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Real-Life Experiences in Subacute Neurological Rehabilitation: Predictors of Functional Outcomes

Subakut Nörolojik Rehabilitasyonda Gerçek Hayat Deneyimleri: Fonksiyonel Sonuçların Belirleyicileri

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ABSTRACT Objective: The aim of this study is to examine the clinical features of patients hospitalized at the subacute neurological rehabilitation unit, to compare the patients who participated in rehabilitation program in the early and late period of the disease and to define the independent determinants that affect the rehabilitation outcome. **Material and Methods:** In this retrospective study, all patients in the subacute neurological rehabilitation clinic were reviewed. The medical records of 230 patients were examined retrospectively. Patients were categorized into two groups as early (≤1 month) and late (1-12 months) according to the time between the onset of the event and admission to the rehabilitation unit. **Results:** A total of 191 patients were included in the study. At the time of admission, percutaneous endoscopic gastrostomy (p=0.001) and tracheostomy (p=0.014) were more common in the late group. Although, all patients benefited from the rehabilitation program, the benefit in terms of Functional Ambulation Classification (FAC) and Brunnstom Motor Recovery Stage, lower extremity was higher in the early group (p=0.030 and p=0.028, respectively). The male gender [odds ratio (OR)=1.85] and being in the early rehabilitation group (OR=1.83) were positive predictors, the presence of contracture (OR=0.28), pressure injury (OR=0.37), respiratory problems (OR=0.23), and sleep problems (OR=0.37) were negative predictors for improvement of FAC. **Conclusion:** The findings of this study indicate that neurological rehabilitation is effective for functional outcomes and that male gender and participation in the early rehabilitation group were independent predictors of increased ambulation.

Keywords: Stroke; traumatic brain injury; spinal cord injury; rehabilitation

ÖZET Amaç: Bu çalışmanın amacı, subakut nörolojik rehabilitasyon ünitesinde yatan hastaların klinik özelliklerini incelemek, hastalığın erken ve geç döneminde rehabilitasyon programına katılan hastaları karşılaştırmak ve rehabilitasyon sonucunu etkileyen bağımsız belirleyicileri tanımlamaktır. **Gereç ve Yöntemler:** Retrospektif olarak tasarlanan çalışmada, subakut nörolojik rehabilitasyon kliniğinde yatan tüm hastalar incelendi. İki yüz otuz hastanın tıbbi kayıtları değerlendirildi. Olayın başlangıcından rehabilitasyon ünitesine kabulüne kadar geçen süreye göre hastalar erken (≤1 ay) ve geç (1-12 ay) olarak 2 gruba ayrıldı. **Bulgular:** Çalışmaya toplam 191 hasta dâhil edildi. Başvuru anında geç grupta perkütan endoskopik gastrostomi (p=0,001) ve trakeostomi (p=0,014) daha sıktı. Rehabilitasyon programından tüm hastalar fayda görmesine rağmen Fonksiyonel Ambulasyon Sınıflandırması (FAS) ve alt ekstremite Brunnstom Motor İyileşme Evresi açısından faydalanım erken grupta daha yüksekti (sırasıyla p=0,030 ve p=0,028). FAS iyileşmesi için erkek cinsiyet [göreceli olasılıklar oranı (odds ratio "OR")=1,85] ve erken rehabilitasyon grubunda olmak pozitif prediktörken (OR=1,83), kontraktür varlığı (OR=0,28), basınç yarası (OR=0,37), solunum sorunları (OR=0,23) ve uyku sorunları (OR=0,37) negatif belirleyiciler olarak bulundu. **Sonuç:** Bu çalışmanın bulguları, nörolojik rehabilitasyonun fonksiyonel sonuçlar için etkili olduğunu ve erkek cinsiyetin ve erken rehabilitasyon grubuna katılımın artan ambulasyonun bağımsız belirleyicileri olduğunu göstermektedir.

Anahtar Kelimeler: İnme; travmatik beyin yaralanması; omurilik yaralanması; rehabilitasyon

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Medical rehabilitation interventions should begin with the medical event and continue with a multidimensional perspective and interdisciplinary care plans as soon as the patient is stable. Subacute neurological rehabilitation clinics are wards that care for patients with brain injury [stroke, traumatic brain injury (TBI), anoxic brain injury], spinal cord injury (SCI), and neurological complications of non-neurological diseases such as critical illness neuropathy and myopathy. With an early rehabilitation approach, better outcomes have been shown in both brain injury and spinal cord injury.[1-5] It has been reported that patients who began rehabilitation treatment immediately after the onset of a stroke had significantly higher treatment efficacy than those who began treatment later.[6] It has also been demonstrated that the time to begin rehabilitation in TBI patients is related to their final functional status, length of stay (LOS), and cost.[7] However, medical complications are also more common among patients in early rehabilitation units.[8,9] Therefore, the clinical characteristics and potential complications of these patients must be identified, as well as the predictive and counterproductive factors of functional recovery. Thus, a cost-effective and patient-benefiting clinical approach can be developed in subacute neurological rehabilitation clinics.

