

# Comparative assessment of Barthel index and functional independence measure in providing rehabilitation care for military personnel with combined injuries

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## Abstract

In the structure of military traumatism, the number of multiple and combined wounds and injuries has increased significantly due to the expansion in the destructive properties of modern weapons. Establishing the correct rehabilitation diagnosis and subsequent stage-by-stage assessment of the results of rehabilitation therapy should be based on adequate functional assessment tools. The Barthel Index is the most widely used measure for assessing the ability to perform activities of daily living. However, recently, many authors have proposed using the Functional Independence Measure (FIM) for this purpose.

**Purpose.** The study aims to investigate the possibility of using the Barthel Index and Functional Independence Measure to assess the effectiveness of rehabilitation of military personnel with combined injuries over a long period.

**Material & Methods.** We conducted a retrospective study of 807 wounded military personnel with complex injuries of varying severity. Our examination included a meticulous analysis of medical records, a comprehensive physical examination, and a survey using the Barthel Index and FIM scale. Due to the nature of the injuries, the servicemen were provided with standard rehabilitation programs.

**Results.** All patients were classified as lightly injured and moderately injured according to the Abbreviated Injury Scale. The initial data in evaluating functioning on the FIM scale made it possible to identify subgroups of patients with a predominance of motor function impairment and a predominant impairment of cognitive functions. Patients with combined TBI should receive more rehabilitation measures to improve cognitive and mental functions, socialization, and communication skills.

**Conclusions.** The inclusion of the FIM scale in the recommended toolkit for assessing the effectiveness of rehabilitation will allow for additional objectification of rehabilitation care and the formulation of individual recommendations for achieving the best results.

**Keywords:** Rehabilitation, combined wounds, Barthel Index, Functional Independence Measure.

## Introduction

In the structure of military traumatism, the number of multiple, combined wounds and injuries has increased significantly due to the expansion in the destructive properties of modern

weapons (Khomenko et al., 2022; Chernozub et al., 2024). Most blast wounds are characterized by multiple damage to blood vessels, nerve fibers, and significant defragmentation of muscles and skin (Shakargy et al., 2023). The treatment of



contemporary combat trauma and restoration of the combat capability of wounded soldiers largely depends on adequate rehabilitation measures. Military personnel with multiple craniocerebral injuries, amputations, burns, etc., need long-term rehabilitation care. Therefore, the standardized approach to the rehabilitation process is of particular importance. The research of various aspects of the organizational and methodological foundations of the military personnel rehabilitation system in different countries demonstrates the need to improve methods for monitoring the effectiveness and quality of the rehabilitation (Olkhovyi et al., 2020, Babov, 2023; Klyce et al., 2024). Establishing the correct rehabilitation diagnosis and subsequent stage-by-stage assessment of the results of rehabilitation therapy should be based on adequate functional assessment tools (Lurin et al., 2023; Belrose et al., 2019). The Barthel Index is the most widely used measure for assessing the ability to perform activities of daily living (ADL). (Barros et al., 2022; Dos Reis et al., 2022; Gao et al., 2021). However, recently, a significant number of authors have proposed using the Functional Independence Measure (FIM) for this purpose as more differentiated one (García-Rudolph et al., 2024; Maritz et al., 2022; Mellick, 2023). Simultaneously, there is virtually no data on using these scales to assess the ability to perform everyday activities in patients with complex injuries. So, this idea formed the basis of this work.

*The study aims* to investigate the possibility of using the Barthel Index and Functional Independence Measure to assess the effectiveness of rehabilitation for military personnel with combined injuries over a long period of time.

## Material and methods

### *Participants*

We conducted a retrospective study of 807 wounded patients in 2023 who were admitted to the Arcadia Clinical Sanatorium of the State Border Service of Ukraine, Odesa. The examination included an analysis of medical records, an examination, and a survey using the FIM scale. A statistical analysis of the nature, localization, severity, and prevalence of injuries was performed. These studies were conducted following the principles of bioethics set out in the Helsinki Declaration and the General Declaration on Bioethics and Human Rights (UNESCO). The studies were approved by the Biomedical Ethics Committee of the State Institution "Ukrainian Research Institute of Medical Rehabilitation and Resort Therapy of the Ministry of Health of Ukraine", (Protocol No. 4 dated 05/23/2024). Before being involved in the study, patients gave informed written consent to participate.

