Acta Clin Croat 2018; 57:5-15 Original Scientific Paper

doi: 10.20471/acc.2018.57.01.01

THE IMPACT OF COMORBIDITY ON REHABILITATION OUTCOME AFTER ISCHEMIC STROKE

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SUMMARY – Comorbidity decreases survival but it still remains unknown to what extent functional recovery after ischemic stroke is affected. The aim of this research was to determine the prevalence of the most common comorbidities in patients with ischemic stroke and to examine their predictive value on the functional status and recovery. In order to obtain relevant information for this research, we conducted a prospective study over a two-year period. It included patients with acute/subacute ischemic stroke who had inhospital rehabilitation treatment in our institution. Functional status of the patients was evaluated by the following three aspects at the beginning and at the end of rehabilitation treatment: Rivermead Mobility Index was used for mobility, Barthel Index for independence in activities of daily living, and modified Rankin Scale for total disability. Modified Charlston Comorbidity Index was used to assess comorbidity. Multivariate analysis was applied to evaluate the impact of recorded comorbidities on the patient functional outcome. Independent predictors of rehabilitation success in our study were the value of modified Charlston Comorbidity Index, atrial fibrillation and myocardial infarction. Our study demonstrated that patients with more comorbidities had worse functional outcome after stroke, so it is important to consider the comorbidity status when planning the rehabilitation treatment.

Key words: *Stroke – rehabilitation; Comorbidity; Rehabilitation; Treatment outcome; Recovery of function; Stroke*

Introduction

Comorbidity is defined as a stable chronic disease the patient has at the time of admission to the hospital, which is not directly connected to the reason of hospitalization[1]. Comorbidities affect survival but it remains unknown to what extent the functional recovery after ischemic stroke (IS) is affected[2]. A higher number of comorbidities is generally associated with a worse functional outcome of medical rehabilitation after IS. Patients with comorbidities recover more slowly and achieve a lower functional outcome[3-5]. In their study of 1,020 patients enrolled in a rehabilitation program after IS, Stineman *et al*. noted that the chances of complete functional recovery decreased with an increasing number of comorbidities[6]. Moreover, comorbidities are associated with further deterioration in the functional status over time and difficulties in performing activities of daily living (ADL)[5,7,8].

There is a correlation between older age and comorbidity burden; thus patients with IS often have more than one comorbidity. Rigler *et al*. found that

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Received November 15, 2016, accepted June 26, 2017

only 6% of patients with IS had no comorbidities, while 40% of patients had three or more concurrent diseases[4]. However, although older age and comorbidity burden have a negative impact on the functional status and recovery after IS, they do not prevent the patient from achieving significant functional improvement. Giaquinto has demonstrated that, although the comorbidity burden is associated with functional status, it is not associated with functional outcome following the process of medical rehabilitation[9].

In most cases, IS is an acute event caused by a systemic disease such as atherosclerosis, hypertensive vascular disease or cardiac embolism. Up to 75% of patients with IS have cardiac comorbidities, including arterial hypertension (AH) and coronary artery disease. Another group of cardiac conditions cause stroke by cardiogenic embolism. These include atrial fibrillation (AF), valvular heart disease, cardiomyopathy, endocarditis, acute myocardial infarction, and left ventricle myxoma[2,10,11]. AH is found in as many as 70%-80% of IS patients. Uncontrolled AH is one of the most common causes of rehabilitation treatment delay, and the values of blood pressure over 200/100 mm Hg represent an absolute contraindication for physical therapy[2,12]. However, there is still no consensus among researchers on the impact of AH on the rehabilitation outcome after IS. Some claim that AH has a negative impact, whereas others consider that it increases the length of hospital stay but has no significant influence on the rehabilitation outcome[13-15]. AH is most frequently associated with lacunar IS, which confirms that the substrate in the development of this type of IS are changes in small penetrating arteries[16].

