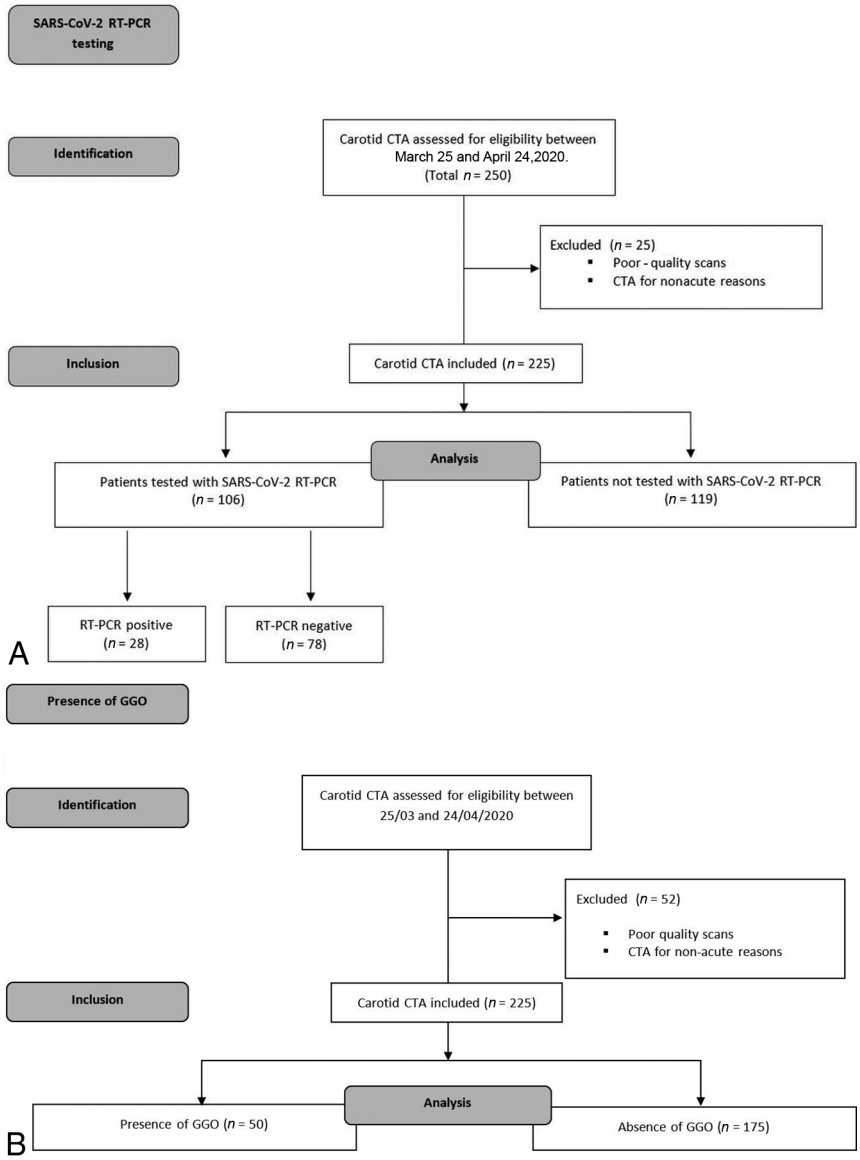
ON-LINE APPENDIX

STROKE VASCULAR IMAGING DEFINITIONS

Carotid occlusion is defined as occlusion of the common carotid artery or the cervical, petrous, or cavernous segments of the internal carotid artery. Large-vessel occlusion is defined as intracranial occlusion of a major intracranial vessel—that is, the distal internal carotid artery (ophthalmic, communicating, choroidal, and terminal segments), vertebral artery (V4) segment, middle cerebral artery (M1), anterior cerebral artery (A1), or posterior cerebral artery (P1). Small-vessel occlusion is defined as vascular occlusion of the middle cerebral artery (M2/3), anterior cerebral artery (A2/3), or posterior cerebral artery (P2/3).

