

Trend corresponding to hospitalization rates in intensive care units due to strokes

Tendência das taxas de internação por acidente vascular cerebral em unidades de terapia intensiva

How to cite this article:

Veronez M, Lentsck MH, Lenhani BE, Sloboda DA, Souza PB, Malaquias TSM, et al. Trend corresponding to hospitalization rates in intensive care units due to strokes. Rev Rene. 2026;27:e97137. DOI: <https://doi.org/10.36517/2175-6783.20262797137>

 Marcelo Veronez¹
 Maicon Henrique Lentsck¹
 Bruna Eloise Lenhani¹
 Dyenily Alessi Sloboda¹
 Pollyanna Bahls de Souza¹
 Tatiana da Silva Melo Malaquias¹
 Tatiane Baratieri¹

¹Universidade Estadual do Centro-Oeste.
Guarapuava, PR, Brazil.

Corresponding author:

Pollyanna Bahls de Souza
Rua dos Lagos, 1240, Cidade dos lagos.
CEP: 85051-035. Guarapuava, PR, Brazil.
E-mail: pobahls@gmail.com

Conflict of interest: the authors have declared that there is no conflict of interest.

EDITOR IN CHIEF: Ana Fatima Carvalho Fernandes 

ASSOCIATE EDITOR: Ana Luisa Brandão de Carvalho Lira 

ABSTRACT

Objective: to analyze the profile and temporal trend corresponding to hospitalizations in intensive care units due to strokes. **Methods:** an ecological study with data from the Hospital Information System managed by the Unified Health System, referring to intensive care hospitalizations. Age, gender and stroke types were analyzed. The hospitalization rates were calculated and assessed by means of generalized linear regression models and the Prais-Winsten procedure (statistical significance: $p < 0.05$). **Results:** an increase in hospitalization rates was observed during the period, with predominance of the male gender and the age group above 60 years old. An upward trend was recorded for unspecified strokes (6.9%; $p < 0.001$) and for reduction in the number of transient events (-7.8%; $p < 0.001$) in men and women alike. Hemorrhagic strokes and sequelae remained stable. **Conclusion:** the hospitalizations in intensive care units due to strokes were more frequent among men and aged individuals. An increase in the number of unspecified cases was observed, as well as a reduction in transient ischemic events, with stability in the other subtypes, suggesting limitations in diagnostic coding. **Contributions to practice:** epidemiological monitoring, assistance planning and preventive strategies targeted at at-risk population groups, in addition to helping understand similar scenarios in other Brazilian regions. **Descriptors:** Stroke; Intensive Care Units; Epidemiology; Temporal Distribution.

RESUMO

Objetivo: analisar o perfil e a tendência temporal das internações por acidente vascular cerebral em unidades de terapia intensiva. **Métodos:** estudo ecológico com dados do Sistema de Informações Hospitalares do Sistema Único de Saúde referentes às internações intensivas. Foram analisados idade, sexo e tipo de acidente vascular cerebral. As taxas de internação foram calculadas e avaliadas por modelos de regressão linear generalizada e procedimento de Prais-Winsten, (significância estatística $p < 0,05$). **Resultados:** observou-se aumento das taxas de internação no período, com predominância do sexo masculino e da faixa etária acima de 60 anos. Houve tendência crescente para acidente vascular cerebral não especificado (6,9%; $p < 0,001$) e redução dos eventos transitórios (-7,8%; $p < 0,001$), igualmente em homens e mulheres. As taxas de acidente vascular cerebral hemorrágico e sequelas permaneceram estáveis. **Conclusão:** as internações por acidente vascular cerebral em unidades de terapia intensiva foram mais frequentes em homens e idosos. Observou-se aumento dos casos não especificados e redução dos eventos isquêmicos transitórios, com estabilidade dos demais subtipos, sugerindo limitações na codificação diagnóstica. **Contribuições para a prática:** os achados contribuem para monitoramento epidemiológico, planejamento assistencial e estratégias preventivas voltadas a populações de risco, além de subsidiar a compreensão de cenários semelhantes em outras regiões brasileiras. **Descritores:** Acidente Vascular Cerebral; Unidades de Terapia Intensiva; Epidemiologia; Distribuição Temporal.

Introduction

Strokes are neurological emergencies characterized by sudden interruption of cerebral blood flow or by intracerebral bleeding, compromising the provision of oxygen and nutrients to nerve cells. This interruption can be ischemic (when a blood vessel is obstructed by a clot or another material) or hemorrhagic (when there is blood vessel rupture), leading to blood leaks into brain tissue. In both cases, interrupted perfusion can result in neuronal death, which causes permanent sequelae, severe disabilities or even death, especially when not timely treated⁽¹⁾.

