



Effect of lockdown on the management of ischemic stroke: an Italian experience from a COVID hospital

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Abstract

Objective To evaluate the impact of the lockdown measures, consequent to the outbreak of COVID-19 pandemic, on the quality of pre-hospital and in-hospital care of patients with acute ischemic stroke.

Methods This is an observational cohort study. Data sources were the clinical reports of patients admitted during the first month of lockdown and discharged with a confirmed diagnosis of stroke or TIA. Data were collected in the interval ranging from March 11th to April 11th 2020. As controls, we evaluated the clinical reports of patients with stroke or TIA admitted in the same period of 2019.

Results The clinical reports of patients eligible for the study were 52 in 2020 (71.6 ± 12.2 years) and 41 in 2019 (73.7 ± 13.1 years). During the lockdown, we observed a significant increase in onset-to-door time (median = 387 vs 161 min, $p = 0.001$), a significant reduction of the total number of thrombolysis (7 vs 13, $p = 0.033$), a non-significant increase of thrombectomy (15 vs 9, $p = 0.451$), and a significant increase in door-to-groin time (median = 120 vs 93 min, $p = 0.048$). No relevant difference was observed between 2019 and 2020 in the total number of patients admitted.

Conclusions Due to the COVID-19 pandemic and lockdown measures, the stroke care pathway changed, involving both pre-hospital and in-hospital performances.

Keywords Stroke · Covid · SARS-CoV-2 · Lockdown · Hub-and-spoke

Introduction

Since the outbreak of the Coronavirus disease 2019 (COVID-19) pandemic, Italian healthcare system has suffered a heavy backlash. On March 11th, 2020, the extension of restrictive measures to the entire Italian territory with closure of all non-essential businesses and industries and limitation to the

movement of people (“lockdown”) required some adaptations of the integrated care pathway (ICP) focused on time-dependent diseases such as stroke [1]. Intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT) in ischemic stroke (IS) are extremely time-sensitive. The “hub-and-spoke model” in the pre-hospital phase and the definition of ICPs with standardized processes within the in-hospital phase are essential to reduce delay and increase the number of treatable patients [2–4].

The quality of pre-hospital care is reflected by the onset-to-door time (ODT) that is the time from stroke onset, or from the last moment the patient was known without symptoms, to emergency department (ED) arrival [5]. The indicators of the in-hospital care pathway are the time elapsing from the moment the patient enters the ED to the moment he/she receives revascularization procedures such as IVT, the door-to-needle time (DNT), and/or EVT, the door-to-groin time (DGT) [6].

The primary objective of this study is to evaluate how the first month of lockdown has influenced the quality of

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pre-hospital and in-hospital care of patients with acute stroke, by analyzing the performance indicators of our hospital ICP dedicated to IS.

Methods

In this observational cohort study, we evaluated the performance indicators of our hospital ICP for acute IS. The sources of the data were the clinical reports of all consecutive patients admitted in the ED of Policlinico A. Gemelli Hospital in Rome for IS, in the time interval between March 11th (according to the Decree of the President of the Council of Ministers, the date of the extension of the quarantine to all of Italy) and April 11th 2020. During this period, before admission to ED, all patients after a pre-triage were classified as suspected (s-COVID) or unsuspected COVID-19 (n-COVID) according to WHO recommendations [7] and divided into separate dedicated pathways. The clinical report was included in the study only if the diagnosis of stroke (ICD-X codes 433,434,436) or TIA (ICD-X codes 435) was confirmed at discharge. The following variables were considered: total amount of patients admitted, age, gender, diagnosis (stroke or TIA), type of access (directly to ED or from a spoke center), ODT, door-to-CT time, time spent in Emergency Department, NIHSS score at admission, NIHSS score at discharge, intra-venous thrombolysis, DNT, endovascular treatment, DGT, fever, pneumonia, length of stay in hospital, death, and stroke team evaluation. As controls, we used the clinical reports of all consecutive patients admitted in the same period of 2019 and successively discharged with a diagnosis of IS or TIA. Statistical analysis was performed in two steps. In the first step, patients admitted for stroke during the lockdown period were compared to those admitted in March–April 2019. Finally, stroke patients admitted during the lockdown, based on the COVID-19 triage, were classified as s-COVID or n-COVID. S-COVID and n-COVID were compared for the same clinical variables. Continuous and categorical data were summarized using median and range or counts and percentages, respectively. Before the comparison, the normality of distribution of numerical variables of the samples has been tested by means of the Shapiro-Wilk test, with a significance level of $p < .05$; the distribution was not normal, and therefore, a non-parametric test (Mann-Whitney U test) was applied for numerical variables. Pearson's Chi-square (χ^2) was used for categorical variables. The threshold for significance was $p < 0.05$. All statistics were performed by means of a dedicated software (Statistical Package for Social Science, SPSS® version 20). The study was conducted according to the declaration of Helsinki and was approved by the local Ethics Committee (Prot. 13729/20 ID:3065).

