



Original Article

# Medical complications experienced by first-time ischemic stroke patients during inpatient, tertiary level stroke rehabilitation

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**Abstract.** [Purpose] The aim of this study was to assess the medical complications in first-time ischemic stroke patients, to identify the factors related to occurrence of complications. [Subjects and Methods] First-time ischemic stroke patients (n=81) admitted to a tertiary level inpatient rehabilitation center during a 5 year period were included in the study. The attending physiatrist noted the presence of specific medical complications and complications that required transfer to the acute care facility from patient records. The Oxfordshire Community Stroke Project classification was used to define the clinical subtypes of the ischemic stroke patients. The Charlson comorbidity index was used to evaluate co-morbid conditions. Functional disability was assessed using the Functional Independence Measure at admission and discharge. [Results] We found that 88.9% of the patients had at least one complication. The five most common complications were urinary tract infection (48.1%), shoulder pain (37.0%), insomnia (37.0%), depression (32.1%), and musculoskeletal pain other than shoulder pain (32.1%) and 11.1% of patients were transferred to acute care facility during rehabilitation period. Functional Independence Measure scores both at admission and discharge were significantly lower in patients with at least one complication than in patients with no complications. [Conclusion] Medical complications are common among patients undergoing stroke rehabilitation. Close interdisciplinary collaboration between physiatrists and other medical specialities is necessary for optimal management.

**Key words:** Stroke, Medical complication, Rehabilitation

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## INTRODUCTION

Stroke is a leading cause of death and disability throughout the world<sup>1)</sup>. The results of stroke are not only persistent neurologic deficits but also marked deconditioning<sup>2)</sup>. Stroke patients constitute the largest group of patients who require rehabilitation services. During the rehabilitation process, patients are vulnerable to various complications as a result of both the stroke and the disability caused by it<sup>3)</sup>.

Medical complications can hinder functional recovery, can extend the hospital length of stay (LOS), worsen stroke outcomes and increase cost of care<sup>4)</sup>. In addition, some patients need to be transferred back to the acute care setting, which interrupts the inpatient rehabilitation therapy and further increases the overall cost of stroke management<sup>5–8)</sup>.

Only a few studies have been performed regarding the medical complications during inpatient stroke rehabilitation, but they indicate that 44–95% of stroke patients undergoing rehabilitation develop medical complications during the inpatient period<sup>3, 5, 7–11)</sup>.

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Moreover, many of these studies suffer from methodological problems, including variability in patient selection criteria, which makes comparisons between settings difficult.

Information on the types and frequencies of medical complications of patients with stroke during inpatient rehabilitation would be helpful for treatment and for providing the best possible environment for their recovery. In addition, many of the complications described are preventable or treatable if recognized early.

To our knowledge, medical complications experienced by first-time ischemic stroke patients from Turkey during the rehabilitation period have not been reported before. Therefore, we conducted this study to assess the types and frequencies of predefined complications in first-time ischemic stroke patients during inpatient tertiary level stroke rehabilitation. We also aimed to determine which complications result in transfer to the acute care facility and to identify factors related to transfer to the acute care facility and factors related to occurrence of medical complications.

## SUBJECTS AND METHODS

The study was conducted at a tertiary level rehabilitation center affiliated with Baskent University Hospital. First-time ischemic stroke patients who were admitted to the inpatient rehabilitation facility during a 5 year period were included. Patient data was retrospectively collected. Written informed consent was obtained from each patient.

The study protocol was approved by the local ethics committee for clinical studies. Stroke was defined according to the World Health Organization's criteria as follows: rapidly developing clinical signs of focal disturbance of cerebral function, lasting more than 24 hours with no apparent origin other than vascular<sup>12)</sup>. Our tertiary rehabilitation center is located in Ankara, the capital of Turkey and patients are accepted from all parts of Turkey. All stroke survivors with functional disability and/or cognitive deficits were candidates for admission to the rehabilitation unit. The criteria for admission to the rehabilitation unit were stable medical status and ability to cooperate in physical therapy and rehabilitation. A patient was considered medically stable if he/she could participate in at least one hour of a physical therapy and rehabilitation program daily without developing symptoms of cardiopulmonary instability.