Strokes remain among the main causes of death and functional disability in the world; in addition, they are the second leading cause of death and rank third in terms of global burden of the disease. A significant increase in the absolute number of cases was observed in the last few decades, with an approximate 70% rise in incidence, 43% in deaths and more than 100% in prevalence and disability-adjusted life years. This increase is directly related to population aging, demographic growth and higher exposure to modifiable risk factors. The global burden of this disease remains high, with deeper impacts on low- and middle-income countries. Such scenario reinforces its relevance as a Public Health problem, especially in contexts marked by inequalities in accessing health services⁽²⁾.

In the initial stroke phase, many patients require hospitalization, especially in Intensive Care Units (ICUs) due to the need for continuous monitoring and advanced support. In more severe cases, the respiratory function can be impaired, the level of consciousness can be depressed or there can be extensive neurological deficits, requiring interventions such as invasive mechanical ventilation to protect the airways⁽³⁾.

In the intensive care context, prolonged hospitalizations are frequently associated with negative repercussions in functional outcomes and prognoses, compromising recovery and resumption of everyday and work activities. This scenario can be worsened by late initiation of rehabilitation interventions (mainly due to muscle atrophy), reduced functional capacity,

healthcare-associated infections and deterioration of the clinical condition⁽⁴⁻⁵⁾.

Analyzing ICU hospitalizations due to strokes becomes relevant for involving a population group characterized by high morbidity and mortality in which less than 20% of the patients present favorable neurological outcomes after six months⁽⁶⁾. Factors such as advanced age, male gender and type of vascular event exert an influence on clinical severity, on the need for intensive support and on these patients' outcomes⁽⁷⁾.

In the last few years, the scientific production has significantly contributed to advancing knowledge about the epidemiology of strokes, researching aspects related to the patients' epidemiological profile, the burden of the disease, the hospitalization trends and the care outcomes. These findings have provided important insights for planning public policies, organizing health services and improving prevention and care strategies⁽⁷⁻¹⁰⁾.

In Brazil, diverse evidence from neurocritical patients corroborates that strokes are among the main causes of ICU hospitalizations, showing the evolution of admissions and outcomes throughout a decade, including the COVID-19 pandemic period⁽⁷⁾. In addition to this study, recent surveys have focused on the trends corresponding to hospitalizations due to ischemic strokes, on the assistance-related costs, on access to reperfusion therapies, on the effects exerted by the COVID-19 pandemic and on the space-time distribution of hospitalizations and mortality, expanding what is known about the epidemiological behavior of this disease in the country⁽⁸⁻¹⁰⁾.

However, the number of population-based studies specifically analyzing the profile and temporal trend corresponding to hospitalizations in intensive care units due to strokes is still scarce, particularly those stratifying their analyses according to gender, age groups and stroke types at the state level.

In this context, the current study seeks to bridge this gap resorting to data from the Hospital Information System managed by the Unified Health System (*Sistema de Informações Hospitalares do Sistema Único de Saúde*, SIH/SUS) according to gender, age groups

and stroke types. Unlike previously published studies, this research analyzes a ten-year time series corresponding to ICU hospitalizations due to strokes in a given Brazilian state, allowing characterizing the epidemiological behavior of the different subtypes of the disease in critically-ill patients. This approach expands what is known about the proportion of intensive care beds devoted to stroke patients and allows identifying epidemiological and assistance patterns which are oftentimes not evidenced in nationwide analyses or in studies conducted at isolated institutions. The results may support planning of the urgency and emergency care network, management of ICU beds, resource allocation and development of strategies targeted at prevention, treatment and rehabilitation for these patients.

Consequently, the objective of this study is to analyze the profile and temporal trend corresponding to hospitalizations in intensive care units due to strokes.

Methods

Study type and setting

This is a time-series ecological study developed in the state of Paraná (Brazil) using secondary data corresponding to ICU hospitalizations due to strokes, duly funded by the SUS from January 2015 to December 2024. The analysis unit was the state of Paraná, and all the hospitalization authorization forms recorded in SIH/SUS referring to people living in the state were considered. Paraná was selected due to its demographic relevance and availability of systematic and continuous records in SIH/SUS, allowing evaluating the temporal trends corresponding to ICU hospitalizations due to strokes over the course of ten years.

The choice for a 10-year period is justified by the possibility of analyzing consistent temporal trends, allowing identifying variations in hospitalization patterns and reducing random fluctuations inherent to short historical series, which contributed to making more robust epidemiological inferences.

The method was structured and described

according to the recommendations set forth in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.

Data source

The data were obtained from the Unified Health System Informatics Department (DATASUS) by resorting to the SIH/SUS database, which gathers diverse information about hospitalizations funded by the public health system⁽¹¹⁾.

