

# Comparison of Disease Profiles and Three-Month Outcomes of Patients with Neurological Disorders with and without COVID-19: An Ambispective Cohort Study

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## Abstract

**Objective:** Neurological emergencies saw a paradigm shift in approach during the coronavirus disease-2019 (COVID-19) pandemic with the challenge to manage patients with and without COVID-19. We aimed to compare the various neurological disorders and 3 months outcome in patients with and without SARS-CoV-2 infection. **Methods:** In an ambispective cohort study design, we enrolled patients with and without SARS CoV-2 infection coming to a medical emergency with neurological disorders between April 2020 and September 2020. Demographic, clinical, biochemical, and treatment details of these patients were collected and compared. Their outcomes, both in-hospital and at 3 months were assessed by the modified Rankin Scale (mRS). **Results:** Two thirty-five patients (235) were enrolled from emergency services with neurological disorders. Of them, 81 (34.5%) were COVID-19 positive. The mean (SD) age was 49.5 (17.3) years, and the majority of the patients were male (63.0%). The commonest neurological diagnosis was acute ischemic stroke (AIS) (43.0%). The in-hospital mortality was higher in the patients who were COVID-19 positive (COVID-19 positive: 29 (35.8%) versus COVID-19 negative: 12 (7.8%),  $P$  value: <0.001). The 3 months telephonic follow-up could be completed in 73.2% of the patients (142/194). Four (12.1%) deaths occurred on follow-up in the COVID-19 positive versus fifteen (13.8%) in the COVID-19 negative patients ( $P$  value: 1.00). The 3-month mRS was worse in the COVID-19 positive group ( $P$  value <0.001). However, this was driven by higher in-hospital morbidity and mortality in COVID-19 positive patients. **Conclusion:** Patients with neurological disorders presenting with COVID-19 infection had worse outcomes, including in-hospital and 3 months disability.

**Keywords:** Ambispective cohort study, COVID-19 neurology, in-hospital mortality, modified Rankin Scale, 3- months follow-up

## INTRODUCTION

Coronavirus disease 2019 (COVID-19) pandemic has affected every medical specialty.<sup>[1]</sup> Neurological manifestations are increasingly being reported in the context of COVID-19.<sup>[2,3]</sup> For many of these manifestations, a causal association is not clear yet, and could be due to a high prevalence of COVID-19 itself. There is emerging evidence suggesting a poor outcome in patients with neurological manifestations with COVID-19 infection, than those without.<sup>[2,4]</sup> However, structured data on follow-up outcomes in the form of survival and disability among these patients is scarce, and would be needed for prognostication. While there is emerging data on disease-specific outcomes in COVID-19 positive and negative patients,<sup>[5,6]</sup> the overall statistics amongst neurological illnesses is lacking. In addition, the long-term outcome comparison data are also scarce.

We, therefore, conducted an ambispective cohort study in patients with neurological disorders, who presented to the emergency in the early part of the pandemic from August 2020 to December 2020. The outcomes were compared based on COVID-19 positivity (in-hospital mortality, disability, and mortality at 3 months follow-up).

## METHODS

### Study design and participants

This was an ambispective cohort study and included adult patients ( $\geq 18$  years of age) presenting to the hospital emergency inpatient services, with any neurological disorder during the period from April 2020 to September 2020. All the patients were tested for COVID-19 by reverse transcription-polymerase chain reaction (RT-PCR) or cartridge-based nucleic acid amplification test (CBNAAT) in the emergency department. The COVID-19 negative patients were admitted to the

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neurology wards, whereas the COVID-19 positive patients were shifted to the designated COVID-19 center in the same hospital. If a patient was COVID-19 positive during the hospital stay, they were transferred to the COVID-19 center of the hospital. The period of outcome assessment was from August 2020 to January 2021. The data between April to August 2020 were collected from in-patient records, whereas from 1<sup>st</sup> September 2020 all data were collected prospectively. Patients who came for day-care procedures or elective admissions were excluded from the study.

