



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.



Clinical study

Neuro-oncology practice guidelines from a high-volume surgeon at the COVID-19 epicenter



Evan Luther*, Joshua Burks, Daniel G. Eichberg, Gregory Basil, Katherine Berry, Victor Lu, Ashish Shah, Gurvinder Kaur, Michael Ivan, Ricardo Komotar

Department of Neurological Surgery, University of Miami Miller School of Medicine, Miami, FL, USA

ARTICLE INFO

Article history:

Received 17 August 2020

Accepted 7 December 2020

Keywords:

Telemedicine

Telehealth

Neurosurgery

Neuro-oncology

COVID-19

Coronavirus

Pandemic

ABSTRACT

Background: During the coronavirus 19 (COVID-19) pandemic, physicians have begun adapting their daily practices to prevent transmissions. In this study we aimed to provide surgical neuro-oncologists with practice guidelines during the COVID-19 pandemic based on objective data from a high-volume brain tumor surgeon at the current COVID-19 epicenter.

Methods: All outpatient visits and surgeries performed by the senior author during the COVID-19 pandemic were compared between the initial quarantine (3/23/20–5/4/20), the plateau period following quarantine (5/5/20–6/27/20), and the second peak (6/28/20–7/20/20). In-person and telemedicine visits were evaluated for crossovers. Surgeries were subdivided based on lesion type and evaluated across the same time period.

Results: From 3/23/20–7/20/20, 469 clinic visits and 196 surgeries were identified. After quarantine was lifted, face-to-face visits increased ($P < 0.01$) yet no change in telehealth visits occurred. Of 327 telehealth visits, only 5.8% converted to in-person during the 4-month period with the most cited reason being patient preference (68.4%). Of the 196 surgeries performed during the pandemic, 29.1% occurred during quarantine, 49.0% during the plateau, and 21.9% occurred in the second peak. No COVID negative patients developed symptoms at follow-up. 55.6% were performed on malignant tumors and 31.6% were benign with no difference in case volumes throughout the pandemic.

Conclusions: Despite exceptional challenges, we have maintained a high-volume surgical neuro-oncology practice at the epicenter of the COVID-19 pandemic. We provide the protocols implemented at our institution in order to maximize neuro-oncology care while mitigating risk of COVID-19 exposure to both patients and providers.

© 2020 Elsevier Ltd. All rights reserved.

1. Introduction

The coronavirus disease (COVID-19) has now infected over 60 million people and has led to nearly 1.5 million deaths globally as November 2020 comes to a close [1]. During this extraordinary health crisis, physicians have altered their daily clinical practices in an attempt to combat the disease. Surgeons and interventionalists have only been performing urgent, time-sensitive procedures and most have begun utilizing telehealth for outpatient visits to prevent transmission [2,3]. In some of the most affected areas, many subspecialists have even redirected their efforts towards direct COVID patient care [4,5]. These alterations have had significant

implications for the neuro-oncology patient who often cannot wait several weeks to undergo treatment. In this study, we demonstrate the feasibility of maintaining a high-volume neuro-oncology practice throughout the COVID-19 pandemic. We also provide operative and clinical guidelines for other surgical neuro-oncologists during these unprecedented times.

2. Material and methods

A retrospective review of the senior author's (RJK) outpatient clinic visits and surgeries during the COVID-19 pandemic (3/23/20 to 7/20/20) was performed. Telemedicine visits were defined by the Current Procedural Terminology (CPT) codes G2010/2012 or the usage of CPT modifier 95. Daily in person clinic visits, telemedicine visits, and surgeries were evaluated during three time periods: the initial quarantine period (3/23/20–5/4/20), the plateau period following quarantine (5/5/20–6/27/20), and the second peak of

* Corresponding author at: Department of Neurological Surgery, University of Miami/Jackson Health System, Lois Pope Life Center, 2nd floor, 1095 NW 14th Terrace, Miami, FL 33136, USA.

E-mail address: evan.luther@jhs.miami.org (E. Luther).

Table 1
Comparison of Outpatient Neuro-Oncology Visit Types during the COVID-19 Pandemic.

