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Original Article

Risk Factors Related to Falling in Patients after Stroke

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Abstract

Background: The aim of this study was to identify the risk factors associated with falling in post stroke patients.

Methods: This retrospective case-control study included 561 neurology patients hospitalized for a stroke and divided into two groups: falling patients and non-falling patients. They referred to the Special Hospital for Cerebrovascular Diseases "Sveti Sava" in Belgrade, Serbia, from 2018- 2019. Logistic regression analysis was applied to examine socio-economic factors associated with predictors of unmet healthcare needs.

Results: A significant difference was seen in the length of hospitalization of falling patients compared to the non-falling (P<0.001). We established statistically significant differences in mental status (P<0.001), sensibility (P=0.016), depressed mood (P<0.001), early (P=0.001) and medium insomnia (P=0.042), psychomotor slowness (P=0.030), somatic anxiety (P=0.044) and memory (P<0.001).

Conclusion: Cerebrovascular disease distribution and the degree of neurological deficit primarily altered mental status, which could be recognized as one of the more important predictors for falling after stroke. The identification of risk factors may be a first step toward the design of intervention programs for preventing a future fall among hospitalized stroke patients.

Keywords: Falls; Stroke patients; Risk factors; Hospitalization

Introduction

Stroke represents one of the leading causes of mortality and disability for adults in developed countries (1). Patients who survive acute ischemic stroke (AIS) are reported to face numerous early and late complications (2, 3). Falls are one of the most common complications of stroke patients, with a reported incidence ranging from 7% in the first week after stroke to 73% in the first year after being discharged from hospital (4,5).

The occurrence of falls in the stationary healthcare may lead to numerous negative outcomes such as the injuries and extended rehabilitation period, increased length of hospital stay, and increased healthcare expenditures along with legal consequences (3,6). Approximately 30% of the falls in hospital settings have been reported to result in some type of injury, whereas severe out-

comes occur on average in 3% to 6% of patients (7).

Most commonly, hematoma, laceration and soft tissue damages are caused by other less serious injuries resulting from falls (8), whereas more severe outcomes are related to open and closed bone fractures, luxations, intracranial hematomas, extensive bleeding, including lethal outcomes as well (9,10). If the fall does not lead to any physical consequences it can affect the emotional health of patients and it can also lead to fear of falling (11, 12). All of the abovementioned facts lead to the impairment of quality of life of patients and their family members, that is, caregivers (13, 14).

Although falls prevention in a hospital setting has been given a significant amount of clinical attention, the incidence of falls and fall-related injuries is still high and little is currently known about post stroke falls in the acute hospital inpatient setting.

The aim of this study was to identify the risk factors associated with falling in poststroke patients.

Methods

Study population

This retrospective case-control study included 561 neurology patients hospitalized for a stroke at the Special Hospital for Cerebrovascular Diseases "Sveti Sava" in Belgrade, Serbia, in the period between 3rd February 2018 and 28th June 2019. The investigation included subjects with ischaemic or hemorrhagic stroke, in the acute phase of the disease, according to an updated definition of stroke (15). Study population was divided into two groups: the one consisted of patients who experienced a fall during hospitalization (falling patients) and the group consisted of patients without a detected fall (non-falling patients).

The data related to sociodemographic characteristics (gender, age, body height and weight, marital status, residence, education and occupation, material status , stroke type, the site and size of the lesion, neuropsychiatric status (including the affected side of the body, symptoms of anxiety and/or depression, insomnia), the existence of other medical diagnoses, patients' falls (place, time, circumstances and consequences of the falls), applied therapy and length of hospitalization were extracted from medical records.

The study was approved by the local Ethical Committee (reference number 03/2256). Written informed consent was obtained from each patient or a close family member if that particular patient was unable to do it.

Measurements

The Morse Fall Scale (MFS) was used as a fall risk assessment scale. The total score of the scale ranges between 0 and 125. According to their fall risk, individuals are distinguished into one of the three categories: without fall risk (0-24), low fall risk (25-44) and high fall risk (≥45) (16).

