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COVID-19: A Time Like No Other in (the Department of) Neurological Surgery

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Coronavirus disease 2019 (COVID-19) has disrupted lives and indelibly impacted the practice of medicine since emerging as a pandemic in March 2020. For neurosurgery departments throughout the United States, the pandemic has created unique challenges across subspecialties in devising methods of triage, workflow, and operating room safety. Located in New York City, at the early epicenter of the COVID-19 crisis, the Weill Cornell Medicine Department of Neurological Surgery was disrupted and challenged in many ways, requiring adaptations in clinical operations, workforce management, research, and education. Through our department's collective experience, we offer a glimpse at how our faculty and administrators overcame obstacles, and transformed in the process, at the height of the COVID-19 pandemic.

pandemic represents one of the most traumatic events in the city's recent collective memory.

For neurosurgery departments throughout the United States, the COVID-19 pandemic has created unique challenges across subspecialties in devising methods of triage, workflow, and operating room safety.²⁻⁵ At the Weill Cornell Medicine (WCM) Department of Neurological Surgery, located in the Upper East Side of Manhattan, these obstacles have been magnified. In response, our department has reimaged the delivery of care to neurosurgical patients, while redeploying faculty and resources to combat the virus on the front lines. In this article, we highlight COVID-19 challenges faced by the Department of Neurological Surgery at WCM and outline the major steps taken by key departmental leaders to drive necessary changes to our clinical operations, workforce management, research, and educational initiatives during a time like no other. Through our department's collective experience, we offer a glimpse at how neurosurgical practice and departmental management has been transformed at the early epicenter of the COVID-19 pandemic.

INTRODUCTION

The World Health Organization officially recognized coronavirus disease 2019 (COVID-19) as a pandemic in mid-March 2020. COVID-19 has since continued to wreak havoc on U.S. health systems and has uprooted the everyday lives of people around the world. As of this writing (August 31, 2020), there have been >more than 6 million confirmed cases in the United States and more than 180,000 deaths. New York City has suffered immensely during this time, with close to 240,000 confirmed cases and more than 23,500 deaths.¹ With the New York City death toll from this illness far surpassing that experienced as a result of the September 11, 2001, terrorist attacks, the COVID-19

TRANSFORMATION OF CLINICAL OPERATIONS

In early March, as the numbers affected by the virus continued to climb in New York City, so too did the concerns about how COVID-19 was going to impact the clinical operations of the WCM Department of Neurological Surgery. What began initially as sporadic murmurs and rumblings about a possible pandemic inevitably progressed to a deafening roar. By mid-March, it was clear that a city-wide shutdown was unavoidable and that our department would have to reinvent our approach to neurosurgical care. **Table 1** provides a comprehensive summary of solutions implemented by our department, which we describe below in further detail.

Key words

- COVID-19
- Education
- Neurosurgery
- New York City
- Pandemic
- Redeployment

Abbreviations and Acronyms

AANS: American Association of Neurological Surgeons
COVID-19: Coronavirus disease 2019
IRB: Institutional review board
PPE: Personal protective equipment

VGSC: Virtual Global Spine Conference

WCM: Weill Cornell Medicine

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Changes to Neurosurgical Workflow

General trends across the NewYork–Presbyterian Hospital system during the COVID-19 pandemic included marked reductions in in-person visits and surgical volume with a corresponding increase in telehealth visits (Figure 1). All elective surgeries were canceled on March 16, 2020. This resulted in a total of 408 surgeries performed from March 16 to June 1 in our department. For a historical comparison, there were 1185 surgeries performed in 2019 during this same period; thus the 2020 number represents a reduction of 65.6%. The surgeries that were performed were considered either emergent or urgent.

The urgency of a case was ultimately adjudicated by a neurosurgical case review committee, which included the chair

and vice chairs, similar to committees described in other neurosurgery departments.^{6,7} This committee met daily to discuss patient histories, imaging, and other salient factors of each case until a consensus was reached. Cases were then presented to a multidisciplinary panel of hospital leadership and department chairs to determine whether the operations would be approved. Typical emergency neurosurgical cases, such as expanding epidural hematomas, were relatively straightforward. Other cases straddled the line between emergent and nonemergent and resided in a gray area, such as a patient with a small asymptomatic intracranial mass who suddenly presented with a seizure. Likewise, the decision to operate on a patient who tested positive for COVID-19 had to be weighed against the potential risk of high viral load exposure to operating room staff and the intensive care resources that would be diverted from patients with a higher chance of a good outcome. The committee process naturally spawned medicolegal questions regarding whether decisions to delay surgery would have negative ramifications on patient outcomes. Concerns about malpractice risk also loomed large over committee decisions to delay surgical treatment for patients falling within treatment gray areas. However, overall, the collaborative nature of the committee, with its shared shouldering of the psychological burden, was important for members making these difficult, but necessary decisions.

