

Epidemiology of Stroke in Costa Rica: A 7-Year Hospital-Based Acute Stroke Registry of 1319 Consecutive Patients

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Background: Limited data on stroke exist for Costa Rica. Therefore, we created a stroke registry out of patients with stroke seen in the Acute Stroke Unit of the Hospital Calderon Guardia. *Methods:* We analyzed 1319 patients enrolled over a 7-year period, which incorporated demographic, clinical, laboratory, and neuroimaging data. *Results:* The mean age of patients with stroke was 68.0 ± 15.5 years. Seven hundred twenty-five were men and the age range was 13-104 years. The most prevalent risk factors were hypertension (78.8%), dyslipidemia (36.3%), and diabetes (31.9%). Fifteen percent had atrial fibrillation and 24.7% had a previous stroke or transient ischemic attack. Prevalence of hypertension and atrial fibrillation increased with age; however, younger patients were more associated with thrombophilia. We documented 962 (72.9%) ischemic and 270 (20.5%) hemorrhagic strokes. Of the ischemic strokes, 174 (18.1%) were considered secondary to large-artery atherothrombosis, 175 (18.2%) were due to cardiac embolism, 19 (2.0%) were due to lacunar infarcts, and 25 (2.6%) were due to other determined causes. Five hundred sixty-nine (59.1%) remained undetermined. Atherothrombotic strokes were mostly associated with dyslipidemia, diabetes, metabolic syndrome, and obesity, whereas lacunar infarcts were associated with hypertension, smoking, sedentary lifestyle, and previous stroke or transient ischemic attack. Of our patients, 69.9% scored between 0 and 9 in the initial National Institutes of Health Stroke Scale (NIHSS). *Conclusions:* We found differences in sociodemographic features, risk factors, and stroke severity among stroke subtypes. Risk factor prevalence was similar to other registries involving Hispanic populations. **Key Words:** Epidemiology—ischemic stroke—hemorrhagic stroke—stroke classification—risk factors—Costa Rica—stroke registry.

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Introduction

Cerebrovascular disease remains one of the leading causes of death and disability in Costa Rica.¹ It is essential to establish stroke registries and data banks to gather important epidemiological stroke information.² Stroke data banks help clinicians to describe the clinical course of the disease, identify prognostic factors, and provide knowledge for future clinical trials.²

Costa Rica currently has a total population of 4,947,490 inhabitants, distributed among 7 provinces. San José is the capital province and the largest city, housing 32.7% of the country population. Of the total population, 22.4% is under 15 years of age, 69.7% is between 15 and 65 years, and 7.9% is over 65 years. We have a high life expectancy at birth of 80 years (population data statistics, INEC, Costa Rica Web site, <https://www.inec.go.cr>; accessed October 4, 2017). We have a public, socialized, and universal health system (Caja Costarricense de Seguro Social [CCSS]) that covers 94% of the total population. The CCSS provides health insurance through 29 hospitals and more than 1000 primary and secondary health-care centers allocated across the whole country. Of these 29 public hospitals, only 3 are considered to be tertiary health-care centers, and the three of them are located in San José. One of these third-level hospitals, Hospital Calderón Guardia, was the first in the country that established an acute stroke unit in January 2009 and started with intravenous thrombolysis therapy after December 2011. This unit is a referral center for 3 main hospitals, serving approximately 1.5 million patients (population ascribed to Hospital Calderón Guardia, CCSS Web site, <https://www.ccss.sa.cr>; accessed July 2, 2017).

In our country, population-based epidemiological registries do not provide information that could be used for the evaluation and management of these patients. Therefore, we created a stroke registry with data from the Acute Stroke Unit of the Hospital Calderón Guardia. We present our first report in which stroke patient profiles, risk factors, stroke subtypes, and severity are evaluated.

Methods

Data were derived from the Costa Rican Stroke Registry Program (CSRP). The CSRP, established in April 2009, is the first hospital-based stroke registry in Costa Rica. The CSRP is a prospective observational registry of patients with acute stroke. This registry incorporates detailed demographic, clinical, laboratory, and neuroimaging data and has 4 main goals: (1) the analysis of causes and mechanisms of stroke, (2) the description of clinical and radiological presentations, (3) the comparison of geographic and ethnic factors, and (4) the design of prevention and interventional studies.