Population and eligibility criteria

In order to define the study population, all hospitalizations in intensive care units and with a main diagnosis of stroke were considered, duly identified by means of the codes set forth in the International Classification of Diseases – Tenth revision (ICD-10), grouped into five categories: Ischemic stroke (I63, I67.3 and I67.8), transient stroke (G45), hemorrhagic stroke (I60, I61 and I62), unspecified stroke (I64 and I67.9) and stroke sequelae (I69).

Although the classification of cerebrovascular diseases includes codes I60 to I69, it was decided to exclude diagnoses not representing acute events with established brain lesions or having a different pathophysiology, such as codes I65, I66 and some I67 subcategories, for not showing a direct connection to the study clinical scope.

In addition, hospitalizations presenting a secondary diagnosis related to external causes (codes V to Y) were also excluded in order to avoid including cases with etiologies not directly associated with primary cerebrovascular events.

Study variables

The variables analyzed were as follows: stroke types (according to the ICD-10 classification), gender, age groups and period during which the hospitalizations took place (from 2015 to 2024). The main outcome was the ICU hospitalization rate due to strokes, ex-

pressed for every 100,000 inhabitants. As a first step, completeness and consistency of the variables selected (gender, age groups, period and stroke diagnosis categories) were evaluated. In all, 42,600 records of hospitalizations in intensive care units due to strokes funded by the SUS were identified. From this total, 267 records were excluded for presenting secondary diagnoses related to external causes (codes V to Y from ICD-10), according to previously established criteria. No records lacking information or with categories checked as “Unknown” were identified for the variables analyzed; therefore, it was not necessary to further exclude observations or apply data imputation methods.

Data collection and database organization

The data were organized on a monthly basis and subsequently categorized according to age groups, gender and stroke types. No records lacking information were identified in the variables selected; therefore, it was not necessary to exclude any observation due to incompleteness. After due organization, the data banks were consolidated into a single database for the state, which allowed analyzing absolute/relative frequencies and relative differences across the groups.

The rates corresponding to hospitalizations in intensive care units due to strokes were calculated for every 100,000 inhabitants according to gender and age groups, considering the patients’ municipalities of residence. With the objective of enabling a comparison across the groups and minimizing the effect exerted by differences in the population age structure, the rates were standardized as per the direct method⁽¹¹⁾.

The temporal trend analysis was performed by means of generalized linear regression, considering the hospitalization rates as dependent variable and the study period years as independent variable. The Prais-Winsten method was employed for controlling the first order serial autocorrelation, based on a previous verification by means of the Durbin-Watson test.

The time series were initially smoothed by means of third-order moving average, with the objective of reducing random fluctuations. Subsequently, a

logarithmic transformation was applied to the rates, allowing stabilizing the variance and preparing dispersion and autocorrelation diagrams.

The trends were classified as upward, downward or stable, according to statistical significance ($p < 0.05$) and to the regression angular coefficient sign (slope). The average annual percentage change was estimated from the regression coefficient, using the $(-1 + 10^b) \times 100$ expression. The 95% confidence intervals were calculated based on the coefficient standard error. The analyses were performed in Stata, version 13.

Control of biases

For being a study with secondary data, there are potential information biases related to under-reporting, filling-in errors and diagnosis classification. The objective of applying rigorous inclusion and exclusion criteria, as well as of using a standardized database, was to minimize these effects.

Ethical aspects

As this research was conducted with secondary data banks holding aggregated information with no possibility of including personally identifiable information, the current study waives appraisal by any Committee of Ethics in Research with Human Beings.

A generative Artificial Intelligence tool (ChatGPT) was used as support to review the writing style and improve clarity of the text.

Results

A total of 8,666,574 general hospitalizations were identified in the state of Paraná between 2015 and 2024. During this period, the admissions to intensive care units corresponded to 11% (953,821) of all hospitalizations. After applying the eligibility criteria, 42,333 hospitalizations in intensive care units due to strokes funded by the SUS were analyzed.

An increase was observed in the rates corres-

ponding to hospitalizations due to strokes in Paraná during the entire period analyzed; these hospitalizations were slightly predominant among males and also as age advanced, with those from 40 to 59 and over 60 years old presenting higher incidence, espe-

cially older adults. As for stroke types, higher hospitalization rates were noticed for the “Unspecified” classification and lower ones in those classified as “Transient” (Table 1).

