Stroke

ORIGINAL CONTRIBUTION

Decrease in Hospital Admissions for Transient Ischemic Attack, Mild, and Moderate Stroke During the COVID-19 Era

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BACKGROUND AND PURPOSE: Since the onset of the coronavirus 2019 (COVID-19) pandemic, doctors and public authorities have demonstrated concern about the reduction in quality of care for other health conditions due to social restrictions and lack of resources. Using a population-based stroke registry, we investigated the impact of the onset of the COVID-19 pandemic in stroke admissions in Joinville, Brazil.

METHODS: Patients admitted after the onset of COVID-19 restrictions in the city (defined as March 17, 2020) were compared with those admitted in 2019. We analyzed differences between stroke incidence, types, severity, reperfusion therapies, and time from stroke onset to admission. Statistical tests were also performed to compare the 30 days before and after COVID-19 to the same period in 2019.

RESULTS: We observed a decrease in total stroke admissions from an average of 12.9/100 000 per month in 2019 to 8.3 after COVID-19 (P=0.0029). When compared with the same period in 2019, there was a 36.4% reduction in stroke admissions. There was no difference in admissions for severe stroke (National Institutes of Health Stroke Scale score >8), intraparenchymal hemorrhage, and subarachnoid hemorrhage.

CONCLUSIONS: The onset of COVID-19 was correlated with a reduction in admissions for transient, mild, and moderate strokes. Given the need to prevent the worsening of symptoms and the occurrence of medical complications in these groups, a reorganization of the stroke-care networks is necessary to reduce collateral damage caused by COVID-19.

Key Words: coronavirus ■ epidemiology ■ health services research ■ incidence ■ subarachnoid hemorrhage

Stroke is one of the leading causes of mortality and morbidity in Brazil and worldwide. Much of the burden caused by stroke can be reduced by the adoption of acute and subacute treatments.[1] Acute-care treatments, such as intravenous thrombolysis (IVT) and mechanical thrombectomy (MT), require that the healthcare system is highly organized in stroke care, enabling patients to receive life-saving procedures in the briefest time from stroke onset. The subacute management requires a multidisciplinary team, usually working in a stroke unit to perform care, such as dysphagia screening, adequate venous thromboembolism prophylaxis, early rehabilitation, and cause investigation.

From late 2019 to early 2020, coronavirus 2019 (COVID-19) started to disrupt the healthcare systems of many nations. From the beginning of the pandemic, it has been a major concern for doctors and public authorities that resources needed to treat other conditions such as stroke are diverted for COVID-19.[2] Also, patients may be unwilling to go to a hospital for stroke treatment due to fear of becoming contaminated with the disease. There is

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also concern that COVID-19 increases stroke risk, which may worsen the burden of stroke.[3]

Using a population-based stroke registry, we developed a study to investigate the impact of the COVID-19 pandemic in stroke care in Joinville, Brazil. Our hypothesis was as follows:

- Hospital admissions for stroke were reduced after the onset of the COVID-19 pandemic.
- The reduction occurred only in transient ischemic attacks (TIA) and mild cases.
- There was a change in the time between stroke onset and hospital admissions.
- The number of patients receiving reperfusion therapies (IVT and MT) has decreased.

METHODS

All data were obtained from a population-based stroke registry known as Joinville Stroke Registry (Joinvasc)—Population-Based Epidemiological Study on Cerebrovascular Diseases in Joinville. The anonymized data supporting the findings of the study are available from the corresponding author upon reasonable request.

The city is located in southern Brazil with an area of 1128 km^2 and 590 466 inhabitants.[4] It is the city with the largest population in the state. Joinville has 6 hospitals, of which 3 are public, and 3 are private. The largest hospital (Hospital Municipal São José [HMSJ]) is a state-run public institution that only works through the Unified Health System (SUS). The SUS is Brazil's universal public healthcare system, having among its principles to provide healthcare of all complexity levels to all individuals without out-of-pocket payments. Around 80% of patients admitted with stroke in Joinville are treated in the HMSJ, whereas 5% are admitted to other hospitals also using SUS, and the remaining 15% use private hospitals (private health insurance or out-of-pocket payments). Around 30% of patients with stroke admitted to the HMSJ come from other cities and are not included in the registry. The hospital holds a TIA unit (4 beds), an acute stroke unit (5 beds), and a comprehensive stroke unit (21 beds) and performs IVT and MT routinely on patients with large vessel occlusion. Other hospitals do not have stroke or TIA units. IVT and MT are performed routinely in HMSJ and 2 private hospitals. Computed tomography or magnetic resonance is routinely performed in all patients with suspected stroke at hospital admission in the city. Therefore, no patient without brain imaging was included in the present analysis.