According to the Framingham Heart Study, 8% of men and 11% of women will have IS in the next six years after the occurrence of myocardial infarction (MI). In these patients, IS occurs after the acute phase of MI because of akinesia/hypokinesia of a part of the myocardium and subsequent frequent development of AF[17]. A previous MI as a comorbidity in IS patients is associated with worse functional outcome and prolonged duration of rehabilitation treatment. Pathological movement patterns that occur in IS patients require high oxygen uptake and pose great burden for the already damaged myocardium, especially after MI. In hemiparetic muscles, there are changes that cause hemiparetic gait to require up to 50%-60% higher oxygen uptake compared to normal gait. Therefore, IS patients with a history of previous MI require exercises of low and moderate intensity[18,19].

Dilated cardiomyopathy (DCM) is associated with an increased risk of cerebral embolism. The reason for this is the tendency towards the formation of thrombotic masses due to slow blood flow in dilated heart chambers. According to the Framingham Heart Study, each 10-mm increase in the size of the left atrium doubles the risk of IS[17]. Several studies have shown DCM to be associated with a worse functional status both before and after medical rehabilitation. However, the authors disagree regarding the functional outcome in these patients. While some argue that patients with DCM achieve poor functional outcome after a completed rehabilitation program, others believe that these patients can achieve a similar functional outcome, although they need more time and an individualized approach in medical rehabilitation[20-22].

The incidence of AF among IS patients ranges from 9.3% to 23%[23,24]. AF is considered a predictor of poor outcome of medical rehabilitation, increased dependency in ADL, and a cause of more frequent institutionalization[25-27]. AF frequently concurs with large cortical brain infarctions, and therefore this heart dysfunction is associated with poor rehabilitation outcome[16]. AF increases five times the risk of lethal outcome during medical rehabilitation and represents one of the most common reasons for disruption of treatment[28]. Several studies have shown AF to be a predictor of increased mortality and disability risk in the first three months after IS[29-31].

Diabetes mellitus (DM) doubles the risk of IS, and approximately 40% of IS patients undergoing medical rehabilitation suffer from this disease[32]. DM is most commonly seen in patients with lacunar IS, and multivariate analysis indicates that DM is a predictor of lacunar IS. It is possible that patients with DM achieve worse functional recovery due to the risk factors and complications associated with this disease (AH, hyperlipoproteinemia and coronary heart disease), which are six times more common in these patients[33]. It has been observed that in patients with DM recovery after IS lasts longer, thereby prolonging rehabilitation treatment[34,35].

Chronic lung diseases, depression and dementia very often concur with IS and affect the outcome of rehabilitation treatment[2,36-39].

The aim of our study was to determine the prevalence of the most common cardiac comorbidities and DM in IS patients, as well as to examine their impact and predictive value on the outcome of medical rehabilitation after IS.

Material and Methods

This prospective study was carried out from January 1, 2013 to December 31, 2014. The study included IS patients treated at the Department of Neurology and/or Department of Emergency Neurology, who afterwards underwent inhospital rehabilitation at the Department of Medical Rehabilitation. The study was approved by the medical ethics committees of the Medical Faculty of Novi Sad and Clinical Center of Vojvodina. All study patients gave their signed informed consent. The functional status of IS patients was evaluated from three aspects: mobility was evaluated by the Rivermead Mobility Index (RMI), independence in ADL was assessed by Barthel Index (BI), and general disability was scored by Modified Rankin Scale (mRS).

The study had three phases (Fig. 1). The first phase was carried out at the Department of Neurology and/or Department of Emergency Neurology, where patients were diagnosed with acute IS and treated accordingly. The diagnosis of IS was based on medical history, clinical neurological examination and brain computed tomography (CT) or magnetic resonance imaging (MRI). Admission and discharge neurological examinations were scored according to the National Institutes of Health Stroke Scale (NIHSS). After stabilization of the general and neurological status, patients were examined by a specialist of physical medicine and rehabilitation, and those with significant functional deficits, determined by mRS score ≥3, were referred to the Department of Medical Rehabilitation.