Table 1 – Hospitalization rates in Intensive Care Units due to strokes during the 2015-2024 period (n=42,333). Guarapuava, PR, Brazil, 2026

Variables	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Paraná	31.1	33.3	34.9	36.6	36.5	42.8	33.5	42.9	44.1	41.5
Gender										
Male	36.8	37.4	40.2	41.9	41.7	49.9	39.2	50.3	51.6	49.7
Female	27.1	30.1	30.7	32.3	33.0	37.0	28.7	36.8	37.4	34.9
Age group (years old)										
0-19	1.8	1.7	1.6	2.0	2.0	2.1	1.7	2.1	2.3	2.8
20-39	6.2	6.7	6.3	6.9	6.7	8.2	6.5	7.7	7.1	8.0
40-59	30.6	34.2	36.1	36.4	34.8	41.5	35.5	41.7	45.1	41.9
≥60	130.1	137.2	145.4	153.4	155.9	181.9	136.5	182.9	185.5	171.6
Stroke types										
Ischemic	3.0	4.2	3.8	3.4	3.1	3.8	3.6	4.1	3.4	3.5
Hemorrhagic	8.9	9.0	9.5	10.3	8.4	9.8	8.3	10.0	9.3	9.4
Unspecified	15.3	15.2	18.3	19.9	21.8	26.7	19.1	25.8	28.5	26.9
Transient	3.2	4.2	2.8	2.6	2.4	2.1	1.8	2.6	2.0	1.5
Stroke sequelae	0.6	0.7	0.5	0.5	0.7	0.5	0.3	0.5	0.7	0.6

In Paraná, the hospitalization rates for strokes presented a 3.3% increase per year ($p<0.001$). In addition to higher rates, in the analysis by gender the upward trend was more accentuated in men, with an annual percentage change of 3.7%. An upward trend was observed in all age groups, with the population aged over 60 presenting a 3.4% annual increase ($p<0.001$); in turn, despite showing the lowest magnitude, the age group from 0 to 19 years old had

the highest increase (4.4%; $p=0.001$). Regarding stroke types, the rates were stable for ischemic/hemorrhagic events and sequelae; in turn, the behavior was significant ($p<0.001$) for increase (6.9% per year) in unspecified strokes and for decrease (-7.8% per year) in the case of transient strokes (Table 2). The data of this study reveal certain discontinuity in the historical series during the first pandemic year, with a subsequent rise in the hospitalization rates.

Table 2 – Biannual rates and trend according to state, gender, age groups and stroke types (n=42,333). Guarapuava, PR, Brazil, 2026

Variables	2015/2016	2017/2018	2019/2020	2021/2022	2023/2024	APC*	p-value	Trend
Paraná	32.1	35.7	39.6	38.2	42.7	3.3	<0.001	Upward
Gender								
Male	37.1	41.0	45.7	44.7	50.6	3.7	<0.001	Upward
Female	28.5	31.4	34.9	32.7	36.1	2.6	<0.001	Upward
Age group (years old)								
0-19	1.7	1.8	2.0	1.9	2.5	4.4	0.001	Upward
20-39	6.4	6.6	7.4	7.1	7.5	2.1	<0.001	Upward
40-59	32.3	36.2	38.1	38.5	43.4	3.3	<0.001	Upward
≥60	133.7	149.4	168.9	159.7	178.5	3.4	<0.001	Upward
Stroke types								
Ischemic	3.6	3.6	3.4	3.8	3.4	-0.2	0.161	-
Hemorrhagic	8.9	9.8	9.0	9.1	9.3	0.2	0.449	-
Unspecified	15.2	19.1	24.2	22.4	27.7	6.9	<0.001	Upward
Transient	3.6	2.6	2.2	2.1	1.7	-7.8	<0.001	Downward
Stroke sequelae	0.6	0.4	0.5	0.3	0.6	-0.2	0.920	-

*APC: Annual Percentage Change

Stability can be seen in the hospitalization rates due to ischemic and hemorrhagic strokes in both genders, as well as in stroke sequelae. The rates rose for both genders and for strokes with unspecified ICD codes, with annual percentage changes of 7.6 and 6.6%, respectively. In turn, the hospitalization trend was downward ($p<0.001$) in both genders for strokes with ICD codes of a transient nature and significantly higher among women (-8.0%) than among men (-0.7%) (Table 3).

Table 3 – Trend corresponding to the hospitalization rates in Intensive Care Units according to stroke types and gender (n=42,333). Guarapuava, PR, Brazil, 2026

Stroke types	Male			Female		
	APC*	p-value	Trend	APC	p-value	Trend
Ischemic	0.1	0.863	–	1.0	0.316	–
Hemorrhagic	0.5	0.257	–	-0.4	0.561	–
Unspecified	7.6	<0.001	Upward	6.6	<0.001	Upward
Transient	-0.7	<0.001	Downward	-8.0	<0.001	Downward
Stroke sequelae	0.2	0.954	–	-1.0	0.726	–