With the corresponding decrease in surgical volume, 23 functional operating rooms were reduced to 5 operating rooms, with many being converted to COVID-19 patient beds. Anterooms were also created for staff to don and doff personal protective equipment (PPE). The clinic volume was reduced to 30% capacity to facilitate social distancing. Relevant paperwork and authorizations required for patient visits were obtained over the phone before and after the visit to minimize the contact time required for checking in or out. Patients' temperatures were checked when they entered the clinic, and specially designated COVID-19 rooms were established for suspected or confirmed cases.

Shift to Telemedicine

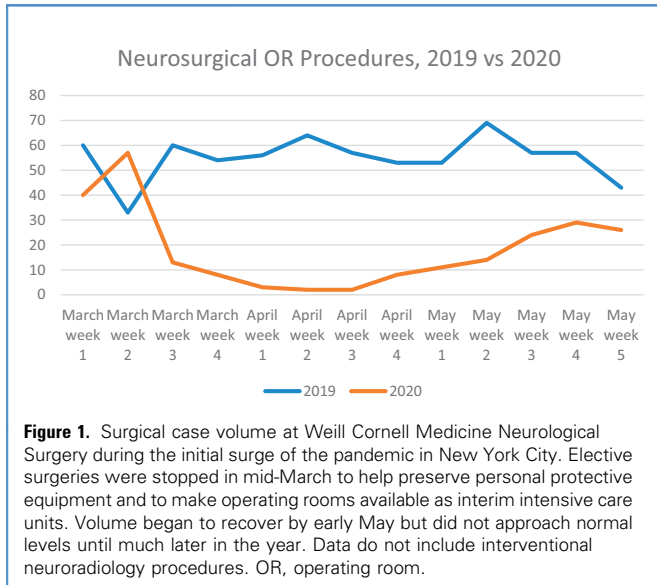
Despite the reduced surgical volume and decline in revenue, departmental salaries were maintained by the hospital administration. This was largely a result of the multiple WCM Physician Organization finance and executive committees formed during this time to help adjudicate finances and implement new hospital protocols. These committees met with higher-level administrative officers to create a mitigation plan aimed at addressing the revenue shortfalls. In response to these shortfalls, discretionary expenses were reduced where appropriate, such as in the areas of transportation and utilities (owing to remote work) and in hiring freezes and other cost-mitigation activities.

Further, with the cancellations of elective surgeries came a corresponding shift to telemedicine. From March 16 to June 1, 1042 telehealth visits were created. These visits accounted for approximately 50% of all patient visits during this period, a proportion that represents a massive leap forward from the telehealth initiatives attempted by the department in previous years, forged out of necessity (Figure 2). Visits were held virtually over Health Insurance Portability and Accountability Act–compliant videoconferencing software that was integrated with the EPIC

Table 1. Summary of Weill Cornell Medicine Department of Neurological Surgery Responses to the COVID-19 Pandemic Stratified by Department Area of Focus

Challenge	Responses
Changes to clinical workflow	<ul style="list-style-type: none"> ■ All elective surgeries canceled effective March 16, 2020 ■ Neurosurgical case review committee to triage emergent and nonemergent cases ■ Department-wide shift to telemedicine ■ Reduce clinic staff to 30% capacity ■ Patient authorizations completed over the phone before and after visits ■ Temperature checks and designated COVID-19 rooms for suspected/confirmed cases ■ One attending physician designated on-call for patient checks
Administration	<ul style="list-style-type: none"> ■ Transition to fully remote workforce ■ Daily virtual COVID-19 reports from the chairman ■ Virtual conferences and e-mail list maintenance for patients and referring physicians ■ Social media outreach to maintain department visibility and patient continuity
Research	<ul style="list-style-type: none"> ■ Basic and translational experiments halted ■ Virtual laboratory meetings ■ Increased emphasis placed on clinical writing and systematic reviews/meta-analyses ■ Medical Student/Resident Neurosurgery Publication Group
Education	<ul style="list-style-type: none"> ■ Virtual grand rounds ■ Department webinars ■ Virtual Global Spine Conference ■ Virtual Morbidity and Mortality conferences ■ Virtual resident journal club ■ Medical Student/Resident Neurosurgery Publication Group

COVID-19, coronavirus disease 2019.



electronic health record (EPIC Systems Corporation, Verona, Wisconsin, USA).