The second phase of the study consisted of patient evaluation on admission to the Department of Medical Rehabilitation. Motor functioning was assessed by the Brunnstrom Motor Evaluation Scale (BMES) for affected arm, leg and hand. Functional status was estimated by use of the scores of functionality in ADL, i.e. BI, RMI and mRS. In addition, all patients were examined by a clinical psychologist and speech therapist.

Based on medical history, physical examination, electrocardiography (ECG) and medical records avail-

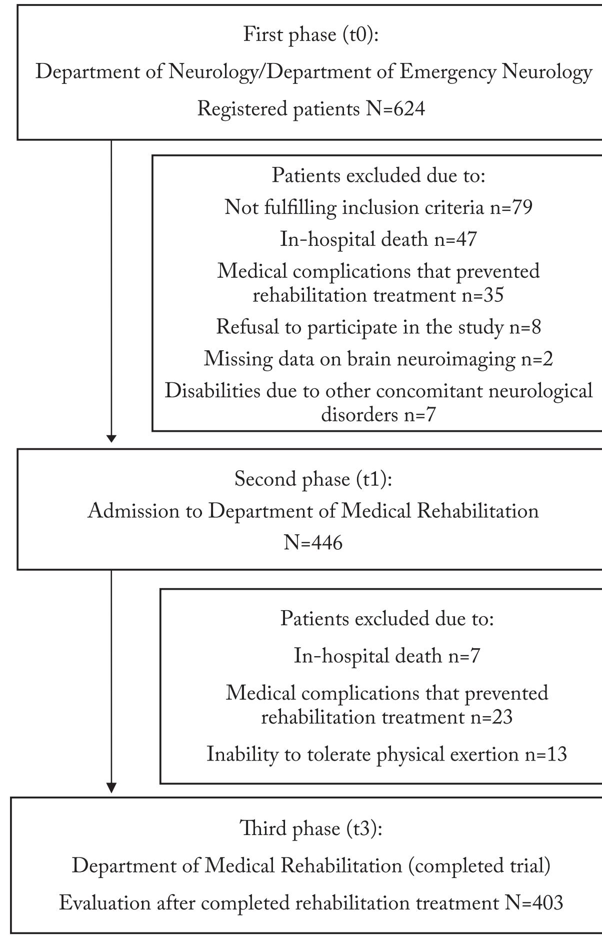

Fig. 1. Flow diagram showing study phases and patients analyzed and excluded from the study.

able, the following cardiologic comorbidities were detected: AF, previous MI, AH and DCM. The presence of DM was detected according to a previously established diagnosis reported by the patient or recorded in his/her medical records, current use of insulin or oral antidiabetic medication, or fasting blood sugar levels above 6.6 mmol/L. Medical history, physical examination and medical records available were used to register other comorbidities, and these were used to calculate the Charlston Comorbidity Index (CCI) modified for stroke.

The CCI modified for stroke is used for the evaluation of comorbidities in IS patients[40]. Fischer *et al.* showed CCI to have a predictive value in the process of medical rehabilitation[41]. This index takes into account the number of comorbidities and their severity. The following comorbidities are evaluated: previous

MI, chronic heart failure, peripheral vascular disease, dementia, chronic obstructive lung disease, connective tissue disease, ulcer disease, diabetes, renal and liver failure, malignant tumors, and AIDS[42].

The rehabilitation treatment consisted of a specially designed program, which took place five days a week for 3 hours a day. The program included kinesitherapy according to the Bobath and Brunnstrom concept and therapeutic exercises (exercises to increase the range of motion in the joints of affected extremities, strengthen muscles, and improve balance, passive stretching exercises, gait exercises and correction of gait). The rehabilitation treatment lasted for four weeks.

The third phase of the study involved evaluation of patients after completed rehabilitation treatment. This included examination of motor recovery of the affected extremities by the BMES, and determination of functional status according to the scores of functionality in ADL on discharge (BI, RMI, and mRS).

