

ORIGINAL RESEARCH

Trends in academic productivity in the COVID-19 era: analysis of neurosurgical, stroke neurology, and neurointerventional literature

Jae Eun Lee ¹, Alina Mohanty ¹, Felipe C Albuquerque,² William T Couldwell,³ Elad I Levy ^{4,5}, Edward C Benzel,⁶ Ajay K Wakhloo,⁷ Joshua A Hirsch ⁸, David Fiorella ^{9,10}, Kyle M Fargen ¹¹, Jan-Karl Burkhardt,^{1,12} Visish M Srinivasan,¹ Jeremiah Johnson ¹, Maxim Mokin ¹³, Peter Kan¹⁴

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/neurintsurg-2020-016710>).

For numbered affiliations see end of article.

Correspondence to

Dr Peter Kan, Department of Neurosurgery, University of Texas Medical Branch, Galveston, TX 77555, USA; ptkan@utmb.edu

Received 4 August 2020
Revised 5 September 2020
Accepted 15 September 2020
Published Online First
30 September 2020

ABSTRACT

Background Academic physicians aim to provide clinical and surgical care to their patients while actively contributing to a growing body of scientific literature. The coronavirus disease 2019 (COVID-19) pandemic has resulted in procedural-based specialties across the United States witnessing a sharp decline in their clinical volume and surgical cases.

Objective To assess the impact of COVID-19 on neurosurgical, stroke neurology, and neurointerventional academic productivity.

Methods The study compared the neurosurgical, stroke neurology, and neurointerventional academic output during the pandemic lockdown with the same time period in previous years. Editors from a sample of neurosurgical, stroke neurology, and neurointerventional journals provided the total number of original manuscript submissions, broken down by months, from the year 2016 to 2020. Manuscript submission was used as a surrogate metric for academic productivity.

Results 8 journals were represented. The aggregated data from all eight journals as a whole showed that a combined average increase of 42.3% was observed on original submissions for 2020. As the average yearly percent increase using the 2016–2019 data for each journal exhibited a combined average increase of 11.2%, the rise in the yearly increase for 2020 in comparison was nearly fourfold. For the same journals in the same time period, the average percent of COVID-19 related publications from January to June of 2020 was 6.87%.

Conclusion There was a momentous increase in the number of original submissions for the year 2020, and its effects were uniformly experienced across all of our represented journals.

all elective surgeries by executive order⁵ to help to reduce the burden on the healthcare system during the pandemic.⁶

Surveys of physicians across varied specialties have unanimously demonstrated marked disruptions in clinical practice due to the pandemic.^{7–10} Interestingly, these disruptions encompass not only elective procedural volumes but also reductions in urgent and emergent procedures. Studies have reported decreased admissions for ischemic stroke,¹¹ a substantial reduction in mechanical thrombectomy volumes,¹² and a sharp decline in the number of stroke imaging evaluations at the height of the pandemic.¹³ In a nationwide survey of US neurointerventionalists, over three-quarters of respondents similarly reported greater than 25% reductions in emergent procedures during the pandemic, with over two-thirds of respondents reporting greater than 50% reductions in overall procedural volumes.¹⁴ Additionally, many institutions and departments have attempted to mitigate the risk of exposure to physicians by using telehealth for clinic visits, postponing non-urgent clinic visits, and reducing the number of physicians carrying out rounds or examining patients in hospital facilities. These factors combined have created an unprecedented situation, where many physicians have faced dramatically reduced clinical and surgical responsibilities. The present study explored whether the restrictions of the pandemic offered academic neurosurgeons, stroke neurologists, and neurointerventionalists opportunities for increased participation in academic activity during the pandemic lockdown period, as reflected by submission of manuscripts.