See online supplementary material for stroke and risk factor definitions, as well as diagnostic evaluations

performed. Three sets of National Institutes of Health Stroke Scale (NIHSS) scores were registered daily for each patient: the initial NIHSS score on admission to the unit, the highest NIHSS score during the whole hospitalization, and the discharge NIHSS score obtained on the last day before leaving the hospital. We also subtracted the discharge NIHSS score from the highest NIHSS score to assess for improvement or deterioration of patients during their stay.

We classified the subtypes of stroke according to the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) criteria as large-artery atherothrombosis, cardiac embolism, lacunar stroke, and other determined and undetermined causes.³ Undetermined causes were classified if they were due to an incomplete evaluation or because of negative results.

The present study was approved by the Ethics Committee of Hospital Calderón Guardia, CCSS.

Statistics

We used Stata (version 13) (StataCorp LP, Texas, USA) for the statistical analysis. Normally distributed variables were reported as mean with 95% confidence intervals (CIs) or standard deviations, whereas continuous but non-normally distributed variables were reported as median with 25th and 75th percentile values (Q1-Q3). Normally distributed variables were compared with paired or unpaired *t* tests and analysis of variance, whereas non-normally distributed variables were compared with the Mann-Whitney *U* test, the Wilcoxon match-paired signed-rank test, or the Kruskal-Wallis test. Frequencies were compared with χ^2 and Fisher exact tests. Clinical outcome scales were modeled using multiple linear or logistic regression, where we report their significance and goodness of fit (r^2); tests were 2-tailed, and the significance was .05.

Results

General Population Characteristics

From April 4, 2009, until October 27, 2016, we registered 1319 events. Seven hundred twenty-five (55.0%) were men and the mean age of the whole sample was 68.0 ± 15.5 years (range 13-104 years). The mean ages were significantly different between men and women, 66.4 (95% CI: 65.3-67.5) and 69.9 (95% CI: 68.6-71.2), respectively; 13% of our patients were under 50 years and 28.1% were over 80 years of age. Of the total number of patients, 84.7% came from the metropolitan area and 24.7% were full- or part-time employed during the event. More men were employed (34.6%) than women (12.6%) ($P < .001$), and less patients were employed as age increased ($P < .001$). Among the patients, 70.8% did not complete high school and increasing age correlated with an incomplete high school education (odds ratio [OR] 1.03, 95% CI: 1.02-1.04, $P < .001$) (Table 1).

Table 1. Demographic data in etiologic subgroups of stroke

Parameter	Ischemic (962, 72.9%)					Undetermined		Hemorrhagic (270, 20.5%)	Others (87, 6.6%)	Total group (1319, 100%)	P
	Large artery (atherothrombotic)	Cardiac	Lacunar	Other causes	Negative results	Incomplete workup					
Total group, n (%)	174 (18.1)	175 (18.2)	19 (2.0)	25 (2.6)	174 (18.1)	395 (41.1)					
Age (y)											
Mean (SD)	69.6 (13.4)	75.5 (12.6)	74.0 (9.5)	41.3 (13.9)	63.4 (17.1)	69.6 (13.8)	65.7 (16.0)	64.5 (16.0)	68.0 (15.5)	<.001	
Under 50, n (%)	14 (8.0)	7 (4.0)	1 (5.3)	19 (76.0)	36 (20.7)	36 (9.1)	44 (16.3)	14 (16.1)	171 (13.0)		
50-59, n (%)	24 (13.8)	11 (6.3)	0 (.0)	4 (16.0)	31 (17.8)	58 (14.6)	51 (18.9)	21 (24.1)	200 (15.2)		
60-69, n (%)	39 (22.4)	34 (19.4)	4 (21.1)	2 (8.0)	34 (19.4)	97 (24.6)	54 (20.0)	11 (12.6)	275 (20.9)		
70-79, n (%)	49 (28.2)	42 (24.0)	10 (52.6)	0 (.0)	28 (16.1)	92 (23.3)	58 (21.5)	23 (26.4)	302 (22.9)		
Over 80, n (%)	48 (27.6)	81 (46.3)	4 (21.1)	0 (.0)	45 (25.9)	112 (28.4)	63 (23.3)	18 (20.7)	371 (28.1)		
Males, n (%)	95 (54.6)	93 (53.1)	11 (57.9)	14 (56.0)	100 (57.5)	212 (53.7)	153 (56.7)	47 (54.0)	725 (55.0)	.93	
Metropolitan area, n (%)	142 (81.6)	159 (90.9)	18 (94.7)	18 (72.0)	147 (85.4)	339 (85.8)	220 (81.5)	74 (85.1)	1117 (84.7)	.03	
Employed full-time or part-time, n (%)	40 (23.0)	20 (11.4)	5 (26.3)	9 (36.0)	49 (28.2)	94 (23.8)	78 (28.9)	31 (35.6)	326 (24.7)	<.001	
Below high school education, n (%)	120 (69.0)	134 (76.6)	15 (79.0)	7 (28.0)	117 (67.2)	283 (71.7)	203 (75.2)	55 (63.2)	934 (70.8)	<.001	