*Annual Percentage Change

The rates corresponding to ICU hospitalizations due to ischemic strokes only presented a significant increase among children and adolescents (APC=1.3; $p=0.036$). In this same age group, an even more expressive increase was observed for unspecified (APC=7.6) and transient (APC=12.2) cases, whereas hemorrhagic events and sequelae remained stable. Among young adults, only the unspecified cases presented an upward trend (APC=5.9), whereas the other subtypes remained stable over the course of all ten years analyzed. In general, the hospitalizations due to hemorrhagic events and sequelae remained stable in all age groups. On the other hand, the unspecified cases presented an upward trend in all age groups, more accentuated among individuals aged from 40 to 59 years old (7.7% per year). As for transient events, an increase was verified among children and adolescents (12.2%; $p=0.003$); in turn, a reduction was recorded in the older age groups, with 5.9% and 8.8% annual declines between the ages of 40 and 59 and among those aged at least 60 years old, respectively (Table 4).

Table 4 – Trend corresponding to the hospitalization rates in Intensive Care Units according to stroke types and age groups (n=42,333). Guarapuava, PR, Brazil, 2026

Variables	0-19 years old		20-39 years old		40-59 years old		≥60 years old	
	APC*	p-value	APC	p-value	APC	p-value	APC	p-value
Stroke types								
Ischemic	1.3	0.036 [†]	0.6	0.594	-0.6	0.475	1.7	0.531
Hemorrhagic	2.5	0.059	-1.0	0.289	0.1	0.759	0.3	0.543
Unspecified	7.6	0.002 [†]	5.9	<0.001 [†]	7.7	<0.001 [†]	6.7	<0.001 [†]
Transient	12.2	0.003 [†]	-3.8	0.156	-5.9	0.004 [‡]	-8.8	<0.001 [†]
Stroke sequelae	-0.5	0.940	1.1	0.899	-0.3	0.909	1.6	0.541

*Annual Percentage Change; [†]Upward trend; [‡]Downward trend

Discussion

ICU hospitalizations due to strokes in Paraná presented an upward trend during the period analyzed, along with the increase in the global burden of the disease. This scenario reflects that strokes are still an important cause of morbidity and mortality,

with approximate estimates of 6.7 million deaths in 2023 and a nearly 70% increase in incidence since 1990, even when lower standardized rates were observed in some countries. This behavior can be partially explained by demographic transition and longer life expectancy, as population aging is directly associated with higher incidence of chronic non-communicable

ble diseases and with accumulation of cardiovascular risk factors over time⁽¹²⁻¹³⁾.

Throughout the historical series, variations in the hospitalization rates can reflect changes in terms of access to and organization of health services. For example: in the COVID-19 pandemic context, a number of studies showed a significant reduction in admissions due to strokes in different countries, along with a change in the severity profile of the cases treated⁽¹⁴⁾.

Fewer hospitalizations due to ischemic, hemorrhagic and transient strokes were observed during the pandemic period; this reduction was more accentuated among the mild cases. These findings suggest that factors such as delays in seeking care, restricted access to health services and reorganization of the assistance network may have contributed to lower utilization of health services and to the relative increase in the severity of the cases treated⁽¹⁵⁾.

Although ischemic strokes are more prevalent in the international literature, predominance of hospitalizations due to hemorrhagic events was observed throughout the period analyzed in this study. This result can reflect the profile of the patients admitted to intensive care units, as that clinical presentation is frequently associated with more severe cases, higher demand of intensive support and less favorable prognoses. Corroborating this finding, recent multicenter studies have shown that individuals affected by hemorrhagic events present more chances of being admitted to intensive care units and of worse clinical outcomes⁽¹⁶⁻¹⁷⁾.

In addition to that, the high proportion of cases classified as "Unspecified" and the higher relative share of hemorrhagic events differ from the expected pattern. In health systems characterized by broader access to imaging diagnoses, the percentage of unspecified cases is significantly lower, reinforcing that this category may reflect assistance-related limitations, delays in diagnostic confirmation and flaws in terms of information recording⁽²⁾.

In this case, the high proportion of strokes classified as unspecified may reflect limitations in timely

access to imaging tests, as well as weaknesses in terms of recording and coding clinical data. Diverse evidence indicates that part of these cases present lesions that can be identified in complementary exams, suggesting underutilization of available diagnostic data. In addition to that, the lower agreement between clinical diagnoses and administrative codes in these cases reinforces the influence exerted by assistance- and organization-related factors on the quality of health records⁽¹⁸⁻¹⁹⁾. In synthesis, potentiated by care urgency and by the severity of cases that evolve to early death, diagnostic uncertainty ends up consolidating the use of non-specific codes in hospitalization authorization forms which, for having administrative purposes, tolerate generic coding to the detriment of etiological precision.

