



HEALTH SCIENCES

Stroke epidemiology in southern Brazil: Investigating the relationship between stroke severity, hospitalization costs, and health-related quality of life

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Abstract: We aimed with the present study to fill the gap on the performance and safety of stroke management and the costs related to hospitalizations, the relevant comorbidities associated with stroke patients, and the stroke patient outcomes health-related quality of life (HRQOL) progress. Our study investigated the clinical, neurological, and social impact of stroke in 220 patients in a tertiary hospital located in the countryside of the state of Santa Catarina, Brazil. Description of clinical and neurological characteristics of stroke patients between 2015 to 2020 was analyzed using electronic medical records. The most affected age group was 61-80 years, being female the most affected sex. Almost 89.5% of the patients had some risk factor, with a higher prevalence of ischemic stroke. This type of stroke was the expensive, in terms of hospitalization, with an average cost of \$74.10. Considering the stroke-specific quality of life scale (SSQOL) score, 88.3% of patients who demonstrated some comorbidity and 47.6% of women had lower quality of life levels post-stroke. Our data could be useful to substantiate a data-base with epidemiology statistics characterization of stroke hospitalizations, indicating the severity of stroke for the patient.

Key words: cerebrovascular disease, costs, quality of life, surveillance.

INTRODUCTION

Accurate stroke epidemiology is still a challenge giving there is a lack of data demonstrating this major health crisis continues to severely affect the global population and leads to economic consequences, specially in low- and middle-income countries (Hankey 2017). Stroke is a complex disease commonly associated with a sudden interruption of blood supply on the brain for more than 24 hours, usually resulting in a focal or global neurological impairment and even death (Farooq et al. 2008). Ischemic stroke is defined as a sudden occlusion provoked by a thrombus of arteries supplying the brain.

On the other hand, hemorrhagic stroke has two different classifications (i) intracerebral hemorrhage characterized by bleeding from one of the brain's arteries into the brain tissue, and (ii) subarachnoid hemorrhage, which occurs with arterial bleeding in the space between the two meninges, pia mater and arachnoidea (Farooq et al. 2008). Although the new strategies and improvements in primary prevention, diagnostic workup, and treatment, stroke is the most common cause of disability, the second most typical cause of dementia, and the fourth cause death in high-income countries (Sveinsson et al. 2014). Also, the reality in the low- and middle-income countries is even worse, representing

80% of these deaths only in countries as Russia, Brazil, China, South Africa, and India. An estimative indicated that in just 30 years, the prevalence of stroke could increase 137% for men and 120% for women in developing countries, increasing the number of mortalities in Latin America, the Middle West, and Sub-Saharan Africa (Sveinsson et al. 2014).

Indeed, worldwide statistics denote that among stroke-affected people, 5 million die and another 5 million are permanently disabled (Farooq et al. 2008), leading the World Health Organization (WHO) to classify stroke as a very costly disease, in many senses. For instance, (i) there is many premature deaths since mid-life individuals are the most affected; (ii) ongoing disability of many who survive; (iii) the need for caregivers; (iv) the impact on families, specially woman who leave workforce to care for sick relatives, and (v) the impact on health services with direct health costs and cost of disability payments. As an estimative, the United States of America (USA) spent, in 2008, about 18.8 billion dollars only with the cost of care of disability caused by stroke and 15.5 billion dollars considering the productive loss and premature deaths (Roger et al. 2012, Copstein et al. 2013). Still, in low- and middle-income countries, the burden of chronic disease rises almost 50% of total disease burden over the past decade. These premature deaths and high rates can be attributed to population aging and changes in the distribution of modifiable risk factors (elevated blood pressure, tobacco use, physical inactivity, diet, heavy alcohol consumption, overweight, and diabetes), which in developing countries signals the neglect with health care involving poor diet, abuse of tobacco use and physical inactivity (Strong et al. 2007, Farooq et al. 2008). Despite the few studies focused on mortality rate, incidence, and prevalence of stroke in low- and middle-income countries,

the worldwide statistics demonstrate that 40% of patients improve and validate the power of interventions currently available for neurological rehabilitation of stroke patients (Heuser 2017). Thereby, more important than the treatment is stroke prevention, since 85% of all strokes are preventable (O'Donnell et al. 2010, Sarikaya et al. 2015).

Promote function recovery, symptom management, and augmented quality of life are extremely important to these patients, considering the health-related quality of life (HRQOL), which contemplate the impact of illness or disease and the limitations caused by them in patient's life (Ramos-Lima et al. 2018). In stroke patients, beyond physical disabilities, numerous psychological consequences, as mood disorders, are experienced, compromising the rehabilitation process and complicating long-term recovery (Rafsten et al. 2018). It is estimated that approximately 20% of stroke patients experience anxiety to varying degrees after the event (Campbell Burton et al. 2013, Rafsten et al. 2018). Another concern is post-stroke fatigue, affecting 48-70% of individuals in the first year following the stroke (Wen et al. 2018). Post-stroke fatigue can be considered a barrier in the treatment, impacting the quality of life, independent living, and overall survival, increasing the chances of an individual of becoming dependent on daily activity (Go et al. 2014, Wen et al. 2018). Moreover, post-stroke depression is also significantly frequent in these patients, rising to 25-80% (Ayerbe et al. 2011).