Abbreviation: SD, standard deviation.

Numbers in parentheses give percentages that add to 100 in each subgroup. Boldfaced values indicate significant difference.

Risk Factors

The foremost risk factors were hypertension (78.8%), dyslipidemia (36.3%), and diabetes (31.9%). Fifteen percent of the patients had known atrial fibrillation and 24.7% had a previous stroke or transient ischemic attack (TIA). Nineteen (1.4%) patients had a thrombophilia, with antiphospholipid syndrome being the most prevalent ($n = 15$) (Table 2).

The prevalence of hypertension, atrial fibrillation, and previous stroke or TIA increased with age ($P < .001$). However, patients under 50 years were more likely associated with a thrombophilia without any other documented risk factor (OR 20.38, 95% CI: 7.24-57.37, $P < .001$).

We observed that increasing age (OR 1.01, 95% CI: 1.00-1.02, $P = .004$), hypertension (OR 1.44, 95% CI: 1.04-2.00, $P = .03$), dyslipidemia (OR 1.40, 95% CI: 1.09-1.81, $P = .009$), atrial fibrillation (OR 1.43, 95% CI: 1.03-2.00, $P = .03$), and being unemployed (OR 1.40, 95% CI: 1.03-1.90, $P = .03$) were significantly associated with having a previous stroke or TIA in the univariate analysis.

Etiology and Subtypes

The main diagnoses were ischemic ($n = 962$, 72.9%) and hemorrhagic ($n = 270$, 20.5%) strokes. The remaining ($n = 87$, 6.6%) were grouped in a category for other causes of neurological deficits, where diagnoses were not specified, and there were no findings in neuroimaging that could explain the neurological deficit. There was a predominance of males in every category of stroke subtype. Of the 962 ischemic strokes, 174 (18.1%) were due to large-artery atherothrombosis, 175 (18.2%) were due to cardiac embolism, 19 (2.0%) were due to lacunar infarcts, and 25 (2.6%) were due to other determined causes. We had 569 (59.1%) ischemic events, confirmed by neuroimaging, without an identified etiology (i.e., undetermined). Atherothrombotic strokes were significantly associated with dyslipidemia (OR 1.51, 95% CI: 1.10-2.10, $P = .01$) and were nonsignificantly correlated with diabetes, metabolic syndrome, and obesity. Likewise, lacunar infarcts showed a nonsignificant association with hypertension, smoking, sedentary lifestyle, and previous stroke or TIA. Thrombophilias and atrial fibrillation were associated with other determined causes and cardioembolic subtypes of stroke, respectively ($P < .001$) (Table 2).

Stroke Severity

NIHSS scores ranged from 0 to 41 points. The median value for the initial NIHSS score was 4 (Q1-Q3: 0-11), that for the highest NIHSS was 7 (Q1-Q3: 2-14), that for the discharge NIHSS score was 3 (Q1-Q3: 0-7), and that for the difference between the highest NIHSS score and the discharge NIHSS score was 2 (Q1-Q3: 0-7). More than half of the patients (52.8%) had an initial NIHSS score

between 0 and 4, and 69.9% of our patients had an initial NIHSS score between 0 and 9 (Table 3). We also found a weak but positive correlation between the age of the patient with stroke and the initial NIHSS score ($r = .10$, $P = .001$). Unemployment (coefficient: .29, 95% CI: .15-.43, $P < .001$) and underschooling (coefficient: .28, 95% CI: .15-.40, $P < .001$) were both associated with higher initial NIHSS scores. Cardioembolic and lacunar strokes were significantly associated with the highest and lowest scores on all of the 3 NIHSS measurements, respectively. We did not find differences in NIHSS improvement scoring between ischemic and hemorrhagic strokes, or among ischemic stroke subtypes.