REFERENCES

1. von Elm E, Altman DG, Egger M, STROBE Initiative, et al. **The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies**. *Lancet* 2007;370:1453–55 CrossRef Medline
2. British Society of Thoracic Imaging. **Thoracic Imaging in COVID-19 Infection**. https://www.bsti.org.uk/media/resources/files/BSTI_COVID-19_Radiology_Guidance_version_2_16.03.20.pdf. Accessed June 20, 2020



ON-LINE FIGURE. Study protocol flow chart. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) flow diagrams shows patient inclusion and exclusion criteria in those undergoing SARS-CoV-2 RT-PCR testing and those with positive or negative RT-PCR test results (*A*) and demonstrating the presence or absence of apical GGO (*B*).[1]

On-line Table 1: COVID-19 CT grading criteria[a]

Normal	COVID-19-Typical Lesions	Indeterminate Lesions	Non-COVID-19 Lesions
COVID-19 not excluded; correlate with RT-PCR	CT: >1 peripheral, bilateral, focal area of ground-glass opacity ± crazy paving ± peripheral consolidation	Fits neither COVID-typical nor non-COVID descriptors	Lobar pneumonia Cavitating infections Lymphadenopathy Effusions Established pulmonary fibrosis Pulmonary edema Diffuse ground-glass opacity

[a] Grading criteria for COVID-19-typical, indeterminate, and non-COVID-19 apical CTA assessments based on the BSTI COVID-19 Radiology Guidance.[2] Grading criteria were adapted from the BSTI COVID-19 Radiology Guidance, following a consensus meeting among the neuroradiologist raters and the expert chest radiologist before grading. The COVID-19-typical category was adapted to remove the term "lower lobe predominance," because only apices were to be assessed. Diffuse ground-glass opacity was added to the non-COVID-19 category to ensure that pulmonary edema was not graded as COVID-19-typical or indeterminate.

On-line Table 2: Baseline characteristics of 2019 and 2020 cohorts ($n = 450$)[a]

	2019 ($n = 225$)	2020 ($n = 225$)	*P* Value
Patient demographics			
Age (yr)	68.9 ± 16·.6	67.4 ± 16.3	.29
Sex, male	55.1% (124/225)	61.3% (138/225)	.18
Stroke parameters			
NIHSS	6.5 ± 7.4 ($n = 222$)	6.9 ± 7.2 ($n = 222$)	.41
ASPECTS (median) (range)	10 (2–10)	10 (0–10)	.11
Time from onset to CTA (median) (IQR) (min)	330 (128–1115)	253 (140–753)	.34
Carotid occlusion[b]	4.0% (9/225)	6.2% (14/225)	.28
Large-vessel occlusion[b]	9.3% (21/225)	10.7% (24/225)	.64
Small-vessel occlusion[b]	12.0% (27/225)	12.0% (27/225)	1.00
Presence of infarct	22.2% (50/225)	24.4% (55/225)	.58
Hemorrhage	6.7% (15/225)	5.8% (13/225)	.70
Treatment			
Thrombolysis	12.0% (27/225)	14.7% (33/225)	.41
Thrombectomy	2.2% (5/225)	4.0% (9/225)	.28
Outcome			
Death (30 days after presentation)	6.2% (14/225)	8.4% (19/225)	.37
Length of stay (day)	9.8 ± 22.6 ($n = 225$)	4.8 ± 6.2 ($n = 218$)	.15
Length of stay of survivors (day)	9.7 ± 22.9 ($n = 211$)	4.4 ± 6.1 ($n = 199$)	.04[c]
Imaging findings on CTA			
GGO present	14.2% (32/225)	22.2% (50/225)	.03[c]
COVID-19 typical[d]	0.0% (0/32)	28.0% (14/50)	<.001[c]
Indeterminate[d]	6.2% (2/32)	24.0% (12/50)	<.001[c]
Non-COVID-19[d]	93.4% (30/32)	48.0% (24/50)	<.001[c]
Lung included on CTA (cm)	7.84 ± 2.1	7·80 ± 2.7	.41

Note:—IQR indicates interquartile range.
[a] Data are mean ± SD or % (No./No.) or, where specified, median (IQR).
[b] Stroke vascular imaging definitions are listed above.
[c] *P* value <.05.
[d] COVID-19 CT imaging definitions are listed in On-line Table 1.