Demographic data, as well as reports of brain computed tomography or magnetic resonance imaging were recorded. Location and size of ischemic lesions were determined by using the Oxfordshire Community Stroke Project (OCSP) classification. Onset admission interval (OAI) and LOS were recorded for each patient. Simple clinical definitions of complications that were modified from those of Davenport were used in the study<sup>13)</sup>. The complications studied were urinary tract infection (UTI), shoulder pain, insomnia, depression, musculoskeletal pain other than shoulder pain, new onset arrhythmia, angina, pneumonia, decubitus, anxiety disorder, gastrointestinal complications (peptic ulcer disease, diarrhea, constipation, abdominal pain), delirium, deep venous thrombosis, new stroke, seizure, hematuria, and pulmonary embolism. Medical complications that led to transfer to an acute care facility were also noted. All patients underwent a rehabilitation program 1–3 hours per day and 6 days per week, with the aim of normalizing movement patterns and minimizing spasticity. Physical therapy included static and dynamic control of position, balance skills, weight shift, and activities of daily living. The rehabilitation team members were physiatrists, rehabilitation nurses, physiotherapists and occupational therapists.

All patients were evaluated by the attending physiatrists and diagnoses of psychiatric complications and insomnia were made by a medical doctor specializing in psychiatry. Also all patients were visited and evaluated weekly by a physician specializing in internal medicine.

The Charlson comorbidity index was used to evaluate general co-morbid conditions<sup>14)</sup>. This index takes into account both the number and seriousness of co-morbid conditions. Myocardial infarction, congestive heart failure, peripheral vascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, and diabetes are each assigned a score of "1". Hemiplegia, moderate and severe renal disease, diabetes with end-stage organ damage, tumors, leukemia, and lymphoma are each assigned a score of "2". Moderate and severe liver diseases are each scored as "3", and metastatic solid tumor and AIDS are each scored as "6".

The Charlson comorbidity index is a valid measure of comorbidity applicable to ischemic stroke outcome studies and it has been previously used for stroke patients<sup>15, 16)</sup>.

The OCSP classification was used to define the clinical subtypes of the ischemic stroke patients. OCSP subtypes included total anterior circulation infarcts (TACIs), partial anterior circulation infarcts (PACIs), posterior circulation infarcts (POCIs), and lacunar infarcts (LACIs)<sup>17)</sup>. OCSP classification is a simple and rapid method of classification for ischemic stroke patients. It has good interobserver reliability, predicts the site and size of infarct and is easy to apply without special neurologic training<sup>18–20)</sup>. Ischemic subtype classification was confirmed by computed tomography or magnetic resonance imaging reports.

Functional disability was assessed using the Turkish version of the Functional Independence Measure (FIM) at admission and discharge. The FIM is an 18-item measure that evaluates the following parameters: self-care, sphincter control, mobility, locomotion, communication, and social cognition. The items of the FIM are scored on a 7-point ordinal scale that ranges between 1 and 7. The lower limit for the score of the FIM is 18, which indicates a low level of functioning; the upper limit for the score is 126, which indicates a very high level of functioning<sup>21)</sup>. The FIM has been documented to be a valid and reliable measure of functional disability for Turkish patients<sup>22)</sup>.

In statistical analysis, all data were classified as continuous or categorical variables. Descriptive characteristics of continu-

ous variables were determined (mean, median, standard deviation, standard error, and 25–75% range). Differences between two groups were compared using the Student's t-test for normally distributed variables and Mann-Whitney U test for non-normally distributed variables. The chi-square method was used for comparing the frequencies of categorical variables. A p value < 0.05 was considered statistically significant. Statistical analyses were performed using the SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA).

## RESULTS

A total of 81 consecutive first-time ischemic stroke patients were included in this study. The mean age of the patients was 66.5±10.3 (mean±standard deviation) years, and 50.6% were male. The mean OAI was 15.6±5.6 days and the median comorbidity score was 3.0 (2.0–4.0) [median (25–75%)]. According to the OCSP classification, 32.1% of patients had a TACI, 25.9% had a PACI, 16.0% had a POCI, and 25.9% had a LACI. The median LOS was 30.0 (19.3–50.0) days. At admission, 23.8% of patients had an indwelling urinary catheter. A description of the demographic and stroke characteristics of the patients is provided in Table 1.