**Inclusion criteria:** combined injuries of the musculoskeletal system, traumatic brain injury, and injury of the musculoskeletal system.

**Exclusion criteria:** combined injuries of the musculoskeletal system and internal organs.

### *Study design*

Due to the nature of the injuries, the servicemen were provided with standard rehabilitation programs, the effectiveness of which was assessed using recommended rehabilitation tools (Potcovaru et al., 2024).

Rehabilitation treatment was carried out by a multidisciplinary team, including a physical and rehabilitation medicine physician, a physical therapist and his assistants, a traumatologist, a neurologist, a psychologist, and, if necessary, other specialists. In most cases, rehabilitation treatment lasted 30 days. The rehabilitation complex was based on physical therapy, the tasks of which were formed according to the specific rehabilitation goal of each patient. Thus, with the prevailing consequences of TBI, the main tasks were to reduce headaches, improve motor skills and coordination, and normalize the tone of the muscles of the trunk and limbs. In the case of neuropathies, post-traumatic, and post-mobilization contractures, the main thing was to improve motor skills, both general and in the affected limbs, increase the range of motion in the joints, and increase muscle strength.

The rehabilitation complex included classes on various exercise equipment, namely a roller trainer, an exercise bike, a treadmill, and soft and balancing platforms. Devices for continuous passive development of movements in the joints of the limbs were actively used. Hardware physiotherapy treatment was prescribed to all patients depending on the manifestations of the TBI symptom complex and the type of limb damage: magnetotherapy, low- and high-intensity laser therapy, electrical myostimulation, sinusoidal modeled current therapy, and darsonvalization.

The rehabilitation treatment complex also included balneological procedures in the form of baths and showers. All patients received classical therapeutic massage, general or in local areas. Psychological rehabilitation was carried out in the form of psychotherapy sessions using individual or group methods.

Additionally, the effectiveness of the rehabilitation was assessed using the Barthel Index and FIM scale. The initial functional status of patients was assessed one week after admission to the sanatorium, after the adaptation period.

The Barthel Index consists of 10 activity indicators: Eating, Bathing, Personal hygiene (washing, brushing teeth, shaving, combing hair), Dressing, Bowel control, Urinary control, Toilet

use, Moving (from bed to chair and back), Ability to move on level ground, Climbing stairs. Each item is assessed from 0 to 10 points. A total score of 45-50 points corresponds to severe disability and dependence on outside help, 50-75 points indicate moderate dependence and 75-100 points indicate minimal limitation or restoration of lost neurological functions. The Barthel Index consists of 10 activity indicators: Eating, Bathing, Personal hygiene (washing, brushing teeth, shaving, combing hair), Dressing, Bowel control, Urinary control, Toilet use, Moving (from bed to chair and back), Ability to move on level ground, Climbing stairs. Each item is assessed from 0 to 10 points. A total score of 45-50 points corresponds to severe disability and dependence on outside help, 50-75 points indicate moderate dependence, and 75-100 points indicate minimal limitation or restoration of lost neurological functions (Wang et al., 2023; Lee et al., 2022).

The FIM scale consists of 18 items assessing 6 functional categories. The elements are divided into two groups: motor (13 parts) and cognitive (5 parts) (Granger et al., 1993). The FIM scale was used to assess the following areas of activity: self-care (eating, hygiene, bathing, dressing the upper body, dressing the lower body, using the toilet), sphincter control, transfer (bed/chair/wheelchair, toilet, bath/shower), ambulation (walking/moving in a wheelchair, walking upstairs), communication (understanding, expression) and social awareness (activities: social relations, problem-solving, memory). Each area of activity involves the performance of specific tasks, the quality of which is assessed in points from 1 to 7. The value of each point is given in Table 1.