The Barthel Index (BI) was used for the assessment of functional status. The scores range from 0 to 100. The levels of dependency are the following: the scores of 0-20 indicate total dependency; 21-60 indicate severe dependency; 61-90 indicate moderate dependency; 91-99 indicate minimal dependency whereas the score of 100 indicates complete independence (17).

The National Institutes of Health Stroke Scale (NIHSS) was used for the assessment of neurological deficits. The total scores of the scale ranges between 0 and 42. According to the NIHSS, individuals are distinguished into one of the following three groups: minimal neurological deficit (NIHSS<5), moderate neurological deficit (NIHSS 5-14) and severe neurological deficit (NIHSS ≥25) (18).

Hamilton Depression Rating Scale (HDRS) was used for assessing symptoms of depression severity. Based on the scores of the HDRS scale, individuals are distinguished into the following categories: the scores of 0-7 are indicative of the absence of depression, the scores of 8-13 are indicative of mild depression, the scores of 14-18 are indicative of moderately severe (major) depression; the scores of 19-22 are indicative of severe (major) depression whereas the scores greater

than >22 are indicative of highly severe (major) depression (19).

Mini Mental State Examination (MMSE) is an instrument used for the assessment of cognitive function. The scores can indicate severe (≤9 points), moderate (10–20 points), early (21–24 points) cognitive impairment and normal cognition (>24 points) (20).

Statistical analysis

All values were expressed as mean ± standard deviation (SD). The commercial software package SPSS, version 21.0 (Chicago, IL, USA) was used for statistical analysis. Differences in the parameters between two groups of patients were evaluated by the Independent samples *t*-test or the Mann-Whitney U-test (depending on the distribution). The Chi-square ($\chi 2$) test was used to compare the differences in the frequency of categorical variables. The relationship between the falls, as a dependent variable, and a set of independent variables was analyzed by bivariate and multivariate logistic regression. For risk assessment, we applied OR (odds ratio), with a 95% confidence interval; *P* values less than 0.05 were considered to be statistically significant.

Results

The analysis of fall dynamics during hospitalization showed that most patients fell once (239 subjects, i.e. 94.8% of the population), while the others recorded two falls (13 subjects, i.e. 5.2% of the population). The frequency of falls was highest on the second day of hospitalization (46 patients, i.e. 18.3%), followed by the first day (41 patients, i.e. 16.3% of the population), and then finally on the third day (38 patients, i.e. 15.1% of the population). The largest number of patients fell near the bed, during the night and most of them had no consequences (Table 1).

Table 1: The characteristics of falls in the patients who have experienced a stroke

The falls		***N°/ Percentage***
Place	Near the bed	143 (56.7)
	In the room	32 (12.7)
	In the hallway	31 (12.3)
	In the toilet	43 (17.1)
	Second place	3 (1.2)
Time	Morning	37 (14.7)
	Before noon	20 (7.9)
	Afternoon	53 (21)
	Night	142 (56.3)
Consequence	Without	131 (52)
	Minor scratch/hematoma	109 (43.3)
	Suture wound	11 (4.4)
	Open fracture	1 (0.4)
Applied therapy after fall	Antitetanus protection	60 (23.8)
	Antibiotics	30 (11.9)
	Elevation of limbs and lining	146 (57.9)
	Analgesics	90 (35.7)
	Sedatives	113 (44.8)
	Orthopedic consultation	50 (19.8)

In line with our expectations, it has been shown a significant difference in the length of hospitalization of falling patients compared to non-falling patients (18.6±5.4 vs. 14.5±4.6 days) (Independent samples *t* test, $P<0.001$). Respectively, the average length of stay at the hospital for the whole study population was 16.3 ± 5.4 days (min 2, max 37 days). Sociodemographic and neurological characteristics of the two groups of patients are shown in Table 2.