The frequencies of preexisting medical conditions among the patients are displayed in Table 2, which revealed that hypertension (69.1%), ischemic heart disease (39.5%), diabetes mellitus (33.3%), hyperlipidemia (22.8%), and arrhythmia (22.2%) were the most common preexisting medical conditions.

Of the 81 patients, 72 (88.9%) had at least one complication and 9 (11.1%) patients had no complications. The five most common complications were UTI (48.1%), shoulder pain (37.0%), insomnia (37.0%), depression (32.1%), and musculoskeletal pain other than shoulder pain (32.1%). Regarding UTI, 78.9% of patients with an indwelling urinary catheter on admission and 39.3% of patients without an indwelling urinary catheter at admission developed a UTI and the difference between these two groups was statistically significant (p=0.003). Table 3 lists the types and frequencies of medical complications.

Nine patients (11.1%) were transferred to acute care facilities during the rehabilitation period. Of these patients, three had a fever of unknown origin, two had cardiac ischemia, one had a new cerebrovascular event, one had arrhythmia, one had intractable deep venous thrombosis, and one had severe abdominal pain. There were no deaths during rehabilitation. The median age of the patients transferred to the acute care facility was 68.0 (59.0–77.0) years and their median comorbidity score was 2.0 (1.0–3.5). Of these patients, six had a TACI, two had a PACI and one had a POCI. Higher comorbidity scores, TACI, lower FIM at admission and lower FIM at discharge were found to be related to transfer to the acute care facility (p=0.020,

**Table 1.** Demographic and stroke characteristics of stroke patients admitted for rehabilitation

Male gender, n (%)	41 (50.6)
Age*	66.5±10.3
FIM at admission**	62.1±27.3
FIM at discharge**	90.0 (60.0–111.5)
Years of education**	5.0 (5.0–8.0)
Comorbidity score**	3.0 (2.0–4.0)
OAI*	15.8±6.6
OCSP classification, n (%)	
TACI	26 (32.1)
PACI	21 (25.9)
POCI	13 (16.0)
LACI	21 (25.9)
Marital status, n (%)	
Single	2.5
Widow	10.1
Married	87.3
Indwelling urinary catheter, n (%)	23.8
Transfer to the acute care facility, n (%)	11.1
Length of stay**	30.0 (19.3–50.0)

\*Mean±standard deviation; \*\*Median (Interquartile range, 25th–75th percentile); FIM: Functional independence measure; OAI: Onset admission interval; OCSP: Oxfordshire Community Stroke Project Classification; TACI: total anterior circulation infarcts; PACI: partial anterior circulation infarcts; POCI: posterior circulation infarcts; LACI: lacunar infarcts.

**Table 2.** Preexisting medical conditions of the study patients

Hypertension, n (%)	56 (69.1)
Ischemic heart disease, n (%)	32 (39.5)
Diabetes mellitus, n (%)	27 (33.3)
Hyperlipidemia, n (%)	18 (22.2)
Arrhythmia, n (%)	18 (22.2)
Myocardial infarction, n (%)	12 (14.6)
Congestive heart failure, n (%)	9 (11.1)
Dementia, n (%)	6 (7.4)
Chronic obstructive pulmonary disease, n (%)	2 (2.5)

p=0.014, p=0.039, p=0.050). Patients transferred to acute care facility and patients not transferred to acute care facility are compared in Table 4.

Patients were grouped as patients with no complications and those with at least one complication, and the groups were compared with each other (Table 5). Mean age, comorbidity scores and LOS were similar between the two groups (p=0.614, p=0.187, p=0.178, respectively). There were no gender differences between the two groups (p=0.482). Patients with a longer OAI were more likely to have at least one complication (p=0.038). FIM scores both at admission and discharge were