The purpose of this study is to compare patients who participated in the neurological rehabilitation program in the early and late stages of the disease, as well as their clinical characteristics, rehabilitation course, frequency, and types of medical complications, using our real-life experiences, and to assess whether early rehabilitation is superior to late rehabilitation. It was also intended to identify the independent determinants that influence rehabilitation outcome.

MATERIAL AND METHODS

The medical records of 230 patients hospitalized in the subacute neurological rehabilitation clinic between March 2020 and June 2022 were reviewed retrospectively. Those who were more than 1 year past the event date and those who did not receive a neurological rehabilitation program were excluded. One hundred ninety one patients were included in the study. This research was carried out in accordance with the Helsinki Declaration's standards. The Ankara City Hospital No. 2 Clinical Research Ethics Committee (date: March 2, 2022; no: E2-22-1479) approved the procedure.

Demographic data, comorbidities, diagnosis of admission to the subacute neurological rehabilitation clinic, and date of the event were noted. Medical complications that occurred during the inpatient rehabilitation unit were recorded for each patient. Motor neurologic deficits for stroke patients were assessed using Brunnstom Motor Recovery Stage (BMRS). The level of disability in activities of daily living (ADL) of all patients was evaluated using The Functional Independence Scale, ambulation ability using the Functional Ambulation Classification (FAC), and cognitive status using Mini Mental State Examination. Functional measures were evaluated at hospital admission and discharge, and the difference was calculated. The time between the onset of the event and admission to the rehabilitation unit and LOS in the rehabilitation service was documented.

Patients were divided into 2 groups based on the time between the onset of the event and admission to the rehabilitation unit: early (≤1 month) and late (1-12 months). After the initial assessment, all patients received training in positioning, pressure ulcer prevention, oral care, and nutrition. Regarding potential medical problems, they were assessed and managed. Patients' education, range-of-motion exercises, progressive resistive exercises, posture exercises, exercises for balance and coordination, and progressive mobilization were the components of the conventional rehabilitation program. Each patient was assessed daily, their specific needs were identified, and if necessary, occupational therapies, speech and language therapies, swallowing rehabilitation programs, cognitive rehabilitation programs, robotic rehabilitations, functional electrical stimulations, cardiopulmonary rehabilitation programs, and electrotherapies were programmed.

SPSS 22.0 was used for statistical analysis (SPSS Inc., Chicago, IL, USA). The normal distribution was tested using the Kolmogorov-Smirnov or Shapiro-Wilk tests. For non-normally distributed and ordinal variables, descriptive analyses were presented using medians and interquartile range. To compare

groups that did not fit the normal distribution, the Mann-Whitney U test was used. Chi-square or Fisher's exact tests were used to compare categorical variables. To determine whether covariates were independently predictive of changes in FAC, ordinal logistic regression was used. The statistical significance level was set at $p<0.05$.

RESULTS

Demographic and clinical data are given in Table 1. Both groups were similar regarding age, gender, comorbidities, and LOS. At the time of admission, percutaneous endoscopic gastrostomy (PEG) (p=0.001) and tracheostomy (p=0.014) were more common in

TABLE 1: Demographic and clinical characteristics of the patients.