### Data collection

Data on demographic details, presenting neurological complaints, COVID-19-related symptoms, neurological diagnosis, comorbidities, biochemical parameters, imaging findings, cerebrospinal fluid (CSF) findings, treatment, hospital course, readmissions, discharge, and in-hospital mortality were collected. Although all the laboratory test results that were obtained at the baseline or within 24 h of admission were collected, wherever not feasible, the available earliest report from admission was documented. Retrospective data were collected from an online record-keeping system.

The information about the outcome at 3 months ( $\pm 1$  month) after discharge was assessed telephonically. The survival and disability status were done via telephonic modified Rankin Scale (mRS).

### Definitions

Case definitions were used to define a broad neurological diagnosis. The following definitions were used: 1- Stroke (acute ischemic stroke (AIS) and 2- intracranial hemorrhage (ICH)) as an acute neurological deficit with evidence of infarct or hemorrhage, respectively, on imaging. 3-Cerebral Venous Thrombosis (CVT) was defined with evidence of occlusion of venous sinuses on imaging. 4- Meningitis, as a clinical, imaging, and cerebrospinal fluid (CSF) evidence of meningeal involvement. Tuberculous meningitis (TBM) was diagnosed according to the criteria given by Ahuja *et al.*<sup>[7]</sup> 5- Encephalopathy as an altered mental state without clinical, CSF, or imaging evidence of infection. 6- Encephalitis as an altered mental state with evidence of cerebral inflammation – clinically such as seizures, or on imaging and/ or CSF. 7- Uncomplicated seizure: seizure in a patient with or without epilepsy, without alteration in mental status or any other neurological axis involvement. 8- CNS demyelination patients with an acute to subacute presentation, without altered mental status, with evidence of demyelination on brain imaging. 9- Acute demyelinating encephalomyelitis (ADEM) was defined as altered mental status with multifocal white matter involvement, with other causes ruled out. 10- Parkinsonism as the presence of bradykinesia along with at least one of either rigidity, tremor, or postural instability. 11- Cranial neuropathy as isolated or multiple cranial nerve palsies. 12- Myeloradiculopathy as evidence of cord and root involvement based on clinical and imaging findings. 12- Acute polyneuropathy as clinical and/or electrophysiological

evidence of peripheral nerve involvement. 13- Neuromuscular junction disorder as a pure motor weakness with clinical and laboratory features suggestive of a neuromuscular junction involvement. 14- Myositis as clinical and biochemical evidence of muscle involvement. Patients were assigned one broad neurological diagnosis based on the most prominent clinical feature at the time of presentation. Pre-existing or new-onset diagnoses were also noted.

### Standard protocol approvals, registrations, and patient consents

The study received approval from the institute ethics committee (IECPG-523/23.09.2020, RT-16/21.10.2020). The informed verbal consent (as per the ICMR guidelines) was obtained from patients enrolled prospectively as the outcome ascertainment was telephonic. The consent was waived by the Institutional Ethics Committee for patients in whom data were collected retrospectively.

### Statistical analysis

For continuous variables, mean (SD) and median (IQR) were used as measures of central tendency for parametric and nonparametric data, respectively. Categorical variables were reported as number (percent). Paired *t*-test and Mann–Whitney U test were used, respectively to compare parametric and nonparametric data. Categorical variables were tested using  $\chi^2$  test. Missing values were not imputed during the analysis. A two-sided value of  $P < 0.05$  was considered significant. For the outcome analysis at 3 months, shift analysis was performed, *P* value analyzed via Cochran–Mantel–Haenszel test. The data were entered in Microsoft excel sheet, and analyses were carried out with SPSS software (version 22).

## RESULTS

In the period between April and September 2020, there were 235 patients with various neurological illnesses who were admitted from medical emergency services [Figure 1]. Of them, 81 (34.5%) were COVID-19 positive. The mean age of the patients was 49.5 (17.3) years, and the majority of the patients were male (148/235) (63.0%). Demographic, clinical, and laboratory findings of the patients have been outlined in Table 1.

