

## TEMPORAL VARIATIONS OF STROKE OCCURENCE

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VREMENSKE VARIJACIJE UČESTALOSTI MOŽDANOG UDARA  
U KLINIČKOM CENTRU KRAGUJEVAC

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## ABSTRACT

Stroke is one of leading causes of death worldwide. Different frequency of stroke occurrence is observed in days of the week and months in the year, and incidence of stroke has irregular time pattern. We analyzed 516 patients who had acute stroke and were treated in Clinic of Neurology, Clinical Center Kragujevac from January 1, 2013 to January 1, 2014, mean age  $72,11 \pm 11,52$ . Statistical analysis is conducted out using the SPSS software version 20.0. We used descriptive statistic, student T-test, chi-square or Fisher exact test.

Friday is day we found the most IS and all stroke types occurrences, and Wednesday is day we found the most IS in men. We found the most strokes in women younger than 65 years on Wednesday, but in women older than 65 years on Friday. Monday is day with the most admissions to hospital for patients with IS, and we observed that there is average delay in the referring to the doctor for  $1.80 \pm 1.44$  days. Friday is the day with the most ICH symptom beginnings and the most admissions to the hospital, and Saturday is the day with the least symptom beginnings and admissions to the hospital in the case of IS and ICH. The most IS occurred in winter (in Decembar), and the least in summer (in August). The most ICH occurred in May, and the least in July and October.

We confirmed that there is a significant weekly variability in the IS symptom onset day.

**Keywords:** stroke, variations, occurrence, time pattern, symptom onset

## SAŽETAK

Moždani udari su jedan od vodećih uzroka smrtnosti širom sveta. Različita učestalost pojave moždanog udara je praćena prema danima u nedelji i mesecima u godini, i primećeno je da njihova incidenca ima nepravilan vremenski obrazac. Analizirali smo 516 pacijenata koji su imali moždani udar i lečeni u Klinici za neurologiju Kliničkog centra u Kragujevcu od 1. januara 2013. do 1. januara 2014. godine, čija je prosečna starost bila  $72,11 \pm 11,52$  godine. Statistička obrada podataka je sprovedena pomoću SPSS softvera, verzija 20.0. Korišćena je deskriptivna statistika, studentov T-test, Hi-kvadrat test i Fišerov test. Petak je dan kada se dešava najveći broj moždanih udara svih tipova, a sredom su najčešći ishemijski moždani udari kod muškaraca. Žene mlađe od 65 godina češće oboljevaju od moždanog udara sredom, a starije od 65 godina petkom. Najveći broj pacijenata sa ishemijskim moždanim udarom je hospitalizovano ponedeljkom u Kliniku za neurologiju, i utvrđeno je da postoji kašnjenje u vremenu hospitalizacije u odnosu na početak simptoma moždanog udara koje iznosi u proseku  $1.80 \pm 1.44$  dana. Najveći broj pacijenata sa hemoragijskim moždanim udarom je hospitalizovano petkom, istog dana kada su se javili prvi simptomi bolesti. Subotom se dešava najmanji broj ishemijskih i hemoragijskih moždanih udara, i to je dan kada je zabeležen najmanji broj hospitalizacija. Najviše ishemijskih moždanih nastaje u zimskom periodu, u decembru, a najmanje tokom leta, u avgustu. Najviše hemoragijskih moždanih udara je zabeleženo u maju, a najmanje u julu i oktobru. Zaključeno je da postoji značajna vremenska varijabilnost u učestalosti moždanih udara.

**Ključne reči:** moždani udar, varijacije, učestalost, vremenski obrazac, početak simptoma



## ABBREVIATIONS

IS - ischemic stroke,  
ICH - intracerebral hemorrhage,  
SAH- subarachnoid hemorrhage.



## INTRODUCTION

Stroke is one of leading causes of death worldwide (1, 2, 3). Studies were conducted in many countries and reported that incidence of stroke has irregular time pattern, and that different frequency of occurrence is observed in days of the week and in months of the year (4, 5). Analysis on temporal pattern of stroke occurrence can help in clarification of mechanisms that we can consider as triggers of this disease occurrence (2, 4, 6, 7).

Ischemic stroke (IS), intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) are different in etiology, and consequently, it is expected they have different incidence according to time variations (8).

Different occurrence of all stroke types is found among men and women of different age (3). Some studies showed Sunday is the day with the lowest incidence of stroke (9, 10). Some of studies found that Monday is the day with the highest IS incidence (2, 4), another found it is Wednesday (3). Monday is the day when occurred one-third of total ICH in both genders (5), some of them showed that the most frequent occurrence of IS were observed on Monday in men. Also, the most ICH were observed on Monday and the most IS were observed on days of weekend in women (6). In patients younger than 60 was observed higher frequency of all stroke types on Mondays compared to weekend days (5).

