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The Return Back to Typical Practice from the "Battle Plan" of the Coronavirus Disease 2019 (COVID-19) Pandemic: A Comparative Study

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BACKGROUND: **Every aspect of the medical field has been heavily affected by the coronavirus disease 2019 (COVID-19) pandemic, and neurosurgical services are no exception. Several departments have reported their experiences and protocols to provide insights for others impacted. The goals of this study are to report the load and variety of neurosurgical cases and clinic visits after discontinuing the COVID-19 Battle Plan at an academic tertiary care referral center to provide insights for other departments going through the same transition.**

METHODS: **The clinical data of all patients who underwent a neurosurgical intervention between May 4, 2020, and June 4, 2020 were obtained from a prospectively maintained database. Data of the control group were retrospectively collected from the medical records to compare the types of surgeries/interventions and clinic visits performed by the same neurosurgical service before the COVID-19 pandemic started.**

RESULTS: **One hundred sixty-one patients underwent neurosurgical interventions, and seven-hundred one patients were seen in clinic appointments, in the 4-week period following easing back from our COVID-19 "Battle Plan." Discontinuing the "Battle Plan" resulted in increases in case load to above-average practice after a week but a continued decrease in clinic appointments throughout the 4 weeks compared with average practice.**

CONCLUSIONS: **As policy-shaping crises like pandemics abate, easing back to "typical" practice can be completed effectively by appropriately allocating resources. This can be accomplished by anticipating increases in neurosurgical volume, specifically in the functional/epilepsy and brain tumor subspecialties, as well as continued decreases in neurosurgical clinic volume, specifically in elective spine.**

INTRODUCTION

In December 2019, a novel coronavirus (coronavirus disease 2019 [COVID-19]) was detected in patients presenting with acute respiratory illness in Wuhan, China.[1] It quickly spread globally, resulting in a pandemic affecting every fabric of society. In the perspective of health care systems, it was initially estimated that approximately 20% of patients suffering from COVID-19 required hospitalization and 5% required intensive care unit–level care.[2] In response, hospitals began improvising and continuously revising protocols to maintain efficient functioning despite significant shortages in facilities and equipment.[3-5]

Every aspect of the medical field has been heavily affected by the COVID-19 pandemic, and neurosurgical services are no exception. Several departments have reported their experiences and protocols to provide insights for others impacted.[6-12] We recently published our response, the "Battle Plan," from the University of South Florida Department of Neurosurgery as well as how the neurosurgical case load had changed during COVID-19 and this plan's implementationo.[13,14] The "Battle Plan" was designed to divide the pool of attending physicians and residents into 3 teams, where each team provided comprehensive coverage of the neuro surgical service for 1 week, followed by a 2-week self-quarantine at home in accordance with the U.S. Centers for Disease

Key words
- Battle plan
- Case load
- Case variety
- COVID-19
- Neurosurgical practice
- Pandemic

Abbreviations and Acronyms
COVID-19: Coronavirus disease 2019
OR: Operating room

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Citation: World Neurosurg. (2020) 142:e481-e486. https://doi.org/10.1016/j.wneu.2020.07.083

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

Control and Prevention recommendations for exposed individuals.[15] Since in emergent cases our personnel on the neurosurgery service could be potentially exposed, in this way they were always able to quarantine for 2 weeks after 1 week of service coverage. As regulations are relaxed both nationally and locally due to the curtail of COVID-19 spread, it remains unclear how the post-COVID-19 world will look, especially as it pertains to health care.

The goals of this study are to report the load and variety of neurosurgical cases and clinic visits after discontinuing the COVID-19 "Battle Plan"[13] at an academic tertiary care referral center to provide insights for other departments planning to go through a similar transition. Our hypothesis is that neurosurgical volume and clinic volume will remain below pre-COVID levels. Specifically, we believe that elective spine procedures and functional procedures will be proportionately lower. We believe that the subspecialty clinic findings will be analogous.