Table 2: Sociodemographic and neurological characteristics of study population

Analyzed parameters		*Study population N(%)*		*Significance*
		Falling patients	Non-falling patients	
Gender	Male	188 (74.6)	218 (70.5)	
	Female	64 (25.4)	91 (29.5)	*P*= 0.286
Age (X ± SD)		74.43 ± 8.7	72.57 ± 8.5	
(min-max range)		(48-93 yr)	(45-95 ys)	*P*= 0.530
Body height in cm (X ± SD)		172.6 ± 7.3	172.2 ± 6.4	*P* = 0.489
Body weight	Malnutrition	4 (1.6)	1 (0.3)	
According to BMI	Normal nutrition	37 (14.7)	45 (14.6)	*P* = 0.281
(X ± SD)	Obesity	210 (83.7)	263 (85.1)	
Marital status	Marriage	91 (36.1)	253 (81.8)	
	Partner	54 (26.4)	30 (9.7)	*P*< 0.001
	Singles	107 (42.5)	26 (8.5)	
Residence	City	207 (82.1)	284 (91.9)	
	Village	45 (17.9)	25 (8.1)	*P*< 0.001
Education	Primary school	6 (2.4)	4 (1.3)	
	High school	230 (91.3)	209 (67.6)	
	University education	11 (4.4)	28 (9.1)	*P*< 0.001
	Academic title	5 (1.9)	68 (22)	
Occupation	Employed	22 (8.7)	42 (13.6)	
	Unemployed	16 (6.3)	9 (2.9)	*P*= 0.037
	Retiree	214 (85)	258 (83.5)	
Material status	< 250 USD	189 (75)	102 (33)	
	250-500 USD	56 (22.2)	152 (49.2)	*P*< 0.001
	> 500 USD	7 (2.8)	55 (17.8)	
Type of cerebrovascular disease	Transient ischemic attack	4 (1.6)	10 (3.2)	
	Ischemic stroke	226 (89.7)	267 (86.4)	*P*=0.356
	Hemorrhagic stroke	22 (8.7)	32 (10.4)	
Type of stroke sindrom*	Total anterior circulation stroke	96 (38.1)	45 (14.5)	
	Partial anterior circulation stroke	60 (23.8)	85 (27.5)	
	Lacunar stroke	41 (16.3)	104 (33.6)	*P*< 0.001
	Posterior circulation stroke	55 (21.8)	75 (24.4)	
Barthel index	Minimal dependency	74 (29.4)	110 (35.6)	
	Slight dependency	52 (20.6)	53 (17.2)	
	Moderate dependency	63 (25)	65 (21)	*P*=0.455
	Severe dependency	25 (9.9)	34 (11.0)	
	Total dependency	38 (15.1)	47 (15.2)	
Barthel index (median (IQR))		72.5 (46.2-100)	80 (45-100)	
NIHSS	Minimal deficit	70 (27.8)	106 (34.0)	
	Moderate deficit	152 (60.3)	171 (55.3)	*P*=0.287
	Severe deficit	30 (11.9)	32 (10.3)	
NIHSS (median (IQR))		10 (7-14)	10 (6-13)	
HDRS	Without depression	51 (20.2)	103 (33.3)	
	Mild depression	81 (32.1)	91 (29.4)	
	Moderate depression	62 (24.6)	59 (19.1)	*P*=0.013
	Severe depression	37 (14.7)	36 (11.7)	
	Highly severe depression	21 (8.3)	20 (6.5)	
HDRS (median (IQR))		13 (9-13)	12 (6-16)	
MMSE	Normal cognition	42 (16.7)	87 (28.2)	
	Early cognitive impairment	60 (23.8)	55 (17.8)	
	Moderate cognitive impairment	127 (50.4)	135 (43.7)	*P*=0.062
	Severe cognitive impairment	23 (9.1)	32 (10.4)	
MMSE (median (IQR))		18 (13-24)	20 (13-25)	

*Bamford classification

NIHSS - The National Institutes of Health Stroke Scale, HDRS - Hamilton Depression Rating Scale, MMSE - Mini Mental State Examination