Visit Type	Overall Daily Visits (mean, SD)	Daily Visits 3/23/20–5/4/20 (mean, SD)	Daily Visits 5/5/20–6/27/20 (mean, SD)	1st and 2nd periods - P-value	Daily Visits 6/28/20–7/20/20 (mean, SD)	2nd and 3rd periods - P-value
In person	1.7 (2.2)	0.4 (0.9)	2.5 (2.1)	<0.01	2.1 (2.8)	0.62
Telehealth	4.3 (3.4)	3.7 (3.8)	3.7 (3.1)	0.97	4.9 (3.5)	0.23

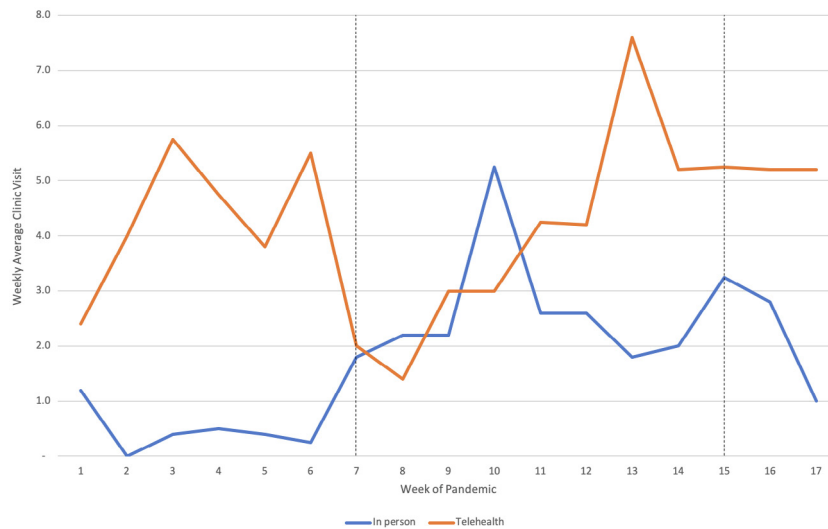


Fig. 1. Average Weekly Clinic Volume Stratified by In Person and Telehealth Visits during the Pandemic. Dotted lines represent transitions from one pandemic period to the next.

COVID-19 cases (6/28/20–7/20/20). Telemedicine crossovers were defined by any in-person clinic visit following an initial telemedicine visit. These crossovers and the reason for in person visitation were tabulated and reported as percentages. Continuous variables were reported as means with standard deviations unless otherwise specified. Categorical variables were reported using frequencies and percentages. Comparison of means was performed using a two-sample *t*-test. A *p* value ≤ 0.05 was considered statistically significant. All data analysis was conducted using SPSS (version 24, IBM). Pandemic practice guidelines for the surgical neuro-oncologist were constructed based on these results and the protocols implemented at our institution.

3. Results

3.1. Outpatient clinic visits

From 3/23/20–7/20/20, 469 total clinic visits were performed. During the initial quarantine period, 129 total clinic visits occurred, of which, 88.4% were telehealth. Average daily telehealth and in person visits were 3.8 and 0.4, respectively. After the quarantine was lifted and prior to the second peak, 235 clinic visits were completed. A larger proportion were in-person visits during this time period (40.4%) and we saw a significant increase in average daily

Table 2
Reasons for Telemedicine Crossovers.

Reason	Frequency (#)	Percent total (%)
Patient preference	13	68.4
Suture removal	4	21.1
More detailed exam	2	10.5

in-person visits when compared to the quarantine period (2.6, *P* < 0.01). Interestingly, the proportion of daily telehealth visits did not change. During the second peak of the pandemic, we saw no significant change in in-person or telehealth visits when compared to the plateau period. Table 1 displays these results. Fig. 1 displays the average weekly clinic visits stratified by visit type during the pandemic.

3.2. Telemedicine crossovers

Telemedicine crossovers during the pandemic have remained low at only 5.8%. Table 2 displays the most frequently cited reasons crossover. Patient preference was the most common (68.4%) followed by suture removal (21.1%) and the need for a more detailed neurologic examination (10.5%).