Interpretation of results: the possible total

score is (18-126); the scores are distributed between (13-91) for motor and (5-35) for cognitive categories. A higher score indicates greater patient independence. The minimum score (18) indicates complete patient dependence on others, while the maximum score of 126 indicates complete patient independence (Weinrebe et al., 2020).

#### Statistical analysis

Statistical data processing was performed using the XLSTAT 2016 statistical software package. The compliance of the clinical trial data distribution with the normal distribution law was checked using the Shapiro-Wilk test. To compare the quantitative data of the two groups, the Student's t-test was used. The Pearson correlation coefficient (r-Pearson) was calculated to study the relationship between two variables. The mean value and the error of the mathematical mean ( $M \pm m$ ) were used to describe the data. The results of comparisons were considered reliable if the error probability value was less than  $p < 0.05$ .

#### Results

All patients under our observation were classified as lightly injured and moderately injured according to the Abbreviated Injury Scale (AIS) (Table 2), which allows for determining the severity of the injury, the prognosis for life, justifying the choice of surgical treatment tactics and organizational and medical features of surgical care at the initial stage of medical evacuation (Rapsang et al., 2015). The initial severity of the injury is of great importance since it has the most significant impact on the effectiveness of further rehabilitation (Van Ditshuizen et al., 2021).

**Table 1. FIM Scoring Criteria**

	Description	Points
Patient does not need help	Full independence	7
	Modified independence (patient requires assistance using additional means, but not physical assistance)	6
Needs help (moderate dependence)	Supervision or accommodation	5
	Minimal assistance (patient can independently perform 75% or more of tasks)	4
	Moderate assistance (patient can independently perform 50% to 74% of tasks)	3
Patient does not need help	Maximum assistance (patient can do 25% to 49% of tasks independently)	2
	Totally requires assistance (patient can do less than 25% of tasks independently or requires assistance from more than one person)	1
	Patient is unable to perform daily activities	0

**Table 2. Distribution of injuries depending on the severity of the injury according to the AdTS, n, %**

Injury severity	Points	Number of injured	
		n	%
Non-severe	Less than 5	372	46,1
Moderate	5-7	435	53,9

Under the treatment, there was damage to the integrity of tissues, organs and systems due to specific morphological manifestations (brain damage, slaughter, crushing, enlargement, wound, dislocation, fracture, injury, injury, frost-bite, etc.). According to the definition, combined injuries were considered simultaneous injuries to the head and the musculoskeletal system, several injuries within different anatomical and functional areas. Multiple trauma is several injuries (by one or more projectiles) within one anatomical area of the body. Combined trauma is several injuries (by one or more projectiles) to two or more anatomical regions of the body (head, neck, chest, abdo-

men, pelvis, spine, limbs).

Patients were admitted for treatment and rehabilitation from hospitals and clinics' surgical, traumatology, and neurology departments. Mine-blast wounds and gunshot wounds of the musculoskeletal system predominated among the total number. The following groups were distinguished: closed craniocerebral trauma and uncomplicated spinal trauma (without damage to the spinal cord, spinal roots, or blood vessels); combined spinal trauma (several parts of the spine); uncomplicated spinal trauma and closed chest trauma; open chest trauma and upper limb trauma; gunshot fracture of the upper limbs; combined trauma of the upper and lower limbs; chest and pelvic trauma (Table 3).

The following results were obtained for various groups depending on the nature of the damage during the examination of patients according to the Barthel scheme (Table 4).

As Table 4 shows, the total score in all study groups was within 68-77 points, which indicates moderate dependence on outside help.