On-line Table 3: Interrater agreement of CTA findings ($n = 225$)[a]

Readers[b]	Presence of GGO	Focal GGO	Bilateral GGO	Peripheral GGO	COVID-19-Typical/Indeterminate/ Non-COVID-19 and Healthy
1, 2, 3, 4	0.81 (0.68–0.95)	0.90 (0.80–1.00)	0.98 (0.87–1.0)	0.87 (0.78–0.98)	0.74 (0.64–0.84)
1, 2 ,3, 4, 5	NA	NA	NA	NA	0.65 (0.60–0.71)

Note:—NA indicates not applicable.
[a] Fleiss κ (95% CI).
[b] 1, 2 ,3, 4 indicate neuroradiologists; 5, thoracic radiologist.

On-line Table 4: Clinical and imaging characteristics in patients tested for SARS-CoV-2 ($n = 106$)[a]

	Negative SARS-CoV-2 RT-PCR ($n = 78$)	Positive SARS-CoV-2 RT-PCR ($n = 28$)	*P* Value
Patient demographics			
Age (yr)	71.9 ± 15.5	69.3 ± 12.8	.26
Sex, male	57.7% (45/78)	64.3% (18/28)	.54
Stroke parameters			
NIHSS	9.0 ± 7.5 ($n = 78$)	11.2 ± 8.5 ($n = 25$)	.30
ASPECTS (median) (range)	10 (0–10)	10 (5–10)	.16
Carotid occlusion[b]	5.1% (4/78)	14.3% (4/28)	.20
Large-vessel occlusion[b]	17.9% (14/78)	10.7% (3/28)	.55
Small-vessel occlusion[b]	12.8% (10/78)	10.7% (3/28)	1.00
Presence of an infarct	33.3% (26/78)	14.3% (4/28)	.56
Hemorrhage	7.7% (6/78)	7.1% (2/28)	1.00
Symptoms at or immediately before the time of CTA			
Subjective fever	11.5% (9/78)	21.4% (6/28)	.22
Cough	25.6% (20/78)	39.3% (11/28)	.17
Headache	9.0% (7/78)	3.6% (1/28)	.68
Nausea/anorexia	5.1% (4/78)	14.3% (4/28)	.20
Abdominal pain	3.8% (3/78)	0.0% (0/28)	.56
New altered mental state	16.7% (13/78)	7·1% (2/28)	.34
Signs at or immediately before the time of CTA			
Heart rate (per min)	83.9 ± 18.3 ($n = 77$)	92.4 ± 20.7 ($n = 26$)	.09
Respiratory rate (per min)	18.9 ± 4.1 ($n = 77$)	21.8 ± 8.9 ($n = 26$)	.09
Systolic blood pressure (mm Hg)	151.7 ± 28.3 ($n = 77$)	143.5 ± 26.8 ($n = 26$)	.29
Diastolic blood pressure (mm Hg)	83·2 ± 16.5 ($n = 77$)	78.2 ± 13.2 ($n = 26$)	.13
Temperature (highest recorded) (°C)	36·7 ± 0.6 ($n = 77$)	37.8 ± 0.8 ($n = 25$)	.91
Oxygen saturation (%)	96.9 ± 2.5 ($n = 75$)	95.4 ± 4.0 ($n = 26$)	.04[c]
Comorbidities and relevant medication			
Hypertension	66.7% (52/78)	60.7% (17/28)	.57
Diabetes	32.1% (25/78)	50.0% (14/28)	.09
Cardiovascular disease	20.5% (16/78)	14.3% (4/28)	.47
Atrial fibrillation	25.6% (20/78)	14.3% (4/28)	.22
Hypercholesterolemia	37.2% (29/78)	39.3% (11/28)	.84
History of stroke/TIA/MI	32.1% (25/78)	21.4% (6/28)	.29
Smoking	29.9% (23/77)	14.3% (4/28)	.11
Obesity	25.6% (20/78)	17.9% (5/28)	.41
Ethnicity (white)	58.7% (44/75)	4.4% (12/27)	.20
ACEI/A2 medication	25.6% (20/78)	21.4% (6/28)	.66
Immunosuppressive medication	2.6% (2/78)	3.6% (1/28)	1.00
Imaging findings on CTA			
GGO present	19.2% (15/78)	7.0% (21/28)	<.001[c]
Focal lesions	10.3% (8/78)	46.4% (13/28)	<.001[c]
Bilateral lesions	17.9% (14/78)	57.1% (16/28)	<.001[c]
Peripheral lesions	11.5% (9/78)	67.9% (19/28)	<.001[c]
COVID-19-typical and indeterminate lesions[d]	7.7% (6/78)	64.3% (18/28)	<.001[c]
Lung included on CTA (cm)	7.38 ± 2.5	7.87 ± 2.8	.39
Treatment			
Thrombolysis	12.8% (10/78)	32.1% (9/28)	.02[c]
Thrombectomy	5.1% (4/78)	3.6% (1/28)	1.00
Outcome			
Death (30 days after presentation)	7.7% (6/78)	28.6% (8/28)	.01[c]
Length of stay (days)	7.2 ± 6·4	9.25 ± 7.7	.20
Length of stay of survivors (days)	6.9 ± 6.4 ($n = 65$)	9.1 ± 8.3 ($n = 20$)	.34

