001**

## 4. Discussion

Altered LOC can be associated with worse outcomes; researchers had suggested that a patient's LOC be considered another vital sign, like heart rate and body temperature [37]. The critical care nurse has a crucial role in assessment, evaluation and provision of direct care for critically ill patient with altered LOC. Therefore, critical care nurse should have specific knowledge and skills focused on the care for those non-communicative patients. It is mandatory to have a standard scale by which clinicians can measure the patients' LOC. In order for such scale to be useful, it must be simple to learn, understandable, applicable and the scoring must be known among health care providers [23]. The FOUR score was recently developed and validated as an alternative to the GCS due to its ability to assess the depth of coma in a more comprehensive manner. Furthermore, the FOUR score is a strong predictor of functional outcomes at hospital discharge, in-hospital mortality, and overall survival in neurologic patients [25]. In the light of this challenging this study was carried out to compare between the FOUR and the MGCS in predicting discharge outcomes in altered consciousness patients.

The ability to accurately predict patient's outcomes post TBI has a vital role in both researcher and clinical practices. Moreover, the prognostic models are statistical templates that integrate some parameters of patient's data in order to predict clinical outcomes and are likely to be more precise than simple clinical indicator [38]. The current carried out to compare the FOUR score and MGCS in predicting discharge outcome. Although both scales were established to assess the LOC and the clinical prognosis they were used for monitoring of the patients in clinical decision-making

whereas, the total score with respect to its self-explanatory ability incorporates comprehensive data than each sub-scale [39].

The current study reveals that the FOUR score on first three days better reflected the patients' outcomes on discharge than MGCS, which means that the prognostic power of the FOUR was better than the MGCS in the first three assessment days explained by the FOUR score being simple, comprehensive and more applicable for intubated patients.

Moreover, FOUR helps to identify the patients' survival rate and/or the disability risk upon recovery. This scale provides a much more accurate snapshot of the patient from a neurological standpoint. This is in line with the findings of Bordini et al., which revealed that the FOUR score is easy to use and provides more neurological details than the GCS, because it includes brainstem reflexes with no verbal response; hence it is more suitable for ICU practices that typically encompass a wide range of intubated and MV patients [40].

In line with the current study findings, Wijdicks et al., reported that the FOUR score is considered as an alternative to the MGCS to evaluate the awareness of the patients with severe brain damage [20]. This also in line with other researchers who revealed that the FOUR score proved to be a fast and reliable method for the examination of patients suffering from severe impaired LOC as its prediction ability for mortality was superior to the GCS [41].

Outcomes assessment in critically ill patient is essential for identifying the best time for hospital discharge, for predicting mortality, and for proper resource management by health care providers [42]. It was documented that coma after 24 hours had about 10% chance of recovery and decreased to only 3% after one week. After 7 days of coma there is higher prevalence of death, persistent vegetative state, and poor recovery [33].

The current study revealed only three patients regained their consciousness and discharged to home. More than one third of the studied patients had regained their consciousness and transferred to medical, surgical, and neurological wards, with one third having complications and physical disabilities associated with their neurological injury and ICU stay. Complications and physical disabilities included anemia, infection, tracheostomy, splenectomy, decubitus ulcer, unilateral amputation, contractures and hemiplegia. Half of the patients died; two thirds of these deaths were associated with secondary brain injury due to hyperthermia, hypoxemia, hypotension, acidosis and coagulopathy. Hyperglycemia, hypotension and hypoxemia are associated with poor patients' outcomes following brain injury [32,38,43]. The deaths associated with secondary injury may be explained by lack of nurses' knowledge about factors that cause secondary brain injury and the standard of care delivered in the ICU. This may be attributed to the shortage of nursing staff, an overcrowded ICU and overworked nursing staff with nurse-patient ratio of one to two or three.

This is in line with Puggina et al., who reported that patients with altered LOC are challenging regarding the nursing care in their daily management of both acute and chronic phases [44]. That is why the critical care nurses have a crucial role in prevention of skin injuries or pressure ulcer, articular deformations, muscle spasticity, in addition to anemia, nutritional problems, hydration and deglutition

problems, respiratory and cardiovascular impairment, total dependence for activities of daily living, and management of intracranial pressure [45].

The current study finding reveals that the majority of patients were admitted to the (ICU) with altered LOC required MV for management of hypoxemia and respiratory failure. Some of them experienced prolonged MV duration ranged up to fifty days. The increased MV duration predisposed the patients to respiratory and other systemic problems which might endanger their lives, increase hospital stay, reduce turnover rate of and burden hospital resources [40]. This is in line with Sudarsanam et al., who demonstrated that the patients with altered LOC admitted to the ICU and were not indicated for ventilatory support their outcomes were significantly better than those requiring ventilatory support [46]. Furthermore, it was found that increased ICU length of stay (LOS) was associated with increased patients' co-morbidity and mortality. This is congruent with the findings of other researchers who demonstrated that the hospital mortality increased with increased the ICU LOS [47,48].

Mechanism of brain injury was also found to be related to the patients' outcomes. In this study, more than two thirds of the deaths were of non-traumatic origin; nearly half of the TBI patients regained their consciousness. Horsting et al., found an increased morbidities and mortality in patients presenting with coma due to a non-TBI. [11] This is in line with many researchers who stated that the traumatic coma patients' outcomes were better than non-traumatic coma patients [49,50].

## 5. Conclusions

The current study proposed evidence that FOUR score was found to be superior to MGCS in predicting discharge outcomes and in-hospital mortality among altered LOC patients with both traumatic and non-TBI origin. The FOUR score provides more neurologic details than the MGCS and is a valid predictor of outcomes in altered LOC patients. Nearly half of studied patients displayed secondary brain insult and died. While around one third of studied patients who were alive up on ICU discharge complained from physical disabilities and/or co-morbidities. There was highly significant relationship between the patients' outcomes and their age, mechanism of brain injury, secondary brain injury, MVDD, and ICU LOS; all these factors were associated with poor patients' outcomes and deaths. Our recommendation is that critical care nurses can rely on FOUR in assessing neurological status and predicting the outcome of altered LOC patients, which will contribute to preventive and therapeutic nursing intervention. Further research is now needed in larger ICUs with different nurse patient ratios and nursing education models.

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## Conflict of Interest

No conflicts of interest are declared by the authors.

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