**Table 3.** Number of patients with medical complications during rehabilitation

Urinary tract infection, n (%)	39 (48.1)
Shoulder pain, n (%)	30 (37.0)
Insomnia, n (%)	30 (37.0)
Depression, n (%)	26 (32.1)
Musculoskeletal pain other than shoulder pain, n (%)	26 (32.1)
Newly occurring arrhythmia, n (%)	17 (21)
Angina, n (%)	13 (16.0)
Pneumonia, n (%)	11 (13.6)
Decubitis, n (%)	9 (11.1)
Anxiety disorder, n (%)	9 (11.1)
Gastrointestinal complications (peptic ulcer disease, diarrhea, constipation, abdominal pain), n (%)	6 (7.4)
Delirium, n (%)	6 (7.4)
Deep vein thrombosis, n (%)	3 (3.7)
New stroke, n (%)	2 (2.5)
Seizure, n (%)	1 (1.2)
Hematuria, n (%)	1 (1.2)
Pulmonary embolism, n (%)	0 (0)

**Table 4.** Comparison of patients transferred to the acute care facility and patients not transferred to the acute care facility

	Patients transferred to the acute care facility (n=9)	Patients not transferred to the acute care facility (n=72)
Male gender, n (%)	5 (55.6)	36 (50.0)
Age**	68.0 (59.0–77.0)	68.0 (58.0–75.0)
Length of stay**	30.0 (22.0–52.0)	30.0 (17.0–50.0)
OAI**	16.0 (13.0–20.0)	15.0 (10.0–20.0)
Comorbidity score**	2.0 (1.0–3.5)*	1.0 (0.0–2.0)
OCSP, n (%)		
TACI	6 (66.7)*	20 (27.8)
PACI	2 (22.2)	19 (26.4)
POCI	1 (11.1)	12 (16.7)
LACI	0 (0.0)	21 (29.2)
FIM at admission**	41 (25.5–60.0)*	64.0 (46.0–80.0)
FIM at discharge**	58.0 (22.5–100.0)*	92.0 (65.0–112.0)
Years of education**	5.0 (5.0–9.5)	5.0 (5.0–5.8)
Marital status, n (%)		
Single	0 (0.0)	2 (2.9)
Widow	2 (22.2)	6 (8.69)
Married	7 (77.8)	62 (88.6)

\*p < 0.05; \*\*Median (Interquartile range, 25th–75th percentile); OAI: Onset admission interval; OCSP: Oxfordshire Community Stroke Project Classification; TACI: total anterior circulation infarcts; PACI: partial anterior circulation infarcts; POCI: posterior circulation infarcts; LACI: lacunar infarcts; FIM: Functional independence measure

significantly lower in patients with at least one complication than in patients with no complications ( $p < 0.001$ ,  $p = 0.004$ ). In addition, having a TACI or PACI (anterior circulation infarct) according to OCSF classification was significantly associated with having at least one complication ( $p = 0.004$ ).

## DISCUSSION

In our study we found that 88.9% of patients had at least one medical complication during rehabilitation. The most common complications were UTI, shoulder pain, insomnia, depression, and musculoskeletal pain other than shoulder pain.

In several studies performed with various designs in different centers, the rate of complications after a stroke varied from 44% to 95%<sup>3, 5, 7-11</sup>. The results from these studies show a wide variation due to differences in the study designs and patient cohorts, selection and diagnostic criteria, LOS and duration of follow-up. Close and strict monitoring of patients in our rehabilitation center may have contributed to high prevalence of medical complications in this study. In our rehabilitation center each patient is visited by rehabilitation nurses (many times in a day) and physiatrists (at least two times daily) regularly. In addition a physician specializing in internal medicine and a physician specializing in psychiatry regularly (at least once a week) visit and evaluate each patient. Also, medical notes of each patient are recorded daily by the following physiatrist. Under these conditions, underestimation of medical complications during inpatient rehabilitation period is unlikely although our study is retrospective in nature. Thus, close monitoring of patients and detailed and timely note keeping may have contributed to the high rate of complications in this study.

Our results were in line with a previous study from Turkey reporting that nearly all patients with stroke experienced at least one complication during rehabilitation. The exact number of patients having at least one complication was not given in the results of that study; however, the most common three complications were listed as shoulder pain (80.7%), hypertension/fluctuations in blood pressure (72.3%) and immobilization (65.1%). That study also had some methodological differences from our study. It was prospective in design, both patients with hemorrhagic strokes and patients with ischemic strokes were included and the definitions of medical complications were also different<sup>23</sup>. Medical complications were defined as new or exacerbated medical problems and complications that generated additional physician evaluation, a change in medication or additional medical interventions. The primary goal of that study was evaluation of stroke rehabilitation outcomes rather than identifying medical complications during the inpatient rehabilitation period. In this context, we believe that the results of our study will add additional valuable information about medical complications experienced by first-time ischemic stroke survivors during inpatient rehabilitation in Turkey.

