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## The use of Functional Capacity Scale in the Assessment of Patients with Traumatic Brain Injury — Multicenter Studies

## Zastosowanie Skali Wydolności Funkcjonalnej w ocenie pacjentów po urazach czaszkowo-mózgowych — badania wielośrodkowe

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### Abstract

**Introduction.** One of the most serious life and health hazards of a modern man are injuries, one of which is traumatic brain injury (TBI). Among functional scales that are most commonly used for the assessment of the condition of a patient after TBI we can distinguish the Modified Rankin Scale, Disability Rating Scale (DRS), Barthel Index, Functional Independence Measure (FIM), Glasgow Outcome Scale and Extended Glasgow Outcome Scale (GOSE).

**Aim.** The main aim of this work was to present Functional Capacity Scale in the assessment of patients after traumatic brain injury.

**Material and Methods.** In the multicenter studies, there were 159 patients examined. They were hospitalized in neurosurgical wards in Bydgoszcz, Lublin and Wrocław due to traumatic brain injury. The research was based on twofold assessment (on the day of admission — assessment 1 and discharge — assessment 2) of the condition of a patient after traumatic brain injury with the use of standardized research tools such as *Glasgow Coma Scale* (GCS), *Functional Capacity Scale* (FCS) and *Glasgow Outcome Scale* (GOS). The method used was direct observation with measurement.

**Results.** The average result of functional capacity in FCS was 34,41 points (71.7%) on the day of admission, and 41,87 points (87.2%) on the day of discharge. After analyzing the differences between the FCS results of men and women, there was no difference between gender groups that would be statistically significant ( $p > 0.05$ ) both on the day of admission and discharge. The age groups remained in statistically significant, low correlation with the results of FCS on the day of admission ( $R = 0.261$ ;  $p = 0.001$ ) and were on the edge of significance ( $R = 0.140$ ;  $p = 0.088$ ) on the day of discharge. The place of residence did not differentiate ( $p > 0.05$ ) the functional capacity assessed with FCS. The results of FCS remained in statistically significant correlation with GCS results ( $p < 0.05$ ) both on the day of admission and discharge and GOS ( $p = 0.000$ ) results on the day of discharge.

**Conclusions.** The FCS scale, suggested for functional assessment of patients with traumatic brain injury, is a tool that appropriately recognizes the functional condition of a patient with traumatic brain injury. It substantially correlates with GCS and GOS, which denotes that its construction and prognostic features are accurate. (JNNN 2014;3(4):175–182)

**Key Words:** traumatic brain injury, Functional Capacity Scale

### Streszczenie

**Wstęp.** Jednym z najpoważniejszych zagrożeń dla życia i zdrowia współczesnego człowieka są urazy, a wśród nich urazy czaszkowo-mózgowe (traumatic brain injury — TBI). Spośród skal funkcyjnych najczęściej używanych do oceny stanu chorego po TBI należy wymienić zmodyfikowaną skalę Rankina (Modified Rankin Scale), skalę niepełnosprawności DRS (Disability Rating Scale), wskaźnik Barthel (Barthel Index), skalę niezależności funkcjonalnej

FIM (Functional Independence Measure) oraz skalę Glasgow wyników końcowych w wersji oryginalnej (Glasgow Outcome Scale) i rozszerzonej GOSE (Extended Glasgow Outcome Scale).

**Cel.** Głównym celem pracy było przedstawienie Skali Wydolności Funkcjonalnej w ocenie pacjentów po urazach czaszkowo-mózgowych.

**Materiał i metody.** W badaniu wielośrodkowym uczestniczyło 159 pacjentów oddziałów neurochirurgii hospitalizowanych w Bydgoszczy, Lublinie i we Wrocławiu z powodu urazu czaszkowo-mózgowego. Badanie polegało na dwukrotnej ocenie (w dniu przyjęcia — ocena 1 i w dniu wypisu — ocena 2) stanu chorego po urazie czaszkowo-mózgowym za pomocą standaryzowanych narzędzi badawczych *Glasgow Coma Scale* (GCS), *Functional Capacity Scale* (FCS) and *Glasgow Outcome Scale* (GOS). W tym celu zastosowano obserwację bezpośrednią z wykorzystaniem pomiaru.