A downward trend for hospitalizations due to transient strokes was also observed in the study throughout the period, with a similar behavior between the genders and variation across age groups. This finding is consistent with recent evidence pointing to a temporal reduction in the incidence of transient strokes, estimated at nearly 54 cases for every 100,000 individuals per year, without significant differences between men and women but with a progressive increase as age advances, especially in subjects over 65 years old⁽²⁰⁾.

Associated with this, adopting diagnostic criteria based on imaging tests has been related to the reduction in the incidence estimates, suggesting higher diagnostic accuracy and a reclassification of cases previously considered as transient⁽²⁰⁾. In this context, the reduction in the number of ICU hospitalizations may not only reflect advances in prevention and early management but also changes in care organization and in risk stratification strategies⁽¹⁴⁾. In turn, the heterogeneity found across age groups can be related to differences in terms of cardiovascular risk profile and clinical presentations, in addition to inequalities in accessing health services^(12,21).

The higher frequency of hospitalizations among men is consistent with epidemiological evidence indicating a higher incidence of stroke at younger ages in this population. This difference may be related to

greater exposure to modifiable risk factors, such as hypertension, smoking, and obesity, as well as lower adherence to preventive health measures. In addition to that, behavioral differences and those related to seeking health services contribute to higher vulnerability to strokes among males^(12,22).

In relation to age groups, the fact that the hospitalizations were concentrated in middle-aged adults suggests a transition in the stroke epidemiological profile, with a relative increase in incidence among younger individuals. Recent evidence shows higher stroke incidence among adults aged less than 60 years old in different world regions, a phenomenon associated with the increasing prevalence of cardiometabolic risk factors such as obesity, diabetes mellitus, arterial hypertension and sedentary life styles, all associated with cumulative exposure throughout life^(21,23).

In turn and although less frequent, the stroke incidence in younger age groups presents a different etiological profile when compared to older adults. In this population segment, factors such as non-atherothrombotic causes like arteriovenous malformations, hematologic diseases and congenital cardiopathies contribute more to this pathology, favoring the relative predominance of the hemorrhagic subtype. Etiological heterogeneity is evidenced across age groups, with more diversity in terms of causes in young individuals, which suggests higher diagnostic complexity in this population segment⁽²⁴⁾.

In this context, the findings detected in the current study (which evidence a higher rate of hospitalizations due to hemorrhagic strokes) can be related both to the intrinsic severity of this subtype and to the proportional incidence of cases in younger age groups, where the etiologies associated with intracranial bleeding are more frequent. This set of factors contributes to a higher need for hospitalizations and, frequently, for management in ICUs.

The analysis regarding the ICU hospitalizations evidences a profile characterized by higher clinical severity among stroke patients, which is consistent with the complexity inherent to cases requiring this care

level. In the current study, associated with the predominance of hemorrhagic cases, the high proportion of ICU hospitalizations reinforces the greater severity of these events and their association with unfavorable clinical outcomes. Recent evidence indicates that stroke patients who evolve to requiring mechanical ventilation present high mortality rates and major functional impairment, especially during the first months after the event, reflecting the systemic and neurological severity of these cases⁽³⁾.

It is estimated that the mortality trends corresponding to cardiovascular diseases in Brazil by 2040 will point to a reduction in mortality due to strokes. However, it remains essential to maintain and strengthen the strategies to prevent and control these health problems. In addition to that, the need stands out to implement public policies targeted at reducing health inequalities, at strengthening health promotion actions and at expanding fair access to evidence-based care. In consonance with these findings, it becomes indispensable to improve primary and secondary prevention strategies, qualify health information systems and ensure timely access to diagnosis and treatment, in order to reduce the burden of this cardiovascular disease and its impacts on morbidity and mortality, especially in health systems characterized by high assistance demand and structural limitations^(2,25).

Study limitations

The limitations of this study are related to having used secondary data from SIH/SUS, which may imply restrictions regarding quality, completeness and precision of the records. The high proportion of hospitalizations classified as unspecified strokes stands out, which can reflect limitations in the diagnostic process, difficulties in timely access to imaging tests or inconsistencies when filling-in hospitalization authorization forms. In addition to that, for exclusively contemplating hospitalization funded by the public health system, the data do not include services provided in the complementary private network, which can

result in having underestimated the actual number of hospitalizations, in addition to the state clipping, which limited nationwide range.

Contributions to practice

As it evidences patterns according to gender, age groups and types of event, this study contributes to the epidemiological monitoring of ICU hospitalizations due to strokes. The findings may support planning of assistance actions such as devising and improving protocols for timely diagnoses and treatments, as well as the implementation of Nursing and multiprofessional care targeted at preventing adverse events. They can also assist in organizing high-complexity services because they allow characterizing the profile, incidence and distribution of the hospitalizations, favoring proper network operation and the possibility of treating stroke patients within the first hours after an event. In addition to that, they can guide preventive strategies targeted at at-risk groups, with potential to qualify care, mitigate the impacts exerted by strokes and contribute to reducing costs and to better allocating financial resources.

