Effect of the COVID-19 pandemic in stroke code activations in the region of Madrid
A retrospective study

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Abstract
Acute stroke is the most common time-dependent disease attended in the emergency medical service (EMS) of Madrid (SUMMA 112). Community of Madrid has been one of the most affected regions in Spain by the coronavirus disease 2019 (COVID-19) pandemic. A significant reduction in acute stroke hospital admissions has been reported during the COVID-19 pandemic compared to the same period 1 year before. As international clinical practice guidelines support those patients with suspected acute stroke should be accessed via EMS, it is important to know whether the pandemic has jeopardized urgent pre-hospital stroke care, the first medical contact for most patients. We aimed to examine the impact of the COVID-19 in stroke codes (SC) in our EMS among 3 periods of time: the COVID-19 period, the same period the year before, and the 2019-2020 seasonal influenza period.

We compared the SC frequency among the periods with high cumulative infection rate (above the median of the series) of the first wave of COVID-19, seasonal influenza, and also with the same period of the year before. One thousand one hundred thirty SC were attended during the 3 periods. No significant reduction in SC was found during the COVID-19 pandemic. The reduction of hospital admissions might be attributable to patients attending the hospital by their means. The maximum SC workload seen during seasonal influenza has not been reached during the pandemic. We detected a nonsignificant deviation from the SC protocol, with a slight increase in hospitals’ transfers to hospitals without stroke units.

Keywords: AS = acute stroke, COVID-19 = coronavirus disease, EMS = emergency medical service, SC = stroke code.

1. Introduction
Acute stroke (AS) is the most common time-dependent pathology attended in the emergency medical service (EMS) of Madrid (SUMMA 112). It is the first cause of mortality among women and the first cause of disability in adults.

Community of Madrid has been one of the most affected in Spain by the coronavirus disease 2019 (COVID-19) pandemic. Community of Madrid has been one of the most affected in Spain by the coronavirus disease 2019 (COVID-19) pandemic. Until May 31st, a total of 68,830 cases and 8691 fatalities have been registered, nearly one-third of the entire country’s total count.

Several studies reported an alarming decrease in hospital admissions for stroke.[1–5] But there is little and inconsistent evidence regarding EMS performance. While some report significant reductions in cases, others report that the frequency of stroke code (SC) has not been affected.[6,7] International guidelines support patient access via EMS, following the stroke code protocol (SC).[6,7] This significantly reduces door-to-needle time and improves patient prognosis. A reduction of SC activation cases (usually the most severe stroke cases) would be a dangerous consequence of COVID-19.

EMS are used to dealing with other work overload situations such as the annual seasonal influenza (health system overload, similar severity risk factors). We hypothesized that the SC protocol has been quite strong despite the high incidence of COVID-19 during the first months of the pandemic. We aimed to study the frequency of SC compared with the previous year, and with the seasonal influenza period.

2. Methods
We conducted a retrospective observational cohort study including all consecutive acute stroke code patients attended by SUMMA 112, the leading EMS in Madrid. We analyzed the daily frequency of SC and hospital destination considering 3 cohorts according to:

• November 24, 2019, to February 14, 2020, corresponding to the seasonal influenza period (incidence of infection above the median of the series).
• March 1 to May 8, 2020, for the COVID-19 period (incidence of infection above the median of the series),
• March 1 to May 8, 2019, for the PreCOVID-19 period (the same period the year before)

We selected the dates defining each period according to the official data on the daily cumulative incidence of infection above the median of the series of influenza (influenza sentinel system from the Institute of Health Carlos III) and COVID-19 (Spanish Health Ministry).

2.1. Study data
Age and sex of the patients, daily SC frequency, and type of hospital destination (stroke-ready hospital, hospital with stroke unit, and hospital with stroke unit and endovascular facilities) from the SUMMA 112 prospective registry of stroke codes.

2.2. Statistical analysis
We used RStudio for statistical analyses and Microsoft Excel for the graphs.

Three groups’ means of SC frequency have been compared using the ANOVA test with the Tukey-Kramer method for pairwise comparisons. The rest of the variables have been compared by ANOVA or Kruskal-Wallis tests as appropriate.

Chi-square test has been used to compare categorical variables. The difference of means has been estimated with a 95% confidence interval, considering statistically significant those with \( P < .05 \).