Note:—ACEI/A2 indicates angiotensin-converting-enzyme inhibitors/angiotensin II receptor blocker; MI, myocardial infarction.

[a] Data are mean ± SD or % (No./No.) or, where specified, median (range).

[b] Stroke vascular imaging definitions are listed in On-line Appendix.

[c] *P* value <.05.

[d] COVID-19 CT imaging definitions are listed in On-line Table 1.

On-line Table 5: Multivariate analysis using demographic and clinical features to determine the likelihood of the presence of GGO ($n = 225$)[a]

	OR	OR (95% CI)	*P* Value
Carotid occlusion[b]	6.82	1.97–23.53	.002[c]
Subjective fever	4.38	1.32–14.52	.02[c]
Cough	0.99	0.33–2.53	.86
Respiratory rate	1.07	0.98–1.18	.13
Oxygen saturation	0.81	0.69–0.95	.009[c]

[a] With regard to the number of cases with GGO (50/225), only the 5 most discriminant characteristics from the univariate analysis ($P \leq .01$) were included. If all 11 variables ($P \leq .20$) were included in the model, the significant predictors of GGO (≤.05) were subjective fever, oxygen saturation, carotid occlusion, and sex, but these findings are at an increased risk of bias in the OR estimation.
[b] Stroke vascular imaging definitions are listed above.
[c] *P* value <. 05.

On-line Table 6: Multivariate Cox proportional hazards model of survival[a]

	Hazard Ratio	Hazard Ratio (95% CI)	*P* Value
Oxygen saturation	0.98	0.97–1.00	.03
Presence of GGO	3.51	1.42–8.66	.006

[a] Cox regression was used to determine the independent risk factors associated with 30-day mortality. Given that the total deaths in our study were 19/225, only the most discriminant signs or symptoms were included from both the univariate analyses of GGO presence and the univariate analyses of SARS-CoV-2 to give 2 variables ($P \leq .001$). If all 5 significant variables ($P \leq .05$) were included in the model, carotid occlusion was significantly associated with decreased survival ($P = .003$) in addition to oxygen saturation and GGO, but these findings are at an increased risk of bias in the hazard ratio estimation.