**Table 3. Distribution of servicemen by type of injury, n, %**

Nature of injuries	Absolute number, n.	Percentage of the total number, %
Closed TBI and uncomplicated spinal trauma	116	14,4
Combined spinal trauma	121	15,0
Uncomplicated spinal trauma and closed chest trauma	104	12,9
Open chest trauma and upper extremity trauma	96	11,9
Chest and pelvic trauma	100	12,4
Combined upper and lower extremity trauma	160	19,8
Closed TBI and limb trauma	110	13,6

**Table 4. Bartell Index indicators in different groups of wounded, M±m**

Bartell Index indicators Nature of lesions	Eating	Bathing	Toileting	Dressing	Bowel control	Urinary control	Toileting	Transfer	Ability to move on level ground	Climbing stairs	Total
Closed TBI and uncomplicated spinal trauma	6,6±1,1	3,6±0,8	4,1±0,6	6,1±1,1	8,0±1,7	7,9±1,6	7,5±1,1	10,3±2,5	10,1±2,1	6,1±1,9	70,3±2,5
Combined spinal trauma	6,4±1,0	3,5±0,9	3,9±0,7	6,2±1,4	7,9±2,0	7,7±1,6	7,4±1,1	9,8±1,7	9,6±1,7	5,8±1,9	68,2±2,0
Uncomplicated spinal trauma and closed chest trauma	7,9±1,1	4,1±0,9	4,4±1,1	6,5±1,2	8,7±2,1	8,5±1,8	8,3±1,7	11,2±1,9	10,2±2,0	6,2±1,8	76,0±2,1
Open chest trauma and upper extremity trauma	7,6±1,0	3,9±0,7	4,2±0,8	6,0±1,1	8,9±1,9	8,8±1,9	8,6±1,9	10,8±2,3	11,2±2,6	7,2±2,1	77,2±2,6
Chest and pelvic trauma	7,2±1,1	3,4±0,6	4,5±0,9	7,8±1,9	7,2±1,6	7,0±2,0	6,9±2,1	9,9±2,2	9,1±2,3	6,1±1,9	69,1±2,3
Combined upper and lower extremity trauma	8,4±1,6	2,9±0,7	3,9±1,0	6,3±1,2	9,1±2,0	8,8±1,5	7,7±2,4	9,7±2,1	9,4±2,2	6,2±2,5	72,4±2,5
Closed TBI and limb trauma	6,8±1,0	3,9±0,6	4,0±0,9	6,5±1,4	8,6±1,9	8,4±1,9	7,9±2,2	9,8±2,1	9,7±2,6	6,7±2,1	72,3±2,6

**Table 5. FIM score indicators in different groups of wounded, M±m**

Nature of lesions \ FIM categories	Self-care	Bowel control	Transfer	Ambulation	Communication	Social cognition	Total
Closed TBI and uncomplicated spinal trauma	28,4±1,5	13,6±1,8	9,1±1,4	6,3±2,1	8,2±1,9	10,9±1,6	76,5±8,1
Combined spinal trauma	24,9±1,6	8,8±1,9	12,2±1,6	8,6±1,9	11,4±2,1	15,3±1,8	81,2±6,1
Uncomplicated spinal trauma and closed chest trauma	26,6±1,4	11,7±1,9	14,4±1,6	8,2±1,8	12,1±2,1	14,3±1,7	87,3±6,3
Open chest trauma and upper extremity trauma	22,1±1,8	13,8±1,8	17,2±1,8	11,9±1,8	12,3±1,9	13,6±1,6	90,9±3,9
Chest and pelvic trauma	24,2±1,6	8,9±1,9	9,4±2,2	8,1±2,4	12,6±1,8	15,2±1,8	78,4±6,1
Combined upper and lower extremity trauma	15,5±2,1	13,8±1,7	9,7±1,9	6,8±2,2	14,1±2,1	19,2±1,4	79,1±4,4
Closed TBI and limb trauma	23,3±1,6	12,9±1,6	7,8±2,1	6,6±2,4	8,3±1,8	10,2±1,6	69,1±6,2

The following results were obtained during the initial rehabilitation examination of the wounded using the FIM scale (Table 5).