INTRODUCTION

On January 20, 2020, the first case of the novel coronavirus disease 2019 (COVID-19) in the United States was confirmed.¹ The World Health Organization subsequently declared COVID-19 a global pandemic, and on March 13, 2020 the American College of Surgeons recommended the cessation of elective surgeries and the triaging of remaining cases by the level of acuity.^{2–4} The recommendation was cemented across the United States when surgical departments were required to cancel

METHODS

Editors who serve as representatives of a spectrum of clinical journals in neurosurgery, stroke neurology, and neurointerventional surgery were invited to participate voluntarily in this study. Manuscript submission was used as a surrogate metric for academic productivity. Respondents provided the total number of original manuscript submissions, organized monthly from January to June, from the year 2016 to 2020. The pandemic lockdown period was defined as March to May 2020, when



© Author(s) (or their employer(s)) 2020. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Lee JE, Mohanty A, Albuquerque FC, et al. *J NeuroIntervent Surg* 2020;**12**:1049–1052.

a significant surge in infections was encountered in the north-east and west of the United States. A total of eight neurosurgical, stroke, and neurointerventional journals were represented: *Neurosurgery*, *Journal of Neurosurgery*, *Journal of Neurosurgery: Spine*, *Journal of Neurosurgery: Pediatrics*, *American Journal of Neuroradiology*, *Journal of NeuroInterventional Surgery*, *Stroke*, and *World Neurosurgery*. For the *American Journal of Neuroradiology*, *Journal of NeuroInterventional Surgery*, *Journal of Neurosurgery*, *Journal of Neurosurgery: Spine*, and *Journal of Neurosurgery: Pediatrics*, the total number of rejections by month for the same time period were also provided. Total number of submissions by month were plotted on a line graph, and the results were separated by year. Statistical analysis using a linear regression model was performed using R (version 3.4.3, Vienna, Austria), in order to obtain the projected submissions during the pandemic lockdown based on previous submissions from 2016 to 2019. Rejection rates were analyzed using two-sample Student's t-test, with significance set at $p < 0.05$. To shed light on how much of a given surge was due to topics related to COVID-19, an online search was performed using each journal's respective website with attention paid to topic and the date of online publication.

RESULTS

Eight academic clinical journals to which neurosurgeons, stroke neurologists, and neurointerventionalists tend to submit material were represented. Our study included each of the top six neurosurgical, stroke neurology, and neurointerventional journals as defined by Google Scholar Metrics which uses h5-index for articles published in the last five complete years. All of the journals exhibited a marked increase in the number of original submissions for the year of 2020, particularly during the pandemic lockdown period from March to May (figure 1). The average yearly percent increase using the 2016–2019 data for each journal was calculated and compared with the percent increase for 2020 (table 1; figure 2).

Percentages denote the observed percent increase from 2019 to 2020, the average 2016–2019 yearly percent increase, and the proportion of COVID-19 related articles to the total count of published articles from January 1 to June 30, 2020 for each journal. Ratio denotes the 2020 increase over the average yearly 2016–2019 increase.

Submission rejection rate

Additionally, the total number of rejections for the same time period were provided by five journals. For the *Journal of NeuroInterventional Surgery*, the rejection rate for 2020 was 61.5%, similar to the 58.5% rejection rate for 2019 submissions (figure 3). For the *American Journal of Neuroradiology*, the rejection rate in original submissions for 2020 was 59.5%, lower than the average yearly rejection rate of 67.9%. For the *Journal of Neurosurgery*, the 2020 rejection rate was 73.5%, higher than the yearly rejection rate of 62.5%. For *JNS: Spine* and *JNS: Pediatrics*, the 2020 rejection rates were 69.0% and 54.0%, respectively, while their historical average rejection rates were 66.1% and 43.2%, respectively. The combined average rejection rate for 2020 was 63.5%, just 2.1% higher than the 2019 combined average rejection rate of 61.4%. These journals did not exhibit a statistically significant change in their rejection rates for 2020 compared with their previous years of 2016–2019 ($p = 0.387$).