Brazil is among the major countries with the highest risk of premature death promoted by stroke, representing 10% of all deaths in 2009. Furthermore, in 2016, stroke was considered the fourth higher leading cause of years of life lost (Copstein et al. 2013, Collaborators 2018, Dantas et al. 2019). The elevated incidence (137 per 100,000 inhabitants per year) of stroke in

Brazil reflects its severity impact on population health, especially when considering the scarcity of public policies for preventive and therapeutic assistance (Pontes-Neto et al. 2008, de Carvalho et al. 2011, Garritano et al. 2012, Pacheco-Castilho et al. 2019). As well, another huge difference observed in Brazil is the cost designate to health care, which represented 2.7 million dollars intended for stroke, diabetes *mellitus*, and cardiovascular disease in 2005, not even 10% of the amount designated to stroke patients by the USA, only in 2008 (Strong et al. 2007, Roger et al. 2012). The impact of stroke on people's lives represents a fundamental challenge for society and a significant economic and social burden. Here we highlight this massive impact in the Brazilian population, considering economic inequalities. Literature has majorly focused on cognitive and physical disability resulting from stroke. However, only very few studies have investigated overall costs, epidemiological aspects and quality of life, following hospitalization of stroke patients in Brazil. The purpose of this study was to describe the frequency of various risk factors, HRQOL, and cost of patient hospitalization admitted with stroke in a private hospital in southern Brazil. Here we perform a data survey to access quality of life from hospitalization to recovery after stroke, and from there, we provide tools to new strategies, guidelines, and recommendations in the prevention, intervention, and management of post-stroke patients.

MATERIALS AND METHODS

Study design

The present study evaluated a quantitative, descriptive, retrospective, observational, and epidemiological study performed with adult patients, in a private tertiary hospital located in the countryside of Santa Catarina – Criciúma,

SC, Brazil. The institution has 126 beds, with a monthly admission rate of 1200 patients, a surgical center, and performs approximately 850 surgical procedures per month and 10.200 surgical procedures per year. Also, the respective hospital has a standardized stroke protocol, since 2015. Data collection occurred from January 2015 to July 2020 and included patients aged 34 to 96 years of age. The study was approved by the Ethics in Research Committee of the Federal University of Santa Catarina and registered in Brazil Platform with number 4.430.814, complying with Resolution 466/12 of the National Health Council.

Participants

Between January 2015 to July 2020, 287.028 patients were attended in the referred hospital; 463 of these were stroke patients, representing less than 1% (0.16%) of total health care provided. Patient's electronic medical records excluded from the sample add up to 243, being 126 with insufficient information, 97 medical records lacking information, 11 patients who did not accept participation in the study, 6 did not answer the phone call and 3 died during the protocol. The target population was volunteers with a stroke diagnosis. All patients were contacted after admission through phone call, informed about the study protocol, and then signed a written consent form. The sample was composed by patients of both sexes, with spontaneous verbalization, with a focal neurological impairment of sudden onset, lasting more than 24 hours, of presumed vascular origin. Patients (i) medical records with a non-conclusive diagnosis of ischemic stroke, hemorrhagic stroke, or transient ischemic accident (TIA) and (ii) with medical records lacking information were excluded.

Study protocol

Primary care medical records were prospectively revised, and then a phone call contact was made to invite the patient to participate in the study. The participants who accepted participate were questioned about sociodemographic and clinical data, such as age, gender, ethnicity, occupation, educational level, marital status, and local of residence. Detailed clinical history also was investigated, including cardiovascular and non-cardiovascular risk factors such as: systemic arterial hypertension (SAH), diabetes mellitus (DM), heart disease, dyslipidemia, smoking, previous stroke, Alzheimer's disease, Parkinson's disease, depression, anemias, cancer, types of stroke (ischemic or hemorrhagic), and tomography report. To evaluate HRQOL we used the stroke-specific quality of life scale (SSQOL), validated and adapted for Brazil. This scale consists of 49 items in 12 domains, varying from 49 to 245 points, with responses varying from 1 to 5. Higher values indicate better HRQOL (Ramos-Lima et al. 2018). All data was collected from the patient's electronic medical records to an Excel spreadsheet by a researcher, using the Tasy system version 3.05.1767.05. Moreover, a descriptive analysis about hospitalization costs (calculating daily rates of hospitalizations, medications administered, imaging costs, and lab tests cost) including clinical or neurological complications was performed. Expenses with medical, nursing, and rehabilitation professionals, as well as food, were not considered. The amounts were converted to dollars (conversion rate BRL 5.26, May 2020).

Statistical analysis

The collected data was analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 22.0 software. Categorical variables were expressed through frequency and percentage (%). The statistical tests were performed with a

significance level of $p=0.05$ and, therefore, 95% confidence interval. The associations between categorical variables were performed by applying Pearson's chi-square tests, likelihood ratio, and Fisher's exact test, followed by residue analysis when statistical significance was observed. Symmetric continuous variables were presented by means and standard deviation and asymmetric continuous variables as median and interquartile range. Normality was checked using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The relationship between continuous and categorical variables was evaluated using ANOVA tests, Kruskal-Wallis H test, student T-test for independent samples.