Conclusion

It was shown that the rates corresponding to hospitalizations in intensive care units due to strokes were predominant among men and older adults, without disregarding the relevant percentage of middle-aged adults. An increase was noticed in the number of hospitalizations due to unspecified cases, as well as a reduction in transient episodes; regarding the ischemic/hemorrhagic forms and sequelae, they remained stable throughout the time series analyzed. The increase in the number of hospitalizations classified as unspecified strokes suggests persistent weaknesses in diagnostic definition and in the quality of in-hospital records, deserving attention from health managers and services.

Authors' contributions

Conception and design or data analysis and interpretation; Drafting of the manuscript or critical review of its intellectual content; Final approval of the version to be published; Agreement to be accountable for all aspects of the manuscript related to accuracy or integrity being investigated and resolved appropriately: **Veronez M, Lentsck MH**. Drafting of the manuscript or critical relevant review of its intellectual content; Final approval of the version to be published: **Lenhani BE, Sloboda DA, Souza PB, Malaquias TSM, Baratieri T**.

Data availability

The authors state that the dataset supporting the results is available upon request to the corresponding author.

References

1. National Heart, Lung, and Blood Institute (NIH). Stroke [Internet]. 2023 [cited Jun 1, 2026]. Available from: <https://www.nhlbi.nih.gov/health/stroke>
2. Feigin VL, Brainin M, Norrving B, Martins S, Sacco RL, Hacke W, et al. World Stroke Organization (WSO): global stroke fact sheet 2022. *Int J Stroke*. 2022;17(1):18-29. doi: <https://dx.doi.org/10.1177/17474930211065917>
3. Sonnevile R, Mazighi M, Collet M, Gayat E, Degos V, Duranteau J, et al. One-year outcomes in patients with acute stroke requiring mechanical ventilation. *Stroke*. 2023;54(9):2328-37. doi: <https://doi.org/10.1161/STROKEAHA.123.042910>
4. Isokuortti H, Virta JJ, Curtze S, Tiainen M. One-year survival of ischemic stroke patients requiring mechanical ventilation. *Neurocrit Care*. 2023;39(2):348-56. doi: <http://doi.org/10.1007/s12028-023-01674-9>
5. Premraj L, Camarda C, White N, Godoy DA, Cuthbertson BH, Rocco PRM, et al. Tracheostomy timing and outcome in critically ill patients with stroke: a meta-analysis and meta-regression. *Crit Care*. 2023;27(1):132. doi: <https://doi.org/10.1186/s13054-023-04417-6>