Data on stroke incidence in Joinville in 1995, 2005 to 2006, and 2012 to 2013 have been published previously.[5,6] The Joinville Stroke Registry is designed to identify patients using a 3-step approach to obtain incidence data,[7] including a daily revision of admissions at all hospitals in the city, a revision of death certificates (every 3 months), and diagnosis of stroke made in neurologists' clinics that do not admit to a hospital (monthly). The registry is regulated by municipal law. The process of data collection is coordinated by a neurologist and performed by 3 nurses, and the diagnosis and cause of stroke are reviewed by a neurologist on a weekly basis. All patients with suspected stroke are interviewed to collect demographic and clinical data. Economic, radiological, and genetic data are also obtained but are not covered in the present study. All study participants or their legal representatives provided informed consent, and the study design was approved by the appropriate ethics review board in the respective hospitals. Only Joinville's residents were taken into account, and cases from death certificates, ambulatory services, or patients that refused to participate were not included in the present analysis.

Data about COVID-19 diagnosis and deaths in Joinville and Brazil were obtained from publications on official governmental websites and were used to provide a clearer view of the pandemic situation in the locations of interest.[8,9] Most confirmed cases are on patients with severe presentations of the disease because large-scale testing was not recommended on patients that are asymptomatic or have mild cases at the time of the study.

The first confirmed case of COVID-19 in Brazil was in February 25.[9] Although there was a provisional measure for the federal government to take responsibility for social restrictions and other COVID-19 control measures,[10] the judicial system decided that such endeavors were the responsibility of states and municipalities.[11] The first confirmed case of COVID-19 in the city was on March 13, 2020,[8] when Brazil had 98 confirmed cases. On March 17 and 18, official decrees to start restrictions on social activities on municipal and state levels were published,[12,13] when there was still one confirmed case of COVID-19 in the city. March 17 was chosen as the cut-off date for the statistical analysis because it was the starting date for social restrictions, corresponding to the most significant changes in the daily activities of residents in the region. Up to that day, no official restrictions were in place at local, state, or national levels. The restrictions took place immediately and included the suspension of educational activities, public gatherings, cultural activities, some public services, the closing of restaurants, commerce, public transportation, reduction in industrial activities, and among other measures. There was also a reduction in ambulatory medical activities in the city, and part of general practitioners' time was reserved to accommodate spontaneous demand.

No additional facilities were opened that could divert patients with suspected stroke, and there was no change in protocols for forwarding patients with stroke. The hospital wards to treat patients with severe COVID-19 were opened in the same hospital that is the reference for stroke treatment in the city for the SUS.

Statistical Analysis

The number of COVID-19 and stroke cases was presented as cases/100 000 inhabitants, using as the denominator the 2019 official population estimates.[4,14] Population was assumed to remain stable from 2019 to 2020 because the change in population in recent years has been small (eg, a 1.2% increase from 2018 to 2019). Also, the 2020 official demographic estimates for 2020 are not yet available.

We compared stroke admissions from February 16 to March 16 and from March 17 to April 15 (30 days before and after the onset of COVID-19 restrictions) to the same periods in 2019. The period from March 17 to April 15 was also compared with 2019 as a whole. Incidence rates were displayed in cases/100 000.