RESULTS

The sample's demographic characteristics were 111 women (50.5%) and 109 men (49.5%). The mean age of women was similar to men ($M= 70.17$ vs. 66.02 , $p<0.0001$) and roughly 74% of all participants were over 61 years of age. Additionally, the self-reported skin color showed that most of the sample consisted of white (91.8%) and 8.2% non-white. When asked about "What is your marital status?" the answers were: 4.1% single, 64.1% married and 31.8% divorced or widowed. Almost 89.5% of the patients had some risk factor, being the highest prevalence of SAH (79.4%) and DM (35.3%). Furthermore, diabetic patients and patients aged older than 81 years old demonstrated a greater risk to develop cardiovascular disease ($p<0.05$). Considering that the higher rates presented (54.1%) were not specific on stroke type (ischemic or hemorrhagic), the greater prevalence of risk factors were observed on ischemic stroke patients (9.1%), (Table I and Table II).

Patients with SAH showed a higher probability of having non-cardiovascular disease. Caucasian patients were more likely

Table I. Sociodemographic, clinical and hospital characteristics in adult population admitted by stroke diagnosis in a private hospital in Southern Brazil.

Clinical history	n (%), median (IQR)
Types of stroke	
Stroke not specified as hemorrhagic or ischemic	119 (54.1)
Ischemic stroke	20 (9.1)
Hemorrhagic stroke	9 (4.1)
Transient ischemic stroke and related syndromes	8 (3.6)
Unspecified reports	64 (29.1)
Comorbidities	
Yes	170 (89.5)
SAH	135 (79.4)
DM	60 (35.3)
Metabolic disease	32 (18.8)
Non-cardiovascular diseases	21 (12.4)
Cardiovascular diseases	19 (11.2)
Neurologic disease	19 (11.2)
None	20 (10.5)
Hospital unit	
Emergency Care	122 (55.5)
Hospitalized	98 (44.5)
Mode of hospitalization	
Primary care	145 (65.9)
Emergency Care	124 (56.4)
Urgent care	38 (17.3)
Hospitalization time (days)	
Up to 7 days	200 (90.9)
Between 8 and 14 days	12 (5.5)
Between 15 and 21 days	6 (2.7)
Between 22 and 28 days	1 (0.5)
More than 29 days	1 (0.5)
Hospital readmission	3 (1.4)
Patient outcome	
Hospital discharge	214 (97.3)
Inter-hospital and intra-hospital patient transfer	5 (2.3)
Death	1 (0.5)
Hospitalization costs (\$)	74.10 (61.56 – 815.81)

IQR: Interquartile range; **SAH:** systemic arterial hypertension; **DM:** diabetes mellitus.

not presenting a non-cardiovascular disease, while black patients were statistically significant more likely presenting it (28.6%). Still analyzing the risk factors, men were more likely to have cardiovascular disease, representing 73.7% of the sample (Table II).

Analyzing the data related to hospitalization, some patients were already hospitalized and 55.5% sought to be admitted to the hospital, of which 65.9% were admitted through primary care. Also, none of patients required rehospitalization, 97.3% were discharged, 2.3% were transferred, and 0.5% died during this period. The average cost of hospitalization was \$74.10, varying between \$65.51 (hemorrhagic stroke) to \$1465.12 (ischemic stroke). Moreover, patients who showed some risk factor demonstrated different hospitalization cost compared to a healthy patient. For instance, costs varied between \$71.91 to \$192.31, for diabetic patients (Table III and Table IV).

Considering the SSQOL score, 88.3% of patients who demonstrated low quality of life indexes also demonstrated some comorbidity. Besides, women had lower quality of life levels post-stroke, representing 58% of the sample. Surprisingly, the age group with the highest rates (52.9%) corresponds to the most affected group, aged between 60 to 81 years. Retired also presented elevated quality of life rates, composing 64.5% of the sample (Table V).

DISCUSSION

The main finding of this study was the worrying rate of comorbidities found in our sample. Modifiable risks indicate over 60% of stroke mortality in low-income and middle-income countries. Our study data blunt with other studies demonstrating that stroke patients have an elevated incidence of SAH, DM, and dyslipidemia (Strong et al. 2007, Cabral et al. 2009, Guzik & Bushnell 2017). Hypertension

Table II. Correlations of sociodemographic and HRQOL with risk factors characteristics in adult population admitted by stroke diagnosis in a private hospital in southern Brazil.