6. Carval T, Garret C, Guillon B, Lascarrou JB, Martin M, Lemarié J, et al. Outcomes of patients admitted to the ICU for acute stroke: a retrospective cohort. *BMC Anesthesiol.* 2022;22(1):235. doi: <https://doi.org/10.1186/s12871-022-01777-4>
7. Kurtz P, Bastos LSL, Zampieri FG, Freitas GR, Bozza FA, Soares M, et al. Trends in intensive care admissions and outcomes of stroke patients over 10 years in Brazil: impact of the COVID-19 pandemic. *Chest.* 2023;163(3):543-53. doi: <https://doi.org/10.1016/j.chest.2022.10.033>
8. Réa-Neto A, Bernardelli RS, Oliveira MC, David-João PG, Kozesinski-Nakatani AC, Falcão ALE, et al. Epidemiology and disease burden of patients requiring neurocritical care: a Brazilian multicentre cohort study. *Sci Rep.* 2023;13(1):18595. doi: <https://doi.org/10.1038/s41598-023-44261-w>
9. Goulart TO, Marazzi TBM, Monteiro RA, Camilo MR, Pontes-Neto OM. Ischemic stroke in Brazil (2017–2025): Trends in admissions, thrombolysis, craniectomy, costs, and COVID-19 disruption. *J Stroke Cerebrovasc Dis.* 2026;35(6):108631. doi: <https://doi.org/10.1016/j.jstrokecerebrovasdis.2026.108631>
10. Bonfim S, Massago M, Giacomini VL, Beltrame MHA, Dutra AC, Costa WF, et al. Spatiotemporal analysis of hospitalizations, mortality and access to intravenous thrombolysis for ischemic stroke in Southern Brazil. *BMC Public Health.* 2026;26:1413. doi: <http://doi.org/10.1186/s12889-026-27097-7>
11. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo Demográfico 2022: população residente e domicílios – primeiros resultados do universo [Internet]. 2023 [cited Jan 12, 2026]. Available from: <https://sidra.ibge.gov.br/pesquisa/censo-demografico/demografico-2022/primeiros-resultados-populacao-e-domicilios>
12. Tsao CW, Aday AW, Almarazgoq ZI, Anderson CAM, Arora P, Avery CL, et al. Heart disease and stroke statistics—2023 update: a report from the American Heart Association. *Circulation.* 2023; 147(8):e93-e621. doi: <https://doi.org/10.1161/CIR.0000000000001123>
13. Cheng Y, Lin Y, Shi H, Cheng M, Zhang B, Liu X, et al. Projections of the stroke burden at the global, regional, and national levels up to 2050 based on the Global Burden of Disease Study 2021. *J Am Heart Assoc.* 2024;13(23):e036142. doi: <https://doi.org/10.1161/JAHA.124.036142>
14. Chang Y, Hwang SH, Bai H, Park S, Cho E, Kim D, et al. The impact of COVID-19 on admissions and in-hospital mortality of patients with stroke in Korea: an interrupted time series analysis. *J Prev Med Public Health.* 2025;58(1):60-71. doi: <https://doi.org/10.3961/jpmph.24.432>
15. Gunnarsson K, Tofiq A, Mathew A, Cao Y, von Euler M, Ström JO. Changes in stroke and transient ischemic attack admissions during the COVID-19 pandemic: a meta-analysis. *Eur Stroke J.* 2024;9(1):78-87. doi: <http://doi.org/10.1177/23969873231204127>
16. Puy L, Parry-Jones AR, Sandset EC, Dowlathshahi D, Ziai W, Cordonnier C. Intracerebral haemorrhage. *Nat Rev Dis Primers.* 2023;9(1):14. doi: <https://doi.org/10.1038/s41572-023-00424-7>
17. Hwang DY, Kim KS, Muehlschlegel S, Wartenberg KE, Rajajee V, Alexander SA, et al. Guidelines for neuroprognostication in critically ill adults with intracerebral hemorrhage. *Neurocrit Care.* 2024;40(2):395-414. doi: <https://dx.doi.org/10.1007/s12028-023-01854-7>
18. Hirsch JL, Burke JF, Hailat R, Kerber KA. Validity of nonspecific stroke location ICD-10 subcodes: A descriptive study. *Cerebrovasc Dis Extra.* 2026;16(1):9-18. doi: <https://dx.doi.org/10.1159/000549823>
19. Ryan OF, Riley M, Cadilhac DA, Andrew NE, Breen S, Paice K, et al. Factors associated with stroke coding quality: a comparison of registry and administrative data. *J Stroke Cerebrovasc Dis.* 2021; 30(2):105469. doi: <https://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2020.105469>
20. Zhang N, Guo J, Liu W, Wu J, Jiang N. Prevalence and incidence of transient ischaemic attack: a systematic review and meta-analysis. *BMC Neurol.* 2026;26(1):226. doi: <http://dx.doi.org/10.1186/s12883-026-04770-3>
21. Greenberg SM, Ziai WC, Cordonnier C, Dowlathshahi D, Francis B, Goldstein JN, et al. 2022 guideline for the management of patients with spontaneous intracerebral hemorrhage: a guideline from the American Heart Association/American Stroke Association. *Stroke.* 2022;53(7):e282-e361. doi: <http://doi.org/10.1161/STR.0000000000000407>

22. Souza OF, Araújo ACB, Vieira LB, Bachur JA, Lopez AGP, Gonçalves TG, et al. Sex disparity in stroke mortality among adults: a time series analysis in the Greater Vitória region, Brazil (2000–2021). *Epidemiologia*. 2024;5(3):402-10. doi: <http://doi.org/10.3390/epidemiologia5030029>
23. Amoah D, Schmidt M, Mather C, Prior S, Herath MP, Bird ML. An international perspective on young stroke incidence and risk factors: a scoping review. *BMC Public Health*. 2024;24(1):1627. doi: <https://doi.org/10.1186/s12889-024-19134-0>
24. Bukhari S, Yaghi S, Bashir Z. Stroke in young adults. *J Clin Med*. 2023;12(15):4999. doi: <https://dx.doi.org/10.3390/jcm12154999>
25. Salerno PRVO, Cotton A, Nascimento BR, Chen Z, Pereira GTR, Abizaid AA, et al. Forecasting ischemic heart disease, stroke, and peripheral artery disease mortality in Brazil through 2040: a Bayesian modeling approach. *Arq Bras Cardiol*. 2025;122(11):e20250189. doi: <https://dx.doi.org/10.36660/abc.20250189i>



This is an Open Access article distributed under the terms of the Creative Commons