The criteria for inclusion in the study were significant functional deficit (mRS ≥3) and the ability and willingness of the patient to participate in the rehabilitation program. The criteria for exclusion from the study were patients with medical problems that developed in the course of treatment, which did not allow continuation of the rehabilitation treatment (re-infarction, deep vein thrombosis, pulmonary thromboembolism, pneumonia, urinary tract infections that required parenteral therapy, sepsis), patients who refused to participate in the study, patients below age 18, patients that died during the treatment, patients unable to tolerate physical exertion, patients who had trouble walking before IS due to some other neurological diseases, and patients without data on brain neuroimaging and functional outcome of medical rehabilitation.

For all patients, the following data were collected: gender and age, type of disability (left or right sided hemiparesis/hemiplegia, aphasia/dysphasia, contralateral homonymous hemianopsia, brainstem syndrome), NIHSS scores on admission and discharge from the Department of Neurology/Department of Emergency Neurology, motor functioning of affected extremities by the BMES, RMI, BI and the mRS on admission and discharge from the Department of Medical Rehabilitation, and presence of concomitant diseases (comorbidities): cardiologic (AF, previous MI, AH, DCM), DM and the value of CCI modified for stroke.

The effects of these comorbidities and the value of CCI modified for stroke on the outcome of rehabilitation of IS patients were investigated using multivariate analysis. Univariate regression analysis was used to select significant determinants ($p<0.05$) for subsequent development of the multivariate linear regression model.

A good (satisfactory) outcome of medical rehabilitation was defined by the values of BI ≥80, RMI ≥13 and mRS ≤2 at the end of the rehabilitation treatment or as an increase in BI of 40 points and in RMI of 7 points and a decrease in mRS of 2 points at the end of the rehabilitation treatment (Δ BI ≥40, Δ RMI ≥7 and Δ mRS ≥2).

Statistical analysis of the collected data included descriptive analysis, calculating the percentage of coded variables, while for numerical variables we calculated arithmetic means with standard deviations and ranges. Numerical variables were compared by parametric tests (T-test and ANOVA), and if required, by non-parametric methods (Mann-Whitney U test and the Kruskal-Wallis H test). Coded variables were analyzed by χ^2-test. The mean values of motor recovery of affected extremities were analyzed using the Wilcoxon Signed Ranks Test on admission and discharge from the Department of Medical Rehabilitation. For the analysis of independent predictors of rehabilitation outcome, we used multivariate regression analysis (linear and logistic).

Results

A total of 624 patients with acute stroke were admitted to the Department of Neurology and/or Department of Emergency Neurology during the study period. Excluded were 221 patients due to failure to meet the inclusion criteria, inhospital death, medical complications that prevented rehabilitation treatment, refusal to participate in the study, missing data, disabilities due to other concomitant neurological disorders, and inability to tolerate physical exertion. The final analyses included data on 403 consecutive patients, 203 (57.1%) of them male, with IS admitted during the two-year period (Fig. 1). The clinico-demographic characteristics of these patients are shown in Table 1. The mean age of patients was 63.9±40.5 years. The most common comorbidities in our study were AH (82.4%) and DM (34.0%), followed by previous MI (17.1%), AF (15.4%) and DCM (9.9%).