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We investigated if there was a change in mean age, sex, time between stroke onset and hospital admission, the number of patients that underwent revascularization procedures, type of stroke (ischemic stroke, intraparenchymal hemorrhage, subarachnoid hemorrhage, and TIA), and stroke severity, which was classified as mild (National Institutes of Health Stroke Scale [NIHSS] score 0–4), moderate (NIHSS score 5–8), and severe (NIHSS score >8). A Shapiro-Wilk test for normality was conducted for monthly stroke incidence and number of revascularization procedures (IVT or MT) per month, and the distributions of time from onset to admission were evaluated in histograms.

Data were compared by univariate analysis using the Wilcoxon-Mann-Whitney test for time from onset to admission and 2-tailed Fisher Exact Test for other variables using SAS Studio 3.8 (SAS Institute Inc, Cary, NC). Differences with $P<0.05$ were considered statistically significant.

RESULTS

From January 2019 to April 15, 2020, the registry included 1169 patients with stroke, of which 917 were admitted in 2019. Only one patient denied participation, whose admission occurred in 2020 before the onset of COVID-19 in the city. Of all registrations, 3 were obtained from death certificates (all in 2019), 3 from ambulatory services (2 in 2019 and 1 in 2020 before COVID-19), and the remaining 1163 from hospital admissions.

Since the onset of COVID-19 restrictions in Joinville, we observed a significant reduction of 36.4% of all causes of stroke ($P=0.0126$) on hospital admissions, when compared with the same period in 2019 (Table 1 and Figure 1).

During 2019, the monthly stroke incidence in Joinville varied from 9.48 to 17.1 per 100 000 inhabitants (test for normality $P=0.882$; mean 12.94, SD 1.99; Figure 2). When the period after COVID-19 was compared with 2019, a reduction in admissions was observed in patients with TIA, mild, and moderate stroke (Table 2). In patients with TIA, a reduction was observed from an average 2.28 cases per 100 000 inhabitants per month in 2019 (SD 0.8) to 0.51 after COVID-19 ($P=0.0049$). In stroke with NIHSS score 0–4, we observed a decrease from an average 7.72 (SD 1.08) to 5.25 ($P=0.0425$), with NIHSS score 5–8 from 1.95 (SD 0.85) to 0.51 ($P=0.0103$), with NIHSS score 9–14 from 1.11 (SD 0.37) to 0.85 ($P=0.1521$) and with NIHSS score >14 from 1.83 (SD 0.67) to 1.52 ($P=0.6181$). The reduction in stroke admissions for TIA and mild stroke is shown in Figure 3. Age varied from mean 66.9 (SD 13.7) to 67.2 (SD 11.8, $P=0.8995$) and the proportion of female patients from 47.3% to 46.9% (0.5752).

The proportion of patients with severe presentations increased in the period, although a significant change in absolute numbers was not observed. While in 2019, severe strokes accounted for 23%, after COVID-19, they corresponded to 29%. The admissions for intraparenchymal hemorrhage remained similar to those in 2019 (0.8 in 2019 [SD 0.4] and 0.5 after COVID-19), as well as those for subarachnoid hemorrhage (0.4 in 2019 [SD 0.2] and 0.2 after COVID-19), while admissions for patients with ischemic stroke reduced from 9.4 in 2019 (SD 1.4) to 6.3 after COVID-19 ($P=0.0195$; Tables 1 and 2).

The hypothesized delay in time from onset to admission was not observed. We observed a nonsignificant decrease in median delay from 4 to 3.4 hours ($P=0.659$). The distribution of hours from stroke onset was right-skewed, with a peak around 1.5 hours, and was similar between periods (Figure 4).

The number of patients provided with reperfusion therapies (IVT and IAT) in 2019 ranged from 0.51 to 1.35/100 000 per month (test for normality $P=0.051$, mean 1.04, SD 0.29). In the 30-day period after COVID-19, only 0.34/100 000 were treated with IVT or IAT, but there was no statistical difference from 2019 ($P=0.1024$).

DISCUSSION

In the present article, we provide evidence of a significant reduction in stroke admissions after the onset of COVID-19 in Joinville, Brazil. The decrease was observed only in cases with transient, mild, or moderate stroke presentations (TIA and NIHSS score 0–8). The number of patients submitted to reperfusion therapies did not significantly decrease, and a change in the time between stroke onset and hospital admission was not observed.