4. Surgical Neuro-oncology cases

196 total surgeries were performed since the beginning of the pandemic. 55.6% were for malignant tumors while 31.6% were benign. The remaining 12.8% comprised mostly of hydrocephalus and trauma. Fig. 2 illustrates the average weekly case totals over the pandemic stratified by malignant and benign tumors. Although there was clearly a trend towards less surgical cases during the first and second peaks this did not reach significance. All patients were screened for COVID-19 prior to surgery and only 3 patients remained positive prior to intervention. Given that the Centers for Disease Control and Prevention do not recommend repeat screening for COVID negative, asymptomatic patients, we did not perform repeat nasal swabs on post-operative patients prior to discharge [6]. However, none of our negative patients developed coronavirus symptoms at follow-up.

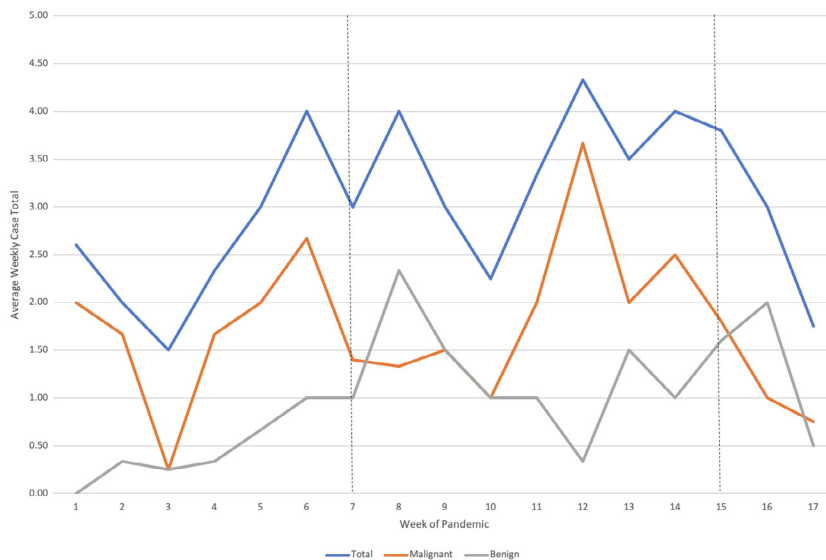


Fig. 2. Average Weekly Surgical Volume Stratified by Malignant and Benign Tumors. Dotted lines represent transitions from one pandemic period to the next.

5. Discussion

As the coronavirus pandemic surges on in the United States (US), many clinicians have been forced to change multiple aspects of their practice in order to continue to provide care while mitigating the risk of COVID-19 transmission to their patients and themselves [4,7]. Much of this has been centered around the use of telemedicine as a substitute for face-to-face clinic visits [2,3,8]. However, few evidence-based COVID-19 guidelines exist for surgical neuro-oncologists who primarily deal with patients requiring time-sensitive interventions [9]. As a result, we made an effort to compile the currently available guidelines from various centers across the globe.

5.1. Available COVID-19 guidelines for the Neuro-Oncology patient

Although this section is not meant to be entirely comprehensive as new guidelines are being continually formed throughout the COVID-19 pandemic, we felt obligated to provide some of the protocols previously utilized during these trying times.

In February 2020 amidst the early pandemic, a consensus statement was created recommending that neuro-oncologists delay surgeries whenever possible especially for those requiring endoscopic endonasal procedures due to the high risk of viral aerosolization [10,11]. However, in patients with malignant tumors or rapidly developing neurologic deficits surgery was still prioritized [12]. In these instances, preoperative temperature screening and performance of a rapid COVID-19 test was recommended. If there was suspicion for COVID-19 positivity, then a chest CT and nucleic acid sequencing was obtained. If they were positive or suspected to be positive, then the patients were quarantined prior to surgery [10]. Furthermore, patients were also discouraged from going to hospitals or clinics for routine follow-up visits and an emphasis was placed on remote consultation in an effort to mitigate transmission risk [13–15]. Although much of these recommendations have remained effective and been integrated into the daily practice of neuro-oncologists worldwide, they were developed early in the pandemic in an effort to limit the spread of the virus with minimal objective data to support them.