Finally, in a multivariate analysis, we found that older females, cardioembolic stroke, and hemorrhagic events were independently associated with higher NIHSS scores ($P < .001$, $r^2 = .10$). While being employed, having a complete high school education, smoking, and lacunar infarcts, were independently and significantly associated with lower NIHSS scores, even after adjusting for confounders such as age and sex ($P < .001$, $r^2 = .10$).

Discussion

General Population Characteristics

The mean age of stroke in our trial was similar to reports from developed countries. Hospital-based registries from developed countries document a higher mean age of stroke⁴⁻¹¹ when compared with the mean age registered for developing countries.¹²⁻²⁰ The predisposition to an earlier onset of stroke in developing countries may be due to a higher prevalence and unsuitable care of cardiovascular risk factors, and an overall smaller proportion of elderly in developing countries populations.²¹ Furthermore, similar developed countries' registries have shown a younger age of stroke among Hispanics and natives when compared with Caucasians,²² suggesting an ethnic or genetic basis instead of only a sociodemographic or economic differentiation.

Our higher mean age of onset of stroke, when compared with other developing countries' registries, could be explained by the high proportion (94%) of patients with access to public primary care health assistance in Costa Rica (percentage of public health coverage from the CCSS Web site, <https://www.ccss.sa.cr>; accessed July 2, 2017), thus having a better control of their cardiovascular risk factors. Also, our population has a high life expectancy at birth, averaged at 80.0 years, with a population age distribution comparable with other developed countries (country statistics and global health estimates by World Health Organization and United Nations partners, <http://www.who.int/gho/en>; accessed July 2, 2017).

Increasing age was associated with a larger proportion of unemployed and underschooled patients. In Costa Rica, we have an overall unemployment rate of 8.5%, where rural areas can reach up to 3 times the

Table 2. Risk factors among etiologies of stroke

Parameter	Ischemic (962, 72.9%)								Total group (1319, 100%)	P
	Large artery (atherothrombotic)	Cardiac	Lacunar	Other causes	Undetermined		Hemorrhagic (270, 20.5%)	Others (87, 6.6%)		
					Negative results	Incomplete workup				
Hypertension, n (%)	143 (82.2)	146 (83.4)	16 (84.2)	8 (32.0)	128 (73.6)	332 (84.1)	208 (77.0)	58 (66.7)	1039 (78.8)	<.001
Dyslipidemia, n (%)	78 (44.8)	59 (33.7)	8 (42.1)	3 (12.0)	65 (37.4)	160 (40.5)	69 (25.6)	37 (42.5)	479 (36.3)	<.001
DM, n (%)	66 (37.9)	53 (30.3)	5 (26.3)	2 (8.0)	56 (32.2)	140 (35.4)	72 (26.7)	27 (31.0)	421 (31.9)	.01
Previous stroke or TIA, n (%)	34 (19.5)	52 (29.7)	7 (36.8)	5 (20.0)	38 (21.8)	95 (24.1)	75 (27.8)	20 (23.0)	326 (24.7)	.16
Smoking, n (%)	45 (25.9)	18 (10.3)	5 (26.3)	4 (16.0)	37 (21.3)	75 (19.0)	28 (10.4)	21 (24.1)	233 (17.7)	.001
Sedentarism, n (%)	30 (17.2)	22 (12.6)	4 (21.1)	4 (16.0)	23 (13.2)	65 (16.5)	33 (12.2)	18 (20.7)	199 (15.1)	.76
Atrial fibrillation, n (%)	0 (.0)	161 (92.0)	2 (10.5)	1 (4.0)	0 (.0)	0 (.0)	27 (10.0)	7 (8.1)	198 (15.0)	<.001
Obesity, n (%)	27 (15.5)	25 (14.3)	2 (10.5)	1 (4.0)	27 (15.5)	55 (13.9)	34 (12.6)	15 (17.2)	186 (14.1)	.80
Metabolic syndrome, n (%)	16 (9.2)	11 (6.3)	1 (5.3)	1 (4.0)	12 (6.9)	19 (4.8)	15 (5.6)	10 (11.5)	85 (6.4)	.60
Thrombophilia, n (%)	0 (.0)	0 (.0)	0 (.0)	16 (64.0)	0 (.0)	0 (.0)	2 (.7)	1 (1.2)	19 (1.4)	<.001
No risk factors, n (%)	11 (6.3)	4 (2.3)	1 (5.3)	3 (12.0)	24 (13.8)	19 (4.8)	25 (9.3)	13 (14.9)	100 (7.6)	.01

Abbreviations: DM, diabetes mellitus; TIA, transient ischemic attack.