Statistical analysis of the data indicated that there were significant differences in marital status, residence, education, occupation, and material status between the examined groups of patients. We found that there were significantly more singles among falling patients (χ^2=128.164, *P*<0.001), who were mainly from rural areas (χ^2=12.123, *P*<0.001). The largest number of them had a high school education (χ^2=57.992, <0.001), were more unemployed compared to the non-falling patients (χ^2=6.588, *P*=0.037) and with lower material incomes (χ^2=103.247, *P*<0.001). No statistically significant difference was found in the type of cerebrovascular disease between falling and non-falling patients (χ^2=2,063, *P*=0.356). In the entire study population the dominant form of the disease was the ischemic stroke. On the other hand, there were significantly more cases of the extensive, total anterior infarction in the patients who experienced a fall, compared to the non-falling patients, who often had a lacunar type of cerebrovascular disease (χ^2= 48.057, *P*<0.001).

As expected, the size of the infarction zone resulted in differences in neurological findings of our patients. Thus, we established statistically significant differences in mental status (*P*<0.001), sensibility (*P*=0.016), depressed mood (*P*<0.001), early (*P*=0.001) and medium insomnia (*P*=0.042), psychomotor slowness (*P*=0.030), somatic anxiety (*P*=0.044) and memory (*P*<0.001). As can be seen from the Table 2, the differences in the degree of depressed mood expression were confirmed by *Hamilton Depression Rating Scale*.

Non-falling patients had better orientation and sensibility, less frequent occurrence of depressed mood, early and moderate insomnia. On the contrary, in the group of patients who experienced a fall, psychosomatic instability, somatic anxiety and poorer memory were more pronounced.

The Barthel Index (BI) of stroke patients functionality indicated there was no statistically significant difference between the examined groups (χ^2=3.656, *P*=0.455). Analysis of their individual daily activities have shown that the main differences between falling and non-falling patients are related to feeding (*P*=0.029), bowel emptying control (*P*=0.009), wheelchair use (*P*=0.001), and moving up/down stairs (*P*=0.008), feeding (*P*=0.029), bowel emptying control (*P*=0.009), wheelchair use (*P*=0.001), and moving up/down stairs (*P*=0.008).

Most of the patients did not have previous fall history, but the most of them had other medical diagnoses, were poorly mobile and received intravenous therapy. *The Morse Fall Risk Assessment* confirmed the previous results about the differences in mental status between two groups of patients, obtained by the neurological examination. Namely, in the group of falling patients, 67.9% of subjects were not oriented in time and space, overestimated their capabilities and forgot the limitations, while in non-falling group this percentage was significantly lower (50.2%) (Table 3).

Finally, regression analysis of all examined parameters highlighted a group of major risk factors for the occurrence of falls in our patients (Fig. 1). In addition to previously confirmed circumstances, the falls were also associated with a body mass index, care level, systolic and diastolic pressure values, and with the applied therapy (more frequent falls in patients receiving intravenous therapy and antibiotics).

Discussion

The aim of our study was to evaluate the occurrence of falls in stroke patients, in the acute phase of the disease. In other words, we analyzed the sociodemographic characteristics, the neurological status and the degree of functionality of stroke patients, in order to quantify and predict the risk factors for the falls.

The stroke patients mainly fell once, near the bed and during the night. Most of them were singles, predominantly from rural areas, with significantly lower material incomes and level of education. When it comes to the other sociodemographic characteristics, we only found statistically significant positive influence of body weight on fall frequency.