Neurologists around the world have reported decreases in stroke cases admitted during the COVID-19 pandemic era.[15–17] However, we found no published

Table 1. Change in Stroke Admissions From 2019 to 2020

	Stroke Admissions/100 000 Inhabitants	*P* Value	Stroke Admissions With NIHSS 0–8/100 000 Inhabitants	*P* Value
February 15–March 16, 2019	11.7		8.5	
March 17–April 15, 2019	13		9.8	
February 16–March 16, 2020	12.7 (+8.7%)	0.6168	9.8 (+16%)	0.5005
March 17–April 15, 2020	8.3 (–36.4%)	0.0126*	5.8 (–41.4%)	0.016*

The percentual change and *P* value are related to the same period in the previous year. NIHSS indicates National Institutes of Health Stroke Scale.

**P* values considered statistically significant.

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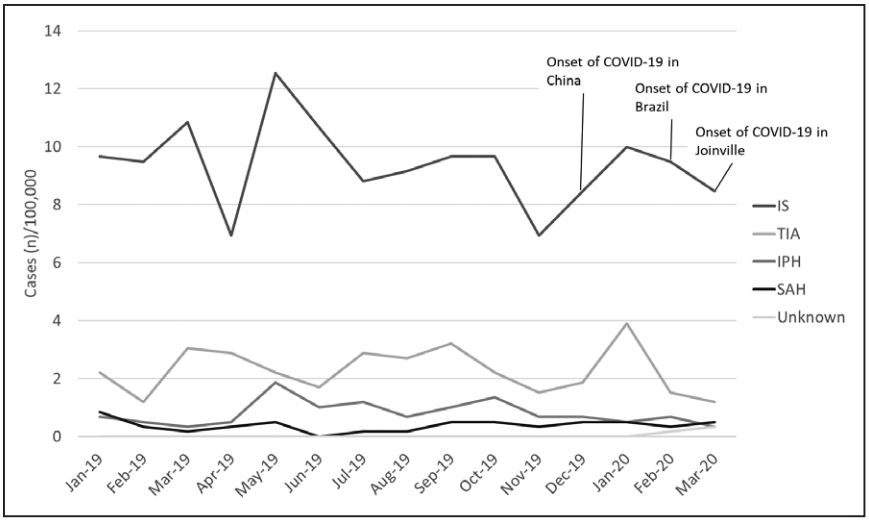

Figure 2. Stroke admissions by time period.
The admission rates per 100 000 inhabitants of ischemic stroke (IS), transient ischemic attack (TIA), intraparenchymal hemorrhage (IPH), subarachnoid hemorrhage (SAH), and strokes of unknown cause are demonstrated for each month in 2019 and the first quarter of 2020. COVID-19 indicates coronavirus 2019.

population-based cohort to compare our data. Authors of a study in South Korea, during the MERS (Middle East respiratory syndrome) outbreak, found a 33% reduction in admissions to emergency services, with a 16.6% decrease in admissions for ischemic stroke.[18] A decline was also noticed in cardiology services for coronary artery disease admissions during the COVID-19 pandemic.[19] Therefore, the finding is probably not restricted to stroke, nor to the geographic region where the present study was conducted.

It is not clear to what extent the reduction in admissions is related to the population's behavior or to changes in the healthcare system. It does not appear that patients are having fewer strokes than before since cases of severe ischemic stroke, intraparenchymal hemorrhage, and subarachnoid hemorrhage are not declining. We hypothesize that the number of less severe strokes is also not falling. Instead, patients are not seeking hospital care. This may be because patients with stroke do not seek any medical care or because they are not correctly forwarded to a hospital.