While the online platform offered greater remote access to patients, reducing infection risk, there have also been difficulties in implementation. For example, as noted in recent publications,^{8,9} assessments of cranial nerve function, tone, strength, sensation, reflexes, and basic components of the examination for movement disorders, such as tremor, rigidity, and bradykinesia, were a challenge to assess over the virtual platform. Furthermore, the technological literacy of some patients was limited, resulting in dropped visits and excess delays in visit times.

Despite these challenges, it was imperative to make this shift to telemedicine, which had great benefits. Our department had begun a modest pilot telehealth program before the pandemic in August 2019. Familiarity with the platforms thus afforded a relatively smooth transition to virtual visits for providers in our department. After the acute COVID-19 period in New York City, our department maintained a video visit rate close to 40%–50% of all total visits from the end of May to July 18, 2020 (Table 2). Because of large gains in efficiency at manageable costs, increased use of telemedicine will likely continue to play a large role in our department's patient triage and clinic visits after the COVID-19 pandemic.

Redeployment to the Frontlines

Faculty, residents, and inpatient advanced practice provider nurses and physician assistants in the department faced many challenges as they were redeployed to the intensive care unit and emergency department. Individual calls were made to each staff member at the onset to discuss the realities of redeployment, quarantine, scheduling, and how practices would remain covered once staff were redeployed. It became clear from these exchanges that staff were unsettled, scrambling for childcare, and worried about job

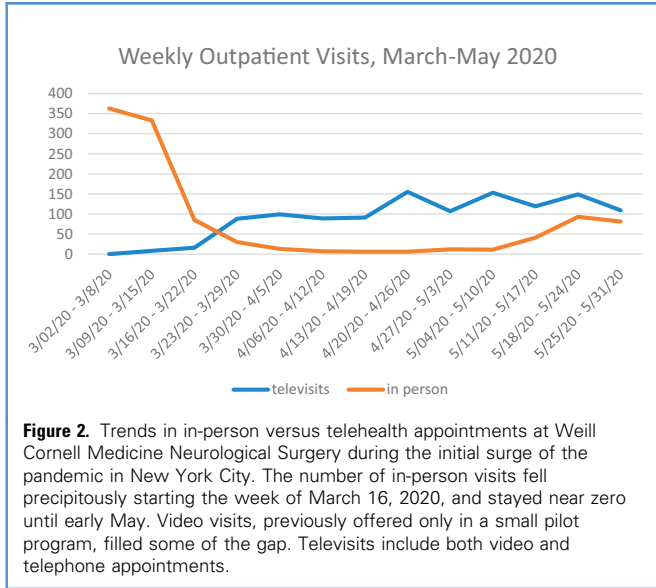
security, PPE shortages, and potential infection of themselves and their family members. Eleven clinical and administrative staff members were quarantined for suspected or confirmed COVID-19 infection. Ultimately, from April 1 through mid-May, 8 faculty members, 9 residents, 7 advanced practice providers, and 4 medical assistants were redeployed to the intensive care unit and other newly created facilities to handle COVID-19 patient overflow. An example of such a facility was the medical triage unit in the Javits Center in New York City, which had never before been used in this way.

Though our staff members were thoroughly trained to practice on a neurosurgical floor, many were confronted with new first-hand experiences of the large-scale mortality caused by COVID-19, for which their training may not have prepared them.¹⁰ For example, on the first day of redeployment, one of our registered nurses recounted that 5 patients had died on her first shift, and it was only through her faith and training that she could hang on by the end of the day. In the midst of the daily loss of lives, redeployed staff members were further humbled by the need to learn and relearn essentials of critical care. Each new day seemed to offer more challenges and constantly evolving information, including PPE guidelines and overwhelming statistics on new admissions and numbers of patient deaths.