**Wyniki.** Średni wynik wydolności funkcjonalnej według skali FCS w dniu przyjęcia wyniósł 34,41 punktu (71,7%), a w dniu wypisu 41,87 punktu (87,2%). Poddając analizie różnice w wynikach w FCS pomiędzy kobietami a mężczyznami nie odnotowano istotnej statystycznie różnicy ( $p>0,05$ ) pomiędzy grupami płci, zarówno w dniu przyjęcia jak i w dniu wypisu. Grupy wiekowe pozostawały w istotnej statystycznie, niskiej korelacji z wynikami FCS w dniu przyjęcia ( $R=0,261$ ;  $p=0,001$ ) i na granicy istotności ( $R=0,140$ ;  $p=0,088$ ) w dniu wypisu. Miejsce zamieszkania nie różnicowało ( $p>0,05$ ) wydolności funkcjonalnej ocenionej w FCS. Wyniki FCS pozostawały w istotnej statystycznie korelacji z wynikami GCS ( $p<0,05$ ) zarówno w dniu przyjęcia jak i wypisu oraz wynikami GOS ( $p=0,000$ ) w dniu wypisu.

**Wnioski.** Zaproponowana do oceny funkcjonalnej pacjentów po urazie czaszkowo-mózgowym skala FCS jest narzędziem trafnie rozpoznającym stan funkcjonalny chorego. Istotnie koreluje z GCS i GOS, co wskazuje na jej prawidłową konstrukcję i właściwości prognostyczne. (PNN 2014;3(4):175–182)

**Słowa kluczowe:** uraz czaszkowo-mózgowy (traumatic brain injury), Functional Capacity Scale

## Introduction

One of the most serious life and health hazards of a modern man are damages, one of which is traumatic brain injury (TBI). Damages appear as the result of the influence of short mechanical cranium injury. The frequency of the TBI occurrence, which is of upward tendency, is estimated for about 200–300/100 000 annually, considering that the mild and serious injuries oscillate between 20% and 30%; those injuries are also considered to be one of the main cause of men's deaths in Poland [1–5]. There are various divisions of TBI. The basic one distinguishes open and closed brain injuries. They can occur both as single isolated damages and in various combinations. Closed injuries often require conservative treatment. However, in the case of cranial bone fracture the surgical treatment is often unavoidable.

The seriousness of the issue of TBI is proved by the fact that injuries are more common cause of deaths of patients who are below 34 years, when compared with any other diseases. Traumatic brain injury is an extremely difficult issue, because it is the most common constituent of multiorgan injuries, referring mostly to young people (most commonly men at the age of 15–24). Their course is insidious and often severe and the prognosis of convalescence and normal functioning in society is precarious.

Patients with traumatic brain injury require intensive care in the scope of the nervous, cardiovascular, respiratory and urinary systems. In care of those who are seriously ill, particular significance is assigned to the level of consciousness. For this aim, the most commonly used scale is Glasgow Coma Scale (GCS). It evaluates three

basic activities of a patient (eye, verbal and movement reaction) and it can assess quantitative consciousness impairment in a simple way. We use it to monitor the neurological condition of patients, aiming at the dynamics of the process of a disease. Beside the consciousness condition, we can also assess other neurological symptoms that can denote increased intracranial pressure, like for example: the wideness and pupils' reaction, meningeal signs, spasm, paresis or Babinski sign. The other issue that needs to be carefully studied is cardiorespiratory capacity of a patient. For this reason we assess the basic cardiovascular parameters (blood pressure, pulse rate and skin colouration), respiratory (the number of breaths per minute, the type of breath, SpO<sub>2</sub>). The centers with proper medical equipment can determine central venous pressure (CVP), invasive (intra-arterial) blood pressure (IBP), partial pressure of carbon dioxide (pCO<sub>2</sub>), cerebral venous oxygen saturation (SjO<sub>2</sub>), intracranial pressure (ICP), perfusion pressure (CPP) or the partial oxygen pressure. In the case of care of a patient with hematoma, particular assessment should be made on water-mineral and acid-base balance. It appears to be significantly important in the case when a patient is under antiedema and diuretic therapy. For this reason, we monitor daily fluid balance, morphology, the level of electrolytes, glucose, creatinine and urea [6–11].

Among functional scales most commonly used for the assessment of a patient there are Modified Rankin Scale [12,13], Disability Rating Scale (DRS) [14,15], Barthel Index [16,17], Functional Independence Measure (FIM) [18,19] Glasgow Outcome Scale and Extended Glasgow Outcome Scale (GOSE) [20–24].