The duration of stay was significantly more in COVID-19 positive patients (COVID-19 positive: 17.0 (8.5;25.0) days versus COVID-19 negative: 8.0 (5.0;17.0), *P* value: 0.002). Amongst the comorbidities, higher proportion of patients with chronic kidney disease (CKD) were COVID-19 positive (COVID-19 positive: 11 (13.8%) versus COVID-19 negative: 4 (2.6%), *P* value: 0.001).

Higher proportion of patients with altered sensorium ranging from delirium to coma were found to be COVID-19 positive (COVID-19 positive: 42 (52.5%) versus COVID-19 negative: 40 (26.0%), *P* value:  $<0.001$ ). The commonest neurological diagnosis was acute ischemic stroke (AIS) (43.0%) followed by intracerebral hemorrhage (ICH) (26.8%) and

meningitis (9.8%). The stroke had a similar prevalence between COVID-19 positive and negative patients. However, a relatively higher proportion of COVID-19 positive patients presented with meningitis (COVID-19 positive: 15 (18.5%) versus COVID-19 negative: 8 (5.2%), *P* value: <0.001). In the COVID-19 positive group, there were two patients with acute bacterial meningitis and one patient with carcinomatous meningitis. There was one cryptococcal meningitis in the COVID-19 negative group. The remaining 19 patients had tuberculous meningitis (TBM). Encephalopathy (COVID-19 positive: 8 (9.9%) versus COVID-19 negative: 3 (1.9%), *P* value: <0.001) was more prevalent in the COVID-19 positive group. COVID-19 positive encephalopathic patients (n = 8) had delirium (n = 2), febrile encephalopathy (n = 1), metabolic encephalopathy (n = 3), hypoxic-ischemic encephalopathy (n = 1), and cerebral malaria along with COVID-19-related encephalopathy (n = 1). Of the COVID-19 negative patients with encephalopathy at presentation (n = 3), two patients had status epilepticus and one had raised intracranial pressure with a brainstem space-occupying lesion. Cerebral venous thrombosis (CVT) was also found to be higher in patients who were COVID-19 positive (COVID-19 positive: 4 (4.9%) versus (COVID-19 negative: 1 (0.6%), *P* value: 0.05), although did not reach statistical significance. One patient had acute disseminated encephalomyelitis (ADEM) and was found to be COVID-19 positive. Neuromuscular disorders in the form of myositis, myasthenia gravis, and Gullian-Barre Syndrome were a small proportion of emergency admissions, and all such patients were COVID-19 negative.

In laboratory parameters, hemoglobin values were lower in COVID-19 positive patients (COVID positive 11.2 (2.7) g/dL versus COVID negative: 12.8 (2.1) g/dL, *P* value <0.001). Urea levels were found to be significantly higher in the COVID-19 positive group (COVID-19 positive: 41.0 (30.0; 41.5) versus COVID-19 negative: 27.0 (20.0; 34.1), *P* value: 0.02). C-reactive protein levels were elevated in both the groups (cut-off value of 0.5 mg/dL), though they were significantly higher in the COVID-19 negative patients in

our cohort (versus COVID-19 positive: 2.1 (0.8; 4.7) versus COVID-19 negative: 5.3 (0.7; 12.4), *P* value: 0.01). The rest of the biochemical parameters were comparable between the two groups [Table 2]. Cerebrospinal fluid examination was done for clinical indications in 33 patients. The median cell count was higher in the COVID-19 positive group (COVID positive 32 (2.5;90) versus COVID negative: 5 (0;5), *P* value: 0.02). Brain imaging in the form of CT head was done in 229 (97.0%) patients. COVID-specific treatment was provided in addition to the neurological medical treatment in the form of hydroxychloroquine (41.5%), doxycycline (20.7%), ivermectin (20.7%), corticosteroids (31.7%), convalescent plasma (14.6%), remdesivir (13.4%), and tocilizumab (13.4%).