	Cardiovascular disease, n (%)		p-value	Non-cardiovascular disease, n (%)		p-value
	Yes	No		Yes	No	
Sex						
Female	5 (26.3)	95 (55.6) ^b	0.015 ^{††}	13 (61.9)	87 (51.5)	0.367 ^{††}
Male	14 (73.7) ^b	76 (44.4)		8 (38.1)	82 (48.5)	
Age						
18-45	-	15 (8.8)	0.008 ^{††}	2 (9.5)	13 (7.7)	0.838 ^{††}
46-60	-	28 (16.4)		2 (9.5)	26 (15.4)	
61-80	10 (52.6)	86 (50.3)		12 (57.1)	84 (49.7)	
>81	9 (47.4) ^b	42 (24.6)		5 (23.8)	46 (27.1)	
Ethnicity						
White	17 (89.5)	157 (91.8)	0.665 [¥]	15 (71.4)	159 (94.1) ^b	0.003 [¥]
Black	2 (10.5)	14 (8.2)		6 (28.6) ^b	10 (5.9)	
Educational status						
Illiterate	1 (5.3)	9 (5.3)	0.015 ^{††}	-	10 (5.9)	0.354 ^{††}
Elementary School	-	43 (25.1) ^b		4 (19.0)	39 (23.1)	
High school	11 (57.9)	75 (43.9)		12 (57.1)	74 (43.8)	
University degree	7 (36.8)	44 (25.7)		5 (23.8)	46 (27.2)	
Marital situation						
Married	12 (63.2)	112 (65.5)	0.483 ^{††}	13 (61.9)	111 (65.7)	0.417 ^{††}
Widowed/divorced	7 (36.8)	53 (31.0)		8 (38.1)	52 (30.8)	
Single	-	6 (3.5)		-	6 (3.6)	
Occupation						
Retiree	15 (78.9)	103 (60.2)	0.292 ^{††}	16 (76.2)	102 (60.4)	0.322 ^{††}
Registered worker	3 (15.8)	31 (18.1)		3 (14.3)	31 (18.3)	
Housewife / Househusband	1 (5.3)	13 (7.6)		-	14 (8.3)	
Self-employed	-	6 (3.5)		-	6 (3.6)	
Health professional	-	6 (3.5)		1 (4.8)	5 (3.0)	
Others	-	12 (7.0)		1 (4.8)	11 (6.5)	
SSQOL Score						
High	13 (72.2)	90 (55.6)	0.175 ^{††}	11 (55.0)	92 (57.5)	0.831 ^{††}
Low	5 (27.8)	72 (44.4)		9 (45.0)	68 (42.5)	
Patient Outcome						
Hospital discharge	19 (100.0)	165 (97.1)	0.999 [¥]	20 (100.0)	164 (97.0)	0.999 [¥]
Inter-hospital and intra-hospital patient transfer	-	5 (2.9)		-	5 (3.0)	
SAH						
Yes	13 (68.4)	122 (71.3)	0.790 ^{††}	6 (28.6)	129 (76.3) ^b	<0.001 ^{††}
No	6 (31.6)	49 (28.7)		15 (71.4) ^b	40 (23.7)	
DM						
Yes	10 (52.6) ^b	50 (29.2)	0.037 ^{††}	5 (23.8)	55 (32.5)	0.417 ^{††}
No	9 (47.4)	121 (70.8) ^b		16 (76.2)	114 (67.5)	
Neurologic disease						
Yes	4 (21.1)	15 (8.8)	0.104 [¥]	4 (19.0)	15 (8.9)	0.236 [¥]
No	15 (78.9)	156 (91.2)		17 (81.0)	154 (91.1)	
Metabolic disease						
Yes	3 (15.8)	29 (17.0)	0.999 [¥]	3 (14.3)	29 (17.2)	0.999 [¥]
No	16 (84.2)	142 (83.0)		18 (85.7)	140 (82.8)	

SAH: systemic arterial hypertension; DM: diabetes *mellitus*; ^{††} Values obtained after application of Pearson's chi-squared test; ^{††} Values obtained after application of Likelihood-ratio test; [¥] Values obtained after application of Fisher's exact test; ^b Statistical difference.

is the most common modifiable risk factor for stroke, with a considerable prevalence in blacks, affecting 41% of men and 44% of women. Moreover, recurrent stroke is directly associated with DM, increasing in 60% risk factor (Guzik & Bushnell 2017). Our findings corroborate with other studies on the most prevalent types of stroke, in which authors reported patients are more affected by ischemic than hemorrhagic stroke (Cabral et al. 2009, Fonarow et al. 2010). Note that each type is directly correlated with patient survival, long-term disability, hospital costs, and HRQOL. Furthermore, above two-thirds of participants in our sample were over 60 years of age. Our finding is in agreement with the literature, where it is estimated that the stroke rate more than doubles for each successive 10 years after 55 years of age in both sexes (Fonarow et al. 2010), in which the age group with more than 65 years old present the most considerable incidence of suffering a stroke (Rothwell et al. 2005, Lloyd-Jones et al. 2009, Fonarow et al. 2010). Stroke is the leading cause of death and disability at this age, mostly affecting low-income and middle-income countries (Strong et al. 2007). Our findings contradict the literature postulating a higher stroke incidence for men and a higher prevalence for women (Mendis 2010, Arnao et al. 2016). Here we report the prevalence of stroke was roughly similar between men and women, slightly higher for women.

Amount of hospital care is the most significant predictor of clinical success in stroke treatment. Modern medical resources must be used, but vary considerably in cost depending on the patient's clinical condition, revealing different costs among stroke's subgroups. The present study showed that in hospital treatment was required particular approaches needed among patients having different types of strokes. Depending on the type of stroke, patterns of service utilization, resource use, and ultimately real costs varied. The

majority of the patient showed ischemic stroke. The monthly sum spent with the treatment of ischemic stroke patients was significantly highest compared to other stroke patients. This proportion increased when the functional status and comorbidities were considered in the calculations. Of note, intravenous thrombolysis and endovascular treatments have substantially developed during stroke treatment. These therapies have been shown to reduce mortality and improve functional outcomes of ischemic stroke patients (Rodrigues et al. 2016, Tan et al. 2017) and have been established to be cost-effective, despite higher costs in the acute phase (Joo et al. 2017, Sevick et al. 2017). Hospitalization rates primarily reflect demographic and clinical characteristics of stroke in Brazil. The annual incidence in young adults in southern Brazil represents 12.61 per 100,000 inhabitants per year. Also, the annual mortality in the same region is about 3.07 per 100,000 inhabitants (de Moraes Bernal et al. 2020). The American heart association predicts that in only 20 years, the direct medical cost involving stroke will increase 238%, elevated rate predicted, greater than any other (Wang et al. 2014). Vieira and colleagues indicate that in a private hospital in Brazil, the median daily cost with ischemic stroke patients is US\$691 dollars, while with subarachnoid hemorrhage stroke, the cost can escalate up to US\$2155 dollars per day (Vieira et al. 2019). Also, some factors, such as neurological intervention, need for intensive care unit (ICU), and physical therapy are considered crucial to hospital cost (Kaur et al. 2014).

