



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

advancement in their careers. The Accreditation Council for Graduate Medical Education has recognized the reduction in patient volume in addition to the redeployment of training staff to support critical services.² Due to these changes, there is a concern among fellows that the time period away from the cardiac catheterization laboratory may impede their ability to hone their skill set.

In summary, there appears to be an overall decline in the number of cardiac catheterization laboratory procedures performed during the COVID-19 pandemic consistent with previously published studies 3 to 5.

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

We are grateful to Meera Kondapaneni, MD and Sanjay Gandhi, MD for their assistance in data procurement.

Sabeeda Kadavath, MD^{a,1}
 Jay Mohan, DO^{b,1}
 Said Ashraf, MD^{c,1}
 Adnan Kassier, MD^d
 Dalia Hawwass, MD^e
 Nidhi Madan, MD, MPH^f
 Negar Salehi, MD^a
 Marie Bernardo, MD^g
 Sagger Mawri, MD, MS^h
 Karim Abdur Rehman, MD^{i,*}
 Lina Ya'qoub, MD^j
 Aaron Strobel, MD^k
 Simon R. Dixon, MBChB^b
 Aisha Siraj, MD^l
 John Messenger, MD^k
 James R. Spears, MD^g
 Angel Lopez-Candales, MD^a
 Ryan Madder, MD^d
 Steven R. Bailey, MD^j
 Khaldoon Alaswad, MD^h
 Michael C. Kim, MD^c
 Robert D. Safian, MD^b
 M. Chadi Alraies, MD MPH^c

^a Division of Cardiovascular Medicine, University of Arkansas for Medical Sciences, Little Rock, Arkansas

^b Department of Cardiovascular Medicine, Beaumont Hospital Royal Oak, Royal Oak, Michigan

^c Division of Cardiology, Wayne State University, Detroit Medical Center, Detroit, Michigan

^d Spectrum Health, Michigan State University, Frederik Meijer Heart & Vascular Institute, Grand Rapids, Michigan

^e Department of Cardiology, Lenox Hill Hospital, Northwell Health Medical Centers, New York, New York

^f Department of Cardiology, Rush University Medical Center, Chicago, Illinois

^g Cardiology Division, Beaumont Hospital Dearborn, Dearborn, Michigan

^h Heart and Vascular Institute, Henry Ford Hospital, Detroit, Michigan

ⁱ Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio

^j Department of Cardiology, Ochsner-Louisiana State University, Shreveport, Louisiana

^k Cardiology Division, University of Colorado, Aurora, Colorado

^l Cardiovascular Division, Case Western Reserve University/MetroHealth Medical Center Campus, Cleveland, Ohio

¹ These authors contributed equally in the article.

1. Nasca TJ, CDC. *Coronavirus Disease 2019 (COVID-19)* [Internet]. Centers for Disease Control and Prevention; 2020. <https://www.cdc.gov/coronavirus/2019-ncov/>.
2. Nasca TJ, CDC. *ACGME Response to the Coronavirus (COVID-19)*. 2020. <https://acgme.org/Newsroom/Newsroom-Details/ArticleID/10111/ACGME-Response-to-the-Coronavirus-COVID-19>.
3. Rodriguez-Leor Oriol, Cid-Alvarez B, Ojeda S, Martin-Moreiras J, Rumoroso JR, Lopez-Palop R, Serrador A, Cequier A, Romaguera R, Cruz I, Prado P, Moreno R. Impact of the COVID-19 pandemic on interventional cardiology activity in Spain. *Rec Interv Cardiol* 2020;2:82–89.
4. Garcia S, Albaghdadi MS, Meraj PM, Schmidt C, Garberich R, Jaffer FA, Dixon S, Rade JJ, Tannenbaum M, Chambers J, Huang P, Henry T reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 pandemic. *J Am Coll Cardiol* 2020;75. (in press). <https://doi.org/10.1016/j.jacc.2020.04.011>.
5. De Filippo O, D'Ascenzo F, Angelini F, Bocchino PP, Conrotto F, Saggietto A. Reduced rate of hospital admissions for ACS during COVID-19 outbreak in northern Italy. *N Engl J Med* 2020;383:88–89. <https://doi.org/10.1056/NEJMc2009166>.

<https://doi.org/10.1016/j.amjcard.2020.06.009>

Prevalence and Outcomes of Acute Ischemic Stroke Among Patients ≤50 Years of Age With Laboratory Confirmed COVID-19 Infection

The COVID-19 epidemic has led to an unprecedented disruption in health care systems worldwide. Concerns have been recently raised about young patients with COVID-19 presenting with large ischemic strokes.¹ Data on stroke in COVID-19 patients remain

limited to a few case reports.¹ In this focused analysis, we investigated the incidence and outcomes of acute ischemic stroke in young adults using a multinational database.

We queried the TriNetx Research Network to select patients <50 years of age with laboratory confirmed COVID-19 infection between January 20, 2020 to April 24, 2020. Patients were identified as COVID-19 positive if they had a billable code for COVID-19 and had an associated positive laboratory confirmation of the infection (eTable-1). TriNetX is a global federated health research network providing access to statistics on electronic medical records (diagnoses, procedures, medications, laboratory values, genomic information) from patients in predominately large healthcare organizations. The TriNetx database (COVID-19 Research Network) is a network of 37 global healthcare organizations (36% based in the United States [US] and 64% outside of the US). The diagnosis of acute ischemic stroke was established via validated international classification of diseases 10th revision diagnosis codes.² Descriptive statistics were presented as frequencies with percentages for categorical variables and as mean ± standard deviation for continuous measures. Baseline characteristics were compared using a Pearson chi-squared test for categorical variables and an independent-samples *t* test for continuous variables. All-cause mortality was displayed in the 2 cohorts using the Kaplan Meier method, and statistical significance of the differences between the 2 groups were assessed with the Log-Rank Test.