Thus, as the pandemic surges on, high volume academic centers that have remained at the forefront of both neuro-oncology and

the ongoing COVID-19 pandemic have become the ideal location for refining such protocols. As such, we felt compelled to provide updated practice guidelines for the neuro-oncology patient based on the results of protocols we have implemented to combat the virus [16].

5.2. Outpatient recommendations: Clinic scheduling

During the initial COVID-19 peak, the local government enforced a city-wide quarantine that prevented all non-essential workers from leaving their homes. In response, our department canceled all elective clinic visits and implemented a telehealth program so that all patients with time-sensitive neurosurgical issues could be evaluated remotely. Face-to-face visits were limited to those unable to do telemedicine or requiring suture removal. All patients presenting for in-person visits were appropriately screened for COVID-19 symptoms prior to entering the clinic and proper personal protective equipment (PPE) and social distancing was performed throughout each patient encounter [2–4]. As a result, a large majority of neuro-oncology clinic visits were completed via telemedicine during this time period.

However, as cases began to plateau and the government-mandated quarantine was lifted, our department was faced with a conundrum. Many patients were requesting in-person visits who did not meet our defined prerequisites. In response, we began offering in-person visits to each patient while suggesting telemedicine as the preferred method for evaluation. Interestingly, during this plateau period we saw a significant increase in face-to-face visits with no change in the amount of telehealth visits. As the second peak began, we also did not see a decrease in demand for in-person visits. Since the local government did not implement a second quarantine, we continued this same protocol even as COVID-19 cases began to rise in the local community. Although anecdotal, during this entire 4-month period we have only had one neurosurgical clinic staff test positive for the coronavirus.

Therefore, if telemedicine is available to you, we would recommend performing all of the outpatient neuro-oncology visits remotely. However, if the patient requests a face-to-face encounter or requires a more detailed neurologic exam, in-person visits should be allowed as long as the patients are properly screened, appropriate PPE is worn, and social distancing is performed.

5.3. Outpatient recommendations: Surgical scheduling

During quarantine, all elective surgical cases were canceled. As a result, surgery was only offered for malignant tumors, such as gliomas and metastasis, or benign tumors causing rapidly progressive neurologic deficits. Other benign tumors that required surgery but could be postponed were intentionally delayed [4]. Although our data showed that less surgeries for benign lesions were performed during quarantine it did not reach significance. This likely reflects selection bias as those patients with worsening neurologic deficits who were scheduled prior to the pandemic remained on the schedule and the other less urgent cases were then replaced by more urgent benign tumors seen in clinic. This was all done, in conjunction with the hospital administration, to ensure that enough intensive care unit (ICU) beds were available should they be needed for COVID-19 patients. As the coronavirus cases plateaued, the restrictions on surgical scheduling were lifted. However, as the second peak began, and our hospital system became overwhelmed with COVID-19 patients requiring ICU status, we became limited to two surgical cases per day. As a result, we were forced to choose only the most urgent of cases. This meant that all incidentally discovered, asymptomatic benign tumors requiring surgery were again delayed for several weeks to allow for more time-sensitive surgeries to continue to occur.

Given all of these findings, we recommend having a candid discussion with your hospital administrators regarding ICU availability in order to triage those patients that cannot wait to undergo surgery. Practically speaking, this means that most gliomas, metastases, and benign tumors causing neurologic decline should be given preference over asymptomatic benign lesions.

5.4. Surgical recommendations: Patients

If you are still able to perform surgeries at your institution during these trying times, we have several recommendations that may help offset some of the burden on your hospital system and prevent any unwanted coronavirus transmissions. Prior to admission, we require all patients to undergo coronavirus screening and testing. For highly aerosolizing procedures in the nasopharynx, we require two separate negative COVID-19 tests prior to admission [17]. If the patient is symptomatic, tests positive, and the surgery can be delayed, then we recommend that the patient self-quarantine for two weeks and repeat testing [4]. These practices alone have resulted in only 3 surgeries being performed on COVID positive patients during the entire 4 month period, all of whom, were in symptomatic large lesions.