Table 1. Demographic and clinical characteristics of patients

	Admission	Discharge	*p-value
Subjects, N	403		
Age (yrs) Mean±SD	63.9±40.5		
Range	20-90		
Sex			
Male, n (%)	230 (57.1)		
Female, n (%)	173 (42.9)		
Type of disability			
Left-sided hemiparesis/ hemiplegia, n (%)	159 (39.2)		
Right-sided hemiparesis/ hemiplegia, n (%)	208 (51.9)		
Brainstem syndrome, n (%)	36 (8.9)		
Hemianopsia, n (%)	58 (14.4)		
Aphasia, n (%)	118 (29.3)		
NIHSS			
Mean±SD	10.3±4.45	7.01±3.76	<0.001
Median (range)	14 (5-23)	7 (0-20)	
BMES			
Arm			
Mean±SD	4.11±1.21	4.85±1.19	<0.001
Hand			
Mean±SD	4.09±1.32	4.85±1.28	<0.001
Leg			
Mean±SD	4.32±1.06	4.99±1.06	
BI			
Mean±SD	53.9±21.1	77.9±21.4	<0.001
Median (range)	55 (0-75)	80 (15-100)	
RMI			
Mean±SD	5.76±3.26	10.2±3.65	<0.001
Median (range)	5 (0-12)	11 (1-15)	
mRS			
Mean±SD	3.86±0.87	2.95±0.89	<0.001
Median (range)	4 (3-5)	3 (1-5)	

NIHSS = National Institute of Health Stroke Scale; BMES = Brunnstrom Motor Evaluation Scale; BI = Barthel Index; RMI = Rivermead Mobility Index; mRS = Modified Rankin Scale; *p calculated using Student's t-test for comparisons of continuous variables and Wilcoxon signed rank test for comparisons of differences between pre- and post measures of Brunnstrom Motor Evaluation

Table 1 also shows the initial and final values of the NIHSS score with minimum and maximum values. The decrease in NIHSS scores on discharge compared to admission was highly statistically significant (p<0.001). Motor function evaluated by the BMES showed a significant increase on discharge for leg, arm and hand. In our study, patients achieved significant improvement in ADL evaluated by RMI, BI and mRS for all three scales (Table 1). Most patients had moderate strokes (mean NIHSS admission value 10.3±4.45) and moderate to severe disabilities (mean BI admission value 53.0±21.1), which can be explained by the fact that our patients were admitted to the rehabilitation setting with acute/subacute stroke. Also, patients with severe stroke who were unable to tolerate intensive rehabilitation were referred to nursing facilities.

We analyzed the outcomes of medical rehabilitation in relation to the following comorbidities: AH, AF, previous MI, DCM and DM. Successful rehabilitation was achieved in 33.7% of patients with AH, 8.1% of patients with AF and 13.0% of patients with previous MI. None of the patients with DCM had successful rehabilitation. Among patients with DM, 28.5% had successful rehabilitation. Patients without comorbidities achieved a higher percentage of rehabilitation success compared to patients with comorbidities (p<0.001) for all concomitant diseases studied (Table 2).

The mean value of modified CCI in patients who successfully completed rehabilitation was 2.16 (SD= 1.14), while in patients with unsuccessful rehabilitation it was 4.17 (SD=1.49). The difference in the CCI values between the two groups of patients was statistically highly significant (p<0.001) (Table 2). Among patients with modified CCI of 0, 1 and 2 (low comorbidity), 80.7% had successful rehabilitation, while rehabilitation was successful in only 33.2% of patients with CCI ≥3 (high comorbidity). The difference in the rehabilitation success achieved with regard to CCI values was statistically significant (p<0.001) (Table 2).

Univariate analysis showed significant associations between all studied comorbidities, modified CCI values and rehabilitation success (Table 3). The univariate analysis was followed by multivariate analysis. The independent variables were the comorbidities shown by univariate analysis to be statistically significant for the prediction of rehabilitation success. The dependent variable was rehabilitation outcome. The dependent variable was defined as dichotomous-binary (0, unsuccessful rehabilitation; and 1, successful rehabilitation). Multivariate logistic regression analysis was performed

Table 2. Rehabilitation outcome in relation to comorbidities and modified CCI values