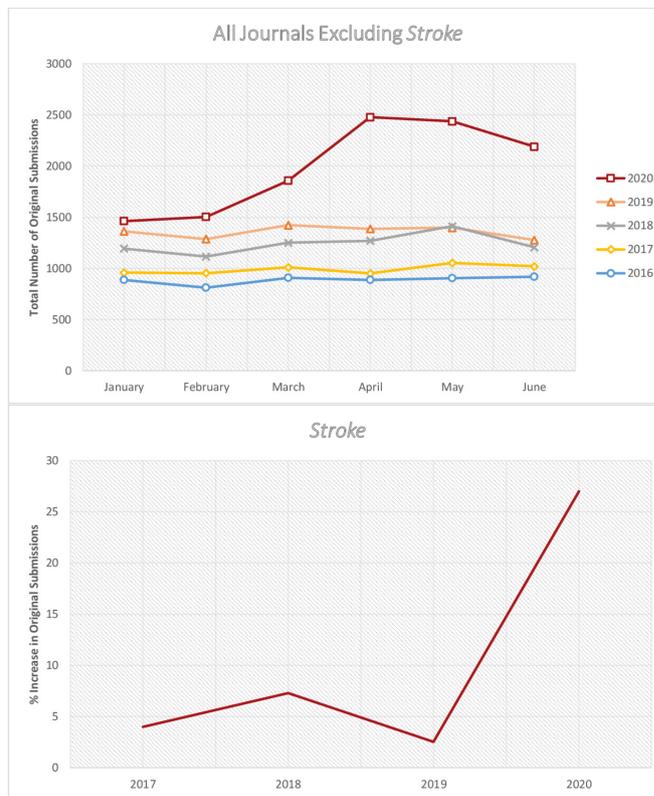


Figure 1 Trends in the number of original submissions by month and year from January to June of 2016–2020. Combined submissions data from seven neurosurgery, stroke neurology, and neurointerventional journals displayed as a graph for the first half of the year for the past 5 years. Limited data were provided for stroke.

All journals aggregated

Looking at the aggregated data from all eight journals as a whole, the combined average increase of 42.3% in their original submissions for 2020 was markedly higher than the average increase of 11.2% exhibited in their previous years. While the projections from the 2016–2019 data for 2020 submissions were modeled graphically, the stark difference between the forecast and actual value from the graph shows that the submissions for

Table 1 Data for percent 2020 increase, average yearly 2016–2019 increase, proportion of observed over expected, and percent of COVID-19 related articles by journal

Journals	Observed 2020 increase	Average yearly increase of 2016–2019	Observed/Expected	COVID-19 related articles
<i>Neurosurgery</i>	27.3%	11.3%	2.42	15.1%
<i>Journal of Neurosurgery</i>	36.4%	3.60%	10.1	8.37%
<i>American Journal of Neuroradiology</i>	41.2%	4.38%	9.41	8.58%
<i>Journal of NeuroInterventional Surgery</i>	31.6%	18.2%	1.74	9.30%
<i>JNS: Spine</i>	62.0%	3.02%	20.5	2.26%
<i>JNS: Pediatrics</i>	55.0%	3.31%	16.6	2.91%
<i>Stroke</i>	27.0%	4.59%	5.88	2.62%
<i>World Neurosurgery</i>	57.6%	41.4%	1.39	5.82%
Total (mean)	42.3%	11.2%	8.51	6.87%

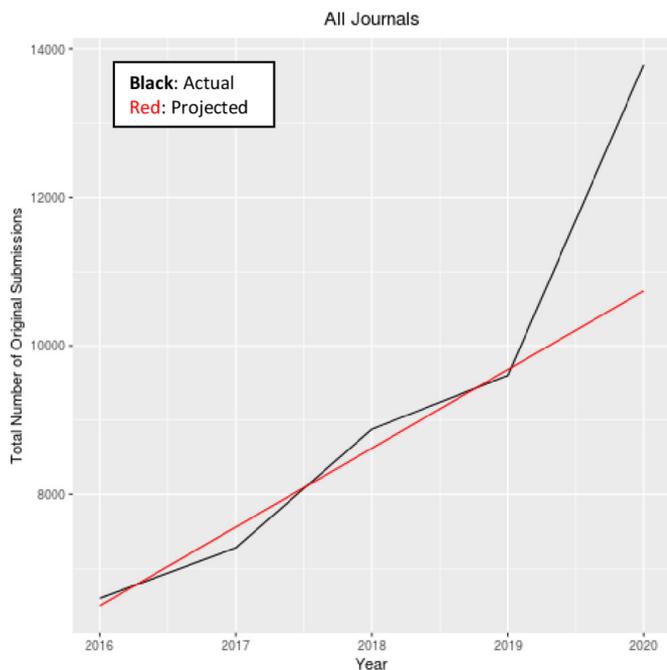


Figure 2 Actual and projected number of original submissions for first half of 2020 based on previous submissions data from 2016 to 2019. The total count of original submissions was predicted based on a linear regression model using the submission counts from the previous years since 2016.