Once screening is complete and the results are negative, then we recommend proceeding with surgery with the following caveat: we have previously demonstrated no difference in wound complications using intradermal, absorbable suture and thus recommend it be used, whenever possible, in order to mitigate the need for suture removal during follow-up [18]. Prior to the pandemic, we also demonstrated that discharging neuro-oncology patients on the first postoperative day is both safe and feasible and continue to recommend this practice in order to decrease the risk of their in-hospital exposure [19,20]. We also recommend transferring uncomplicated surgeries directly to the stepdown unit in an effort to maintain available ICU beds for COVID-19 patients. If the patient requires an ICU bed, we insist that they be physically separated from the COVID-19 units. If this is not possible then we would not recommend proceeding with the surgery given that many neuro-oncology patients can be immunocompromised [21]. Lastly, we do not allow any visitation while in the hospital in order to further reduce face-to-face interactions as an inpatient [4]. Although restrictive, it is these limitations that have prevented any of our patients from developing COVID-19 symptoms during

their hospitalization and in follow-up. Although we recognize that our follow-up is limited, if the patients were to manifest symptoms it would likely occur within the two week period between surgery and their next clinic visit [22].

5.5. Surgical recommendations: Surgeons

Protecting yourself from infection and subsequent transmission is equally important as protecting the patient. Therefore, we recommend some simple guidelines to lower this risk. Firstly, PPE should be worn at all times while in the hospital, proper hand hygiene should be performed, and social distancing should be maintained. This is especially important during patient interactions given that you alone could be a fomite for transmission. With that being said, we have not had to alter much of our intraoperative surgical practices given that the room is already a sterile environment. However, we have restricted the number of providers rounding on patients in an effort to again minimize the potential for exposure.

Lastly, we have been fortunate enough to have a single operating room dedicated to COVID-19 positive patients. Although we have only performed 3 surgeries on COVID-19 positive neuro-oncology patients, we recommend performing complete donning and doffing using full PPE as outlined by the World Health Organization [23].

6. Conclusions

Based on the results of protocols implemented at our institution to combat transmission of COVID-19, we created practice guidelines for the surgical neuro-oncologist. Although our data is retrospective, we demonstrate that by using proper PPE, good hand hygiene, telemedicine, absorbable suture, and early patient discharge we can limit patient and provider transmissions even as our local community has become the US epicenter of the pandemic.

Funding

Dr. Daniel Eichberg is supported by a grant from the National Cancer Institute (NCI; T32 CA 211034). No federal funds or funds from nongovernmental sources were used to fund the project. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Declaration of Competing Interest

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.

References

- [1] World Health Organization Coronavirus disease 2019 (COVID-19) Weekly Epidemiological Update. 2020; <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>. Accessed November 18, 2020.
- [2] Eichberg DG, Basil GW, Di L, Shah AH, Luther EM, Lu VM, et al. Telemedicine in Neurosurgery: Lessons Learned from a Systematic Review of the Literature for the COVID-19 Era and Beyond. *Neurosurgery* 2020.
- [3] Basil GW, Eichberg DG, Perez-Dickens M, Menendez I, Ivan ME, Urakov T, et al. Letter: Implementation of a Neurosurgery Telehealth Program Amid the COVID-19 Crisis—Challenges, Lessons Learned, and a Way Forward. *Neurosurgery* 2020;87:E260–2.
- [4] Eichberg DG, Shah AH, Luther EM, Menendez I, Jimenez A, Perez-Dickens M, et al. Letter: Academic Neurosurgery Department Response to COVID-19 Pandemic: The University of Miami/Jackson Memorial Hospital Model. *Neurosurgery* 2020;87:E63–5.