In this case, the total score was within 69–90 points, which, like the Bartell index, indicates a moderate dependence of patients on others. Analysis of motor and cognitive skill levels is an important prognostic factor when assessing and monitoring the patient's condition. With an FIM value of <5 for such categories as self-care, movement, and ability to move, we can talk about the patient's complete dependence and form a rehabilitation prognosis and directions for restorative treatment. The FIM score  $\geq 6$  for each indicator of the motor (self-care (eating, hygiene procedures, bathing, dressing, bowel control, movement) and cognitive (acoustic/visual comprehension, verbal/nonverbal expression, social behavior, and problem-solving) categories are assessed as modified independence (the patient requires assistance with the use of additional means, but not physical assistance). Among the servicemen under our observation, no one had an FIM score <5. All the examined wounded had an initial assessment of more than 6 points on the FIM scale. The initial data in evaluating functioning on the FIM scale made it possible to identify subgroups of patients with a predominance of motor function impairment and a predominant impairment of cognitive functions, respectively (Chumney et al., 2010; Izumi, 2019).

## Discussion

One of the most important conditions for successful patient rehabilitation is an adequate assessment of the physical and functional state to determine the direction and extent of the necessary interventions. Due to the severity and complexity of modern injuries, this is especially true for

combat victims. One tool for such an assessment is the Functional Independence Measure (Chokshi et al., 2021; Colomer et al., 2023). The Functional Independence Measure (FIM) is part of the Uniform Data System for Medical Rehabilitation (UDSMR). It was developed to measure disability for various populations and is not specific to any diagnosis. The FIM scale is one of the methods of testing social and everyday skills, widely used in rehabilitation medicine that offers a unified system for determining the independence of the patient based on the International Classification of Impairments, Disabilities and Social Deficiencies for use in the medical system (Ann Peleg & Justo, 2024). The level of the patient's disability justifies the necessary level of care, the elements of the scale specify what kind of assistance a person needs to carry out everyday activities. FIM scores determine the degree of disability subjectively experienced by patients and their progress through medical rehabilitation programs (Çerezci & Boneval, 2023). This scoring system is most often used for patients who have had a stroke (Güp et al., 2023; Kakehi et al., 2023). However, recently FIM has increasingly begun to be successfully used in patients with severe injuries: hip fractures, spinal fractures, spinal cord injury (Pozin et al., 2024; Harvey et al., 2021; Hoenig et al., 1999).

Traditionally, the Barthel Index is used to assess daily living activities, which is a reliable indicator of disability (Collin et al., 1988; Katano et al., 2021). Simultaneously, subsequent studies, especially in recent years, have shown greater sensitivity of the FIM scale compared to the Barthel Index (Alookaran et al., 2022; Hachisuka et al., 1997). In addition, the FIM's resistance to Differential Item Functioning is higher than that of the Barthel Index (Caronni & Scarano, 2024; Lee et al., 2022).

In our study, we considered that standard tools for assessing the effectiveness of rehabilitation in military personnel with combined injuries may be insufficient. Combined injuries are complex pathological conditions, so patients with this type of injury need a more differentiated approach to determining functional capacity at all stages of rehabilitation. It is essential to consider the differentiation of functional disorders by the motor and cognitive components depending on the nature of the combined injury, adaptive and readaptive capabilities of the organism (Olkhovyi et al., 2016). The FIM scale is appropriate as a tool for assessing functional independence to more effectively determine the amount of necessary assistance and objectively assess rehabilitation results. Determining the level of functional abilities can also be considered an additional method of sorting regarding the direction to a certain stage of rehabilitation. Since one of the critical components of high-quality rehabilitation is the establishment of effective communication between hospitals and rehabilitation centers that carry out rehabilitation in the subacute and long-term periods of rehabilitation, including in the form of permanent supportive rehabilitation care, in our opinion, the standardization of medical care and the use, in particular, of the FIM scale, would contribute to increasing the effectiveness and quality of rehabilitation measures in different periods of rehabilitation. Thus, further directions of rehabilitation intervention in patients with certain combined injuries should be formed, taking into account the prevalence of motor or cognitive impairments. This will allow individualization of rehabilitation programs and increase their effectiveness.

## Conclusions

Using the functional independence scale as a tool for assessing the long-term effectiveness of rehabilitation for military personnel with combined injuries allows for a more effective determination of the amount of necessary assistance and objectification of rehabilitation results. The inclusion of the FIM scale in the recommended toolkit for assessing the effectiveness of rehabilitation will allow for additional objectification of rehabilitation care and the formulation of individual recommendations for achieving the best results.

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