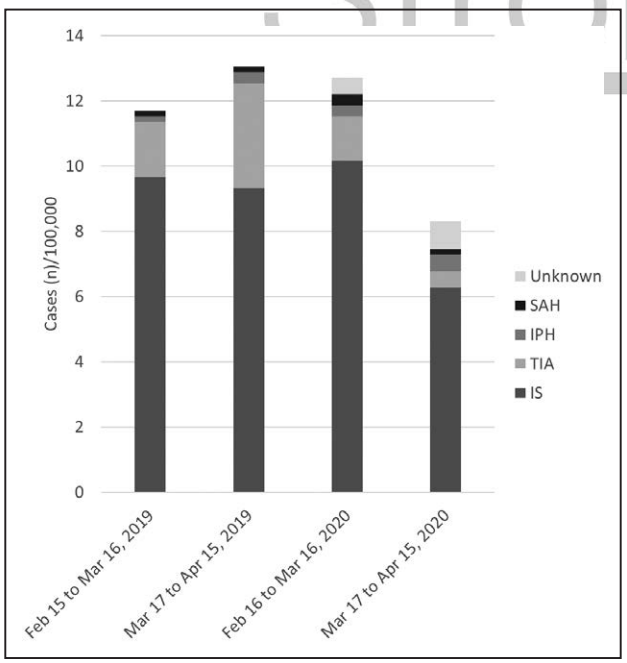

Figure 1. Stroke admissions comparing before and after coronavirus 2019 (COVID-19) with the same periods in 2019.
The admission rates per 100 000 inhabitants of ischemic stroke (IS), transient ischemic attack (TIA), intraparenchymal hemorrhage (IPH), subarachnoid hemorrhage (SAH) and strokes of unknown cause for the 30 days before and after the onset of COVID-19 are compared with the same period in 2019.

Patients may be reluctant to seek hospital care for fear of becoming infected. Also, some people may be confused about stay-at-home orders meant to slow the spread of COVID-19. If patients look for medical care, they may consult with less-busy health services, which are not stroke facilities. Doctors in these services may be diagnosing fewer cases of stroke or not referring all cases to hospitals. Of note, the hospital reference for stroke treatment in Joinville for patients using SUS is the HMSJ, which is also the region's reference for treating COVID-19.

Although people may be concerned about seeking a hospital, where they may have an increased risk of COVID-19 infection, appropriate management of cases of suspected stroke continues to be recommended.[20,21] A delay in evaluation of mild cases may have severe consequences, such as pneumonia and early stroke recurrence, and may increase the burden on intensive care units. The correct management of TIAs, for example, has been demonstrated to reduce in 80% the risk of early stroke recurrence.[22,23]

Another possibility is that social restrictions cause individuals to be alone more often, and mild stroke signs or deficits accompanied by negligence may be unnoticed. Such an effect has suggested being a cause of delay in hospital admissions.[24]

Joinville is an industrial city, and since social restrictions, industrial activity, and car traffic have been reduced. Authors from the Global Burden of Disease Study estimated that the population-attributable risk factor of ambient air pollution for stroke is 18.4%.[25] There is also evidence that short-term increases in $PM_{2,5}$ and NO_2

Table 2. Differences in Hospital Admissions for Stroke Before and After COVID-19

	2019 (Monthly Average)	2020 Before COVID-19	2020 After COVID-19	*P* Value
Stroke incidence (cases/100 000, SD)	12.9 (1.9)	12.7	8.3	0.0029*
IS	9.4 (1.4)	10.2	6.3	0.0195*
TIA	2.3 (0.8)	1.4	0.5	0.0049*
IPH	0.8 (0.4)	0.3	0.5	0.3645
SAH	0.4 (0.2)	0.3	0.2	0.4453
Unknown	<0.1 (0.1)	0.5	0.8	<0.0001*
Age (mean, SD)	66.9 (13.7)	67.3 (12.5)	67.2 (11.8)	0.8995
Gender (female proportion)	47.3%	53.3%	46.9%	0.5752
NIHSS (cases/100 000, SD)				
0–4	7.7 (1.1)	8.1	5.3	0.0425*
5–8	2 (0.8)	1.7	0.5	0.0103*
9–14	1.1 (0.4)	0.3	0.8	0.1521
>14	1.8 (0.7)	1.9	1.5	0.6181
Unknown	0.3 (0.2)	0.7	0.2	0.5893
Hours from onset to admission (median, IQR)	4 (1.7–17.1)	5 (1.5–20.1)	3.4 (1.7–19.6)	0.659
Reperfusion therapies (cases/100 000, SD)	1 (0.3)	2.2	0.3	0.1024

The period before COVID-19 refers to between February 16, 2020, and March 16, 2020, and after COVID-19 refers to March 17, 2020, and April 15, 2020. *P* values are calculated comparing 2020 after COVID-19 (30 d) and all patients in 2019. COVID-19 indicates coronavirus 2019; IPH, intraparenchymal hemorrhage; IQR, interquartile range; IS, ischemic stroke; NIHSS, National Institutes of Health Stroke Scale; SAH, subarachnoid hemorrhage; and TIA, transient ischemic attack.