Considering the types of complications, Kalra et al. found that there appeared to be significant differences in different

**Table 5.** Comparison of patients with no complications and with at least one complication

	Patients with no complications (n=9)	Patients with at least one complication (n=72)
Male gender, n (%)	6 (66.7)	35 (48.6)
Age**	64.9±10.6	66.7±10.3
Length of stay***	22.5 (16.3–30.0)	30.0 (19.3–54.3)
OAI**	11.6±5.9	16.3±6.5*
Comorbidity score***	3.0 (2.5–4.5)	3.0 (2.0–4.0)
OCSF, n (%)		
TACI	0 (0.0)	26 (36.1)*
PACI	0 (0.0)	21 (29.2)*
POCI	5 (55.6)	8 (11.1)
LACI	4 (44.4)	17 (23.6)
FIM at admission***	82 (74–115)	58 (41–74)*
FIM at discharge***	113 (102–118)	88 (55–109)*
Years of education***	5 (5–11)	5 (5–5)
Marital status, n (%)		
Single	0 (0.0)	2 (2.8)
Widow	1 (11.1)	7 (9.7)
Married	8 (88.9)	63 (87.5)

\* $p < 0.05$ ; \*\*Mean±standard deviation; \*\*\*Median (Interquartile range, 25th–75th percentile); OAI: Onset admission interval; OCSF: Oxfordshire Community Stroke Project Classification; TACI: total anterior circulation infarcts; PACI: partial anterior circulation infarcts; POCI: posterior circulation infarcts; LACI: lacunar infarcts; FIM: Functional independence measure

stroke care settings. The types of complications recorded in the stroke unit (e.g., aspiration, musculoskeletal pain and depression) suggested that the staff had a greater awareness of stroke related problems, whereas more severe and potentially life threatening complications (e.g., pulmonary embolism, cardiac problems and chest infections) were more frequently reported for stroke patients managed in general medical wards<sup>10</sup>.

The present study is in agreement with previous studies in terms of preexisting medical conditions that are also important risk factors for stroke (hypertension, coronary artery disease, diabetes mellitus, hyperlipidemia and cardiac arrhythmia)<sup>24–28</sup>.

The five most common complications (urinary tract infection, shoulder pain, insomnia, depression, musculoskeletal pain other than shoulder pain) encountered during the rehabilitation period are discussed in the following section.

UTIs occur frequently after stroke and are associated with poorer outcomes with increased odds of decline in neurological status during hospitalization for death or disability at 3 months as well as increased LOS<sup>29, 30</sup>.

Failure to manage a UTI in time may lead to pyelonephritis, hydronephrosis, ureter stone and/or chronic renal failure, resulting in prolonged hospitalization and social and financial losses. We found that UTI was the most common complication (48.1%) during the rehabilitation period. This may be because of the high number of patients with urinary catheters on admission and close monitoring of patients for urinary tract infections. We found that 23.8% of patients had urinary catheters at admission and that patients with urinary catheters were more likely to develop urinary tract infections during rehabilitation. Urinary catheters are a well-described risk factor for health care-associated UTI, and their inappropriate use may be more common in patients with stroke, thereby further increasing the risk of UTI<sup>31</sup>.

Clinicians caring for patients with stroke should minimize the use of catheters, reserving them for patients with clear indications like acute bladder obstruction or for strict monitoring of fluid status.

Hemiplegic shoulder pain is a major problem in stroke patients. Its incidence varies from 5% to 84%<sup>32–35</sup>. In most cases loss of support to the shoulder girdle from muscle paralysis, joint inflammation, soft tissue contracture, and nerve injury cause this pain<sup>36</sup>.