METHODS

This study was approved by our institutional review board with a waiver of patient consent. Clinical data of all consecutive patients who were seen in our neurosurgical clinic or who underwent a neurosurgical intervention between May 4, 2020, and June 4, 2020, were obtained from a prospectively maintained database. These were the first 4 weeks of clinical practice after discontinuing the "Battle Plan."[13] Urgency of cases was defined as emergent, requiring immediate transfer to the operating room (OR); urgent—within 1 day, or urgent—within 1 week, where the intervention should be performed within 1 day or 1 week, respectively, to preserve neurologic function; and elective, where the intervention was scheduled from a clinic appointment to be performed at a prearranged time. Data of patients who underwent neurosurgical interventions over a 6-month period (January 1—June 30, 2019) were retrospectively collected from the medical records as a control group for the same neurosurgical service before the COVID-19 pandemic began and averaged to 4 weeks for proper comparison of the 4-week data collected after discontinuing the "Battle Plan."[13]

Clinical visits were defined as nonoperative—a visit in which further workup or conservative management was advised; preoperative—the visit that the physician and patient agreed to neurosurgical intervention; postoperative—any visit after a neurosurgical intervention; surgical consult—a visit with an advanced practitioner days before surgery to ensure preoperative workup was complete and administrative documents were appropriately filled out; and procedural—in-office electromyography or lumbar puncture. The control group for this cohort was retrospectively obtained from our practice's records of clinic visits over a 3-month period (April 1—June 30), which was then averaged to 4 weeks for proper comparison.

RESULTS

Neurosurgical Interventions

The demographic and clinical data of 161 patients who underwent neurosurgical interventions over the 4 weeks after discontinuing the "Battle Plan"[13] are summarized in **Table 1**. The mean age at surgery was 56 years (range 18—94 years). One hundred two patients (63%) were admitted for elective surgery from clinic, 47 (29%) presented through the emergency department, 11 (6.8%) were transfers from outside hospitals, and 1 (0.6%) presented to our service from an in-hospital consult. One hundred two patients (63%) underwent elective interventions, 43 (27%) required an urgent intervention (23 within 1 day, 20 within 1 week), and 16 (10%) required an emergent intervention. This delay in 20 urgent cases to within 1 week was a result of conditions in which such a delay was deemed appropriate (carotid endarterectomies following strokes; cord decompression and spinal fusion following central cord syndrome, etc.) in combination with a limitation in OR availability. The average length of operative time was 2.88 hours in the 127 patients undergoing nonendovascular interventions. In discharged patients (N = 135 of 161), mean length of stay was 4.18 days. Of those discharged, 107 (67%) returned home, 21 (13%) were discharged to inpatient rehabilitation, 1 patient was discharged to an outside hospital, and 1 to a skilled nursing facility. One patient (0.6%) died during their hospital stay; no patients were found to have died on follow-up. Eight patients required emergent or urgent return trips to the OR during their hospitalization (due to ventriculoperitoneal shunt surgeries, hematomas, wound washouts, etc.). Sixty-two of sixty-four patients who were recommended to follow-up within the data collection window attended their follow-up appointments—57 of which were in-person and 5 were through telemedicine.

Comparison of relative percentages of neurosurgical interventions by patient population (adult vs. pediatric) and subspecialty (craniotomy/biopsy for brain tumor, trauma or pain; open vascular; endoscopic endonasal; functional and epilepsy; ventriculoperitoneal shunt; peripheral nerve; spine; and endovascular) between regular practice and resumption of practice after discontinuing the "Battle Plan"[13] are reported in **Figure 1**. Comparison of relative percentages of neurosurgical interventions as a function of time is plotted in **Figure 2** to evaluate the relationship between neurosurgical volume and time from peak-COVID regulations and 'Battle Plan' regulations.[13]

Clinic Visits

The demographic and clinical data of 701 patients who visited the neurosurgical clinic over these 4 weeks are summarized in **Table 2**. Patients were seen by 1 of 12 attending physicians or 2 advanced practitioners within the Neurosurgery Department. The mean age at clinic visit was 56 years (range 5—95 years). Of these visits, 325 (46%) occurred in person; 376 (54%) occurred via telemedicine. Of the types of appointments, 80 (11.4%) were preoperative in nature, 216 (31%) were postoperative, 325 (46%) were nonoperative, 68 (9.7%) were surgical consults, and 21 (3%) were procedural (18 electromyograms, 3 lumbar punctures).