**P* values considered statistically significant.

levels are correlated with more hospital admissions for stroke.[26] Therefore, a reduction in air pollution may have contributed in reducing stroke incidence, although it is unlikely to be the sole cause because of a disproportionate reduction of admissions for TIA and other less severe presentations of stroke.

Our data do not provide evidence of a significant difference in median time from stroke onset to admission.

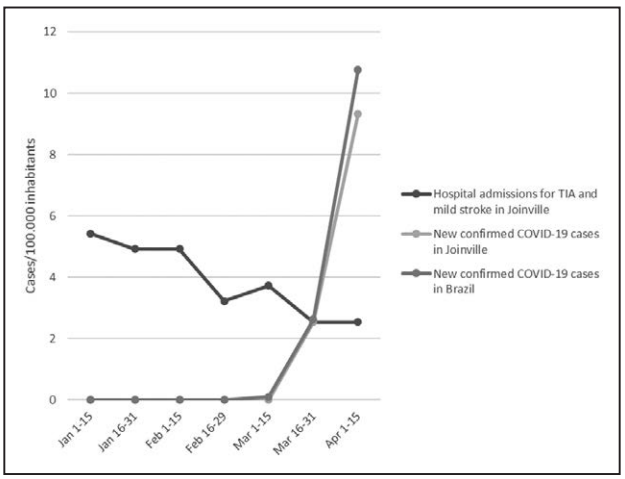

Figure 3. Time from stroke onset to admission according to time period.
These graphs demonstrate the proportion of patients according to time between stroke onset to admission, stratified by 0.5-h period. Of note, the shape of the distribution is similar between periods, with a peak around 1.5 h for all groups. COVID-19 indicates coronavirus 2019.

Although some patients may experience a delay in seeking medical care (which our data do not support), a higher proportion of patients admitted with severe stroke creates a selection bias. In more severe cases, patients may seek help faster and call ambulances more often.[24]

As initial measures to mitigate the situation in Joinville, doctors in emergency departments and emergency medical services were contacted and instructed to continue referring all patients with suspected stroke to the stroke center. Following the instructions of the World Stroke Organization, healthcare professionals and stroke patients' associations began to inform the population through local media about the importance of acting correctly in a suspected case of stroke.

Strengths and Weaknesses

The study uses prospectively obtained incidence of stroke on a population-basis according to the World Health Organization Steps Criteria,[7] using patient-level data. To our knowledge, this is the first population-based study to publish data about hospital admissions for stroke after the spread of COVID-19.

Of particular concern to the present analysis is the integrity of the process of collecting data in a time of a pandemic. The authors reviewed if the same protocols were being undertaken and found no changes in the number of staff or routine of data collection. There was also no change in official referral pathways of patients with suspected stroke or other severe illness. However,