Some studies demonstrated that stroke patient age, gender, independence in daily living and mobility, educational level, socioeconomic level, social support, health care services, risk factors, and stroke severity are significantly associated with the HRQOL of stroke survivors (Khalid et al. 2016, Ramos-Lima et al. 2018). Patients in a transition phase from adulthood

Table III. Hospitalization costs characteristics in adult population admitted by stroke diagnosis in a private hospital in southern Brazil.

	Hospitalization cost (\$)	p-value
	Median (IQR)	
Types of stroke		
Stroke not specified as hemorrhagic or ischemic	65.57 (58.66 – 76.29) ^a	<0.001 [†]
Ischemic stroke	1465.12 (575.42 – 3120.99) ^b	
Hemorrhagic stroke	65.51 (60.73 – 67.71) ^a	
Transient ischemic stroke and related syndromes	69.67 (62.75 – 796.98)	
Unspecified reports	629.71 (407.36 – 1147.21) ^b	
Age		
18-45	77.47 (62.62 – 757.53)	0.952 [†]
46-60	82.20 (63.03 – 1190.41)	
61-80	73.24 (61.37 – 737.97)	
>81	107.83 (61.39 – 948.24)	
Sex		
Female	72.07 (61.73 – 650.15)	0.381 [†]
Male	99.55 (61.73 – 933.61)	
Educational level		
Illiterate	141.77 (57.05 – 570.52)	0.915 [†]
Elementary School	99.55 (62.06 – 1001.68)	
High school	73.24 (61.31 – 777.04)	
University degree	73.12 (63.03 – 659.70)	
Occupation		
Retiree	100.28 (62.07 – 764.68)	0.794 [†]
Registered worker	77.47 (65.37 – 1052.25)	
Housewife / Househusband	65.33 (55.54 – 444.33)	
Self-employed	64.72 (56.77 – 609.25)	
Health professional	71.91 (64.46 – 1190.41)	
Others	71.31 (51.85 – 814.45)	
Comorbidities	83.38 (62.07 – 943.85)	0.122
SAH	99.55 (61.31 – 951.21)	0.984
DM	192.31 (62.92 – 1055.64)	0.218
Cardiovascular disease	73.24 (63.06 – 521.10)	0.902
Non-cardiovascular disease	69.46 (65.21 – 1028.11)	0.956
Neurologic disease	77.47 (68.08 – 888.33)	0.662
Metabolic disease	100.16 (61 – 1041.66)	0.791

IQR: Interquartile range; [†]Values obtained after application of Kruskal-Wallis H test; ^{a,b}Statistical difference; #Values obtained after application of U of Mann-Whitney test; SAH: systemic arterial hypertension; DM: diabetes *mellitus*.

to senescence represent the most affected age group, which include 60-80 years old, indicating that individuals in an economically active age are affected as for loss of the independent performance of their daily living activities as for the decrease in their social roles (Ramos-Lima et al. 2018). Furthermore, women represent the group with lower rates of HRQOL, especially when older (Kilkenny et al. 2019). Education levels are routinely expressed as an essential indicator of the quality of life to stroke patients, considering that low education rates are directly related to an increase in the incidence of ischemic stroke, mainly when combined with socioeconomic and cultural factors, which also impairs adherence to treatment and maintenance of a healthy lifestyle (Ramos-Lima et al. 2018). Finally, higher care quality during the hospitalization represents a better HRQOL post-stroke, especially when patients are treated in a stroke unit (Kilkenny et al. 2019).

Considering the high epidemiological rates in Brazil, which represents one of the main of the countries with the highest risk of premature death promoted by stroke, characterizing the profile of the most affected patients, means implementation and improvement of local health policies, as promotion of healthy, reduction of risk factors, and greater awareness about signs and symptoms of a stroke. Our results were able to raise relevant points observed in the complete care of a patient with stroke, aiming to draw attention to notifications of ill-established medical records, care with prevention and the profile of the affected patient, and with the levels of quality of life after stroke.

Limitations

Our study strength relies on the ability to provide data on currently scarce regional studies and that could contribute to better understand inpatient with stroke. However, results interpretation should

be carried out considering some limitations. First, the location and type of infarction influenced the treatment costs; both the cost of an inpatient episode and the daily costs vary between infarction subtypes. However, only a small number of previous studies (Mamoli et al. 1999, Huang et al. 2013) have revealed differences in expenses among ischemic stroke subtypes. Second, we cannot exclude the probability of mistakes in medical records. Nonetheless, we have no indications of any irregularities or even that they could have any unevenly occurred across diagnosed subgroups, causing systematic errors. Finally, the generalization of findings, even though we have recruited a representative sample of stroke inpatients from southern Brazil.

Brazil is one of the major countries with the highest risk of premature death caused by stroke. In lieu of epidemiological data, new strategies must be adopted, aiming for prevention and health promotion. Implementing and improving local health policies, promoting healthy cultural habits, reducing risk factors, and raising awareness about signs and symptoms of stroke would lead to a better overall management rate. Early intervention strategies, specialized professionals, and well-established protocol assist in minimizing clinical complications, mortality and hospitalization time, as well as costs; thus, better stroke-patients prognosis. Is crucial to ensure projects turn to the most impoverished social strata and that stroke-centers will have access to it. In-home phase, physiotherapy service, neurophysiological monitoring, and psychological support are extremely important for maintaining HRQOL. Lastly, easy access to very clear epidemiological information could proportionate a favorable environment for government and researchers, facilitating the translation and integration of the collected data to new strategies implementation.