So far, there have been many works already written on traumatic brain injuries and their functional consequences (mainly with reference to the quality of life). In Poland, despite the dynamic development of neurotraumatology, the number of works written on that topic is still very low, particularly in the functional sphere.

The main aim of this work was to present the Functional Capacity Scale in the assessment of patients after traumatic brain injury.

## Material and Methods

### Subjects

The multicenter studies comprised 159 patients of neurosurgical wards, hospitalized in Bydgoszcz, Lublin and Wrocław due to traumatic brain injury. The considerable majority were men — 113 people (71.7%). The average age of patients was over 55 years (to be exact 55 years and 2 months). The average age of women appeared to be higher — nearly 64 years (63 years and 10 months), when compared to the average age of men — nearly 52 years (51 years and 8 months). The standard deviation is over 36% of an average value, which means that there is a great variety when it comes to age. The minimal age

is differentiated, lower in the group of men — 16 years. Maximal age is also differentiated, higher in the group of women — 93 years. Due to the significance level ( $p < 0.05$ ), it was noted that there is statistically significant difference between men and women that refers to age. In the initial phase, the patients were divided into seven age groups: 30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, 71–80 years and 81 and over 81 years. The most numerous was the group between 51–60 years — 38 patients (23.9%). The lowest number was in the group between 61 and 70 years — 18 patients (11.3%). Most of the examined patients declared that their place of residence is a city — 115 patients (72.3%). Only one out of every four patients is a countryside resident. The most numerous group were patients hospitalized for 4–6 days — 57 patients (38.0%). The least numerous was the group of patients hospitalized over 10 days — 24 patients (16.0%). In the group of 159 there were 9 deaths noted (5.9%) (Table 1, Figure 1).

Table 1. The characteristic of a group examined

	N=159 (100%)
Gender	
Woman	46 (28.9)
Man	113 (71.1)
Age	
to 30 years	22 (13.8)
31–40 years	19 (11.9)
41–50 years	19 (11.9)
51–60 years	38 (23.9)
61–70 years	18 (11.3)
71–80 years	21 (13.2)
81 years and more	22 (13.8)
Place of residence	
Countryside	44 (27.7)
City	115 (72.3)
Hospitalization period	
1–3 days	42 (28.0)
4–6 days	57 (38.0)
7–10 days	27 (18.0)
Over 10 days	24 (16.0)

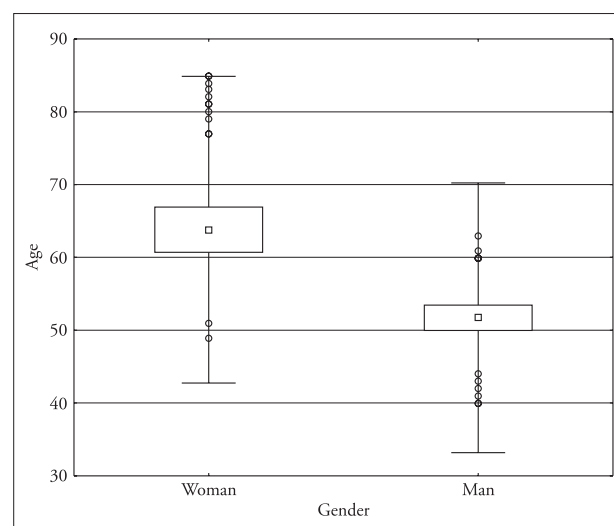


Figure 1. The presentation of average age with reference to gender groups

### Procedure

The research was based on twofold assessment (on the day of admission — assessment 1 and discharge — assessment 2) of the condition of a patient after traumatic brain injury with the use of standardized research tools such as Glasgow Coma Scale (GCS), Functional Capacity Scale (FCS) and Glasgow Outcome Scale (GOS). The method used was direct observation with measurement.

### Instruments

The consciousness level of the respondents was assessed with the Glasgow Coma Scale [25], with the acceptance of the following criteria: mild injury (15–13

points), moderate (12–9 points), severe — unconsciousness (8–3 points). Functional capacity was assessed with the use of the Functional Capacity Scale (FCS) [26,27], in which the deficit of care was classified as: I group (48–40 points) — independence (self-sufficient patient), II group (39–31 points) — moderate independence (patient needs help), III group (30–21 points) — moderate dependence (patient needs significant help), IV group — 20–12 points — dependence (patient needs intensive care). For the assessment of final results there was Glasgow Outcome Scale used [20], in which 5 means convalescence (good recovery), 4 — moderate disability, 3 — severe disability, 2 — persistent vegetative state, 1 — death.

