Association between the functional independence measure and Glasgow coma scale regarding the rehabilitation outcomes of traumatic brain injury

Muhammed D. Al-Jarrah, *PhD, PT,* ***Mahmoud E. Nazzal,*** *MD, PhD,* ***Mohammed A. Jamous,*** *MD, PhD,* ***Mohammed A. Azab,*** *MD, PhD,* ***Mikhled F. Maayah,*** *PhD, PT.*

ABSTRACT

الأهداف: تقييم نتائج برنامج إعادة التأهيل لمرضى الإصابات الدماغية (TBI) باستخدام القياس الوظيفي المستقل (FIM)، ودراسة العلاقة بين القياس الوظيفي المستقل (FIM)، وتصنيف غلاسكو للغيبوبة (GCS) بعد الإصابات الدماغية لتحديد خصائص مرضى الإصابات الدماغية الذين يستفيدون بشكل أكبر من برامج إعادة التأهيل.

الطريقة: تم علاج واحد وخمسين مريضا تعرضوا لإصابة دماغية بمركز إعادة التأهيل – جامعة الأردن للعلوم والتقنية – المستشفى التعليمي – اربد – الأردن، خلال الفترة مابين أغسطس 2006م وحتى فبراير 2008م. سبعة وأربعون مريضاً أتموا هذه الدراسة، كان متوسط العمر للمرضى 33 عاماً (8 إناث و 39 ذكور). تم تحديد درجة غلاسكو للغيبوبة (GCS) للمرضى عند الدخول للمستشفى. كما تم تحديد القياس الوظيفي المستقل للمرضى (FIM) عند الدخول وعند الخروج من المستشفى. بالاعتماد على مقياس غلاسكو للغيبوبة (GCS) تم تقسيم المرضى إلى ثلاثة مجموعات: مرضى الإصابات الدماغية الشديدة (GCS من 3–8) وعددهم 24 مريضاً، مرضى الإصابات الدماغية المتوسطة (GCS من 9–12) وعددهم 12 مريضاً، ومرضى الإصابات الدماغية البسيطة (GCS من 13–15) وعددهم 11 مريضاً. تمت دراسة وتقييم العلاقة بين مقياس غلاسكو للغيبوبة (GCS) والتغير في مقياس الوظيفي المستقل (FIM).

النتائج: أظهرت النتائج تحسن ملحوظ وهام في المقياس الوظيفي المستقل (FIM) بعد التأهيل ($p<0.0001$) لمرضى الإصابات الدماغية الشديدة. كما كان هناك تحسن ملحوظ في المقياس الوظيفي المستقل (FIM) لمرضى الإصابات الدماغية المتوسطة بعد خضوعهم لبرنامج إعادة التأهيل ($p<0.001$)، بينما لم يكن هناك تحسن في المقياس الوظيفي المستقل (FIM) لمرضى الإصابات الدماغية البسيطة ($p=0.15$).

خاتمة: إن خضوع مرضى الإصابات الدماغية الشديدة والمتوسطة لبرنامج إعادة التأهيل في وقت مبكر بعد الإصابة يحسن بشكل ملحوظ وهام القدرة الوظيفية للمرضى باستخدام المقياس الوظيفي المستقل (FIM).

Objectives: To evaluate the outcomes of early comprehensive rehabilitation protocols for traumatic brain injury (TBI) using the functional independence measure (FIM), and to study the relationship between FIM and Glasgow coma scale (GCS) variables to determine which patients will be best served by rehabilitation therapies.

Methods: Fifty-one subjects with diagnosed TBI receiving treatment at a single inpatient rehabilitation facility at Jordan University of Science and Technology, Teaching Hospital, Irbid, Jordan were enrolled in this experimental study between August 2006 and February 2008. Of the enrolled subjects, 47 completed the study. The mean age of the participants was 33 years (8 females and 39 males). Glasgow coma scale was measured on admission. Functional independence measure score was measured on admission and on discharge. According to the GCS, the participants were divided into 3 groups as severe injury (GCS: 3-8 [n=24]), moderate injury (GCS: 9-12 [n=12]), and mild or no injury (GCS: 13-15 [n=11]). The FIM score and CGS and their relation were evaluated.

Results: Evaluation outcomes revealed a significant improvement in FIM scores after rehabilitation compared to the FIM admission ($p=0.00006$) in severe TBI. In moderate TBI, the FIM scores were significantly improved ($p=0.0004$) after rehabilitation. However, with minimal injury, the FIM scores were not significantly improved ($p=0.15$).

Conclusion: Early rehabilitation interventions significantly improved the FIM scores in moderate and severe TBI patients.