Previous studies showed differences in time of delay of admission to hospital for IS, some of them found it was 8.8 hours, other 3 hours and other more than 24 hours (11, 12, 13).

Some studies showed that stroke occurrence was more frequent on weekdays than on weekends (6, 7, 9, 14).

Some studies showed the highest incidence of IS in January and the lowest incidence for women in August, and for men in June (15). Other studies showed the highest incidence in January for all stroke types (15), and in September (16), while the highest incidence of ICH is in February but the lowest in August. (5)

The incidence was higher in the summer season for IS (16), other studies showed the highest incidence of IS during the winter (5), or in autumn (17).

The aim of this study was to analyze weekly and monthly variations in incidence of IS, ICH and SAH. Knowledge of temporal variations can be important for health care professionals and for organization of work in stroke units.

## MATERIAL AND METHODS

This is observational and cohort, preliminary, retrospective, one-year study. We observed all patients who had acute stroke in 2013 and were treated in Clinic of Neurology, Clinical Center Kragujevac.

Diagnosis of stroke is determined by anamnesis, neurological examination and appropriate diagnostic procedures, involving computed tomography (CT) or magnetic resonance imaging (MRI).

**Table 1.** Distribution of patients by gender and diagnosis

diagnosis	both gender	male	female
IS	415	209	206
ICH	88	44	44
SAH	13	7	6
Total	516	260	256

We analyzed 516 patients (table 1).

We collected general demographic data (gender, age), date of symptom onset and date of admission to the Clinic of Neurology. According to stroke type patients were divided into three groups (IS, ICH, SAH), and based on anamnesis of former stroke were divided into two groups (first stroke and previous stroke).

Patients were divided into seven groups according to the day of symptom onset (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday), also they were divided into twelve groups according to month of the year (January, February, March, April, May, Jun, July, August, September, October, November and December), and into four groups according to season (winter, spring, summer and autumn).

Descriptive statistic is used to present distribution of patients by days, months and seasons. We used student T-test to compare mean age of patients. Comparing categorical variables is carried out using a chi-square or Fisher exact test. Distribution of patients is examined separately for each stroke types. Statistically significant is  $p < 0.05$ . Statistical analysis is carried out using the SPSS software version 20.0.

## RESULTS

From January 1, 2013 to January 1, 2014 we registered 516 patients with all stroke types, 260 (50,4%) male and 256 (49,6%) female. Mean age of all patients by diagnosis and gender is shown in table 2.

We found that male patients were significantly younger than female patients in total group, and also in group with IS.

There were 430 patients with first stroke (83,3%), and 86 patients (16,7%) with previous stroke. We observed day of symptom onset in 489 patients (94,76%), and in 27 patients (5,23%) there was no reliable data about time of symptom onset.

**Table 2.** Mean age for patients by diagnosis, and gender

diagnosis	both gender	gender		p
		male	female	
IS	72,94±11,22	69,80±12,60	76,13±8,53	0.000
ICH	69,83±11,94	66,61±11,03	73,05±12,08	0.011
SAH	60,77±11,06	59,14±12,79	62,67±9,44	0.589
Total	72,11±11,52	68,98±12,476	75,29±9,489	0.000



**Table 3.** Distribution of patient's first stroke symptoms according to the stroke type, day of the week, gender, and age

diagnosis	day of the week	gender		age		total
		male	female	≤65 years	>65 years	
Ischemic stroke	Monday	30	27	18	39	57
	Tuesday	33	29	9	53	62
	Wednesday	35	27	16	46	62
	Thursday	16	24	9	31	40
	Friday	32	39	15	56	71
	Saturday	16	18	5	29	34
	Sunday	32	34	13	53	66
	total	194	198	85	307	392
	<i>p</i>		0,693		0,326	
Intracerebralhemorrhage	Monday	7	6	4	9	13
	Tuesday	10	7	8	9	17
	Wednesday	6	5	3	8	11
	Thursday	3	6	1	8	9
	Friday	9	9	5	13	18
	Saturday	0	5	0	5	5
	Sunday	7	4	6	5	11
	total	42	42	27	57	84
	<i>p</i>		0,276		0,188	
Subarachnoid hemorrhage	Monday	1	0	1	0	1
	Tuesday	2	0	1	1	2
	Wednesday	1	3	3	1	4
	Thursday	0	0	0	0	0
	Friday	1	2	3	0	3
	Saturday	2	0	2	0	2
	Sunday	0	1	0	1	1
	total	7	6	10	3	13
	<i>p</i>		0,199		0,310	
All stroke types	Monday	38	33	23	48	71
	Tuesday	45	36	18	63	81
	Wednesday	42	35	22	55	77
	Thursday	19	30	10	39	49
	Friday	42	50	23	69	92
	Saturday	18	23	7	34	41
	Sunday	39	39	19	59	78
	total	243	246	122	367	489
	<i>p</i>		0,967		0,560	

In the table 3 we showed distribution of stroke occurrence by gender and age in patients with all stroke types, considering to time of symptom onset.