*Statistical Analysis*

All the calculations and figures were prepared with the use of Microsoft Excel and Statistica version 10.0. The interdependence between two variables was calculated

with Spearman correlation index (R). The significance level of  $\leq 0.05$  was accepted as statistically significant.

*Ethical Approval*

The study obtained consent of the Bioethics Commission of the Nicolaus Copernicus University in Toruń at Ludwik Rydygier Collegium Medicum in Bydgoszcz (KB no. 291/2013).

**Results**

Analyzing the functional capacity of a patient on the admission day, it has appeared that most of the patients belong to group II of moderate independence — 59 patients (39.3%). The least number are patients belonging to IV group of dependence — 14 patients (9.3%). On discharge day, most of the patients are those of I group of independence — 112 patients (74.7%), the least

Table 2. The functional capacity of patients in the assessment with the use of FCS

FCS	Admission day	Discharge day
	N (%)	N (%)
I group; patient does not need assistance/independence	48 (32.0)	112 (74.7)
II group; patient needs assistance/moderate independence	59 (39.3)	23 (15.3)
III group; patient needs significant help/moderate dependence	29 (19.3)	6 (4.0)
IV group; patient needs intensive care/dependence	14 (9.3)	9 (6.0)
Total	150 (100.0)	150 (100.0)
mean $\pm$ standard breathing – $\bar{x} \pm SD$	34.1 $\pm$ 9.855	41.87 $\pm$ 9.414

Table 3. Care markers of FCS

Care markers of FCS	Admission day			Discharge day		
	$\bar{x}$	SD	%	$\bar{x}$	SD	%
1. Ambulation	2.46	1.053	61.5	3.33	0.988	83.3
2. Alimentation	2.75	1.036	68.8	3.46	0.910	86.5
3. Personal hygiene	2.51	1.073	62.8	3.29	0.985	82.2
4. Physiological needs	2.55	1.078	63.7	3.37	0.973	84.3
5. Life functions measurement — (GCS)	2.89	1.053	72.2	3.65	0.811	91.3
6. Breathing	3.58	0.907	89.5	3.71	0.771	92.8
7. Diagnosis	3.19	0.932	79.8	3.65	0.787	91.2
8. Pre- and post surgical treatment	3.21	1.012	80.2	3.62	0.808	90.5
9. Dressing and drainage	3.31	1.003	82.7	3.42	0.846	85.5
10. Acuteness of pain	2.49	0.903	62.3	3.43	0.830	85.7
11. Pharmacotherapy	2.51	0.857	62.7	3.45	0.848	86.2
12. Neuropsychological outcome	2.96	0.989	74.0	3.49	0.841	87.3

$\bar{x} \pm SD$  – mean  $\pm$  standard deviation

number refers to group III — moderate dependence — 6 patients (4.0%) (Table 2).

Analyzing the care indicators on the day of admission, the highest results were noted with reference to — breathing — mean 3.58 points (89.5%), dressing and drainage — mean 3.31 points (82.7%), pre- and post surgical treatment — mean 3.21 points (80.2%). The lowest results, however, were obtained with reference to pharmacotherapy — mean 2,51 points (62.7%), the acuteness of pain — mean 2.49 points (62.3%) and ambulation — mean 2.46 points (61.5%). On the discharge day, the highest results were obtained in the case of: breathing — mean 3.71 points (92.8%), life functions measurement — (GCS) — mean 3.65 points (91.3%) and diagnostics — mean 3.65 points (91.2%). The lowest results were obtained in the case of: physiological needs — mean 3.37 points (84.3%), ambulation — mean 3.33 points (83.3%) and personal hygiene — mean 3.29 points (82.2%). Generally, in the case of all of the care factors, there was an increase of the mean value of the scores. The highest result was obtained in the case of: pharmacotherapy — 23.5%, the acuteness of pain — 23.3% and ambulation — 21.8%. The lowest result was obtained in the case of: pre- and post surgical treatment — 10.3%, breathing — 3.3% and dressing and drainage — 2.8% (Table 3). An average result of

functional capacity measured with FCS on the day of admission was 34.41 points (71.7%). On the day of discharge it increased to 41.87 points (87.2%) (Figure 2).