	All (n=191)*	Early (n=69)*	Late (n=122)*	p value
Age (year)	62 (47-72)	65 (53-72)	60 (42.8-71)	0.083
Gender (female)	79 (41.4)	30 (43.5)	49 (40.2)	0.656
Event to hospitalization time (day)	52 (24-113)	17 (12.5-25)	95 (55-141.8)	**<0.001**
LOS (day)	38 (21-54.5)	38 (25-56.5)	38 (21-55)	0.613
Diagnosis				**0.003**
Hemiplegia	135 (70.7)	57 (82.6)	78 (63.9)	**0.006**
Paraplegia	15 (7.9)	5 (7.2)	10 (8.2)	0.815
TBI	12 (6.3)	0 (0)	12 (9.8)	**0.005**
Tetraplegia	10 (5.2)	4 (5.8)	6 (4.9)	0.750
Anoxic brain injury	7 (3.7)	0 (0)	7 (5.7)	**0.050**
Other	12 (6.2)	3 (4.4)	9 (7.5)	0.542
PEG	27 (14.1)	2 (2.8)	25 (20.5)	**0.001**
Tracheostomy	10 (5.2)	0 (0)	10 (8.2)	**0.014**
Foley catheter	102 (53.4)	38 (55.1)	64 (52.5)	0.961
Comorbidities				
Hypertension	119 (62.3)	45 (65.2)	74 (62.2)	0.678
CAD	56 (29.3)	25 (36.2)	31 (26.1)	0.141
Diabetes mellitus	50 (26.2)	21 (30.4)	29 (24.4)	0.364
Thyroid dysfunction	17 (8.9)	5 (7.2)	12 (10.2)	0.502
Congestive heart failure	11 (5.8)	5 (7.2)	6 (5.0)	0.536
Atrial fibrillation	10 (5.2)	3 (4.3)	7 (5.7)	0.679
Chronic kidney disease	8 (4.2)	3 (4.2)	5 (4.2)	0.962
Complications				
Sleeping disorders	80 (41.9)	29 (42.0)	51 (43.6)	0.835
Spasticity	79 (41.4)	25 (36.2)	54 (46.2)	0.186
Urinary tract infection	76 (39.8)	25 (36.2)	51 (43.6)	0.324
Dysphagia	73 (38.2)	23 (33.3)	50 (42.7)	0.205
Depression	63 (33)	25 (36.2)	38 (32.5)	0.601
Cognitive impairment	53 (27.7)	14 (20.3)	39 (33.3)	0.057
Aphasia	48 (25.1)	15 (21.7)	33 (28.2)	0.330
Pressure ulcer	44 (23.0)	15 (21.7)	29 (25.0)	0.614
Epilepsy	34 (17.8)	5 (7.2)	29 (24.8)	**0.003**
Respiratory problem	29 (15.2)	10 (14.5)	19 (16.1)	0.769
Agitation	26 (13.6)	5 (7.2)	21 (17.9)	**0.042**
Contracture	20 (10.5)	6 (8.7)	14 (12.1)	0.475
Deep vein thrombosis	13 (6.8)	5 (7.2)	8 (6.8)	0.916
Heterotopic ossification	12 (6.3)	2 (2.9)	10 (8.5)	0.215
Pulmonary embolism	6 (3.1)	1 (1.4)	5 (4.3)	0.415

*Values are given using median interquartile range or n (%); LOS: Length of stay; TBI: Traumatic brain injury; PEG: Percutaneous endoscopic gastrostomy; CAD: Coronary artery disease.

the late group. The diagnoses of the patients were different between the 2 groups. There was no TBI or anoxic brain injury in the early period. Hemiplegia was less common in the late period (p=0.006). The most common complications are shown in Table 1. Sleep problems, spasticity, urinary tract infection, dysphagia, depression, and cognitive impairment were the most common complications. While epilepsy and agitation were more common in the late rehabilitation group (p=0.003 and p=0.042, respectively), there was no difference in terms of other complications (all p>0.05). The most frequently consulted departments were internal medicine 117 (61.3%), infectious diseases 111 (58.1%), cardiology 106 (55.5%), neurology 97 (50.8%), and psychiatry 96 (50.3%), and there was no difference between the groups (all p>0.05). While 143 (74.9%) patients were discharged to their homes, 26 (13.6%) were transferred to another service, and 13 (6.8%) were transferred to the intensive care unit (ICU). Aspiration pneumonia was the most common reason for ICU admission. Only one patient (0.5%) died.

All patients were enrolled in the conventional rehabilitation program. 102 (54.5%) occupational therapies, 45 (24.1%) speech and language therapies, 71 (38%) swallowing rehabilitation programs, 42 (22.5%) cognitive rehabilitation, 84 (44.9%) robotic rehabilitations, 100 (53.5%) functional electrical stimulations, 45 (24.1%) cardiopulmonary rehabilitation programs, 55 (29.4%) electrotherapies were also administered based on their needs. There was no difference between the groups in terms of treatment programs (all p>0.05). All patients benefited from the rehabilitation program. The changes in functional evaluations are given in Table 2. The early group had a greater benefit in terms of FAC and BMRS lower extremity (LE) (p=0.030 and p=0.028, respectively). At the end of the rehabilitation program, the number of patients with PEG decreased from 27 (14.1%) to 19 (9.9%), those with tracheostomy decreased from 10 (5.2%) to 7 (3.6%), and those with Foley catheter decreased from 102 (53.4%) to 28 (14.6%).