The in-hospital mortality was higher in the patients who were COVID-19 positive (COVID-19 positive: 29 (35.8%) versus COVID-19 negative: 12 (7.8%), *P* value: <0.001) [Table 3]. Among 194 patients who were discharged from the hospital, we could contact 73.2% (142/194) of the patients telephonically. There were 4 (12.1%) deaths in COVID-19 positive versus 15 (13.8%) in COVID-19 negative patients (*P* value: 1.00). A lower proportion of COVID-19 positive patients had a favorable telephonic mRS (0–2) at 3 months (COVID-19 positive: 18 (29%) versus COVID-19 negative: 76 (62.8%), *P* value: <0.001). The overall disability assessed at 3 months via telephonic mRS was higher in the COVID-19 positive group (*P* value <0.001) [Figure 2].

## DISCUSSION

Our study found that 34.5% of the patients with neurological diseases were COVID-19 positive in the initial 6 months of the pandemic. Deranged renal functions, systemic symptoms, meningitis, encephalopathy, and CVT were more common in the COVID-19 positive patients. The in-hospital mortality was higher in patients with COVID-19 positivity, although the mortality after discharge, up to 3-month follow-up was similar in both the groups. The overall disability at 3 months was higher in the COVID-19 positive patients.

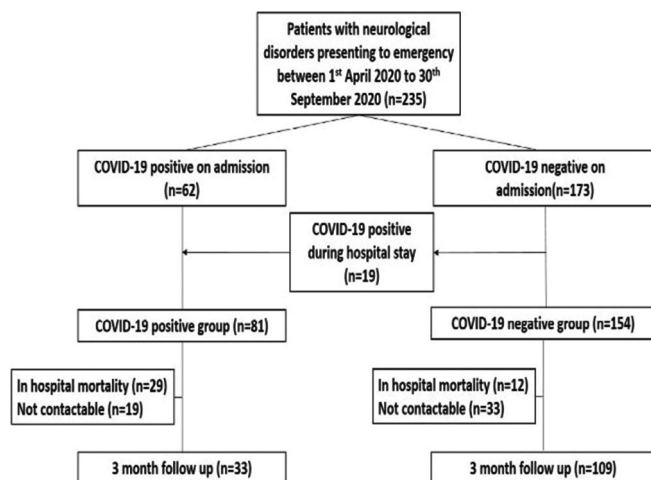


Figure 1: Flow diagram showing patient enrollment and follow-up

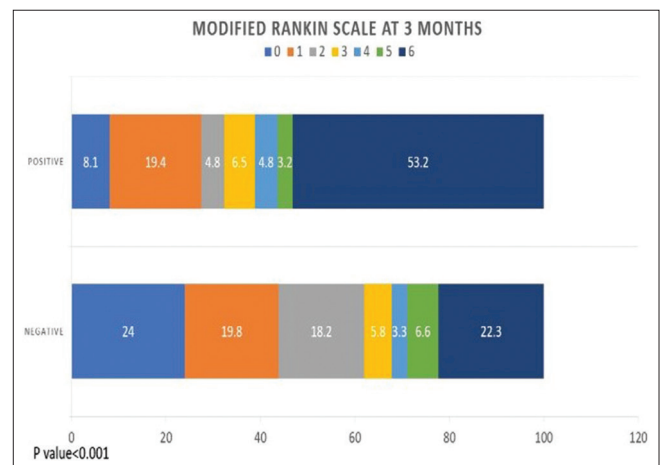


Figure 2: Shift analysis showing modified Rankin Scale (mRS) at 3 months in the COVID-19 positive and COVID-19 negative groups