2020 did indeed increase at a greater rate than the predicted values (figure 2). These findings are statistically significant, manifested by the high reproducibility of this trend in all eight of our journals. Finally, for the same journals in the same time period, a search was performed to analyze the number of COVID-19 related publications compared with the total number of publications. The analysis showed that the average percent of COVID-19 related publications from January to June of 2020 was 6.87% (table 1). Individual trends for each journal are shown in the (online supplemental data).

DISCUSSION

This study sought to quantitatively analyze whether the reduced time spent in surgical practice translated into an increase in

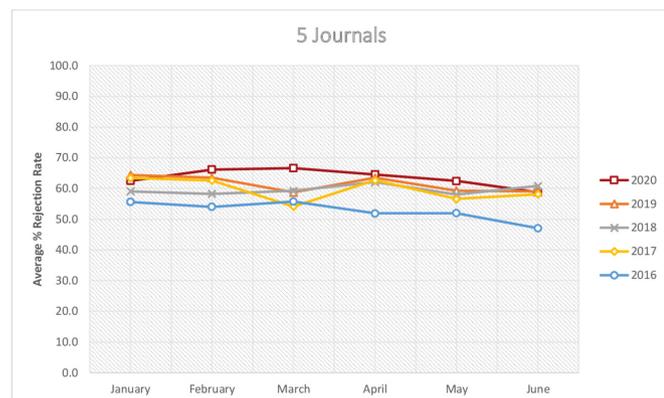


Figure 3 Rejection rate of original submissions by month and year from January to June of 2016–2020. Journals represented are *Journal of NeuroInterventional Surgery*, *American Journal of Neuroradiology*, *Journal of Neurosurgery*, *Journal of Neurosurgery: Spine*, and *Journal of Neurosurgery: Pediatrics*.

scientific and clinical academic productivity, specifically by looking at neurosurgery, stroke neurology, and neurointerventional surgery academic output during the period of lockdown.

The data clearly demonstrate that there was a momentous increase in the number of original submissions for the year 2020, which was largely beyond the predicted value for the year using a linear regression model. The effects were experienced across all of our represented journals. *World Neurosurgery*, *Journal of Neurosurgery: Spine*, and *Journal of Neurosurgery: Pediatrics*, in particular, have faced dramatic increases in total submissions of over 50% compared with the previous year which cannot be accounted for by the historical yearly average percent increases. *Neurosurgery*, *Journal of Neurosurgery*, *Stroke*, *American Journal of Neuroradiology*, and *Journal of NeuroInterventional Surgery* have all shown increases for 2020 of over 25%, with their total submission counts similarly well above their respective predicted values.

While the restrictions of the pandemic created increased time for clinical research, it has also created substantial challenges to ongoing research efforts. A survey study of neurointerventional research centers revealed widespread disruptions in aneurysm and stroke clinical trials due to missed enrollments and protocol deviations from missed clinical or imaging follow-up.¹⁵ Similar reductions in oncologic clinical trial enrollment have been reported.¹⁶

Given the dramatic increase in submissions for 2020 in the setting of widespread disruptions in ongoing prospective studies, one could argue that the quality of submissions may have decreased during the pandemic lockdown period. We sought to investigate this relationship by using rejection rate as a surrogate from the five journals that were able to provide these data. The rejection rates for the journals that could supply this information did not appear to differ significantly from the rates from previous years ($p=0.387$), suggesting that the quality of the submissions may have been maintained during the pandemic lockdown despite a large surge in the number of submissions. It is noted that the rate of rejections may be driven in certain journals by the number of issues printed per year as well as the allocated number of pages dictated by the publisher.

When the published articles from the same journals within the same time frame were categorized into COVID-19 pandemic related and non-related, just under 7% of all new article submissions during the pandemic time period were COVID-19 related. There are two ways in which the sharp increases in original submissions can be interpreted: that this is a natural consequence of an increased amount of untapped topics that have now been made available to explore in the wake of COVID-19,¹⁷ or that this is a consequence of the unprecedentedly increased time neurosurgeons, stroke neurologists, neurointerventionalists, and trainees have had due to the reductions in the clinical and surgical workload. Both may, in part, help to explain the 2020 surge, yet the relatively small percentage of COVID-19 related articles in comparison with the total number of articles published seems to lend more credence to the latter interpretation that academic physicians across the globe have used this unstructured time to advance scientific knowledge.