As seen in **Table 2**, each visit was assigned to a neurosurgical subspecialty. The 3 most common categories were degenerative spine (40%), intracranial tumors (13%), and miscellaneous: cerebrospinal fluid (8.3%; this category includes ventri culoperitoneal shunt, Arnold—Chiari malformations, idiopathic intracranial hypertension, etc.). For preoperative and postoperative visits, type of intervention was recorded using the same categories as the neurosurgical interventions in the preceding section. From preoperative visits, the 3 most common categories were functional and epilepsy (30%), adult spine (29%), and adult

Table 1. Demographic and Clinical Data of Patients Undergoing Neurosurgical Interventions Over a 4-Week Period After Dismantling the "Battle Plan"

Variable	Number of Patients (%)
Sex	
Male	92 (57.1)
Female	69 (42.9)
Medium of presentation	
Scheduled from clinic	102 (63.4)
Emergency department	47 (29.2)
In-hospital consult	1 (0.6)
Transfer from outside hospital	11 (6.8)
Classification of neurosurgical intervention	
Elective	102 (63.4)
Urgent—1 day	23 (14.3)
Urgent—1 week	20 (12.4)
Emergent	16 (9.9)
Discharge disposition	
To be determined	28 (17.4)
Home	107 (66.5)
Inpatient rehabilitation	21 (13.0)
Outside hospital	1 (0.6)
Skilled nursing facility	1 (0.6)
Died	1 (0.6)
Age at intervention, years, mean ± 2SE	56.19 ± 2.57
Length of admission, days, mean ± 2SE	4.18 ± 0.934; $N = 135$ (current inpatients excluded)
Length of surgery, hours, mean ± 2SE	2.88 ± 0.356; $N = 127$ (endovascular procedures excluded)

$N = 161$, unless otherwise specified.
SE, standard error.

craniotomy for tumor (15%). From postoperative visits, the 3 most common categories were adult spine (38%), functional and epilepsy (16%), and adult craniotomy for tumor (15%). The average time from preoperative visit to neurosurgical intervention in this cohort was 18 days. The average follow-up time of the postoperative visits during this time period from their initial surgery was 13 months.

Figure 2 compares the relative percentages of clinic visits as a function of time to evaluate the relationship between clinic volume and time from peak-COVID and "Battle Plan" regulations.[13] Comparison of clinic visits in each neurosurgical subspecialty between these 2 time periods was not possible within our database. Four patients (0.6%) recommended surgery preferred to postpone it due to COVID-19 fears. Eight telemedicine visits (2.1%) concluded with providers noting they would likely recommend surgery but would need to see the patient in-person first.

DISCUSSION

This study highlights our center's experience in the period immediately following the discontinuation of our COVID-19 "Battle Plan"[13] and its differences with "typical" practice. One week after resuming non-"Battle Plan" practice, neurosurgical interventions reached and then exceeded the "typical" volume seen at our center. Of neurosurgical interventions, the subcategories of "adult functional and epilepsy" and "adult brain tumor" were more prevalent in the 4 weeks after COVID-19 than in "typical" practice, whereas "adult spine" and "endovascular" procedures were less prevalent than in "typical" practice. Clinic volume, in contrast, remained less busy than in average "typical" practice for each of the 4 weeks evaluated. In clinics, in the 4 weeks following COVID-19 "Battle Plan"[13] relaxation, degenerative spine and intracranial tumors were the 2 most common neurosurgical subspecialties for which patients came to see a physician.