Table IV. Correlations of patient outcome, clinical history and sociodemographic characteristics with HRQOL in adult population admitted by stroke diagnosis in a private hospital in southern Brazil.

	Patient Outcome, n (%), median (IQR)		p-value
	Hospital discharge	Patient transfer	
SSQOL Score			
High	120 (56.1)	1 (20.0)	0.302 ^{**}
Low	83 (38.8)	4 (80.0)	
Did not answered	9 (4.2)	-	
Death	2 (0.9)	-	
Neurologic disease			
Yes	19 (10.3)	-	0.999 [†]
No	165 (89.7)	5 (100.0)	
Comorbidities			
Yes	166 (90.2)	3 (60.0)	0.088 [†]
No	18 (9.8)	2 (40.0)	
SAH			
Yes	132 (71.7)	3 (60.0)	0.625 [†]
No	52 (28.3)	2 (40.0)	
DM			
Yes	60 (32.6)	-	0.180 [†]
No	124 (67.4)	5 (100.0)	
Metabolic disease			
Yes	30 (16.3)	2 (40.0)	0.200 [†]
No	154 (83.7)	3 (60.0)	
Hospitalization cost (\$)	74.10 (61.73 – 817.25)	99.55 (57.66 – 126.03)	0.502 [‡]
Sex			
Female	109 (50.9)	2 (40.0)	0.680 [†]
Male	105 (49.1)	3 (60.0)	
Age			
18-45	22 (10.3)	1 (20.0)	0.136 ^{**}
46-60	34 (15.9)	-	
61-80	100 (46.7)	4 (80.0)	
>81	58 (27.1)	-	
Ethnicity			
White	197 (92.1)	5 (100.0)	0.999 [†]
Black	17 (7.9)	-	
Educational status			
Illiterate	11 (5.1)	-	0.852 ^{**}
Elementary School	48 (22.4)	1 (20.0)	
High school	96 (44.9)	2 (40.0)	
University degree	59 (27.6)	2 (40.0)	
Marital situation			
Married	137 (64.0)	3 (60.0)	0.769 ^{**}
Widowed/divorced	68 (31.8)	2 (40.0)	
Single	9 (4.2)	-	
Profession			
Retiree	130 (60.7)	2 (40.0)	0.619 ^{**}
Registered worker	45 (21.0)	2 (40.0)	
Housewife / Househusband	14 (6.5)	-	
Self-employed	8 (3.7)	-	
Health professional	6 (2.8)	-	
Others	11 (5.1)	1 (20.0)	

SAH: systemic arterial hypertension; DM: diabetes *mellitus*; IQR: Interquartile range; ^{**} Value obtained after application of Likelihood Ratio test; [†] Values obtained after application of Fisher's exact test; [‡] Values obtained after application of U of Mann-Whitney test.

Table V. Quality of life characteristics in adult population with stroke diagnosis in a private hospital in southern Brazil.

		n (%), mean ± standard deviation		
HRQOL				
High		121 (57.9)		
Low		88 (42.1)		
SSQOL Score		161.06 ± 42.23		
SSQOL domain		mean ± standard deviation		
Energy		11.81 ± 4.03		
Family roles		11.71 ± 3.71		
Language		14.76 ± 4.93		
Mobility		16.51 ± 6.10		
Mood		15.09 ± 4.57		
Personality		11.89 ± 3.76		
Self-care		14.80 ± 5.20		
Social roles		14.69 ± 4.82		
Memory/thinking		11.78 ± 4.06		
Upper Extremity function		14.78 ± 4.76		
Vision		11.72 ± 3.69		
Work/productivity		11.52 ± 3.46		
		SSQOL Score, n (%)		p-value
		Low	High	
Sex				
Female		51 (58.0)	56 (46.3)	0.096 ^{††}
Male		37 (42.0)	65 (53.7)	
Age				
18-45		11 (12.5)	11 (9.1)	0.084 ^{††}
46-60		19 (21.6)	13 (10.7)	
61-80		34 (38.6)	64 (52.9)	
>81		24 (27.3)	33 (27.3)	
Ethnicity				
White		80 (90.9)	112 (92.6)	0.666 ^{††}
Black		8 (9.1)	9 (7.4)	
Educational status				
Illiterate		5 (5.7)	5 (4.1)	0.732 ^{††}
Elementary School		20 (22.7)	27 (22.3)	
High school		36 (40.9)	58 (47.9)	
University degree		27 (30.7)	31 (25.6)	
Marital situation				
Married		55 (62.5)	77 (63.6)	0.708 ^{††}
Widowed/divorced		28 (31.8)	40 (33.1)	
Single		5 (5.7)	4 (3.3)	
Occupation				
Retiree		47 (53.4)	78 (64.5)	0.374 ^{††}
Registered worker		24 (27.3)	21 (17.4)	
Housewife / Househusband		6 (6.8)	7 (5.8)	
Self-employed		3 (3.4)	5 (4.1)	
Health professional		4 (4.5)	2 (1.7)	
Others		4 (4.5)	8 (6.6)	
Comorbidities			93 (90.3)	
Yes		68 (88.3)	10 (9.7)	0.669 ^{††}
No		9 (11.7)		
Neurologic disease			9 (8.7)	
Yes		10 (13.0)	94 (91.3)	0.359 ^{††}
No		67 (87.0)		
SAH			79 (76.7)	
Yes		49 (63.6)	24 (23.3)	0.056 ^{††}
No		28 (36.4)		
DM			37 (35.9)	
Yes		20 (26.0)	66 (84.1)	0.156 ^{††}
No		57 (74.0)		
Metabolic disease			17 (16.5)	
Yes		14 (18.2)	86 (83.5)	0.768 ^{††}
No		63 (81.8)		