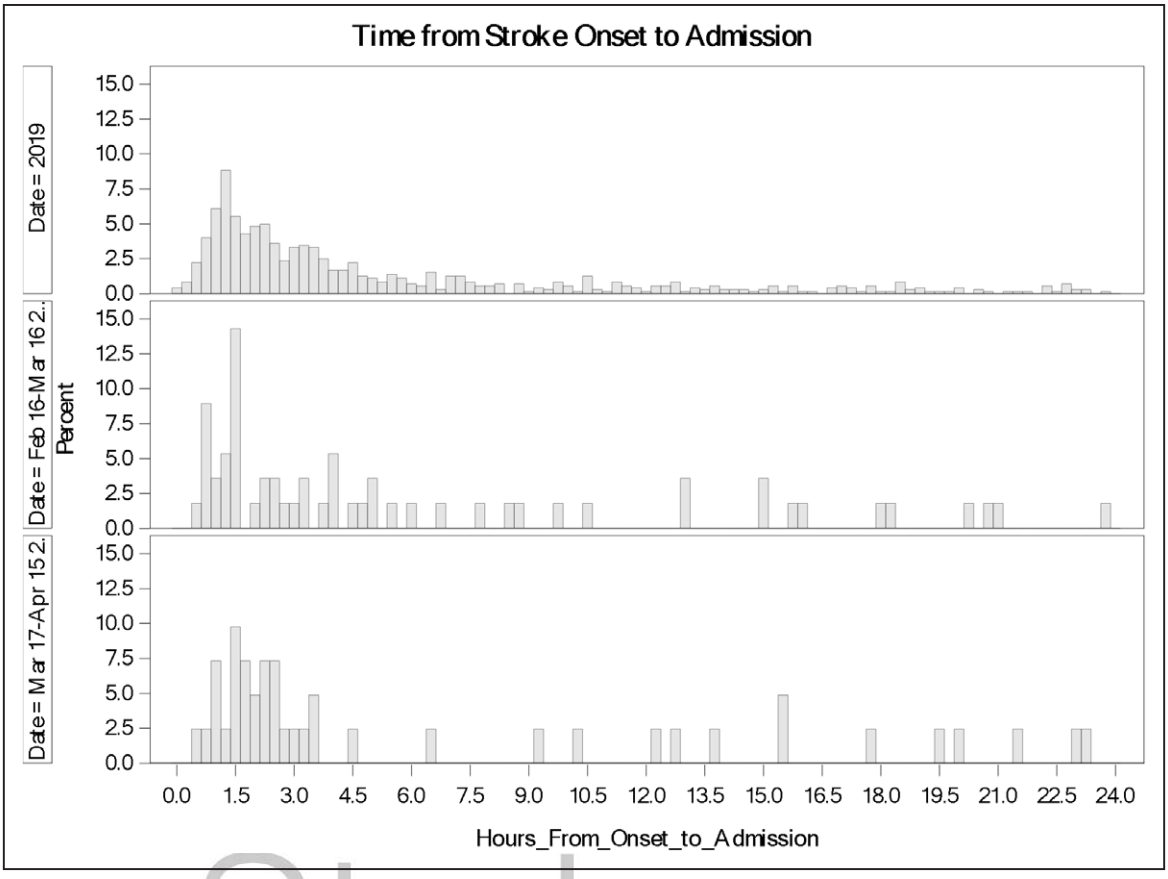

Figure 4. Hospital admissions for mild stroke and transient ischemic attack (TIA) before and after the spread of coronavirus 2019 (COVID-19).
This graph illustrates a correlation between cases diagnosed with COVID-19/100 000 inhabitants in Brazil and Joinville, and the number of patients admitted with TIA or mild stroke to a hospital in Joinville.

it is unknown if some doctors have individually chosen to stop referring patients to hospitals. Additional cases of patients with stroke may enter the registry from death certificates or ambulatory cases, but those cases were not included in the present analysis.

The article is unable to demonstrate how epidemiological data evolve months after the spread of COVID-19. The authors are highly concerned about the long-term consequences of the pandemic in stroke. Changes in the healthcare system such as a reduction in GP visits, the suspension of patients' groups for managing hypertension, smoking, and diabetes mellitus, a reduction of 16% in beds in the stroke unit, and a decrease in the number of staffs may have consequences observed in the following months to years. Also, it was not possible to demonstrate the impacts of stroke directly related to COVID-19 since no case of stroke with COVID-19 was detected in the city.

Conclusions

The onset of COVID-19 was correlated with a reduction in hospital admissions for stroke in patients with less severe presentations. A rapid reorganization of stroke-care networks is necessary to reduce collateral damage caused by COVID-19. Particular attention should be given in reassuring the population about the importance of seeking medical assistance in case of symptoms of stroke, even if the presentation is mild or transient.

ARTICLE INFORMATION

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