Numbers in parentheses give percentages that add to 100 in each subgroup. Boldfaced values indicate significant difference.

Table 3. Length of hospitalization and severity in stroke subtypes

Parameter	Ischemic (962, 72.9%)					P	
	Large artery (atherothrombotic)	Cardiac	Lacunar	Other causes	Undetermined		
LOS median (first-third quartile) (d)	4 (3-6)	6 (3-10)	3 (2-5)	6.5 (3.5-9.5)	7 (4-10)	5 (3-8)	.001
NIHSS median (first-third quartile) (d)	7 (2-13)	7 (0-15)	2 (0-4)	3 (2-8)	4 (0-10)	3 (0-11)	<.001
Initial	7.5 (3-14)	10 (5-19)	3 (0-4)	4 (2-10)	7 (2-12)	6 (0-15)	<.001
Highest	1 (0-6)	3 (0-11)	0 (0-3)	1 (0-4)	2 (0-7)	1 (0-9)	.001
Discharge	3 (1-8)	3 (0-8)	.5 (0-3)	2 (.5-5)	2 (0-6)	2 (0-6.5)	.01
Difference*							

Abbreviations: LOS, length of stay; NIHSS, National Institutes of Health Stroke Scale.

Boldfaced values indicate significant difference.

*NIHSS difference score was calculated by subtracting the discharge NIHSS score from the highest NIHSS score.

unemployment rate observed in urban areas. In our registry, we found an unemployment rate of 46.8% in patients less than 50 years of age that increased up to 88.1% in patients over the age of 70. Furthermore, in our country, only 38.6% of the population over the age of 15 has completed secondary education. We found in this registry that 70.8% of the patients had an incomplete secondary education. Both unemployment and underschooling increased in rural areas and with increasing age in our registry, as well as in the national census statistics (population data statistics, INEC, Costa Rica Web site, <https://www.inec.go.cr>; accessed October 4, 2017).

In our data, we established that unemployment and having an incomplete high school education were significantly and independently associated with higher scores on initial NIHSS, even after controlling for age as a confounder. Unemployment and having a lower education are considered independent risk factors for many diseases, including stroke, even after adjusting for cardiovascular risk factors.²³⁻²⁵ This relates to the “healthy worker effect” where healthier people are more likely to enter and remain in the workforce.^{26,27} Additionally, unemployment is associated with lower access and underuse of health-care services,²⁸ higher prevalence of chronic comorbid conditions,²⁴ limited access to preventive interventions,²⁹ lower socioeconomic status,³⁰ and worse clinical outcomes.²⁴ Low education is associated with increased incidence and mortality of stroke,^{31,32} being attributed to a higher prevalence of cardiovascular risk factors (i.e., hypertension), poor nutritional education, and differences in health-care access and utilization.^{30,31,33,34} In view of the high unemployment and underschooled rate reported in this registry, compared with the healthy Costa Rican population of the same age; and being both factors significantly associated with stroke severity, we presume that interventions implemented toward reducing unemployment and underschooling, could eventually reduce stroke severity and its further complications.

Stroke Risk Factors

Cerebrovascular risk factor prevalence and distribution were consistent with prior reports.^{9,11,15,17,18,22,35-39} Hypertension was the most prevalent, then dyslipidemia and diabetes, followed by previous stroke or TIA, smoking, and atrial fibrillation. Increased prevalence of smoking and less utilization of health services by men could lead to a reduced diagnosis and a worse control of cardiovascular risk factors, further explaining the male predominance in most of the stroke registries,^{5,7-13,15-17,20,22,35-38,40-42} as well as the lower age of stroke onset reported for men in this and in several other trials.^{4,7,8,11,18,35,40,43,44} Like other reports, older patients experienced more hypertension and atrial fibrillation, reflecting the increasing prevalence of atherothrombotic and cardioembolic stroke subtypes in the elderly.^{4,11,35,39,45,46}

Even though other registries have found smoking to be highly associated with a younger age at stroke onset,⁴⁷ in our trial we did not find this. Instead, thrombophilias (especially antiphospholipid syndrome) showed a remarkable association (OR 20.38, 95% CI: 7.24-57.37, $P < .001$) with young adult stroke onset in our registry. Obesity⁴⁸ and waist-to-hip ratio⁴⁹ are regarded as risk factors for stroke⁵⁰; a few hospital-based registries have reported the frequency of obesity in their samples,^{10,13,14,35} this being similar to the frequency we described in our patients (14.1%). And even though other large cohorts have reported a relationship between elevated body mass index and stroke,^{39,51,52} we did not find an association between them.