After the analysis of the difference between the results of FCS between men and women, it was assumed that there was no statistically significant difference ( $p>0.05$ ), between gender groups, both on the admission and discharge day.

Most of the independent patients on the admission day are people below 30 years — 13 patients (59.1%). The next group is 31–40 years — 8 patients (42.1%), patients at the age of 51–60 — 12 patients (34.3%), the age of 61–70 — 4 patients (23.2%) and the age of 41–50 — 4 patients (22.2%). The lowest number are patients between 81 and 90 years — 3 patients (16.7%). Generally, the most independent patients on the admission day were people below 30 years old. They are followed by patients at the age of 30, 31–40, 51–60, 61–70 and 41–50 years. The least dependent were patients at the age of 71–80. The age groups remained in statistically significant, low correlation with FCS results on the admission day ( $R=0.261$ ;  $p=0.001$ ). The results on the discharge day were on the edge of significance ( $R=0.140$ ;  $p=0.088$ ) (Table 4).

The place of residence also did not differentiate ( $p>0.05$ ) the functional capacity (the assessment with the use of FCS of population examined both on the admission and discharge day).

It has been observed that on the admission day, all of the independent, self-reliant patients (I group FCS) have mild consciousness impairment. When it comes to the group of patients of slight dependence (II group FCS) — 4 patients (6.8%) presented mild consciousness impairment. Similar dependence was observed on the day of discharge, when patients who are independent in their everyday life activities showed results of 15–13 points in GCS. Whereas, in the group of patients dependent from their surroundings, there were no patients with mild consciousness impairment noted. The results of GCS remained in statistically significant correlation (on the edge of high correlation level) with the results of FCS both on the day of admission and discharge ( $p<0.05$ ) (Table 5).

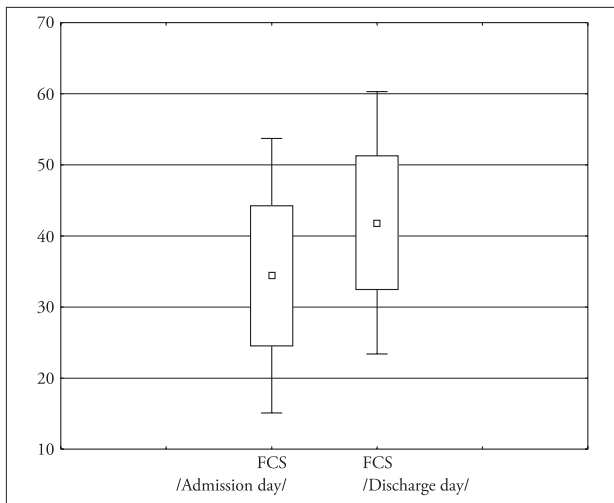


Figure 2. The presentation of the results of general means in FCS

Table 4. The presentation of the FCS results in gender groups on the admission day

FCS	Age N (%)						
	to 30 years	31–40	41–50	51–60	61–70	71–80	81–90
I (48–40 points)	13 (59.1)	8 (42.1)	4 (22.2)	12 (34.3)	4 (23.5)	4 (19.0)	3 (16.7)
II (39–31 points)	5 (22.7)	9 (47.4)	9 (50.0)	12 (34.3)	7 (41.2)	10 (47.6)	7 (38.9)
III (30–21 points)	3 (13.6)	2 (10.5)	1 (5.6)	8 (22.9)	5 (29.4)	3 (14.3)	7 (38.9)
IV (20–12 points)	1 (4.5)	0 (0.0)	4 (22.2)	3 (8.6)	1 (5.9)	4 (19.0)	1 (5.6)
Total	22 (100.0)	19 (100.0)	18 (100.0)	35 (100.0)	17 (100.0)	21 (100.0)	18 (100.0)

Table 5. The presentation of the results of FCS and GCS on the admission and discharge day