Table 3: Distribution of patients according to the risk factors as assessed by the Morse Fall Scale (MFS)

Risk factor		*Falling patients*		*Non-falling patients*		*Significance*
		N	%	N	%	
Previous fall	No	220	87.3	272	88.0	*P*=0.806
	Yes	32	12.7	37	12.0	
Other medical diagnoses	No	4	1.6	2	0.6	*P*=0.507
	Yes	248	98.4	307	99.4	
Mobility aids	Not using aids, resting in bed, Movement with the help of a nurse, Wheelchair	151	59.9	170	55.0	*P*=0.471
	Crutches, cane, walker	52	20.6	75	24.3	
	Furniture	49	19.4	64	20.7	
Infusion	No	15	6.0	14	4.5	*P*=0.572
	Yes	237	94.0	295	95.5	
Mobility	Normal, resting in bed, immobile	47	18.7	52	16.8	*P*=0.749
	Weak	114	45.2	149	48.2	
	Unstable	91	36.1	108	35.0	
Mental status	Oriented	81	32.1	154	49.8	*P* <0.001
	Forgets / restrictions	171	67.9	155	50.2	

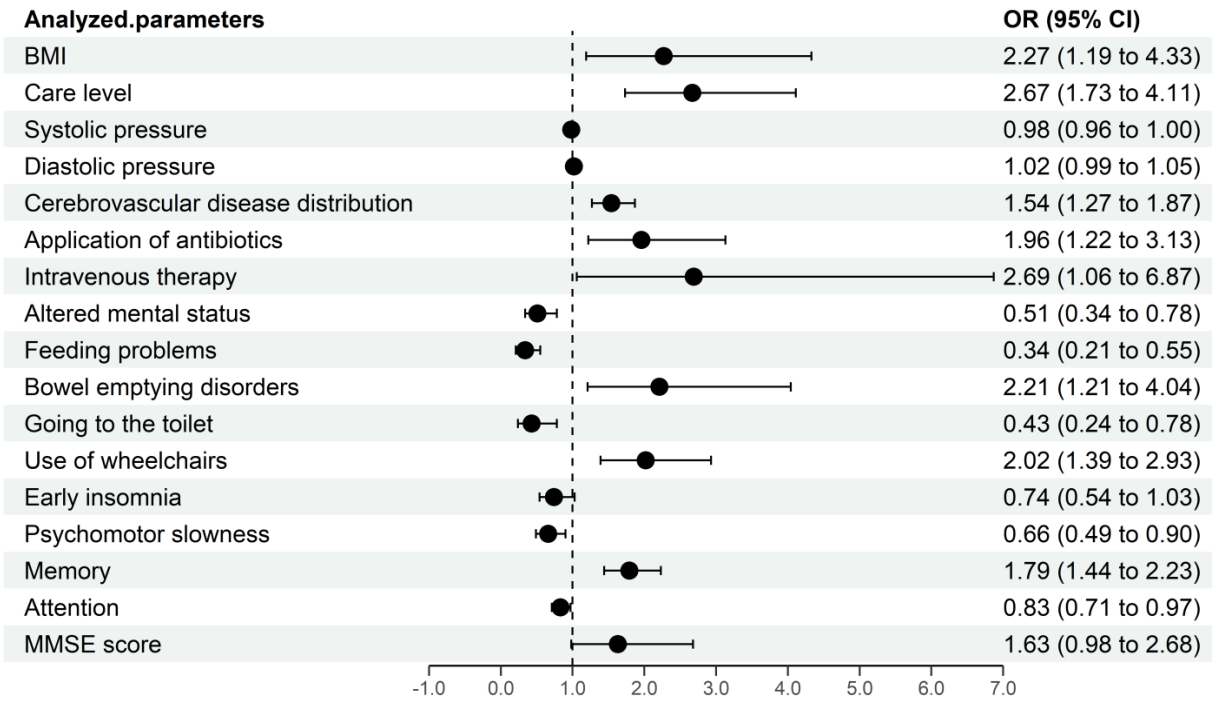

Fig. 1: Forest plot of the influence of different parameters on the occurrence of falls

Although there were no differences in the prevalence of stroke type (the ischemic form was dominant in the whole population study), a significant deviation has been recorded in the localization of the disease. Thus, total anterior infarction was the most represented in falling patients.