Rehabilitation outcome	Unsuccessful	Successful	Total	*p
	n (%)	n (%)	n (%)	
Hypertension				
Yes	220 (66.3)	112 (33.7)	332 (100.0)	< 0.001
No	22 (31.0)	49 (69.0)	71 (100.0)	
Atrial fibrillation				
Yes	57 (91.9)	5 (8.1)	62 (100.0)	<0.001
No	185 (54.3)	156 (45.7)	341 (100.0)	
Myocardial infarction				
Yes	60 (87.0)	9 (13.0)	69 (100.0)	<0.001
No	182 (54.5)	152 (45.5)	334 (100.0)	
Dilatative cardiomyopathy				
Yes	40 (100.0)	0 (0.0)	40 (100.0)	<0.001
No	202 (55.6)	161 (44.4)	361 (100.0)	
Diabetes mellitus				
Yes	98 (71.5)	39 (28.5)	137 (100.0)	=0.001
No	144 (54.1)	122 (45.9)	266 (100.0)	
Modified CCI				
n (%)	242 (60.0)	161 (40.0)	403 (100.0)	
Mean value±SD	4.17±1.49	2.16±1.14	3.24±1.56	<0.001**
Median (range)	5 (0 – 8)	2 (0 – 5)		
Modified CCI <3				
n (%)	11 (19.3)	46 (80.7)	57 (100.0)	
Modified CCI ≥3				<0.001
n (%)	231 (66.8)	115 (33.2)	346 (100.0)	

CCI = Charlston Comorbidity Index; *p calculated using Student's t-test for comparisons of continuous variables; **p calculated using Mann Whitney U test

Table 3. Univariate and multivariate linear regression analysis (ENTER method)

Determinant	Univariate analysis		Multivariate analysis	
	p	Beta	p	Beta
Modified CCI	0.000	-0.584	0.000	-0.408
Hypertension	0.012	-0.175	0.058	-0.023
Atrial fibrillation	0.000	-0.479	0.006	-0.061
Myocardial infarction	0.001	-0.357	0.029	-0.454
Dilated cardiomyopathy	0.004	-0.289	0.998	-0.010
Diabetes mellitus	0.001	0.178	0.547	0.023

CCI = Charlston Comorbidity Index

using the ENTER method (all parameters/risk factors were entered into the model). The ENTER method showed that independent predictors of rehabilitation success were the value of modified CCI, AF and previous MI (Table 3).

Discussion

The main finding of this study was that patients with more comorbidities were associated with worse functional outcome after IS. Furthermore, the independent predictors of poor rehabilitation success were higher values of modified CCI (CCI >3), AF and previous MI. These results are complementary to the findings by Ferriero *et al.*, who noticed a correlation between the number of comorbidities and functional status, so that a higher number and greater severity of comorbidities contributed to more pronounced disability and slower functional recovery[7]. Similarly, Patrick *et al.* concluded that comorbidity was the best predictor of the effectiveness of rehabilitation treatment[43]. By contrast, Van de Port *et al.* in the FuPro-Stroke Study, using the method of multivariate analysis, did not find association between the presence of comorbidity and rehabilitation outcome[44]. The association between the comorbidity status and outcome of medical rehabilitation was confirmed by Gialanella *et al.*, who used the method of univariate analysis and found a correlation between comorbidity as assessed by the Cumulative Illness Rating Scale and rehabilitation outcome[45].

In our study, multivariate analysis showed that AH was not an independent predictor of medical rehabilitation outcome (p=0.058). Similarly, in the study by Gokkaya *et al.*, the prevalence of AH among patients undergoing rehabilitation treatment was 65%; however, the authors did not find correlation between the functional outcome and AH[46]. On the other hand, Nazzal *et al.* report that AH had a significant negative impact on rehabilitation outcome after IS (p=0.009)[47]. Al-Eithan *et al.* found an association between AH and prolonged medical rehabilitation in IS patients[48]. Turhan *et al.* emphasize the association between hypertension and lacunar IS and report that in their research AH was not associated with poor functional rehabilitation outcome[49].