Although similar quantitative studies of COVID-19 and its effect on neurosurgical academic output have not been published, it is possible to compare the findings of this study with those of recent studies that used self-reported surveys. Pelargos *et al* described findings from a survey distributed to neurosurgery residents across the United States and Canada assessing changes to clinical and educational workload. More than 91% of residents reported that their clinical responsibilities have been reduced,

and 65.2% stated that they have been spending increased time on clinical research.⁶ Zoia *et al* similarly conducted a survey of neurosurgery residents in Italy, and observed that participants homogeneously reported an increase in educational and scientific endeavors, with 55.7% reporting an increase in the production of scientific papers and research projects.¹⁸ Both findings are similar to our results, and serve to show the consequences of such increased attention directed towards academic engagement.

This study has important limitations. First, owing to the observational nature of our study, one cannot draw conclusions about the variables being studied and can only gather correlational relationships. The influence of confounders that could have affected the observed increase in journal submissions, separate from, or in coordination, with the pandemic, cannot fully be evaluated by the present study out of respect for the privacy of investigators. Second, there is a lag time between submission and publication, and we cannot account for COVID-related studies that are still in progress, leading to potential underestimation of the contribution of COVID-related articles to the increase. This was, however, offset by the fact that many COVID-related articles were fast tracked to publication during that period. Third, the study mainly contained neurosurgical journals, and looked only at clinical journals and not neuroscience journals. Clinical research was thought to be a better surrogate of academic productivity as the vast majority of laboratories were closed during the lockdown period. Lastly, there is no straightforward or uniform way in which to report on other potential submission quality metrics across the spectrum of included journals, such as study design or level of evidence, that would allow for standardization of article quality among the eight diverse journals.

CONCLUSION

There was an unprecedented increase in article submissions to eight major neurosurgical, stroke neurology, and neurointerventional peer-reviewed journals during the pandemic, with a combined average increase of 42% for 2020 compared with the average expected increase of 11% found during 2016–2019. COVID-19 related articles comprised just under 7% of the total submissions from January to June of 2020. These findings suggest that reductions in clinical and surgical workload during the pandemic may have translated to increased academic productivity among neurosurgical, stroke, and neurointerventional physicians.

Author affiliations

¹Department of Neurosurgery, Baylor College of Medicine, Houston, Texas, USA

²Department of Neurosurgery, Barrow Neurological Institute, Phoenix, Arizona, USA

³Department of Neurosurgery, University of Utah, Salt Lake City, Utah, USA

⁴Neurosurgery, Jacobs School of Medicine University at Buffalo, Buffalo, New York, USA

⁵Neurosurgery, Gates Vascular Institute at Kaleida Health, Buffalo, New York, USA

⁶Department of Neurosurgery, Cleveland Clinic, Cleveland, Ohio, USA

⁷Neurointerventional Radiology, Lahey Hospital and Medical Center, Burlington, Massachusetts, USA

⁸NeuroEndovascular Program, Massachusetts General Hospital, Boston, Massachusetts, USA

⁹Department of Neurosurgery, Stony Brook University, Stony Brook, New York, USA

¹⁰Department of Radiology, Stony Brook University, Stony Brook, New York, USA

¹¹Neurological Surgery and Radiology, Wake Forest University, Winston-Salem, North Carolina, USA

¹²Department of Neurosurgery, Texas Children's Hospital, Houston, Texas, USA

¹³Department of Neurosurgery, University of South Florida, Tampa, Florida, USA

¹⁴Department of Neurosurgery, University of Texas Medical Branch, Galveston, Texas, USA

Twitter Joshua A Hirsch @JoshuaAHirsch

Contributors Conception and design: PK, JEL, AM; acquisition of data, interpretation, and analysis: all authors; editing and approval of manuscript: all authors; study supervision: PK.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

This article is made freely available for use in accordance with BMJ's website terms and conditions for the duration of the covid-19 pandemic or until otherwise determined by BMJ. You may use, download and print the article for any lawful, non-commercial purpose (including text and data mining) provided that all copyright notices and trade marks are retained.