**Table 1: Clinical features and neurological diagnosis**

	Total (n=235)	COVID-19 positive (n=81)	COVID-19 negative (n=154)	P
Age, years, mean (SD)	49.5 (17.3)	48.2 (18.6)	50.2 (16.6)	0.40
Stay duration (days), median (IQR)	9.0 (5.0; 20.0)	17.0 (8.5; 25.0)	8.0 (5.0;17.0)	0.002
Age >50 years, n (%)	116 (49.4)	38 (46.9)	78 (50.6)	0.59
Sex, male, n (%)	148 (63.0)	44 (54.3)	104 (67.5)	0.05
Hypertension, n (%)	117 (50.0)	38 (47.5)	79 (51.3)	0.58
Diabetes mellitus, n (%)	61 (26.1)	16 (20.0)	45 (29.2)	0.13
Hypothyroidism, n (%)	11 (4.7)	4 (5.0)	7 (4.5)	0.88
Chronic Kidney Disease, n (%)	15 (6.4)	11 (13.8)	4 (2.6)	0.001
Chronic Liver Disease, n (%)	2 (0.9)	0 (0.0)	2 (1.3)	0.31
Coronary Heart Disease, n (%)	13 (5.5)	3 (3.8)	10 (6.5)	0.39
Non-neurological symptoms, n (%)				
Fever	44 (18.7)	33 (40.7)	11 (7.1)	<0.001
Cough/sore throat	18 (7.7)	14 (17.3)	4 (2.6)	<0.001
Shortness of breath	15 (6.4)	11 (13.6)	4 (2.6)	0.001
Chest pain	10 (4.4)	8 (11.0)	2 (1.3)	0.001
Others (anorexia/diarrhea)	18 (7.7)	14 (17.28)	4 (2.6)	<0.001
Neurological symptoms, n (%)				
Headache	74 (32.3)	27 (36.0)	47 (30.5)	0.41
Altered sensorium	82 (35.0)	42 (52.5)	40 (26.0)	<0.001
Dizziness	23 (9.8)	12 (15.0)	11 (7.1)	0.06
Seizure	15 (6.4)	3 (3.8)	12 (7.8)	0.23
Vision loss	9 (3.8)	3 (3.7)	6 (3.9)	0.94
Diplopia	2 (0.9)	0 (0.0)	2 (1.3)	0.30
Dysarthria	76 (32.5)	21 (26.3)	55 (35.7)	0.14
Hemiparesis	132 (56.2)	43 (53.1)	89 (57.8)	0.49
Paraparesis	6 (2.6)	1 (1.2)	5 (3.2)	0.35
Quadriparesis	7 (3.0)	3 (3.7)	4 (2.6)	0.64
Sensory loss	6 (2.6)	3 (3.7)	3 (1.9)	0.42
Myalgia	9 (4.2)	4 (6.1)	5 (3.4)	0.37
Broad Neurological Diagnosis				
Acute Ischemic Stroke (AIS)	101 (43.0)	29 (35.8)	72 (46.8)	0.11
Intracerebral Hemorrhage (ICH)	63 (26.8)	18 (22.2)	45 (29.2)	0.25
Meningitis	23 (9.8)	15 (18.5)	8 (5.2)	0.001
Encephalopathy	11 (4.7)	8 (9.9)	3 (1.9)	0.009
Uncomplicated seizures	8 (3.4)	0 (0.0)	8 (5.2)	0.05
CNS demyelination	7 (3.0)	3 (3.8)	4 (2.6)	0.69
Encephalitis	5 (2.1)	0 (0.0)	5 (3.2)	0.17
Cerebral Venous Thrombosis	5 (2.1)	4 (4.9)	1 (0.6)	0.05
Myeloradiculopathy	3 (1.3)	2 (2.5)	1 (0.6)	0.27
Myositis	3 (1.3)	0 (0.0)	3 (1.9)	0.55
Myasthenia gravis	2 (0.9)	0 (0.0)	2 (1.3)	0.55
Acute Disseminated Encephalomyelitis	1 (0.4)	1 (1.2)	0 (0.0)	0.35
Acute neuropathy	1 (0.4)	0 (0.0)	1 (0.6)	0.47
Cranial neuropathy	1 (0.43)	0 (0)	1 (0.65)	1.00
Parkinsonism	1 (0.4)	1 (1.2)	0 (0.0)	0.35

The mean age of our patients was nearly two decades younger than the other series reported.<sup>[1,4]</sup> This might be a reflection of the difference in mean life expectancy between the countries.<sup>[8,9]</sup> This might be also due to referral bias as younger and sicker patients were triaged to inpatient services. Although there were more patients with neurological COVID-19 with CKD, association with other comorbidities like chronic liver disease, diabetes, hypertension, and coronary heart disease was not found in our study, which is a different finding from

other studies.<sup>[10,11]</sup> This may be because of the small sample size and needs to be explored with more data. Another explanation would be that some patients with systemic disorders and neurological involvement were admitted under medicine and geriatric facilities and therefore under represented in this study.