Nevertheless, despite the visceral first-hand accounts of trauma, our redeployed workers relayed several positive experiences during redeployment. First, the amazing generosity of the community—offering food, hand-sewn masks, and modified headbands—was a welcome gift that enabled many of our redeployed workers to continue fighting despite the very real mental and physical exhaustion. Another positive result of redeployment to the medicine floors was the knowledge that our neurosurgical teams brought to the front lines in the form of the neurological examination and neurosurgical workup skills. For instance, similar to many other neurosurgical and neurology departments in New York City, we were alarmed at what seemed to be a high rate of intracranial stroke and hemorrhage in patients with COVID-19.^{11–13} The co-occurrence of hypoxia-induced delirium, decreased frequency of nursing checks, frequent use of therapeutic anticoagulation, and high rate of ischemic stroke created a perfect storm for delays in the identification of neurosurgical issues. However, the introduction of neurologists, neurosurgeons, and neurointensivists into the general medical teams helped offset this potential harm and highlighted the need to equip our medical colleagues with a better understanding of the neurological examination. Our redeployed staff returned to their usual roles in the Department of Neurological Surgery by mid-May as plans for gradual reopening began to be implemented.

ADMINISTRATIVE CHALLENGES AND SOLUTIONS

The perspective of administrators is rarely reported in neurosurgical publications,¹⁴ but as neurosurgery departments around the world have been forced to devise new algorithms for patient triage and models of employee workflow during the COVID-19 pandemic,¹⁵ it has become increasingly important to report on challenges faced by administrators during these times of heightened financial and technological burdens on hospital systems.



Switching to a Remote Workforce and Maintaining Communication

Throughout this chaotic time, much of the onus fell on our department administrators to find creative ways to maintain efficient workflows and a sense of cohesion within the department, given resource limitations and significant barriers to communication. As institution-wide policies began shutting down elective procedures and limiting access to the hospital for nonfrontline workers in early March, it became immediately apparent that the department needed to be transformed into a remote workforce overnight. This switch to a virtual day-to-day routine was intended to reduce the number of nonessential workers in the hospital, thereby reducing the spread of infection. WCM, which had a small percentage of employees connecting remotely each day, suddenly faced an overwhelming demand for remote access with continued maintenance of patient and provider security. The staff, some of whom had less experience with the technical aspects of telehealth visits, now had to learn how to connect their devices, conduct meetings, and share files from multiple off-site locations.

Internal and external communications had to be increased. Externally, communications to patients about new appointments and visitor policies were hampered by the fact that e-mail addresses were missing for a significant number of patients. Patients who could be reached were contacted 3–4 times over the first 10 weeks with relevant updates regarding their care and

constantly evolving hospital policies. Referring physicians also needed ongoing outreach, although there were similar limitations with missing e-mail addresses.

As a solution to these logistical issues, multiple virtual conferences were created to reach out to providers at other institutions and gather additional contact information. List building and list management became significant new tasks to be accomplished by administrators while adhering to Health Insurance Portability and Accountability Act requirements. Social media efforts were also increased to maintain visibility and continuity with the public. It was important to convey that our department was still open and available for nonemergent telemedicine appointments and consultations and that we were actively making efforts to maintain a safe environment for necessary emergency visits.

Internally, we required constant communication among members of our department, the WCM Physician Organization, and hospital teams to ensure that our messages aligned. At the department level, regular communication from the chairman to clinical, administrative, and research teams was critical in updating and reassuring employees, many of whom were anxious, grieving personal losses, and fearful of possible infection and job loss. Once the hospital began making sweeping policy changes in mid-March, our department chairman began hosting daily virtual COVID-19 reports, where up-to-the minute information regarding the COVID-19 patient census in the hospital, number of patients requiring ventilators, and redeployment status of neurosurgery staff was relayed to members of the department. These hour-long meetings were also used as a time to disseminate information regarding COVID-19 testing facilities and mental health resources.

SUSTAINING RESEARCH PRODUCTIVITY

Basic science laboratories at WCM were required to modify research operations effective March 17, 2020. To maintain social distancing measures, only a discrete list of essential laboratory postdoctoral fellows and principal investigators were allowed entrance into their respective laboratories. Even so, these individuals were encouraged to engage in remote nonlaboratory work, such as grant writing and data analysis, and were forced to put their basic science experiments on pause. Invasive animal research procedures also ceased, though mouse breeding was maintained, and weekly laboratory meetings were converted to videoconferences. These modifications, especially the limitations on animal work, were a huge blow to the neurosurgery research pipeline, which drives so much of our department’s innovation in the field. Thus, contingency plans were put in effect to continue the department’s research productivity.

Table 2. Number of In-Person and Video Visits and Corresponding Percentage of Total Visits During the Period From May 31 Through July 18, 2020

	5/31–6/6	6/7–6/13	6/14–6/20	6/21–6/27	6/28–7/4	7/5–7/11	7/12–7/18
In-person visits	111 (51%)	124 (58%)	133 (50%)	151 (51%)	145 (58%)	143 (60%)	184 (59%)
Video visits	106 (49%)	90 (42%)	133 (50%)	147 (49%)	107 (42%)	97 (40%)	129 (41%)

Since the initial acute phase of the COVID-19 pandemic, utilization of telehealth has remained high, ranging from 40% to 50% of total visits at our department.