In a previously reported study from Turkey, shoulder pain was the most common medical complication experienced by stroke survivors during rehabilitation period<sup>23</sup>. Concordant with these findings, shoulder pain was the second most common complication together with insomnia accounting for 37.0% of patients in our study. Many reports have documented the negative impacts of shoulder pain in stroke patients, including obstruction of the rehabilitation process, delay of motor recovery in the upper extremities, decrease in the functional performance of daily activities, and prolongation of hospital stay<sup>34, 37, 38</sup>.

To prevent and alleviate shoulder pain, proper positioning of the shoulder, range of motion activities and avoidance of immobilization should be assured<sup>39–43</sup>.

The studies of Davenport et al., Langhorne et al., Roth et al. and Kalra et al. (all of which investigated multiple complications) did not include insomnia as a complication<sup>7, 10, 13, 44</sup>, yet insomnia and stroke seem to be associated.

In our study, insomnia was included in the main list when it was found to be a very common complication in the “others” column; 37% of our patients had insomnia during rehabilitation.

Increasing awareness and improving screening for sleep disorders is of paramount importance in improving stroke outcomes<sup>45</sup>. Stroke patients with untreated insomnia may lack the motivation, energy, and concentration necessary to participate in intensive rehabilitation therapy.

Most studies report the incidence of poststroke depression as being between 29% and 36%, depending on the diagnostic criteria used, the time since stroke, the stroke population being studied, and the preferred measurement tools<sup>46, 47</sup>. The diagnosis of post stroke depression may be difficult and is reported to be missed in 50–80% of cases by non-psychiatric physicians<sup>48</sup>.

In our study, the diagnosis of depression was made by a psychiatrist who regularly visited the rehabilitation service and 32.1% of stroke survivors were diagnosed with depression. Depression is relatively frequent in our study probably due to diagnosis by a psychiatrist.

Treatment strategies for depression after stroke include psychiatric counselling, cognitive behavioral therapy and treatment with antidepressants. We suggest psychiatric counselling for all stroke patients hospitalized for rehabilitation. Aggressive treatment of depression early in rehabilitation period may result in improved function and quality of life<sup>49</sup>.

Hansen et al. found that 45.8% of stroke patients had poststroke pain during the first 6 months<sup>50</sup>. In our study shoulder pain was also common, so we discussed musculoskeletal pain other than shoulder pain as a separate entity. We found that 32.1% of patients had musculoskeletal pain other than shoulder pain. The cause of musculoskeletal pain can often be multifactorial. Elderly patients with stroke can have preexisting painful disorders such as arthritis, and decreased mobility, changes in gait, and adoption of abnormal body postures can contribute to pain in others<sup>51</sup>. Also central poststroke pain can develop in a small number of patients with stroke<sup>52</sup>.

We agree with Zorowitz et al. who reported that appropriate and timely treatment of painful conditions will result in maximum function and the ability in patients to lead active lives and maintain an adequate quality of life<sup>53</sup>.

Our study confirms the conclusion of Kalra et al. which was that a stroke service must be medically active and therefore must have access to acute care and diagnostic facilities<sup>10</sup>. Our rehabilitation service is a university affiliated center and we were able to transfer patients to acute care facilities of the central university hospital in case of emergencies. In our study, 11.1% (n=9) patients were transferred to the acute care facility. The most common causes were fever of unknown etiology and cardiac diseases. In our study, higher comorbidity scores, TACI, lower FIM at admission and lower FIM at discharge

were found to be related to transfer to the acute care facility.

Few studies have examined rates of acute transfers during rehabilitation. Acute care facility transfer rates were reported to be 5.7% and 19% in previous studies conducted in rehabilitation services in Singapore and the USA respectively<sup>3, 7</sup>. Our transfer rate is in between these two results. Our rehabilitation service was physically separate from acute medical facilities of the central University hospital and therefore the threshold for transfer may have been lower than the rehabilitation center in Singapore which had on-site acute medical facilities. In the study reported from the USA, the severity of neurological deficit at admission to rehabilitation unit was found to be a predictor of complications that required transfer to the acute care facility<sup>7</sup>. Similarly, we found that patients with lower FIM scores on admission and patients with lower FIM scores at discharge were more likely to be transferred to acute care facility.