For the day of the week of stroke onset, statistic significantly difference was found for all stroke types ( $\chi^2=28.642$ , df 6,  $p=0.000$ ). The most stroke occurrences were observed on Friday (17.8%), and the least on Saturday (7.9%).

We also found statistic significantly difference for IS occurrence ( $\chi^2=20.321$ , df 6,  $p=0.02$ ). Most IS were found

on Friday (18.1%), and the least on Saturday (8.2%). Statistic significance didn't reach for ICH occurrence, although we found that most ICH occurred on Friday and the least on Saturday. We found no statistic significance for SAH because of small sample.

There was statistic significantly difference of men who had IS by the day of symptom onset ( $\chi^2=14.340$ , df 6,  $p=0.026$ ). For the most of men first symptoms began on Wednesday (16.7%), and for the least on Thursday (7.7%) and Saturday (7.7%). Statistic significance wasn't found in men who had ICH ( $\chi^2=4.286$ , df 5,  $p=0.509$ ), and SAH ( $\chi^2=0.857$ , df 4,  $p=0.931$ ).

We found no statistic significant difference in the day of symptom onset for women regardless of stroke type – for IS ( $\chi^2=9.737$ , df 6,  $p=0.136$ ), for ICH ( $\chi^2=2.667$ , df 6,  $p=0.849$ ), and for SAH ( $\chi^2=1.000$ , df 2,  $p=0.607$ ). According to results Friday was day with the most IS (19.7%) and ICH occurrence (21.4%).

We found statistic significantly difference in women older and younger than 65 years ( $\chi^2=13.520$ , df 6,  $p=0.035$ ). Most women younger than 65 years noticed symptom beginning on Wednesday, but women older than 65 years noticed first symptoms mostly on Friday. We found that the most male younger

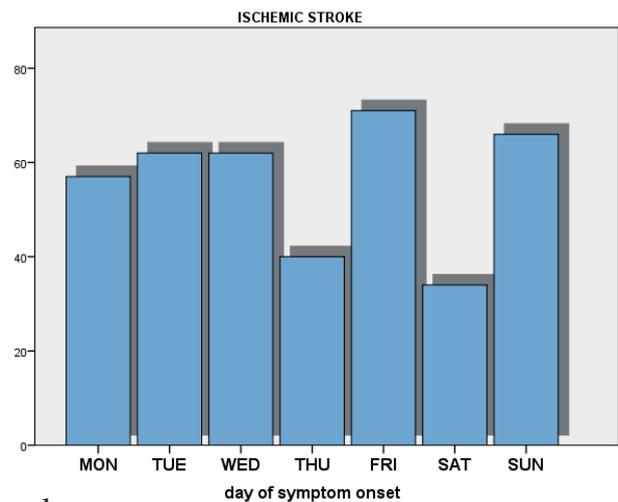


Figure 1.

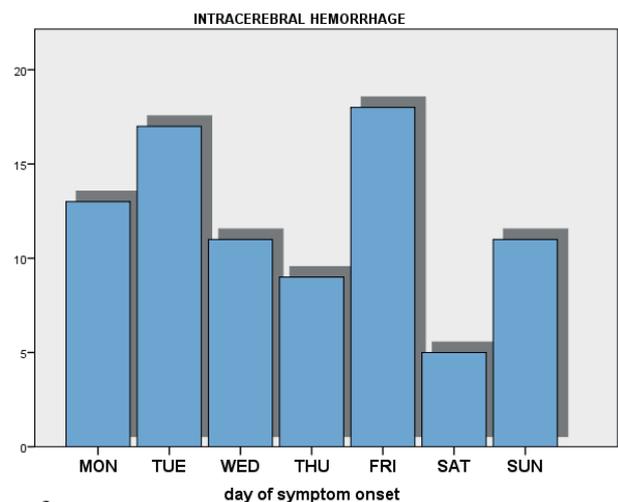


Figure 2.