ORCID iDs

Jae Eun Lee <http://orcid.org/0000-0001-9262-4811>

Alina Mohanty <http://orcid.org/0000-0002-7053-7597>

Elad I Levy <http://orcid.org/0000-0002-6208-3724>

Joshua A Hirsch <http://orcid.org/0000-0002-9594-8798>

David Fiorella <http://orcid.org/0000-0002-2677-8780>

Kyle M Fargen <http://orcid.org/0000-0001-8979-1993>

Jeremiah Johnson <http://orcid.org/0000-0002-9920-5895>

Maxim Mokin <http://orcid.org/0000-0003-4270-8667>

REFERENCES

- Holshue ML, DeBolt C, Lindquist S, *et al*. First case of 2019 novel coronavirus in the United States. *N Engl J Med* 2020;382:929–36.
- Jean WC, Ironside NT, Sack KD, *et al*. The impact of COVID-19 on neurosurgeons and the strategy for triaging non-emergent operations: a global neurosurgery study. *Acta Neurochir* 2020;162:1229–40.
- Field NC, Platanitis K, Paul AR, *et al*. Letter to the editor: decrease in neurosurgical program volume during COVID-19: residency programs must adapt. *World Neurosurg* 2020;141:6–7.
- Burke JF, Chan AK, Mummaneni V, *et al*. Letter: the coronavirus disease 2019 global pandemic: a neurosurgical treatment algorithm. *Neurosurgery* 2020;87:E50–6.
- Thomas JG, Gandhi S, White TG, *et al*. Letter: a guide to the prioritization of neurosurgical cases after the COVID-19 pandemic. *Neurosurgery* 2020;87:1–6.
- Pelargos PE, Chakraborty A, Zhao YD, *et al*. An evaluation of neurosurgical resident education and sentiment during the coronavirus disease 2019 pandemic: a North American survey. *World Neurosurg* 2020;140:1–6.
- Martinelli F, Garbi A. Change in practice in gynecologic oncology during the COVID-19 pandemic: a social media survey. *Int J Gynecol Cancer* 2020;30:ijgc-2020-001585.
- Sharma A, Maxwell CR, Farmer J, *et al*. Initial experiences of US neurologists in practice during the COVID-19 pandemic via survey. *Neurology* 2020;95:215–20.
- Murray BH, Gordon BM, Crystal MA, *et al*. Resource allocation and decision making for pediatric and congenital cardiac catheterization during the novel coronavirus SARS-CoV-2 (COVID-19) pandemic: a U.S. multi-institutional perspective. *J Invasive Cardiol* 2020;32:E103–9.
- Patel RJ, Kejner A, McMullen C. Early institutional head and neck oncologic and microvascular surgery practice patterns across the United States during the SARS-CoV-2 (COVID19) pandemic. *Head Neck* 2020;42:1168–72.
- Pandey AS, Daou BJ, Tsai JP, *et al*. Letter: COVID-19 pandemic-the bystander effect on stroke care in Michigan. *Neurosurgery* 2020;87:E397–9.
- Schirmer CM, Ringer AJ, Arthur AS, *et al*. Delayed presentation of acute ischemic strokes during the COVID-19 crisis. *J Neurointerv Surg* 2020;12:639–42.
- Kansagra AP, Goyal MS, Hamilton S, *et al*. Collateral effect of Covid-19 on stroke evaluation in the United States. *N Engl J Med* 2020;383:400–1.
- Fargen KM, Leslie-Mazwi TM, Klucznik RP, *et al*. The professional and personal impact of the coronavirus pandemic on US neurointerventional practices: a nationwide survey. *J Neurointerv Surg* 2020;12:13–31.
- Rai AT, Leslie-Mazwi TM, Fargen KM, *et al*. Neuroendovascular clinical trials disruptions due to COVID-19: potential future challenges and opportunities. *J Neurointerv Surg* 2020;12:831–5.
- Unger JM, Blanke CD, LeBlanc M, *et al*. Association of the coronavirus disease 2019 (COVID-19) outbreak with enrollment in cancer clinical trials. *JAMA Netw Open* 2020;3:e2010651.
- Chae JK, Haghdel A, Guadix SW, *et al*. Letter: COVID-19 impact on the medical student path to neurosurgery. *Neurosurgery* 2020;87:E232–3.
- Zoia C, Raffa G, Somma T, *et al*. COVID-19 and neurosurgical training and education: an Italian perspective. *Acta Neurochir (Wien)*. 2020;16:1789–94.