Our results confirmed AF as an independent predictor of rehabilitation outcome. The prevalence of AF in the study by Karatas *et al.* was 20.9%. They report that patients with AF had worse functional outcome than patients with sinus rhythm. They also found a correlation between large cortical infarction and AF. Strokes in patients with AF usually have a cardioembolic etiology, affect the major cerebral arteries, thereby causing more severe IS[28]. It has been observed that AF has a negative impact on the recovery after IS. Several authors have come to the conclusion that patients with AF have a higher mortality in the first 30 days after IS[50-53]. Turhan *et al.* in their research used univariate analysis to show the negative impact of AF on stroke rehabilitation outcome, but after performing multivariate analysis, they concluded that this impact was indirect and associated with large cortical infarcts caused by AF[49]. Di Carlo *et al.* in their study of 2,740 patients noted a correlation between AF and an increased risk of death, disability, and handicap[54].

In our research, univariate analysis showed that previous MI had a considerable impact on the functional outcome of rehabilitation of IS patients. The ENTER method of multivariate logistic regression confirmed MI to be an independent predictor of stroke rehabilitation outcome (p=0.029). Mustanoja *et al.* report the prevalence of previous MI of 11%, which is somewhat lower than in our study[55]. Our results concur with Atalay *et al.* who, on a sample of 300 patients, using multivariate regression analysis, found a correlation between rehabilitation outcome, duration of rehabilitation and previous MI[15]. Furthermore, Roth *et al.* report that patients with coronary artery disease had a significantly longer period from IS onset to initiation of rehabilitation, three times more cardiac complications during rehabilitation, and significantly worse functional recovery compared with patients without coronary heart disease[56].

Our findings implied that DCM was not an independent predictor of rehabilitation outcome (p=0.998). Atalay *et al.* report a prevalence of 12.4%, which is similar to our results. Likewise, they found no association between DCM and rehabilitation outcome[15]. On the other hand, Vemmos *et al.* in their research on a sample of 2,904 IS patients found that DCM had a negative impact on stroke rehabilitation outcome and was a significant predictor of 10-year survival[57]. Censori *et al.* used univariate analysis and recorded significant association between DCM and poor rehabilitation outcome; however, multivariate analysis showed that DCM was not an independent predictor of stroke rehabilitation outcome[58]. Sharma *et al.* found that DCM increased IS mortality independently of other factors[27].

Our results showed that DM was not an independent predictor of rehabilitation outcome (p=0.547), but that its impact was indirect and associated with other factors. Di Carlo *et al.* report that 21.8% of their patients had DM, which is somewhat lower than in our study[54]. Results similar to ours were obtained in a study by Mizrahi *et al.*, where 37.7% of patients had DM[59], and by Atalay *et al.* who report a DM prevalence of 35.9%[15]. Our results concurred with Van de Port *et al.* (FuPro-Stroke Study), who used multivariate analysis to show that the existence of an association between DM and poor rehabilitation outcome was indirect and dependent on other factors[44]. Ones *et al.* did not find an association between DM and stroke rehabilitation outcome and concluded that patients with DM had the same potential for rehabilitation as patients without this comorbidity[60].

In our study, we used the CCI modified for stroke to assess the cumulative effect of comorbidities on the outcome of rehabilitation after IS. After multivariate logistic regression analysis, our findings implied that modified CCI was the strongest independent predictor of stroke rehabilitation outcome ($p<0.001$). The CCI takes into account both the number and severity of comorbidities. Goldstein *et al.* showed the number and severity of comorbidities as assessed by CCI to be an independent predictor of functional outcome at discharge from rehabilitation department, as well as a predictor of mortality in the next year[40]. On the contrary, Atalay *et al.* found CCI to show positive correlation with age ($p=0.04$; $r=0.156$); however, linear regression analysis found no association between CCI and medical rehabilitation outcomes[15]. Turhan *et al.* in their research using multivariate regression analysis found that the comorbidity status as assessed by CCI was a significant predictor of the outcome of medical rehabilitation after IS[49]. Similarly, Liu *et al.* demonstrated correlation between the outcome of IS and comorbidity status as assessed by CCI[59]. Therefore, we can conclude that our results imply that CCI modified for stroke is an important tool for predicting functional outcome in stroke patients.