On the contrary, non-falling patients had mainly a lacunar form of the disease. Accordingly, we found that the size of the infarction zone caused differences in the degree of neurological deficit. Non-falling patients had better orientation and sensibility, less frequent occurrence of depressed mood along with early and moderate insomnia as well. In the group of falling patients, psychosomatic instability, anxiety and poorer memory were more pronounced. Our results, which are consistent with the previously published papers, have shown that the falls in stroke patients occurred as the consequence of motor and balance disorder but also due to impaired cognitive function (21, 22). Defective cognitive function reduced safety in movement of post stroke patients (23). Depression appears to be one of the important risk factors, as shown in our and the other studies as well (24, 25). There is a causal link between depressive symptoms and the falls. Namely, the knowledge of disability in people after stroke results in the appearance of a depressed mood, which then leads to an attention decrease, increasing the risk of falling (25). The anxiety was also significantly more common in our falling patients. Despite the fact that the role of anxiety in the fall occurrence has not been completely understood, it is assumed that the anxiety is rather a consequence than the cause of falling. In fact, it arises from the fear of falling (26, 28), which brings to poor posture and muscle weakness (29). In fact, fear of falling induces patients to move less (26, 28) which brings to poor posture and muscle weakness (29).

As neurological damage causes the disturbances in activities of daily living, we examined functional capacity of our patients using the Barthel Index. Unlike previous studies (30, 31), we did not find significant differences in the mean Barthel Index scores between the falling and non-falling patients. We only demonstrated a slightly larger difference in performing daily activities in the subgroup of patients with minimal restrictions. Statistical processing of the data indicated more frequent problems with feeding, bowel emptying, moving up/down stairs and more often required the wheelchairs in this population. These results could be a consequence of a similar degree of motor impairment in the two groups of subjects in our study. We actually found that the main differences between patients who experienced a fall and control subjects were in the domain of mental status, preservation of sensibility, orientation and perception of their own (dis)abilities. Sensibility disorder in patients after stroke can cause overbalancing, impaired postural stability and altered movement dynamics (32, 33). This is supported by the fact that many factors responsible for peripheral neuropathy (nutritional deficiencies, medications, diabetes) can lead to falls (34, 35). Namely, peripheral neuropathy causes many disturbances including sensory loss, numbness, and pain or burning sensations in distal limbs. Over time, distal muscle weakness may occur and increase the risk of falling (36).

As mentioned above, most of the patients from our study fell once. The frequency of falls was highest on the second day of hospitalization and during the night. Our results are not consistent with the data of another study that most falls of stroke patients appeared during their daytime activity (25). Potential explanation for the more frequent occurrence of falls in our patients at night could be insomnia, which has shown to be significantly more common in the group of falling patients. Otherwise, many authors showed that the falls after stroke occurred predominantly during the day, but they dealt with the analysis of stroke patients in the rehabilitation period, in the late stages of the disease (30, 37). The occurrence of falls in the first days after stroke could be the consequence of subjects unprepared for the challenges that arise from neurological deficit. Even though the largest number of falls passed without any complications, the average length of hospitalization was significantly higher in the falling patients than in non-falling patients.

Finally, the assessment of fall risk factors using regression analysis confirmed the neurological deficits whereas questionnaire investigation indicated pronounced disorientation, overestimated capabilities and forgetfulness the limitations in falling patients.

Conclusion

Some of the most common risk factors for falls in stroke patients are cerebrovascular disease distribution and the degree of neurological deficit, in the first place altered mental status (the occurrence of depression, anxiety, psychomotor slowness, memory and attention). Failure to accept restrictions on performing usual daily activities such as feeding and going to the toilet increases the risk of falls in the acute phase of cerebrovascular disease. Undoubtedly, insomnia and the application of specific therapies (intravenous therapy, antibiotics) as well as the changes in blood pressure (systolic and/or diastolic) promise a contribution. Some further investigations will be needed to clarify the complex interaction of numerous risk factors for falling in this population. Here we underlined some of them with the aim of creating preventive measures, improving the quality of health care for patients and their safety. The first step in these efforts would certainly relate to an adequate psychological support and the level of hospital care for stroke patients.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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