Results

In years 2020 and 2019, the clinical reports of patients eligible for the study were 52 (31 men and 21 women, mean age: 71.6 ± 12.2 years) and 41 (19 men and 22 women, mean age: 73.7 ± 13.1 years), respectively. No significant differences were observed between groups concerning age and gender.

Regarding pre-hospital measures, a significant increase in ODT was observed in 2020 (median = 387 vs 161 min, $p = 0.001$). Regarding in-hospital performance indicators, we observed a significant reduction of the total number of thrombolysis (7 vs 13, $p = 0.033$) and a non-significant increase of EVT (15 vs 9, $p = 0.451$) performed during the first month of lockdown. Moreover, we observed a significant increase in DGT in the 2020 period (median = 120 vs 93 min, $p = 0.048$), while no significant difference was observed in DNT. Finally, a significant reduction of length of hospitalization was observed in 2020 (median = 4 vs 6 days; $p = 0.007$). Detailed results are shown in Table 1.

Comparing s-COVID with n-COVID patients, DGT was significantly longer in s-COVID (median = 168 vs 105, $p = 0.004$). It was not possible to make a comparison between groups for the DNT because in the s-COVID group, the only thrombolytic treatment was performed in a SPOKE center. The total number of deaths was significantly higher in the s-COVID group (2 vs 3, $p = 0.015$). Detailed results between s-COVID and n-COVID are shown in Table 2.

Discussion

The massive spread of COVID-19 and the 'lockdown' strategy in Italy have impacted procedures of time-dependent disease management [8].

The Gemelli Hospital, one of the 4 Hubs in the Stroke Network of Regione Lazio, serves a population of around 1.7 million and is equipped with a specific ICP for IS management. Due to the outbreak of COVID-19 pandemic, the Gemelli Hospital was appointed as a COVID Hospital and the local stroke ICP underwent some changes with the identification of s-COVID-19 and n-COVID-19 pathways.

As primary endpoint, we observed a significant increase in the ODT, the key performance indicator of pre-hospital stroke care related to the behavior of patients and bystanders and the efficiency of the emergency medical service (EMS) [9]. Psychological factors such as fear of exposure to COVID-19 could have contributed to a detrimental wait-and-see behavior. The dangerous interpretation of "stay at home" probably is due to the lack of specific education campaigns explaining the serious health consequences of a delay in diagnosis of IS and the erroneous perception that COVID-19 is more severe than stroke. Less likely, the increase in the ODT could be due to a delay in a COVID-oriented EMS.

Table 1 Demographic, clinical features, and performance indicators: 2020 vs 2019

	2019 (<i>n</i> = 41)	2020 (<i>n</i> = 52)	<i>p</i> value
Age, years, mean (SD)	73.7 (13.1)	71.6 (12.2)	NS
Gender, male, No. (%)	19 (46.3)	31 (59.6)	NS
Diagnosis			
Stroke, No. (%)	38 (92.7)	49 (94.2)	NS
TIA, No. (%)	3 (7.3)	3 (5.8)	NS
Type of access			
Directly to ED, No. (%)	37 (90.2)	41 (78.8)	NS
Spoke, No. (%)	4 (9.8)	11 (21.2)	NS
Integrated care pathway performance indicators			
Onset-to-door time, min, median (range)	161 (31–6042)	387 (35–9496)	0.001 (<i>U</i> = 1277.500)
Door-to-CT time, min, median (range)	45 (5–720)	54 (13–502)	NS
Thrombolysis, No. (%)	13 (31.7)	7 (13.5)	0.033 (χ^2 = 4.521)
Door-to-needle time, min, median (range)	58 (27–132)	63 (41–70)	NS
Thrombectomy, No. (%)	9 (22.0)	15 (28.8)	NS
Door-to-groin time, min, median, (range)	93 (69–122)	120 (83–271)	0.048 (<i>U</i> = 101.000)
Thrombolysis + thrombectomy, No.	6.0 (14.6)	6.0 (11.5)	NS
Length of stay in ED, min, median (range)	195 (0–3395)	134 (3–1078)	NS
Hospitalization, days, median (range)	6 (1–30)	4 (0–26)	0.007 (<i>U</i> = 622.000)
Death, No. (%)	3 (7.3)	5 (9.6)	NS
Stroke team evaluation, No. (%)	36 (87.8)	50 (96.2)	NS
Clinical features			
NIHSS at admission, median (range)	4 (0–24)	5 (0–25)	NS
NIHSS at discharge, median (range)	1 (0–18)	2 (0–23)	NS
Fever during hospitalization, No. (%)	9 (22.0)	17 (32.7)	NS
Pneumonia during hospitalization, No. (%)	4 (9.8)	12 (23.1)	NS