- [5] Goldhamer MEJ, Pusic MV, Co JPT, Weinstein DF. Can Covid Catalyze an Educational Transformation? Competency-Based Advancement in a Crisis. *N Engl J Med* 2020.
- [6] Centers for Disease Control and Prevention Discontinuation of Transmission-Based Precautions and Disposition of Patients with COVID-19 in Healthcare Settings (Interim Guidance). 2020; <https://www.cdc.gov/coronavirus/2019-nCoV/hcp/disposition-hospitalized-patients.html>. Accessed August 17, 2020.
- [7] Pesce A, Palmieri M, Armocida D, Frati A, Santoro A. Letter: Neurosurgery and Coronavirus (COVID-19) Epidemic: Doing our Part. *Neurosurgery* 2020;87:E48–9.
- [8] Keshvaridoost S, Bahaadinbeigy K, Fatehi F. Role of Telehealth in the Management of COVID-19: Lessons Learned from Previous SARS, MERS, and Ebola Outbreaks. *Telemed J E Health* 2020;26:850–2.
- [9] Tsamakis K, Gavriatopoulou M, Schizas D, Stravodimou A, Mougkou A, Tsiptsios D, et al. Oncology during the COVID-19 pandemic: challenges, dilemmas and the psychosocial impact on cancer patients. *Oncol Lett* 2020;20:441–7.
- [10] Gupta P, Muthukumar N, Rajshekhar V, Tripathi M, Thomas S, Gupta SK, et al. Neurosurgery and Neurology Practices during the Novel COVID-19 Pandemic: A Consensus Statement from India. *Neurol India* 2020;68:246–54.
- [11] Kondziolka D, Couldwell WT, Introduction RJT. On pandemics: the impact of COVID-19 on the practice of neurosurgery. *J Neurosurg* 2020:1–2.
- [12] Sun Y, Editorial MY. Response to COVID-19 in Chinese neurosurgery and beyond. *J Neurosurg* 2020:1–2.
- [13] Gupta T, Singh VP, Balasubramian A, Menon H, Kurkure PA, Kumar S, et al. ISNO Position Statement on Treatment Guidance in Neuro-oncology During Pandemics. *Neurol India* 2020;68:769–73.
- [14] Ganapathy K. Telemedicine and Neurological Practice in the COVID-19 Era. *Neurol India* 2020;68:555–9.
- [15] Khilnani GC. The COVID-19 Pandemic: Challenges for the Neurosurgeons and Neurologists. *Neurol India* 2020;68:244–5.
- [16] Luther EM, McCarthy D, Berry KM, Rajulapati N, Shah AH, Eichberg DG, et al. Hospital teaching status associated with reduced inpatient mortality and perioperative complications in surgical neuro-oncology. *J Neurooncol* 2020;146:389–96.
- [17] Francis N, Dort J, Cho E, Feldman L, Keller D, Lim R, et al. SAGES and EAES recommendations for minimally invasive surgery during COVID-19 pandemic. *Surg Endosc* 2020;34:2327–31.
- [18] Luther E, Berry K, McCarthy D, Sandhu J, Mayrand R, Guerrero C, et al. Hair-sparing technique using absorbable intradermal barbed suture versus traditional closure methods in supratentorial craniotomies for tumor. *Acta Neurochir (Wien)* 2020;162:719–27.
- [19] Richardson AM, McCarthy DJ, Sandhu J, Mayrand R, Guerrero C, Rosenberg C, et al. Predictors of Successful Discharge of Patients on Postoperative Day 1 After Craniotomy for Brain Tumor. *World Neurosurg* 2019;126:e869–77.
- [20] Eichberg DG, Di L, Shah AH, Luther E, Richardson AM, Sarkiss CA, et al. Brain Tumor Surgery is Safe in Octogenarians and Nonagenarians: A Single-Surgeon 741 Patient Series. *World Neurosurg* 2019;132:e185–92.
- [21] Hu YJ, Zhang JM, Chen ZP. Experiences of practicing surgical neuro-oncology during the COVID-19 pandemic. *J Neurooncol* 2020;148:199–200.
- [22] Backer JA, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *Euro Surveill.* 2020;25.
- [23] World Health Organization HOW TO PUT ON AND TAKE OFF Personal Protective Equipment (PPE). 2020; <https://www.who.int/csr/resources/publications/putontakeoffPPE/en/>. Accessed August 1, 2020.