In our cohort, a significantly higher proportion of COVID-19 positive patients presented with altered sensorium and encephalopathy. This is consistent with other studies.<sup>[4,12]</sup> In

**Table 2: Laboratory characteristics of patients**

	Total (n=235)	COVID-19 positive (n=81)	COVID-19 negative (n=154)	P
Hb, g/dL, (n=215)	12.3 (2.5)	11.2 (2.7)	12.8 (2.1)	<0.001
TLC, per cc, (n=218)	10880.8 (8256.3)	10363.9 (5181.8)	11125.4 (9372.0)	0.53
Neutrophil, per cc, (n=194)	8318.1 (7589.5)	8034.8 (5353.2)	8424.6 (8289.8)	0.75
Lymphocyte, per cc, (n=208)	1626.5 (995.3)	1512.2 (768.4)	1679.7 (1083.1)	0.26
Platelet, per cc, (n=216)	206273.5 (85536.8)	196,250.0 (95784.5)	210,878.9 (80321.7)	0.24
INR (n=209)	1.1 (1.0; 1.2)	1.1 (1.0; 1.2)	1.1 (1.0; 1.2)	0.63
APTT (n=130)	28.0 (26.0; 31.1)	26.0 (24.5; 34.0)	28.0 (25.5; 31.1)	0.10
Urea, mg/dL (n=225)	30.0 (21.0; 44.9)	32.0 (23.5; 63.5)	30.0 (21.0; 39.0)	0.01
Creatinine, mg/dL (n=225)	0.7 (0.6; 1.1)	0.8 (0.5;1.4)	0.7 (0.6; 1.0)	0.06
Total bilirubin, mg/dL (n=193)	0.7 (0.5; 1.2)	0.6 (0.5; 0.7)	0.7 (0.5; 1.1)	0.63
Direct bilirubin, mg/dL (n=142)	0.2 (0.2; 0.4)	0.2 (0.2; 0.3)	0.2 (0.2; 0.4)	0.17
Aspartate transaminase, U/L (n=207)	37.0 (26.0; 52.0)	34.0 (30.0; 38.0)	35.0 (26.0; 52.5)	0.63
Alanine transaminase, U/L (n=208)	30.0 (21.2; 51.0)	26.0 (22.5; 27.5)	29.0 (22.0; 52.5)	0.42
Alkaline phosphatase, mg/dL (n=206)	95.0 (73.7; 124.3)	126.0 (122.5; 132.5)	89.0 (72.0; 111.5)	0.07
Uric acid, mg/dL (n=121)	4.6 (3.4; 5.8)	5.6 (3.9)	4.5 (2.0)	0.05
Lactate dehydrogenase, U/L (n=91)	298.0 (233.0; 372.0)	382.7 (212.5)	291.9 (120.8)	0.07
Erythrocyte sedimentation rate, cm/h (n=55)	36.0 (18.0; 97.0)	31.4 (18.3)	56.9 (38.1)	0.09
C-Reactive Protein, mg/dL (n=128)	3.19 (0.7; 9.1)	2.1 (0.8; 4.7)	5.3 (0.7;12.4)	0.02
D-dimer, mg/L (n=84)	0.5 (0.5; 0.5)	0.5 (0.5; 1.95)	0.5 (0.5; 0.5)	0.22
Total cholesterol, mg/dL (n=59)	106.5 (67.4)	119.4 (30.9)	103.5 (73.1)	0.27
CSF				
TLC (n=33)	5 (0; 54)	18.5 (2.5; 90)	5 (0; 5)	0.02
Proteins (n=27)	70.8 (45.0; 137.0)	56.5 (45.4; 89.0)	80.4 (43.7; 178.7)	0.72
Sugar (n=33)	68.0 (59.5; 92.5)	63.7 (57.0; 78.0)	73.9 (60.7; 102.2)	0.18