On-line Table 7: Clinical and imaging characteristics in patients with and without apical GGO ($n = 225$)[a]

	Absence of GGO ($n = 175$)	Presence of GGO ($n = 50$)	*P* Value
Patient demographics			
Age (yr)	66.8 ± 16.7	69.6 ± 14.2	.43
Sex, male	64% (112/175)	52% (26/50)	.12
Stroke parameters			
NIHSS	6.2 ± 6.7 (174/175)	9.4 ± 8.5 (48/50)	.02[b]
ASPECTS (median) (range)	10 (0–10)	10 (0–10)	.92
Carotid occlusion	3.4% (6/175)	16.0% (8/50)	.004[b]
Large-vessel occlusion	10.9% (19/175)	10.0% (5/50)	.86
Small-vessel occlusion	12.6% (22/175)	10.0% (5/50)	.66
Presence of infarct	25.1% (44/175)	22.0% (11/50)	.65
Hemorrhage	5.7% (10/175)	6.0% (3/50)	1.00
Symptoms at or immediately before the time of CTA			
Subjective fever	4.6% (8/175)	18.0% (9/50)	.004[b]
Cough	13.1% (23/175)	32.0% (16/50)	.002[b]
Headache	13.7% (24/175)	4.0% (2/50)	.06
Nausea/anorexia	6.9% (12/175)	10.0% (5/50)	.54
Abdominal pain	1.1% (2/175)	2.0% (1/50)	.53
New altered mental state	10.9% (19/175)	12.0% (6/50)	.82
Signs at or immediately before CTA			
Heart rate (per min)	80.7 ± 15.4 ($n = 171$)	87.0 ± 21.4 ($n = 48$)	.16
Respiratory rate (per min)	18.3 ± 3.3 ($n = 168$)	20.5 ± 7.1 ($n = 48$)	.005[b]
Systolic blood pressure (mm Hg)	152.8 ± 27.7 ($n = 172$)	149.1 ± 32.4 ($n = 47$)	.31
Diastolic blood pressure (mm Hg)	83.9 ± 17.0 ($n = 172$)	80.7 ± 15.5 ($n = 47$)	.27
Temperature (highest recorded) (°C)	36.62 ± 0.6 ($n = 171$)	36.72 ± 0.8 ($n = 46$)	.43
Oxygen saturation (%)	97.5 ± 2.0 ($n = 168$)	95.8 ± 3.4 ($n = 48$)	<.001[b]
Comorbidities and relevant medication			
Hypertension	57.1% (100/175)	64.0% (32/50)	.39
Diabetes	28.0% (49/175)	38.0% (19/50)	.17
Cardiovascular disease	14.3% (25/175)	24.0% (12/50)	.10
Atrial fibrillation	16.6% (29/175)	16.0% (8/50)	.92
Hypercholesterolemia	32.6% (57/175)	42.0% (21/50)	.22
History of stroke/TIA/MI	24.6% (43/175)	28.0% (14/50)	.62
Smoking	25.9% (45/174)	18.0% (9/50)	.25
Obesity	20.0% (35/175)	24.0% (12/50)	.54
Ethnicity (white)	67.0% (111/165)	66.0% (31/47)	.91
ACEI/A2 medication	25.7% (45/175)	24.0% (12/50)	.81
Immunosuppressive medication	1.1% (2/175)	2.0% (1/50)	.53
Imaging findings			
Lung included on CTA (cm)	7.72 ± 2·7	8.06 ± 2.5	.36
Treatment			
Thrombolysis	13.1% (23/175)	20.0% (10/50)	.23
Thrombectomy	4.6% (8/175)	20.0% (1/50)	.69
Outcome			
Death (30 days after presentation)	5.7% (10/175)	18.0% (9/50)	.02[b]
Length of stay (days)	4.1 (169/175)	6.9 (49/50)	.001[b]
Length of stay of survivors (day)	3.8 ± 5.8 ($n = 159$)	6.6 ± 6.8 ($n = 40$)	.004[b]

[a] Data are mean ± SD or % (No./No.) or, where specified, median (range).
[b] *P* value <.05.