A total of 9,358 COVID-19 positive patients age ≤50 years of age were identified in the database, of whom 33.2% were hospitalized for severe symptoms. The incidence of acute ischemic stroke was 64/9,358 (0.7%). Compared with patients who did not experience a stroke, those with acute ischemic strokes were older (39.3 ± 9.0 vs 36.7 ± 8.5 years, *p* < 0.001), but had similar proportions of females (60.9% vs 60.4%, *p* = 0.93). They, however, had higher prevalence of key comorbidities: hypertension (61.0% vs 11.7%); diabetes (32.8% vs 6.5%); heart failure (15.6% vs 1.5%), nicotine dependence (34.4% vs 5.9%); obesity (46.9% vs 17.4%); chronic obstructive



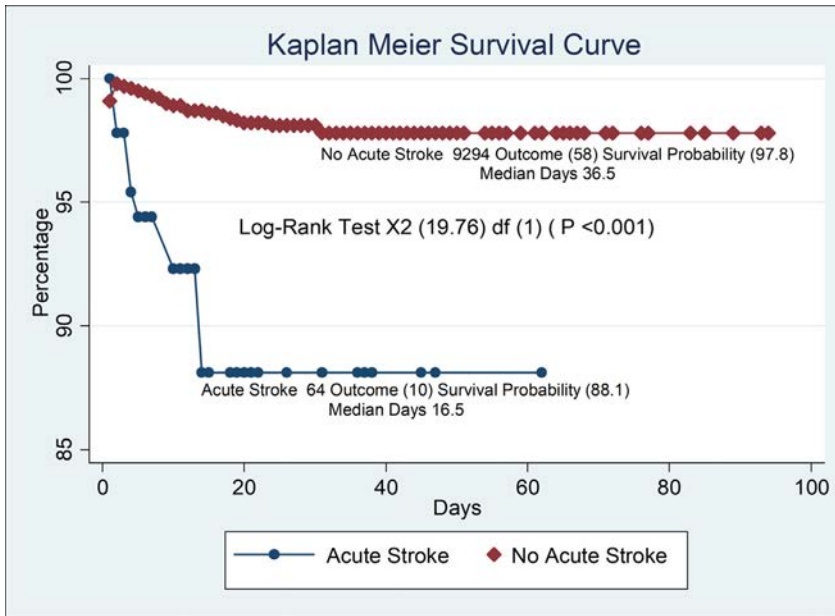


Figure 1. Kaplan meier survival analysis of young adults with COVID-19 with or without stroke.

lung disease (15.6% vs 1.0%); prior history of stroke (28.1% vs 0.5); and renal insufficiency (15.6% vs 2.0%), $p < 0.001$ for all. Median follow up was 16.5 days in the stroke cohort and 36.5 days in the no stroke cohort. All-cause mortality occurred in 10/64 patients (15.6%) in the stroke cohort vs. 58/9,294 patients (0.6%) in the no stroke cohort. In the Kaplan Meier survival analysis, patients with stroke had significantly lower odds of survival compared with those without stroke (p -log rank < 0.001) (Figure 1).

To our knowledge, this is the first study to report the incidence and outcomes of acute ischemic stroke in young adults with COVID-19 infection. We found a low overall incidence but a grim prognosis of acute ischemic stroke among unselected young adults with COVID-19. The findings of this analysis need to be interpreted in the context of its limitations. Due to the nature of this observational database, it is not possible to distinguish whether patients presented with strokes then tested positive for COVID-19 or vice versa. Also,

given the lack of a control arm without COVID-19, these findings cannot confirm an association between COVID-19 and increased risk of ischemic stroke especially with the higher prevalence of comorbidities in the stroke cohort.

Disclosures

No relevant disclosures.

Frank Annie, PhD^a

Mark C. Bates, MD, DSc^{a,b}

Aravinda Nanjundappa, MD^{a,b}

^a Charleston Area Medical Center Institute (CAMC) for Academic Medicine and CAMC Health, Education and Research Institute, Charleston, West Virginia

^b West Virginia University, Charleston Division, Charleston, West Virginia

Deepak L. Bhatt, MD, MPH

Brigham and Women's Hospital Heart & Vascular Center, Harvard Medical School, Boston, Massachusetts

Mohamad Alkhouli, MD*

Department of Cardiovascular Medicine, Mayo Clinic, Rochester, Minnesota
12 May 2020

1. Oxley TJ, Mocco J, Majidi S, Kellner CP, Shoirah H, Paul Singh I, De Leacy RA, Shigematsu T, Ladner TR, Yaeger KA, Skliut M, Weinberger J, Dangayach NS, Bederson JB, Tuhim S, Fifi JT. Large-vessel stroke as a presenting feature of Covid-19 in the young. *N Engl J Med* 2020.
2. Alhajji M, Kawsara A, Alkhouli M. Validation of acute ischemic stroke codes using the international classification of diseases tenth revision. *Am J Cardiol* 2020;125:1135.

<https://doi.org/10.1016/j.amjcard.2020.06.010>