One of the limitations of this study was the fact that the research was restricted to a single facility. Furthermore, it was not a population-based study and therefore not all patients who survived stroke were enrolled. This study was performed in a population admitted to a rehabilitation hospital in need of physical rehabilitation, thus our population did not reflect the actual functional disability of all stroke patients. Those patients with slight impairment did not require inpatient rehabilitation, while extremely disabled patients would have been transferred directly to skilled nursing facilities after acute care. Another important limitation of this study was that we did not include all possible comorbidities in the regression analysis. Nevertheless, the regression analysis included those comorbidities that are most common in stroke patients and those that in previous studies were shown to be important predictors of rehabilitation outcome in stroke patients[59-61]. Additional research is needed to analyze in greater depth and confirm our results in different groups of rehabilitation inpatients, as well as additional studies to compare them with other similar indices.

Since our results imply that independent predictors of poor rehabilitation success are multiple comorbidities (CCI >3) and cardiologic concomitant diseases, i.e. AF and previous MI, it appears that patients for rehabilitation treatment after stroke should be carefully selected and that their comorbidities should be taken into account when planning rehabilitation treatment. For patients with multiple comorbidities, lower intensity of rehabilitation treatment and prolonged and delayed rehabilitation might be needed to improve their outcome and this should be the ground for further research. Patients with AF and previous MI would probably benefit if cardiologic rehabilitation was part of their rehabilitation treatment, which should also be a subject of further research.

Conclusion

According to our study, patients with multiple comorbidities have worse functional outcome after IS. Independent predictors of poor rehabilitation outcome after IS are modified CCI >3, AF and previous MI. Taking into account these findings, it is essential to consider comorbidity status when planning rehabilitation treatment. Further research is needed to assess the best approach and rehabilitation treatment for patients with multiple comorbidities in order to improve their functional outcome after stroke.

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Sažetak

UTJECAJ KOMORBIDITETA NA ISHOD REHABILITACIJE NAKON ISHEMIJSKOG MOŽDANOG UDARA

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Komorbiditeti smanjuju preživljavanje nakon ishemijskog moždanog udara, ali još uvijek ostaje nepoznato koliki je njihov utjecaj na funkcijski oporavak. Cilj ovoga istraživanja bio je utvrditi učestalost najčešćih komorbiditeta u bolesnika s ishemijskim moždanim udarom i ispitati njihovu prediktivnu vrijednost na funkcijski status i oporavak. U cilju dobivanja relevantnih podataka za ovu studiju proveli smo prospektivno istraživanje u razdoblju od dvije godine. Studija je uključila bolesnike s akutnim/subakutnim ishemijskim moždanim udarom koji su imali bolnički rehabilitacijski tretman u našoj ustanovi. Funkcijsko stanje bolesnika je ocijenjeno s tri aspekta na početku i na kraju rehabilitacijskog tretmana: Indeks mobilnosti Rivermead je primijenjen za mobilnost, Barthelov indeks za neovisnost u aktivnostima svakodnevnog života, a modificirana Rankinova ljestvica za ukupnu onesposobljenost. Charlstonov indeks komorbiditeta modificiran za moždani udar je primijenjen za procjenu komorbiditeta u bolesnika. Multivarijatna analiza primijenjena je za procjenu utjecaja ispitivanih komorbiditeta na funkcionalni ishod bolesnika. Nezavisni prediktori uspjeha rehabilitacije u našem istraživanju bili su vrijednost Charlstonova indeksa komorbiditeta modificiranog za moždani udar, atrijska fibrilacija i infarkt miokarda. S obzirom na to da je naše istraživanje pokazalo kako bolesnici s većim brojem komorbiditeta postižu lošiji funkcijski ishod nakon ishemijskog moždanog udara, bitno je razmotriti komorbiditetni status pri planiranju rehabilitacijskog tretmana.

Ključne riječi: *Moždani udar – rehabilitacija; Komorbiditet; Rehabilitacija; Ishod liječenja; Oporavak funkcije; Moždani udar*