**Table 3: In-hospital and 3 months follow up outcomes**

	Total (n=235)	COVID-19 positive (n=81)	COVID-19 negative (n=154)	P
In-hospital mortality	41 (17.4)	29 (35.8)	12 (7.8)	<0.001
	<b>Total (n=142)</b>	<b>COVID-19 positive (n=33)</b>	<b>COVID-19 negative (n=109)</b>	<b>P</b>
Mortality after discharge (n=142)	19 (13.4)	4 (12.1)	15 (13.8)	1.00
	<b>Total (n=183)</b>	<b>COVID-19 positive (n=62)</b>	<b>COVID-19 negative (n=121)</b>	<b>P</b>
Overall mortality at 3 months (n=183)	60 (33.0)	33 (53.2)	27 (22.3)	<0.001
	<b>Total (n=183)</b>	<b>COVID-19 positive (n=62)</b>	<b>COVID-19 negative (n=121)</b>	<b>P</b>
mRS 0-2 at 3 months	94 (51.4)	18 (29.0)	76 (62.8)	<0.001
	<b>Total (n=183)</b>	<b>COVID-19 positive (n=62)</b>	<b>COVID-19 negative (n=121)</b>	
mRS at 3 months	34 (18.6)	5 (8.1)	29 (24.0)	
	36 (19.7)	12 (19.4)	24 (19.8)	
	25 (13.7)	3 (4.8)	22 (18.2)	
	11 (6.0)	4 (6.5)	7 (5.8)	
	7 (3.8)	3 (4.8)	4 (3.3)	
	10 (5.5)	2 (3.2)	8 (6.6)	
	60 (32.8)	33 (53.2)	27 (22.3)	

this study, although cerebral venous sinus thrombosis (CVT) formed just 2.1% of the cohort, there were more patients with CVT who were COVID-19 positive, and this association is not new.<sup>[13]</sup> There were significantly more patients with meningitis who were COVID-19 positive. The co-occurrence of TBM with COVID-19 has been limited to a few cases.<sup>[14,15]</sup> Suppressed immunity can unmask a latent tuberculosis infection in COVID-19 patients and vice versa.<sup>[14-16]</sup>

Amongst the blood biomarkers, we found that low hemoglobin and high urea values were associated with COVID-19 infection in patients with neurological disorders. Higher CRP was found in patients who were COVID-19 negative. One possible explanation for this finding was the uncertainty of CRP values being collected before administration of steroids, which could have given fallaciously low values. Another reason could be a subsequent rise of CRP values in COVID-19

positive patients which was not captured in our study. This is especially so in view of other acute phase reactants like erythrocyte sedimentation rate (ESR), d-dimer values being similar between the two groups.

This study highlights the spectrum of neurological disorders amongst patients presenting to the emergency during the pandemic, differences in clinical presentation and biomarkers in COVID-19 positive and negative groups and information about the in-hospital and 3 months outcome amongst these patients. It also provides insight that the higher in-hospital mortality drives the overall poor outcome in COVID-19 positive patients with neurological manifestations. Once discharged, their disabilities are comparable to COVID-19 negative patients. Strategies towards more aggressive care of COVID-19 patients with neurological manifestations may make this difference, but this needs to be confirmed in larger and future studies. Any imaging or blood biomarkers should also be explored in future studies.

There are several limitations to our study. Due to the logistic constraints during the peak of the COVID-19 pandemic, not all laboratory tests and imaging studies were performed in all patients, though this reflects the best available information in such constrained situations. The disability and outcome assessments were done by telephonic mRS only. More detailed evaluation via Barthel Index, quality of life indices, and nonmotor disability could have added value to the study. Although standard treatment by similar treating teams was provided to both groups of patients, the limited physical access and investigations in the COVID-19 positive group may have influenced the outcomes. Another limitation was that the data was from a single center and there would be selection bias due to many sicker patients getting referred to our tertiary care center. These patients might not be truly representative of the actual population. Lastly, the study was partly retrospective, and there were missing data which may warrant interpreting the findings of the study with caveats.

## CONCLUSION

Our study found that 34.5% of all neurological emergencies were COVID-19 positive during the study period, which was mostly during the initial stages of the pandemic in the country. The higher overall 3 months disability as well as mortality was driven by higher in-hospital mortality in the COVID-19 positive group.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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