Shifting Modes of Engagement

With encouragement from the department chair, clinical research efforts accelerated during this time. However, even with this increased vigor in clinical writing came logistical obstacles. For example, the institutional review board (IRB) pipeline significantly slowed for non-COVID research projects. Thus, reviews of clinical projects that may have taken several weeks were now delayed on the order of months. In response, the department placed a special emphasis on understanding the impact of COVID-19 on neurosurgical practice and trainee education. Many of these COVID-19-related projects received expedited approval from the IRB and helped quickly disseminate crucial information for the practice of neurosurgery at large. Owing to the flurry of papers, there was often great overlap between projects, which required discussion between primary investigators and combining of research teams. For non-COVID-19 projects, increased emphasis was placed on systematic reviews and meta-analyses to research relevant clinical questions, as these projects can often be carried out without IRB approval.

WCM Medical Student/Resident Neurosurgery Publication Group

Research productivity was severely affected for students interested in neurosurgery at our institution and across the United States. National estimates show that about 76% of medical students interested in neurosurgery reported canceled or slowed research in the basic sciences during the pandemic.¹⁵ This was especially true at our institution for first-year students who had summer research plans dashed and for students conducting basic science as part of their research year and area of concentration.

In response to laboratory closures and IRB roadblocks, the WCM Medical Student Neurosurgery Publication Group was founded to ensure trainee productivity in neurosurgery research. The Publication Group was started by members of the WCM American Association of Neurological Surgeons medical student chapter under the guidance of a faculty mentor and now includes 20–30 students and 5–10 residents/faculty members on a weekly basis. Meetings have been held over Zoom¹⁶ to discuss collaboration on new research projects, collectively brainstorm new project ideas, and report on ongoing research progress. In addition, this platform naturally spawned opportunities for education and student mentorship. Each week, various rotating faculty members and residents began giving brief presentations on topics such as “Publishing while in medical school,” “How to conduct a meta-analysis/systematic review,” and “Life as editor of a neurosurgery journal.” Soon the neurosurgery residents joined as near-peer mentors and coauthors on publications.

Results thus far have demonstrated extremely high research productivity, with 3 peer-reviewed publications^{15,17,18} from projects initiated at the founding of the Publication Group in mid-March. Several other projects have also recently been submitted to peer-reviewed journals. Data from the Publication Group have shown dramatic decreases in self-reported clinical and basic science research activity from medical students interested in neurosurgery around the United States during the pandemic. These same students highlight virtual mentorship as one of the most desirable interventions to compensate for canceled research conferences and lost opportunities for shadowing and networking with

neurosurgery leaders. The Publication Group has thus been a powerful solution created for and driven by our own students in these 2 key areas of academic growth and development. Because of the success of the Publication Group, neurosurgery faculty members now actively look to recruit these students onto their research projects.

EXPANDING ACCESS TO EDUCATION

In addition to altering methods of research and patient care, our department has translated neurosurgical teaching sessions to virtual platforms with great success. As a result of new remote learning opportunities, faculty members have been able to expand our department's national reach and become stronger mentors to residents and medical students in the process. In this section, we focus on 3 key educational initiatives offered by our department: virtual grand rounds, department webinars, and the Virtual Global Spine Conference (VGSC).

Virtual Grand Rounds

Per hospital-wide policies in early March, in-person conferences were restricted to a maximum of 10 people. In response, biweekly grand rounds transitioned to Zoom starting on March 16 and proved to be the educational focal point of the department. The switch to an online medium provided an impetus for the faculty to critically reappraise the content and overall reach of grand rounds. After overcoming some minor growing pains in maintaining security and chat functionality, it quickly became apparent that this environment allowed for greater faculty engagement and increased flexibility for participation.