However, in our center patients were followed up in cooperation with physicians specializing in internal medicine. Therefore, our transfer rate was lower than that of the study reported from the USA where the rehabilitation center was completely physically separate from the central hospital. As a result of our findings, it is possible to say that physicians dealing with patients with stroke should be more alert for patients with higher comorbidity scores, TACI and lower FIM scores, as these patients are at risk of occurrence of severe and life threatening complications. To the best of our knowledge, these are the first results about acute care facility transfer reported from a Turkish rehabilitation center and may reflect the Turkish experience.

Advanced age was found to be predictive of complications in a study by Davenport et al. but was reported as unrelated to complications in other studies<sup>8, 13</sup>. Age was not associated with having at least one complication in our study. In the study of Davenport et al., the median age of patients was 73 (65–81) years and a relatively high frequency of patients (22.4%) died in the hospital<sup>13</sup>. In our study the patients were younger with a mean age  $66.5 \pm 10.3$  and there were no deaths during rehabilitation. These differences in study groups may have contributed to the difference in findings concerning this issue between the study of Davenport et al. and our study.

In line with previous reports, we also found that there were no gender differences between patients with no complications and patients with at least one complication<sup>3, 7, 13</sup>.

We evaluated the association of occurrence of medical complications with specific ischemic subtypes and found that having anterior circulation infarct was significantly associated with having at least one complication. Similarly, Davenport et al. found that having anterior circulation infarct was a risk factor for developing medical complications<sup>13</sup>. These findings are somewhat expected because TACI and PACI refer to extensive lesions of the anterior circulation in the OCSF classification<sup>17</sup>. Previously, having TACI was reported to be associated with significantly higher mortality and morbidity<sup>54, 55</sup>. Therefore, physicians dealing with patients with stroke should be more careful when treating patients with anterior circulation infarcts for the occurrence of medical complications.

In our study, longer OAI was found to be correlated with the presence of at least one complication. Many studies have reported that as the OAI increases, the outcome becomes less favorable<sup>56–59</sup>. Thus, it is possible to say that early rehabilitation is important for prevention of occurrence of medical complications and for better outcomes.

We found that higher comorbidity scores were not associated with the presence of at least one medical complication. Similarly, Hung et al. found that comorbid conditions were not predictors for the occurrence of medical complications in their study conducted in a inpatient tertiary rehabilitation center<sup>8</sup>. Most of the complications seen in our study setting and other rehabilitation centers are not life threatening (e.g., shoulder pain, depression, sleep problems) and are not directly linked to co-existing medical conditions. Thus, it is possible to say that patients with stroke can have a medical complication during rehabilitation even in the presence of low comorbidity scores. Another possible conclusion based on this finding is that most of the complications seen after a stroke are related to stroke itself and stroke-related disability rather than other comorbidities.

The role of LOS in the etiology of complications in stroke rehabilitation was difficult to assess. In our study, presence of at least one complication did not have an association with LOS. This may be related to the high number of patients being discharged early either because they were judged to be unable to benefit from further rehabilitation or due to health insurance problems. It is likely that the interplay between the LOS and stroke complications is complex and needs further investigation.

Previous authors have noted a strong association between poststroke complications and poor outcome and have suggested that complications may act as barriers to recovery<sup>7, 10, 11, 60</sup>. Similarly, we found that patients with at least one complication were more functionally disabled both at admission and discharge. Patients with more severe stroke and lower function at admission to rehabilitation are more likely to have a medical complication during rehabilitation. In addition, our study provides valuable information regarding occurrence of complications during stroke rehabilitation in Turkey.

Our study has some limitations. Firstly, our study was retrospective and our data were dependent on accurate documentation. Secondly, it was a single-center study and this might limit the generalizability of our findings.

Multicenter prospective studies performed on larger patient groups are required for more conclusive results.

In conclusion, medical complications during rehabilitation are common in patients with stroke. The five most common complications were UTI, shoulder pain, insomnia, depression, and musculoskeletal pain other than shoulder pain. Approximately 90% of the patients had at least one complication. Strategies to prevent complications should focus especially on UTI, which was the most common complication.

Careful prevention, early diagnosis and treatment of complications after stroke are important to facilitate recovery. Close interdisciplinary collaboration between physiatrists and other medical specialties is necessary for optimal management of patients with stroke.

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