HRQOL: health-related quality of life; SSQOL: stroke-specific quality of life scale. ^{††} Values obtained after application of Pearson's chi-square test; ^{**} Values obtained after application of the Likelihood Ratio Test.

CONCLUSION

Stroke burden is high and continues to increase. However, in view of the high expenses observed, the rational management of resources would be by allocating most investment to prevention and treatment of risk factors instead of directly to stroke treatment, so we would have a lower proportion of direct and indirect costs with stroke inpatients. Furthermore, given the scarcity of epidemiological data, the importance of conducting new studies aiming to gather data on stroke is increasingly evident. Large-scale, multicentric community, and hospital-based studies are essential to facilitate decreasing stroke incidence rate. Furthermore, new studies could significantly reduce the death and disability induced by stroke. Our data showed the relationship between stroke severity, disability, hospitalization costs and HRQOL. Characterizing the profile of the most affected patients, means creating new policies and strategies for this disease, reducing hospitalization cost, stroke prevalence, and improving the population's quality of life. Management of the risk factors is crucial for reducing the risk of stroke and promote prevention.

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REFERENCES

ARNAO V, ACCIARRESI M, CITTADINI E & CASO V. 2016. Stroke incidence, prevalence and mortality in women worldwide. *Int J Stroke* 11(3): 287-301.

AYERBE L, AYIS S, RUDD AG, HEUSCHMANN PU & WOLFE CD. 2011. Natural history, predictors, and associations of depression 5 years after stroke: the South London Stroke Register. *Stroke* 42(7): 1907-1911.

CABRAL NL, GONCALVES AR, LONGO AL, MORO CH, COSTA G, AMARAL CH, FONSECA LA & ELUF-NETO J. 2009. Incidence of stroke subtypes, prognosis and prevalence of risk factors in Joinville, Brazil: a 2 year community based study. *J Neurol Neurosurg Psychiatry* 80(7): 755-761.

CAMPBELL BURTON CA, MURRAY J, HOLMES J, ASTIN F, GREENWOOD D & KNAPP P. 2013. Frequency of anxiety after stroke: a systematic review and meta-analysis of observational studies. *Int J Stroke* 8(7): 545-559.

COLLABORATORS GBDB. 2018. Burden of disease in Brazil, 1990-2016: a systematic subnational analysis for the Global Burden of Disease Study 2016. *Lancet* 392(10149): 760-775.

COPSTEIN L, FERNANDES JG & BASTOS GA. 2013. Prevalence and risk factors for stroke in a population of Southern Brazil. *Arq Neuropsiquiatr* 71(5): 294-300.

DANTAS LF, MARCHESI JF, PERES IT, HAMACHER S, BOZZA FA & QUINTANO NEIRA RA. 2019. Public hospitalizations for stroke in Brazil from 2009 to 2016. *PLoS ONE* 14(3): e0213837.

DE CARVALHO JJ, ALVES MB, VIANA GA, MACHADO CB, DOS SANTOS BF, KANAMURA AH, LOTTENBERG CL, NETO MC & SILVA GS. 2011. Stroke epidemiology, patterns of management, and outcomes in Fortaleza, Brazil: a hospital-based multicenter prospective study. *Stroke* 42(12): 3341-3346.

DE MORAES BERNAL H, DE ABREU LC, PINHEIRO BEZERRA IM, ADAMI F, TAKASU JM, JI YOUNG SUH JV, DE LIRA RIBEIRO S & DE SOUSA SANTOS EF. 2020. Incidence of hospitalization and mortality due to stroke in young adults, residents of developed regions in Brazil, 2008-2018. *PLoS ONE* 15(11): e0242248.

FAROOQ MU, CHAUDHRY AH, AMIN K & MAJID A. 2008. The WHO STEPwise Approach to Stroke Surveillance. *J Coll Physicians Surg Pak* 18(10): 665.

FONAROW GC, REEVES MJ, ZHAO X, OLSON DM, SMITH EE, SAVER JL & SCHWAMM LH. 2010. Age-related differences in characteristics, performance measures, treatment trends, and outcomes in patients with ischemic stroke. *Circulation* 121(7): 879-891.

GARRITANO CR, LUZ PM, PIRES ML, BARBOSA MT & BATISTA KM. 2012. Analysis of the mortality trend due to cerebrovascular accident in Brazil in the XXI century. *Arq Bras Cardiol* 98(6): 519-527.