FCS	GCS					
	Admission day			Discharge day		
	I (15–13 p.)	II (12–9 p.)	III (8–3 p.)	I (15–13 p.)	II (12–9 p.)	III (8–3 p.)
I (48–40 points)	48 (100.0)	0 (0.0)	0 (0.0)	112 (100.0)	0 (0.0)	0 (0.0)
II (39–31 points)	55 (93.2)	4 (6.8)	0 (0.0)	21 (91.3)	2 (8.7)	0 (0.0)
III (30–21 points)	15 (51.7)	9 (31.0)	5 (17.2)	1 (16.7)	3 (50.0)	2 (33.3)
IV (20–12 points)	0 (0.0)	2 (14.3)	15 (85.7)	0 (0.0)	2 (22.2)	7 (77.8)
	N=150 R=-0.652; p=0.000			N=150 R=-0.687; p=0.000		

Table 6. The presentation of results of the assessment with the use of FCS and GOS on the discharge day

FCS	GOS			
	5	4	3	2
I (48–40 points)	89 (98.9)	18 (75.0)	4 (18.5)	0 (0.0)
II (39–31 points)	1 (1.1)	6 (25.0)	15 (55.6)	1 (1.1)
III (30–21 points)	0 (0.0)	0 (0.0)	5 (18.5)	1 (11.1)
IV (20–12 points)	0 (0.0)	0 (0.0)	2 (7.4)	7 (77.8)
Total	90 (100.0)	24 (100.0)	27 (100.0)	9 (100.0)

In the group of patients qualified as ill, a person can continue her/his normal life (5 GOS). Most of the patients are qualified as independent patients in FCS — 89 participants (98.9%). There is a similar situation in the group of mild disability (4 GOS) — an independent patient — 18 patients (75.0%). In the group of patients of serious disability (3 GOS), most of participants are patients slightly dependent in FCS — 15 people (55.6%). In the group of patients in vegetative condition (2 GOS), most of the patients are qualified as dependent patients — 7 people (77.8%). The results of FCS, remained in statistically significant, high correlation with the results of GOS (R=-0.784; p=0.000) (Table 6).

## Discussion

Brain injuries caused by rapid hit or acceleration (braking) of head movement belong to the group of most common neurological diseases [28]. Most of the hospitalized patients can be saved and after a few months their life expectancy and the risk of death do not considerably depart from those of general population [29,30]. Unfortunately, the intracranial pathology determined with damage can cause neurological, physical deficit and the deficit of cognitive and psychosocial functions, which along with post-traumatic stress, lead to various functional impairments [30].

The life expectancy of both patients after TBI and the population of disabled people in general, depends from the following problems, which the patients have

to deal with: immobilization, urinary and fecal incontinence, aphagia, uncontrolled and early epilepsy and serious cognitive and intellectual loss. In the context of those issues the most important thing appears to be the assessment of the functional condition of a patient; in our own research it was FCS. The results obtained show that on the day of hospital admission about 29% of respondents required considerable or intensive help in the range of everyday activities; whereas the amount of such patients on the day of discharge was 10%. On the basis of the literature overview, it can be assumed that the limits of ability after mild and serious injury, after the period of at least one year since hospitalization, oscillate between a dozen or so and 50% of patients, including 15% of those who need constant help [31]. It is worth to add that, the results of those measurements clearly correlate with the age — the older the patient is, the higher functional limitations are, which complies with the claims of other authors [32]. Our own studies did not show any correlation of the results of functional capacity with gender or the patients' place of residence.

Literature says that there is a reliable way to determine the treatment prognosis after traumatic brain injury [33]. However, using Glasgow Coma Scale (GCS) there is a possibility of some generalizations, such as: the lower initial classification in GCS is — the worse treatment result or the longer coma period is — the worse treatment result. Presented results clearly show that there was a correlation between GCS and FCS obtained.

Literature shows that about 50% of patients, who survived severe traumatic brain injury, have moderate or

serious disability assessed with GOS [34]. In our own research, those patients were 24%. In this case, there was also noted a significant correlation between the result of GOS and FCS.

## Conclusions

The FCS scale, suggested for functional assessment of patients with traumatic brain injury, is a tool that appropriately recognizes the functional condition of a patient with traumatic brain injury. It substantially correlates with GCS and GOS, which denotes that its construction and prognostic features are accurate.

## Implications for Nursing Practice

This study presents the results of multicenter research with reference to the functional capacity of patients after traumatic brain injury in the early period of hospitalization. The FCS was presented as a tool suggested for the assessment of the patient's condition by nursing teams.

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