This study was approved by the Ethics Committee of the Community of Madrid. As a retrospective study, patient consent was waived.

3. Results
SUMMA 112 attends an average of 150 SC (95% CI: 133-167) per month (Fig. 1). We attended 1130 SC during the 3 periods. During the period of COVID-19, a non-significant daily reduction of 13% SC was observed compared with the pre-COVID-19 period (difference of –0.68 daily cases, 95% CI: 0.15 to –1.51) and a statistically significant reduction of 24% compared with the seasonal influenza period (–1.41, 95% CI: –0.62 to –2.21) (Fig. 2).

A significant younger age of the COVID-19 group (95% CI: 67.6-71) compared with the other 2 groups (pre-COVID-19, 95% CI: 71.2-74; influenza, 95% CI: 71.8-74.3) was found. Also, a lower proportion of women were attended with suspected stroke (COVID-19: 43.9%, 95% CI: 38.2%-49.7%; pre-COVID-19: 51.9%, 95% CI: 46.4%-57.2%; influenza: 53.3%, 95% CI: 48.8%-57.8%) (Table 1).
Finally, there was also a non-significant reduction in transfer rates to stroke centers (87% vs 90%, \(P = .61\)) at the cost of increasing transfers to hospitals without stroke units (5% vs 3%, \(P = .17\)).

### 4. Discussion

Our EMS (SUMMA 112) did not detect a significant decrease in SC cases during the COVID-19 period (Fig. 2). However, many hospitals reported a dramatic reduction in the number of admissions for acute stroke. If we assume that hospital admissions are the sum of patients transported by EMS and those who come by their means, if the former has not decreased, the latter may have decreased. It is congruent with the reported reduction in transient ischemic attack and mild strokes. Patients with mild or temporary symptoms may have been more concerned about being infected in the hospital or having delayed their evaluation. Efforts should be made in awareness campaigns, in the message to call 112 whenever the patient identifies a sign of stroke.

An increase in SC has also not been detected, despite the evidence of thrombotic events associated with SARS-CoV-2 infection. It may be due to the saturation of the EMS resources, including emergency hotlines that might have blocked potential patients with stroke symptoms from being attended. It is a major limitation of this study, and also the fact that only EMS transported SC patients were analyzed, so the information on other AS patients is lacking.

| Table 1 | Characteristics of SC patients and destination hospitals. |
|---------|----------------------------------------------------------|
|         | **PreCOVID 19 period** | **COVID 19 period** | **Seasonal influenza 19-20** | **\(P\)** |
| Stroke codes | n | 345 | 303 | 482 |  |
| SC per day, mean (SD) | 5.07 (2.03) | 4.39 (1.88) | 5.8 (2.22) | <.01 |
| Age, mean (SD) | 72.5 (13.5) | 69.2 (15.1) | 73 (14) | <.01 |
| Male sex, n (%) | 166 (48.1%) | 170 (56.1%) | 225 (46.7%) | .029 |
| Destination hospital |  |
| Referral to a CSC, n (%) | 311 (90.1%) | 266 (87.8%) | 430 (89.2%) | .61 |
| Referral to a PSC, n (%) | 22 (6.4%) | 21 (6.9%) | 39 (8.1%) | .655 |
| Referral to other hospital, n (%) | 12 (3.5%) | 16 (5.3%) | 13 (2.7%) | .167 |

CSC = comprehensive stroke centre, PSC = primary stroke centre, SD = standard deviation.

Stroke patients were younger in the COVID-19 period. Older people may have tried to avoid attending the emergency department and strictly followed the messages of staying at home.

We want to highlight the stability of the SC protocol that has succeeded under those extraordinary circumstances. We detected a non-significant reduction with a slight increase in transfers to hospitals without stroke units, most of the cases due to overcrowding of the stroke unit with covid patients.

To our knowledge, this is one of the first studies to analyze the behavior of pre-hospital EMS in a time-dependent pathology as prevalent as AS. We did not find evidence of a significant reduction of SC during the COVID-19 pandemic compared with the same period of the year before. The number of SC was significantly lower during the COVID-19 period than the 2019 to 2020 seasonal influenza period, thus SC seems to operate correctly, even with such a high level of health system saturation.

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