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From the Departments of Physiotherapy and Rehabilitation Sciences (Nazzal, Maayah, Al-Jarrah), Neurosurgery (Jamous), Forensic Medicine and Toxicology (Azab), Jordan University of Science and Technology, Irbid, Jordan and the Physical Therapy and Rehabilitation Sciences Department (Al-Jarrah), University of Kansas Medical Center, Kansas City, Kansas, United States of America.

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Address correspondence and reprint request to: Dr. Muhammed D. Al-Jarrah, Department of Physiotherapy and Rehabilitation Sciences, Jordan University of Science and Technology, PO Box 3030, Irbid 22110, Jordan. E-mail: jarrahm@just.edu.jo

Traumatic brain injury (TBI) is a widespread and significant source of disability and one of the leading causes of death and disability among children and adolescents in the USA.[1] In assessing the severity of the original injury, several pieces of information are collected including the duration of hospitalization and the initial score on the Glasgow coma scale (GCS). At one time, the duration of the coma was considered to be the best index of the severity of brain injury.[2] However, the GCS is the severity scale now used in most hospitals and emergency departments in the USA.[3] Introduced in 1974 as a means of assessing the depth and duration of impaired consciousness and coma. The GCS was also created to gauge the deterioration or improvement in the early stages of brain damage or lesions, as well as in predicting the ultimate outcome.[4] It is a 15-point scale that determines depth of coma and length of post-traumatic amnesia. By placing patients in global outcome categories, the GCS has been used to correlate early injury severity measures and outcome after injury.[5] Neurological rehabilitation outcomes are usually assessed by the functional independence measures (FIM) test.[6] The FIM was developed in 1983 by a task force of the National Institute on Disability and Rehabilitation Research (NIDRR) and the American Congress of Rehabilitation Medicine (ACRM).[7] It was designed to serve as a universal rehabilitation medicine data set for measuring severity and outcome in the following functional domains: self care, sphincter control, transfers, locomotion, communication, and social cognition. The FIM is one of the widely recognized measures of functional ability. Higher FIM scores indicate greater function and independence, whereas lower scores indicate less function and more dependence. Functional independence measure scores are based on 18 items rated on an ordinal Likert scale from 1-7. The motor function was assessed in 13 items, and cognitive function was assessed in 5 items.[8] While the GCS and FIM are used extensively in rehabilitation, the relationship between the GCS and FIM scores regarding the rehabilitation outcomes of TBI is an important issue to understand rehabilitation settings. The main goal of this study was to assess the relationship between those 2 factors in order to improve their prognostic capabilities in the rehabilitation field, and to provide guidelines for determining which patients will be best served by rehabilitation therapies.

Methods. The experimental-design study was conducted using data from 51 patients treated for TBI in patient rehabilitation. Written informed consent was obtained from all subjects according to the human research committee guidelines of Jordan University of Science and Technology (JUST), Irbid, Jordan at an inpatient rehabilitation center at JUST between 2006 and 2008. The studies plan was explained to all participants. Rehabilitation was provided with an individualized care plan based on injury and severity of each case, which included physical therapy services for 40 minutes; 5 days a week. Additional services such as occupational therapy, speech pathology and psychology were provided as needed. Of the 51 participants, 47 completed the study. Inclusion and exclusion criteria required that participants in the study had TBI and were medically stable for rehabilitation according to their medical doctors. Functional independence measure scores were obtained at admission and discharge. The motor and cognitive sections of the FIM were computed as individual subscale scores and collectively as the total FIM score. The FIM was administered by 3 physical therapists within 48 hours of admission to the rehabilitation unit and within 24 hours of discharge from the rehabilitation unit. The GCS was evaluated 48 hours after the initial admission by 2 physical therapists; both of them were trained to use FIM and GCS. According to the severity of GCS, the 47 participants were divided into 3 groups; severe injury (GCS: 3-8, n=24), moderate injury (GCS: 9-12, n=12), and mild or no injury (GCS: 13-15, n=11). Four patients did not finish the rehabilitation program upon their request, because they moved to another country and we were unable to measure the FIM on their discharge.

Paired t-test was used to detect the significance level between the FIM score at admission and on discharge. Ninety-five percent confidence interval of $p<0.05$ was considered significant. We used the SPSS version 10.0 to perform the statistical analysis in this study.

Results. Subject demographics according to GCS are listed in **Table 1**. There were far more males admitted for rehabilitation with a diagnosis of TBI as compared to females. The participants' mean age was 33 years. Their average length of hospitalization was 81 days, with 63 days at the in patient rehabilitation facility. The

Table 1 - Patients demographics and their FIM score results (n=47).