Audiences for each meeting included faculty, residents, and staff from our department and interested medical students at WCM, with an average attendance of 40 participants, including approximately 19 faculty members. Faculty members from WCM and outside institutions gave talks on a variety of topics, including psychiatry, neurology, and public health. Talks from experts in infectious disease and population health focused on COVID-19 and the effects of pandemics on clinical operations. This was key in educating our department on the clinical course and epidemiology of the disease and what trends to expect as the pandemic continued to unfold, including availability of hospital resources and likelihood of a second wave. These sessions were especially welcome given some indication that neurosurgery residents would benefit from more education on COVID-19 and proper use of PPE.¹⁹

Grand rounds also offered new ways for students and residents to engage with the faculty during the pandemic. One session was dedicated for members of WCM with accepted research presentations for the 2020 American Association of Neurological Surgeons (AANS) Annual Scientific Meeting, which had been canceled because of COVID-19. Three 10-minute oral presentations were given during the hour-long session, one each by a second-year medical student, a sixth-year resident, and a senior faculty member (attending neurosurgeon). Ten minutes were allotted after each presentation for discussion with faculty participants. This session coincided with WCM's Diversity Week

and thus proved to be an excellent showcase of WCM neurosurgery talent at all levels of training.

Benefits of this new session for attendees were at least 2-fold: 1) presenting to the department increased exposure for trainees who aimed to remain productive in neurosurgery research, and 2) faculty discussion allowed for immediate feedback on the research presented and possible new directions for trainees to pursue. This opportunity had never been offered by our department before and was a direct response to the cancellations brought about by the pandemic. This could not have been more timely for medical students interested in neurosurgery, as they have reported great concern about how canceled research conferences and networking opportunities will affect their residency applications.^{16,17,20}

To date, we have hosted 8 virtual grand rounds, in addition to virtual Morbidity and Mortality conferences, a resident journal club, and resident educational lectures. The faculty and staff feedback has been excellent, with nearly everyone preferring the virtual model as a baseline. One challenge will be capturing the interaction and social connection that is inherent to face-to-face contact in a virtual format. However, with opportunities to expand virtually, including hosting global speakers and offering multi-institution grand rounds, we envision this model of virtual grand rounds persisting into the foreseeable future.

Continuing Medical Education and Department Webinars

Our department typically hosts 4 continuing medical education events each spring and 4 events in the fall. Once the pandemic was made official, 1 hands-on laboratory course was immediately canceled, and 2 lecture courses were rescheduled for the fall. This proved to be a logistical challenge, as competition emerged for available fall dates with other rescheduled events.

Despite these and other logistical challenges, leaders in neurosurgical education within our department emerged with new, innovative proposals for interinstitutional virtual education. Senior faculty members began hosting Zoom webinars that were free and open to the public. The webinar format consisted of a 15-minute presentation of basic definitions, indications, and treatment options for a neurosurgical condition followed by a 5-minute story from an actual patient and concluded with a 10-minute period for audience questions. Four webinars have been held on vestibular schwannoma, trigeminal neuralgia, and spine surgery for back pain, with a combined total of more than 1150 attendees.

Virtual Global Spine Conference

In response to the mass cancellation of spine conferences worldwide, WCM led a multi-institutional team of spine surgeons

in creating the VGSC.²¹ Experts in spine care were invited to give case-based presentations on spinal surgery and spine-related conditions during biweekly meetings. More than 1500 surgeons, radiologists, and trainees from more than 40 countries have participated in the VGSC since its first meeting in early April, demonstrating a global reach true to its name. A major reason for its success has been the involvement of neurosurgeons at prominent medical centers around the United States early in the program's implementation. These 6 founders later acted as the hosts for each session to guide discussion on a variety of spine-related topics. The interinstitutional collaboration displayed at the virtual meetings has been a reflection of the VGSC founding members.

Owing to its global reach and equitable access at no cost, virtual conferences such as the VGSC will likely become the new norm in neurosurgery education. In fact, recently published data from the VGSC research team shows that 94% of participants would continue attending VGSC meetings after the pandemic is over. Using this model, conceived initially at WCM, other neurosurgical subspecialties around the United States can begin building virtual programs for continued education.

CONCLUSIONS

The COVID-19 pandemic has been devastating for patients, families, and health care workers around the world. Our WCM Department of Neurological Surgery has faced immense challenges during this time owing to our location at the early epicenter of the pandemic in New York City. We have highlighted the unique voices of our faculty and staff who have shown extreme resilience and leadership to reinvent our department's clinical operations, workforce management, research, and education at a time like no other.

As of this writing, there are still more than 30 U.S. states and territories that require mandatory quarantine for returning travelers to New York State under Executive Order 205. It is unclear how neurosurgical practice will continue to be impacted by this ever-shifting sociopolitical landscape. However, the resilience and resourcefulness of our staff will ensure that our department will be ready. Through the telling of our experiences, we hope to better equip those departments facing continued outbreaks throughout the United States.

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