- GO AS ET AL. 2014. Heart disease and stroke statistics-2014 update: a report from the American Heart Association. *Circulation* 129(3): e28-e292.
- GUZIK A & BUSHNELL C. 2017. Stroke epidemiology and risk factor management. *Continuum (Minneapolis)* 23(1): 15-39.
- HANKEY GJ. 2017. Stroke. *Lancet* 389(10069): 641-654.
- HEUSER RR. 2017. The role for Cardiologists in stroke intervention. *Prog Cardiovasc Dis* 59(6): 549-554.
- HUANG YC, HU CJ, LEE TH, YANG JT, WENG HH, LIN LC & LAI SL. 2013. The impact factors on the cost and length of stay among acute ischemic stroke. *J Stroke Cerebrovasc Dis* 22(7): e152-158.
- JOO H, WANG G & GEORGE MG. 2017. A literature review of cost-effectiveness of intravenous recombinant tissue plasminogen activator for treating acute ischemic stroke. *Stroke Vasc Neurol* 2(2): 73-83.
- KAUR P, KWATRA G, KAUR R & PANDIAN JD. 2014. Cost of stroke in low and middle income countries: a systematic review. *Int J Stroke* 9(6): 678-682.
- KHALID W, ROZI S, ALI TS, AZAM I, MULLEN MT, ILLYAS S, UN-NISA Q, SOOMRO N & KAMAL AK. 2016. Quality of life after stroke in Pakistan. *BMC Neurol* 16(1): 250.
- KILKENNY MF, GRIMLEY R & LANNIN NA. 2019. Quality of life and age following stroke. *Aging (Albany NY)* 11(3): 845-846.
- LLOYD-JONES D ET AL. 2009. Heart disease and stroke statistics-2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 119(3): e21-181.
- MAMOLIA, CENSORI B, CASTO L, SILEO C, CESANA B & CAMERLINGO DM. 1999. An analysis of the costs of ischemic stroke in an Italian stroke unit. *Neurology* 53(1): 112-116.
- MENDIS S. 2010. Prevention and care of stroke in low- and middle-income countries; the need for a public health perspective. *Int J Stroke* 5(2): 86-91.
- O'DONNELL MJ ET AL. 2010. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *Lancet* 376(9735): 112-123.
- PACHECO-CASTILHO AC, VANIN GM, DANTAS RO, PONTES-NETO OM & MARTINO R. 2019. Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. *Dysphagia* 34(4): 499-520.
- PONTES-NETO OM, SILVA GS, FEITOSA MR, DE FIGUEIREDO NL, FIOROT JA, ROCHA TN, MASSARO AR & LEITE JP. 2008. Stroke awareness in Brazil: alarming results in a community-based study. *Stroke* 39(2): 292-296.
- RAFSTEN L, ANIELSSON A & SUNNERHAGEN KS. 2018. Anxiety after stroke: A systematic review and meta-analysis. *J Rehabil Med* 50(9): 769-778.
- RAMOS-LIMA MJM, BRASILEIRO IC, LIMA TL & BRAGA-NETO P. 2018. Quality of life after stroke: impact of clinical and sociodemographic factors. *Clinics (São Paulo)* 73: e418.
- RODRIGUES FB, NEVES JB, CALDEIRA D, FERRO JM, FERREIRA JJ & COSTA J. 2016. Endovascular treatment versus medical care alone for ischaemic stroke: systematic review and meta-analysis. *BMJ* 353: i1754.
- ROGER VL ET AL. 2012. Heart disease and stroke statistics-2012 update: a report from the American Heart Association. *Circulation* 125(1): e2-e220.
- ROTHWELL PM ET AL. 2005. Population-based study of event-rate, incidence, case fatality, and mortality for all acute vascular events in all arterial territories (Oxford Vascular Study). *Lancet* 366(9499): 1773-1783.
- SARIKAYA H, FERRO J & ARNOLD M. 2015. Stroke prevention-medical and lifestyle measures. *Eur Neurol* 73(3-4): 150-157.
- SEVICK LK, GHALI S, HILL MD, DANTHUREBANDARA V, LORENZETTI DL, NOSEWORTHY T, SPACKMAN E & CLEMENT F. 2017. Systematic Review of the Cost and Cost-Effectiveness of Rapid Endovascular Therapy for Acute Ischemic Stroke. *Stroke* 48(9): 2519-2526.
- STRONG K, MATHERS C & BONITA R. 2007. Preventing stroke: saving lives around the world. *Lancet Neurol* 6(2): 182-187.
- SVEINSSON OA, KJARTANSSON O & VALDIMARSSON EM. 2014. Cerebral ischemia/infarction - epidemiology, causes and symptoms. *Laeknabladid* 100(5): 271-279.
- TAN CC, WANG HF, JI JL, TAN MS, TAN L & YU JT. 2017. Endovascular Treatment Versus Intravenous Thrombolysis for Acute Ischemic Stroke: a Quantitative Review and Meta-Analysis of 21 Randomized Trials. *Mol Neurobiol* 54(2): 1369-1378.
- VIEIRA L, SAFANELLI J, ARAUJO T, SCHUCH HA, KUHLOFF MHR, NAGEL V, CONFORTO AB, SILVA GS, MAZIN S & CABRAL NL. 2019. The cost of stroke in private hospitals in Brazil: a one-year prospective study. *Arq Neuropsiquiatr* 77(6): 393-403.
- WANG G, ZHANG Z, AYALA C, DUNET DO, FANG J & GEORGE MG. 2014. Costs of hospitalization for stroke patients aged 18-64 years in the United States. *J Stroke Cerebrovasc Dis* 23(5): 861-868.

WEN H, WEYMANN KB, WOOD L & WANG QM. 2018. Inflammatory Signaling in Post-Stroke Fatigue and Depression. *Eur Neurol* 80(3-4): 138-148.

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