Table 2 Demographic, clinical features, and performance indicators: s-COVID vs n-COVID

	n-COVID (<i>n</i> = 42)	s-COVID (<i>n</i> = 10)	<i>p</i> value
Age, years, mean (SD)	70.5 (12.9)	76.1 (7.5)	NS
Gender, male, No. (%)	26 (61.9)	5 (50.0)	NS
Diagnosis			
Stroke, No. (%)	39 (92.9)	10 (100)	NS
TIA, No. (%)	3 (7.1)	0 (0)	NS
Type of access			
Directly to ED, No. (%)	34 (81.0)	8 (80)	NS
Spoke, No. (%)	8 (19.0)	2 (20)	NS
Integrated care pathway performance indicators			
Onset-to-door, min, median (range)	387 (35–9496)	632 (75–4725)	NS
Door-to-CT, min, median (range)	53 (13–366)	70 (39–502)	NS
Thrombolysis, No. (%)	6 (14.3)	1 (10.0)	NS
Door-to-needle time, min, median (range)	63 (41–70)	–	NS
Thrombectomy, No. (%)	12 (28.6)	3 (30.0)	NS
Door-to-groin time, min, median (range)	105 (83–123)	168 (129–271)	0.004 (<i>U</i> = 36.000)
Thrombolysis + thrombectomy, No. (%)	5.0 (11.9)	1.0 (10.0)	NS
Length of stay in ED, min, median (range)	131 (3–1078)	233 (16–567)	NS
Hospitalization, days, median (range)	4 (0–26)	6 (1–10)	NS
Death, No. (%)	2 (4.8)	3 (30.0)	0.015 (χ^2 = 5.920)
Stroke team evaluation, No. (%)	41 (97.6)	9 (90.0)	NS
Clinical features			
NIHSS at admission, median (range)	4 (0–24)	7 (1–25)	NS
NIHSS at discharge, median (range)	2 (0–23)	2 (0–5)	NS
Fever during hospitalization, No. (%)	10 (23.8)	7 (70.0)	0.006 (χ^2 = 7.526)
Pneumonia during hospitalization, No. (%)	6 (14.3)	5 (50.0)	0.025 (χ^2 = 5.056)
Confirmed diagnosis of COVID-19, No. (%)	2 (4.8)	1 (10.0)	NS

Besides, we observed in 2020 a significant reduction in the number of IVT which could be due to the ODT delay and to an increase in the number of patients accessing to ED outside the time window for IVT. We observed a significant increase of DGT, essentially due to the delay in EVT observed in s-COVID patients since their DGT is significantly higher than DGT of n-COVID patients.

The increase of DGT in s-COVID patients is widely expected and strictly linked to the complexity of the clinical care pathway of the s-COVID patient that includes the time needed to wear recommended personal protection equipment, safe transport with bio-containment measures, preparation, and cleaning of the CT or angiography rooms.

In apparent conflict with other authors [8, 10, 11], we did not observe a reduction in the overall number of IS patients admitted to our ED when comparing the current lockdown period with the same period of 2019, which is in line with the number of monthly patients admitted throughout the whole year.

The reason for the lack of the expected reduction of admitted stroke patients could be linked to the role of hub of our hospital within the Lazio region network, which means a stroke physician 24 h a day and an interventional neuroradiologist on call 24/7. In order to avoid time-wasting and to reduce the risk of diffusion of SARS-CoV-2 between hospitals, emergency medical services could have opted for a primary centralization of stroke patients at our institution. However, Hub-and-Spoke model was not modified during lockdown period in our area. Further studies, involving spokes and other hubs of the stroke regional network, are warranted with the aim to clarify the overall number of stroke patients admitted in regional hospitals during lockdown.

We observed a significantly shorter hospitalization in 2020, due to the need to reduce the risk of exposure to SARS-CoV-2 and to a shorter waiting list for radiological or laboratory tests, due to the interruption of all non-urgent activities. Moreover, an interruption of non-essential activities at the internal and external rehabilitation facilities could have resulted in a higher availability of beds and, in turn, in a faster transfer of patients to rehabilitation units.

Comparing s-COVID and n-COVID patients, we observed an increase in mortality in patients who entered the s-COVID care pathway. This result, with the limit of the sample size, could mean that the management of a patient within the s-COVID pathway is independently associated with an increased risk of death probably due to previous respiratory comorbidity, signs of current infection, and to a more complex medical and nursing management.

The main limitations of this study are the sample size and the short observation period, due to the choice to describe the management of acute stroke during the first month of Italian lockdown as a single-center experience, in a COVID hospital. The study highlights how during the COVID-19 pandemic

and for the adoption of the lockdown strategy, the stroke care pathway changed, involving the management of patients both with and without SARS-CoV-2 infection. Furthermore, our data point out that it is crucial to preserve the integrity of stroke network and to continue sensitization campaigns on time-dependent pathologies during the COVID-19 pandemic.

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Authors' contributions Giovanni Frisullo, Valerio Brunetti, Riccardo Di Iorio, and Giacomo Della Marca: design and conceptualized the study; acquired, analyzed, and interpreted the data; drafted and revised the manuscript for intellectual content.

Aldobrando Broccolini, Pietro Caliendo, Mauro Monforte, Roberta Morosetti, Carla Piano, Fabio Pilato, and Paolo Calabresi: acquired and interpreted the data; revised the manuscript for intellectual content.

Data availability Anonymized data will be shared on request from any qualified investigator.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. This study was approved by the local Ethics Committee (Prot. 13729/20 ID:3065).

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