Variables	GCS severe	GCS moderate	GCS minimal
Patient			
Male (mean age [years])	20 (34)	10 (32)	9 (33)
Female (mean age [years])	4 (30)	2 (31)	2 (31)
FIM (mean ± SE)			
Admission	30.7 ± 3.5	81.5 ± 6.9	105.5 ± 19.0
Discharge	49.9 ± 5.8	89.2 ± 2.6	109.8 ± 7.4

GCS - Glasgow coma scale
FIM - functional independent measure, SE - standard error

average time from injury to rehabilitation was 21 days. The 2 main causes of TBI were motor road traffic crush (n=41, [87%]) and falls from height (n=6, [13%]). Based on the GCS scores, the subjects were divided into severe, moderate, or minimal brain injury. Twenty-four participants had GCS scores that placed them in the severe category on admission (**Table 1**). The mean GCS score for the severe category was 5.9 ± 1.8. Twelve participants were placed in the moderate category based on their GCS scores. Their average GCS score for the moderate group was 10.3 ± 1.2. Eleven people had minimal brain injury according to their GCS scores (13.5 ± 0.6). In the severe group the mean admission FIM was 30.7. The moderate group FIM was 81.5 and the score for the minimal group was 105.5. Evaluation outcomes revealed significant improvements in the FIM scores after rehabilitation (p=0.00006) in severe TBI group. In those with moderate TBI, the FIM score also significantly improved (p=0.0004). However, in the minimal injury group the FIM did not significantly improve during the course of rehabilitation (p=0.15).

Discussion. Rehabilitation following TBI is very important to return the patients to their normal life. Several research studies have shown significant improvements that can be made in people with TBI with rehabilitation.[9,10] The evaluation of the rehabilitation outcomes in TBI has been usually addressed in terms of the length of stay in the hospital,[11-13] age,[14-16] or other variables such as nursing efforts during the medical rehabilitation of TBI patients.[17] In this study, we evaluated the rehabilitation outcomes of TBI in relation to their severity score based on the GCS. The results of our study showed a significant improvement of the most severely injured group according to the GCS classification, followed by the moderately injured group. There was no significant improvement in the FIM before and after rehabilitation, in the minimally injured group. This may be because the minimal-injury group had fewer participants compared to the severely injured group. A study by Cowen et al,[18] aimed at determining the relationship between GCS and FIM scores, found that patients in the severely impaired (GCS: 3-7) group showed significantly lower mean admission and discharge motor scores than patients in the mildly impaired. These findings are in agreement with our results showing that even with rehabilitation, the severe injury group had a lower FIM score at discharge. In spite of the lower discharge score, the amount of improvement is greater in the severe group. These results are in agreement with Toschlog et al study,[19] in which they tested the relationship of the injury severity score and GCS to rehabilitative potential in patients suffering TBI. They found that severely injured TBI patients had a better rehabilitative gain toward functional independence when compared with those less severely injured. These results emphasize the need for early rehabilitation intervention for TBI. In a separate study, Whitlock and Hamilton[20] defined the functional status of people with TBI at rehabilitation discharge. They concluded that even the most severely disabled persons admitted for acute rehabilitation after TBI could show a large degree of measurable functional improvement.[20] Early intervention for TBI in this study is also in agreement with other studies by Sorbo et al,[21] which showed that severe TBI patients who received early formalized rehabilitation had a better functional outcome and better frequency of return to work.

Worldwide, TBIs are most common in young males and mainly due to road traffic crush. As noted in **Table 1** of this study, the mean age for all participants was 33.6 years of age. Thus, the results from this study are best applied to the young TBI patient. In agreement with Worsowicz et al's[22] study, our result shows that the disability measure of FIM score improvement was greater in younger individuals. The fact that the patients in the minimally-injured group showed no significant difference in the FIM score at admission and discharge may be due to a ceiling effect. The maximum FIM score is 126 and our subjects approached that value in the minimal and moderate groups at discharge. As the minimally-injured group started with a high FIM score, a significant increase was more difficult to attain. This limitation has been noted before as a ceiling effect was measured using the FIM for post-rehabilitation assessment in those with moderate and severe TBIs.[23]

The most interesting finding of the study was the lack of correlation between the GCS score and the FIM, either at admission or discharge. While this may seem alarming, these assessment tools look at completely different aspects of brain injury. It is important for health care professionals in the field to avoid making predictions and prognoses based on the admission GCS for young TBI patients. The GCS is important for determining the severity of the head trauma early in the hospitalization, but it appears to have little predictive ability for the functional outcome of the person at discharge. Information on patients on admission or initial observation such as dizziness, headache, and amnesia was not included in the study. It is possible that the type of brain injury and information of initial observation could explain the lack of association between the initial GCS score and FIM in our patients, and is a limitation of this study.

In conclusion, while the GCS and FIM assessment tools have been used extensively in the field of rehabilitation, a relationship between them has not

been studied from rehabilitation view. In this report, we found that severely and moderately injured TBI patients significantly improved their functional abilities with early rehabilitation.

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