We registered 326 (24.7%) patients with a previous stroke or TIA. Of these patients, only 16 repeated their events during the registry follow-up period and were seen again at our unit. They were considered, for registry purposes, as separate patients. We acknowledge that this is surely a low number of recurrent events; therefore, we assumed that most of the patients who presented with repeated strokes, but never entered in our registry, could be due to several reasons. First, many patients, especially those with greater stroke sequelae, will stay at their homes instead of visiting any health center when having another event. Second, there are few instances when patients with low-severity recurrent strokes will be seen first at our outpatient clinic, rather than being admitted to the hospital. These patients will be thoroughly studied and their therapies will be adjusted as needed, but because they were not received at our unit, they also cannot be introduced in our registry. Third, many of the patients with recurrent strokes may visit a center different from ours. This is rather frequent, especially because many patients change hospitals usually after their stroke, when they go on living with a relative in a different city. Finally, we follow up all of our patients at our stroke continuity clinic, and we constantly insist on secondary prevention interventions that are fully accessible to all of them. We certainly expect that these interventions may further reduce the number of recurrent events seen at our center.

Stroke Subtypes

The distribution of ischemic stroke subtype in our report did not agree with other hospital-based registries. This finding is due to our large proportion of events classified as undetermined causes.

Prior publications have confirmed a larger proportion of lacunar infarcts in Asians, blacks, and Hispanics,^{9,15,16,20,22,36,39,53-57} whereas Caucasians have been classically related to atherosclerotic and cardioembolic^{4,8,9,11,22,58} stroke subtypes. Thus, we expected to observe a much larger frequency of lacunar strokes in our sample, especially after having a high prevalence of hypertension (i.e., main risk factor). Possibly,

this finding is the result of an important underdiagnosis or missed recording of lacunar infarcts in our registry. We performed head computed tomography scan in 97.4% of our patients, yet only 13.6% of the whole registry underwent a brain magnetic resonance imaging. This reduced availability of MRI studies for our patients, certainly decreased our diagnostic yield for identifying those individuals where clinical features suggested a lacunar infarct, but was not confirmed in the brain computed tomography scan.

Likewise, the high number of undetermined strokes is because our acute stroke unit does not focus on a diagnostic approach, but on the attention and care of patients with acute stroke, particularly as a referral center for thrombolysis. This finding is corroborated by the occurrence of only 30.6% of undetermined strokes with a complete but negative evaluation. Our high bed turnover, short overall patient length of stay (LOS) (a median of 5 days), but especially shorter among undetermined strokes with an incomplete workup (Table 3), and the high percentage of thrombolysed patients (14.2%), support this point of view. Patients classified as undetermined with a complete but negative workup were younger than undetermined patients with stroke with an incomplete workup. In our unit, every patient receives standard of care and basic diagnostic evaluations to confirm the stroke and treat it properly. Nonetheless, younger patients, most of them with no other vascular risk factors, would certainly impel the treating neurologist to perform an extended workup previous to the patient discharge out of the unit, in the interest of determining the etiology of the stroke but at the expense of increasing the LOS of this subset of patients.

Ischemic strokes with a determined cause followed a distribution congruent with other data sets,^{4,19,20,22,36,42} particularly those including predominantly Asian and Hispanic patients. Older age categories showed an increased frequency of cardioembolic strokes related to an increased prevalence of atrial fibrillation, whereas younger age categories presented with more events classified as other determined causes, where a higher prevalence of thrombophilias explained most of the strokes observed.