When age, gender, LOS, and rehabilitation group were included in the ordinal logistic regression analysis for delta FAC, male gender [odds ratio (OR) 1.85 (1.04-3.37) p=0.036] and being in the early rehabilitation group [OR 1.83 (1.04-3.24) p=0.037] were found to be independent predictors. The presence of contracture, pressure injury, respiratory problems, and sleep problems were identified as negative independent predictors of improvement in the ambulation category when all complications for all patients were included in the ordinal logistic regression analysis (Table 3).

TABLE 2: Comparison of outcomes between early and late rehabilitation groups.

	Early	Late	p value
FAC			
Baseline	0 (0-1)	0 (0-1)	0.984
Discharge	3 (0-4)	1 (0-3)	0.139
p value	**<0.001**	**<0.001**	
Δ change	1 (0-3)	0 (0-2)	**0.030**
FIM			
Baseline	47 (31.8-78.5)	43 (26-77.5)	0.621
Discharge	65 (52-110)	65 (42.5-101)	0.657
p value	**<0.001**	**<0.001**	
Δ change	15 (8-21)	8.5 (3-20)	0.166
BMRS (UE)			
Baseline	2 (1-5)	2 (1-5)	0.515
Discharge	4 (2-6)	3 (2-5)	0.370
p value	**<0.001**	**<0.001**	
Δ change	0 (0-1)	0 (0-1)	0.102
BMRS (Hand)			
Baseline	1.5 (1-5)	3 (1-5)	0.535
Discharge	4 (2-6)	3.5 (2-5)	0.620
p value	**<0.001**	**<0.001**	
Δ change	1 (0-1)	0 (0-1)	0.335
BMRS (LE)			
Baseline	3 (1-5)	3 (2-4)	0.964
Discharge	4 (3-5)	3 (2-5)	0.167
p value	**<0.001**	**<0.001**	
Δ change	1 (0-1)	0 (0-1)	**0.028**
MMSE			
Baseline	28 (21-29)	26 (20-28)	0.191
Discharge	29 (26-29)	28 (25-29)	0.279
p value	0.068	**0.003**	
Δ change	0 (0-0)	0 (0-2)	0.223

*Values are given using median interquartile range; FAC: Functional Ambulation Classification; FIM: Functional Independence Measure; BMRS: Brunnstom Motor Recovery Stage; UE: Upper extremity; LE: Lower extremity; MMSE: Mini Mental State Examination.

DISCUSSION

Sleep problems, spasticity, urinary tract infection, dysphagia, depression, and cognitive impairment were the most common complications in hospitalized

TABLE 3: Ordinal logistic regression analysis for delta FAC according to complications.

Covariates	OR	95% CI	p value
Contracture	0.28	0.08-0.98	0.046
Pressure injury	0.37	0.17-0.82	0.014
Respiratory problems	0.23	0.09-0.63	0.004
Sleep problems	0.37	0.18-0.78	0.009

FAC: Functional Ambulation Classification; OR: Odds ratio; CI: Confidence interval.

patients in the subacute neurological rehabilitation clinic. Although patients who received treatment in both the early and late periods benefited from the medical rehabilitation program, the early rehabilitation group benefited more. While being male and being in the early rehabilitation group were positive predictors of FAC improvement, the presence of contracture, pressure injury, respiratory problems, and sleep problems were negative predictors.

Neurological rehabilitation helps in the reduction of disability and encourages participation in daily activities. It is intended for this purpose to prevent dysfunction, improve function, and provide the greatest level of independence possible.[10] Following the onset of a stroke, a multidisciplinary and early rehabilitation program can help to minimize functional disability, prevent complications, and reduce LOS.[11] According to Paolucci et al., the effectiveness of treatment started within the first 20 days was higher, but the rate of treatment discontinuation due to complications was also higher in the early group.[6] It was stated that, young age, low baseline disability, and early rehabilitation were associated with positive outcomes.[12] A systematic review revealed that mobilization within 24 hours of the onset of a stroke did not increase the stroke-related mortality rate (OR: 1.08), but rather reduced LOS [mean difference (MD): -1.44] and improved mean ADL (MD: 1.94).[13] In a multicenter study, an intensive rehabilitation program initiated within the first month after stroke resulted in greater improvement in ADL, nutrition, cognition, and shorter LOS than a traditional program initiated later.[14] It is widely known that recovery is relatively quick in the first month following a stroke and then slows down 3 to 6 months later.[15] Hence, the first month, which is considered as a window of opportunity, should be included in the rehabilitation period. Nevertheless, due to both the patients' long ICU stays and the long rehabilitation waiting lists, it is not always possible to begin rehabilitation early. In the current study, the early rehabilitation group improved more in terms of ambulation and LE motor recovery.