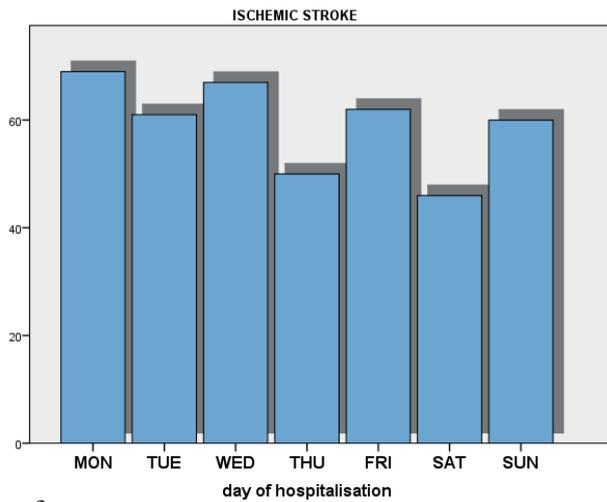


Figure 3.

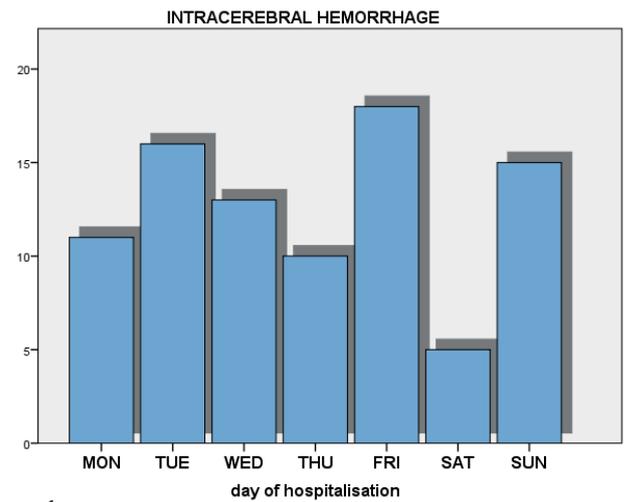


Figure 4.

than 65 years had symptom onset on Monday, but older than 65 years mostly had symptom beginning on Friday, but there was no significant difference ( $\chi^2=6.086$ ,  $df\ 6$ ,  $p=0.414$ ).

According to our results, the most patients with IS and ICH had symptom onset on Friday (Fig. 1, 2). The most hospitalizations were realised on Monday for IS (Fig. 3). The most patients with ICH were hospitalized on Friday (Fig. 4), and that is also a day with most symptom onsets for ICH were observed. Saturday is a day when we noticed the smallest number of stroke onsets, and the smallest number of hospitalized patients who had IS and ICH (Fig. 1, 2, 3, 4).

According to how many days passed between the date of symptom onset and the date of hospitalisation, we figured out that in total of 489 patients who we could get reliable data about the day of first symptoms, 389 patients (79,6%) were hospitalized in the day of symptoms beginning, 57 patients (11,7%) were hospitalized one day after the day of symptoms beginning, and 19 patients (3,9%) two days after. We excluded six cases who were hospitalized seven or more days after first symptom, and average delay for remaining 94 patients is  $1,78\pm 1,34$ .

Patients with IS had average delay  $1.80\pm 1.44$ , and patients with ICH  $1.71\pm 0.726$ . There is no statistically significant difference between those two groups of patients ( $p=0.833$ ). We observed that of total 392 patients with IS 84 patients had delayed hospitalisation (21,42%), and of total 79 patients with ICH there were 14 patients who had delayed admission to hospital (17,72%).

We found no statistically significant differentiations among weekend and weekday distribution of occurrence for all stroke types ( $\chi^2=0.943$ ,  $df\ 2$ ,  $p=0.624$ ).

In the table 4 we showed distribution of IS occurrence by month and season, gender and age. Statistic analysis by all stroke types showed no significant variations in seasons when disease occurred – for IS ( $\chi^2=6.619$ ,  $df\ 3$ ,  $p=0.085$ ), ICH ( $\chi^2=4,273$ ,  $df\ 3$ ,  $p=0.233$ ), and for SAH ( $\chi^2=2,077$ ,  $df\ 3$ ,  $p=0.557$ ). There are no significant variations in months – for IS ( $\chi^2=11.449$ ,  $df\ 11$ ,  $p=0.406$ ), ICH ( $\chi^2=8.545$ ,  $df\ 11$ ,  $p=0.664$ ) and for SAH ( $\chi^2=2,923$ ,  $df\ 8$ ,  $p=0.939$ ). Although

statistic significance did not reach, we noticed that there were the most IS in winter (30,12%), in December (11,32%), and the least in summer (21,68%), in August (6,26%). The most ICH occurred in May (13,63%), and the least in July (4,54%) and October (4,54%).