The atherothrombotic subtype was associated with diabetes mellitus, dyslipidemia, metabolic syndrome, and obesity, all of them involved in the atherosclerosis process and endothelial pathophysiology.^{11,20,35,59} Remarkably and despite the very few lacunar infarcts documented, we found them more likely to be associated with hypertension and smoking. Whereas hypertension^{11,20,35,41,60} and smoking^{15,39,47,61,62} have been already described in association with lacunar infarcts, others have found a stronger association between smoking and atherosclerosis leading to large-vessel subtype of stroke.^{11,20,35,40} Aside from increasing the atherosclerotic load,⁶³ smoking could cause stroke also through reversible factors such as increased platelet aggregation and arterial vasoconstriction by augmenting sympathetic activity, explaining the stroke risk

reduction observed when patients stop smoking.^{39,64,65} Other authors have established an association between small-vessel strokes and glucose intolerance³⁹ or diabetes,^{11,59,62} but we did not find this correlation.

We observed a considerable number of hemorrhagic strokes (20.5%), consistent with previous publications reporting increased proportions of hemorrhagic strokes in Asian, Hispanic, and Native American populations compared with Caucasian data sets.^{9,12,18,19,22,37,54,66-70} This finding is explained by putative shared ancestry, genetic predisposition, similar dietary habits, widespread abuse of over-the-counter medications that may predispose to bleeding, high alcohol intake and a higher prevalence of uncontrolled hypertension.^{12,19,37}

Stroke Severity

Although NIHSS scoring spanned almost the whole set of values available, 69.9% of the patients scored between 0 (most of them TIAs that were admitted for diagnostic and vigilance purposes) and 9 (i.e., low to moderate severity). This finding is similar to those of other series.^{17,35} Our predominance of low to moderately severe strokes might be due to the fact, that if bed availability allowed for it, very critical patients with highly severe strokes, would be admitted to our neurointensive care unit instead of our acute stroke unit.

Among stroke subtypes, cardioembolic and lacunar strokes were independently and significantly associated with higher and lower NIHSS scores, respectively. This finding is also described elsewhere where cardioembolic strokes tend to be more abrupt and sudden, resulting in higher initial NIHSS scores,^{8,11,20,35,36,60,71} whereas lacunar infarcts have also been associated with lower NIHSS results.³⁵ In embolic strokes, the acute occlusion does not allow for an angiogenic process to occur, resulting in a lack of collateral circulation, a larger infarct extension, more neurological deficits, and worse outcomes.¹¹ As expected, hemorrhagic events were independently and significantly associated with higher scores in the NIHSS, and this is also consistent with prior reports, particularly influenced by hematoma volume.⁷² Interestingly, we found previous and current cigarette smoking associated with lower scores in the NIHSS, exclusively for ischemic strokes. Difficult to explain, given our main limitation where we did not differentiate between previous and current smoking, we hypothesize that past and current smokers could be more aware of stroke as a disease and would consult promptly even if the neurological deficit was mild. Also, it could be that past or current smokers with much higher scores in the NIHSS would be directly admitted to our neurointensive care unit, leaving only the milder ones in our unit. Additionally, as mentioned previously, smoking was correlated with small-vessel disease, and lacunar infarcts were associated with lower scores in the NIHSS. Yet, even after adjusting for the

presence of lacunar infarcts, smoking status remained independently associated with lower NIHSS scores. Kimura et al discussed that patients continued smoking probably because of better health, and this could represent a bias by making it seem as if smoking reduces the risk of stroke.⁷³

Limitations

Because ours is not a population-based but a hospital-based stroke registry, this might reduce the generalizability of these results. This is also an observational study; therefore, we cannot assess for the therapeutic efficacy of the interventions, and we know that the results and associations found are subject to bias regarding physicians, patients, and treatment selection.

Conclusions

This is the first study that reports on sociodemographics, risk factors, and clinical presentation of patients admitted to an acute stroke unit in Costa Rica. We found that patients' baseline characteristics and conventional stroke risk factor distribution were consistent with other series that included Hispanic populations. Additionally, unemployment and incomplete education were independently and significantly associated with stroke severity.

We had an important proportion of undetermined ischemic strokes where the strict application of TOAST criteria increased the difficulties in assigning a particular subtype of stroke. Even though under-registry was the main culprit for this, our reduced LOS and high bed turnover led to a large proportion of patients with an incomplete diagnostic evaluation.

NIHSS scoring showed a mild to moderate severity of stroke in the majority of our patients, and we were able to ascertain significant correlations between NIHSS scores and subtypes of stroke.

Appendix: Supplementary Material

Supplementary data to this article can be found online at doi:10.1016/j.jstrokecerebrovasdis.2017.11.030.

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