Similar to stroke, the initiation time of rehabilitation was found to be associated with functional outcomes in SCI and TBI. With a 5-year follow-up period in the SCIRehab study, which included six inpatient SCI rehabilitation centers and 1,376 patients, a long time from the date of injury to transfer to the rehabilitation unit was associated with worse outcomes.[16] It has been reported that for TBI patients, the time to reach the rehabilitation unit was associated with final functional status, LOS, and cost.[7] In another study, the early rehabilitation group in TBI achieved more functional gain. Additionally, duration of rehabilitation, early rehabilitation, heterotopic ossification, and deep venous thrombosis (DVT) were found to be predictors for functional improvement.[17] Likewise in our study, the early rehabilitation group benefited more, and the male gender and early rehabilitation were found to be positive predictors for ambulation. Moreover, contracture, pressure injury, respiratory problems, and sleep problems were found to be negative predictors of FAC improvement.

It has been reported that women are more dependent after a stroke. This may be due to the low rate of admission to hospital within the first 3 hours after stroke and the low rate of rehabilitation access, especially in low-income countries.[18] Another possible explanation is that women have lower muscle strength than men.[19] In a study of 440 stroke patients comparing men and women, it was observed that men had approximately three times more independence.[19] The fact that men and women perceive their disability differently may also have an impact on functional development. While women are more willing to accept assistance, men typically hide their need for additional help.[20] Thus, men may be trying hard for greater independence. In another retrospective cohort analysis, female patients in the neurorehabilitation clinic were found to have worse functional status at both admission and discharge.[21] Similarly, the male gender was more advantageous in terms of ambulation changes in our study.

The most common complications in neurological rehabilitation are spasticity, contracture, subluxation, pain, edema, fatigue, pressure injury, falls, malnutrition, incontinence, DVT, dysphagia, heterotopic ossification, and seizure.[22-24] In TBI, 50% sleep disturbance, 18-61% depression, and 10% epilepsy have been reported.[23] Similar to the literature, the most common complications in our study were sleep disorders, spasticity, urinary tract infection, dysphagia, depression, and cognitive impairment. While all complications were similar between the two groups, agitation and epilepsy were found more common in the late group. The most significant reason for this discrepancy is that patients with TBI and anoxic brain injury were only included in the late group. However, there are also studies on this aspect.[25,26] Agitation has been reported at a rate of 20-41% in TBI patients, but at a rate of 70% in rehabilitation units.[26] In a cohort study of 5,389 TBI patients, epilepsy was seen in 6% of patients in the first 1 year and 10% of patients at the end of 8 years.[25] It is critical to be aware of potential complications during rehabilitation and to refer patients to acute care when necessary. In a study of stroke patients, the most common complications were urinary tract infection and depression, while the most common reasons for transfer to acute care were DVT and urosepsis.[8] In the current study, 6.8% of patients were transferred to ICU, and the most common reason for the transfer was aspiration pneumonia.

There were several limitations to this study. First, a retrospective design was used. Therefore, the data were restricted the database of the patients and the groups were not homogeneous in baseline characteristics and diagnoses. The absence of TBI and anoxic brain injury in the early rehabilitation group may be the cause of the greater rates of agitation and epilepsy, as well as PEG and tracheostomy, in the late rehabilitation group. Second, complications may become more frequent as a result of starting rehabilitation later than planned, or they may even be the cause of the delay. Thus, defining a direct relationship might not be appropriate. Since the study was retrospective, it cannot be generalized to the whole population. Finally, the follow-up period was limited to LOS in rehabilitation units because of the retrospective design.

CONCLUSION

In conclusion, even though all patients included in the neurological rehabilitation program in both early and late periods showed functional improvement, the improvement was greater in the early period, and male gender and being in the early rehabilitation group were independent predictors of the increase in ambulation. In addition, contracture, pressure injury, respiratory problems, and sleep problems were negative predictors of ambulation gain. Consequently, patients should be included in the rehabilitation program as early as possible before complications develop. Indisputably, further prospective longitudinal multicenter studies and longer follow-up periods are needed also taking into account cost-effectiveness.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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