## DISCUSSION

Studies around the world were conducted to determine the variability in the occurrence of stroke according to the

**Table 4.** Distribution of patients with IS by month and season of stroke occurrence, gender and age

IS	gender		age		total
	M	F	≤65	>65	
month					
December	25	22	12	35	47
January	19	18	10	27	37
February	19	22	8	33	41
Winter	63	62	30	95	125
<i>p</i>	0,929		0,796		0,544
March	39	19	20	7	39
April	35	15	20	10	35
May	29	19	10	6	29
Spring	103	53	50	23	103
<i>p</i>	0,768		0,531		0,478
June	31	16	15	6	31
July	31	14	17	8	31
August	26	18	8	8	26
Summer	90	49	41	24	90
<i>p</i>	0,399		0,715		0,753
September	29	12	17	7	29
October	32	16	16	8	32
November	37	16	21	5	37
Autumn	97	44	53	19	97
<i>p</i>	0,361		0,218		0,607



day of the week. We found that Friday was a day when the most patients with IS had symptom onset. Monday was a day with the most hospitalized patients with IS. For patients with ICH Friday was day with most symptom onsets and most hospitalisations. In this sample were not considered patients with SAH because of their small number.

The most of studies shows that Monday is the day with the highest incidence (2, 4, 8, 9), and our results showed the most hospitalized patients on Monday, but Friday is a day with most symptom onsets. According to results of some studies Sunday is the day with the lowest incidence of stroke (9, 10), but we found Saturday as a day when occurred the least number of patients with symptom onset and the least number of hospitalized patients with IS and ICH.

Some studies showed a different occurrence of all stroke types among men and women of different age. The most patients with IS in study conducted in Nis, Serbia, was found on Wednesday (3). Monday is the day when occurred one-third of total ICH in both genders (5), but we found that Friday is leading for symptom onset and day of hospitalisations in patients with ICH. Wednesday is day when occurred most IS in men in our study, while some studies showed that the most frequent occurrence of IS were observed on Monday in men. The most ICH were observed on Monday and the most IS were observed on days of weekend in women (6). According to our results Friday was day with the most IS occurrence in women. Frequency of all stroke types was higher on Mondays compared to weekend days in patients younger than 60 (5). Our results showed that in patients younger than 65 years, symptom onset is mostly noticed on Wednesday in women, and on Monday in men. Patients older than 65 years mostly had symptom onset on Friday.

We found that 20.4% of all patients were not hospitalized on the day of symptom onset, but they were hospitalized in next days. Comparing our results with other studies, there is a divergence in delay times of admission to hospital. Some of them found time of delay 8.8 hours for ischaemic stroke, other 3 hours (11, 12). In Minnesota study results showed that half patients arrived within 3 hours of symptom onset, and 90% arrived within 24 hours. Patients with approximated delay times had longer delays, and less than 40% of these patients were hospitalized within 24 hours of symptom onset. They explain this by the ethnicity, which involves different cultural patterns. (13).

According to some studies stroke occurrence was more frequent on weekdays than on weekends (6), and usually on Mondays (7, 9, 14). Some studies found no difference in the frequency of occurring of all stroke types by days of the week (2), some of them found no difference for ICH and SAH (4, 7). We found no statistical significant differences among weekend and weekday distribution for all stroke types.

Some studies showed that the highest incidence of IS was in January, but in our study most IS occurred in December although we found no statistical significant difference. We found the least incidence in August for both

gender, and other studies found the lowest incidence for women in August, and for men in June (15). Other studies showed the highest incidence in January for all stroke types (15), and in September (16). The highest incidence of ICH is found in February but the lowest in August (5), and we found that May is month with the most ICH, and July and October with the least ICH occurrences.

The incidence was higher in the summer season compared to the winter for IS, while the difference has not been established for hemorrhagic stroke (16). Other studies showed the highest incidence of IS during the winter (5), as we found, another in autumn (17).

In our country, it is necessary for health promotion strategies to improve community awareness of early symptoms of stroke. Constantly informing the public of the need to seek medical help promptly after stroke onset and using an ambulance and direct transportation to the hospital. Also it is necessary to have more effective in-hospital organization in order to improve availability of effective acute treatment options to stroke patients (14).

Those are only a preliminary results of our study whose limitation is decreased power to detect variabilities because of small sample and short duration of research. It should be confirmed with future investigations and higher number of patients.

In conclusion, we confirmed that there is a significant weekly variability in the IS symptom onset day.

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