Neurosurgical interventions in the first week following the end of the COVID-19 "Battle Plan"[13] remained below "typical" volume before increasing to above "typical" volume for the next 3 weeks. This week-delay in volume can be attributed to new administrative barriers and infrastructure associated with operative cases in our institution. For example, all patients are required to have COVID-19 testing 24 hours before surgery. As well, it took some time at our institution for ancillary staff to be available to staff more operative suites—for the first week, our service only had access to 2 ORs for non—add-on procedures in addition to 2 angiography suites. For the remaining 3 weeks reported, our service typically had 3 ORs for elective cases (plus 2 angiography suites), identical to the pre-COVID period. The increase to above "typical" volume for the latter 3 weeks studied was a result of permitting elective cases after having canceled all elective cases from March 20 until May 4, reducing our volume by more than half.[14] This correlates with the increase in adult functional/epilepsy surgery volume seen during these 4 weeks post-"Battle Plan," as it was the subspecialty most affected by the cancelling of elective cases during implementation of the "Battle Plan."[13,14] Adult brain tumor surgeries were also increased post-"Battle Plan" era (13.7% vs. 9%), as providers could not continue holding patients from elective tumor resection. We expect that neurosurgical volume will remain at a greater level for some months.

Adult spine procedures were greatly decreased in the post-"Battle Plan" era (21% vs. 25%). This can likely be attributed to the pandemic causing many patients to lose their medical insurance, paid time off, and savings combined with the elective nature of these surgeries. Endovascular procedures witnessed a decline compared with "typical" practice (21% vs. 27%), which is likely a result of regressing toward the mean in light of an increase in procedures during the month prior[14]; however, it could also be due to patients postponing treatment/monitoring due to lack of medical insurance, paid time off, and savings. It does not appear that fears of COVID-19 were major detractors of surgical intervention in our practice.

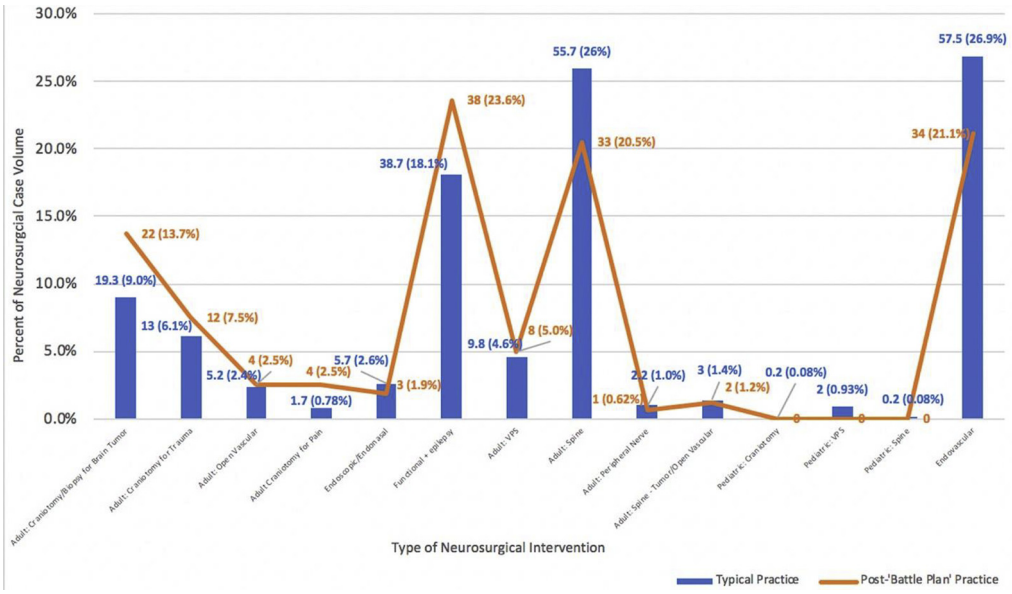

Figure 1. Comparison of numbers and relative percentages of neurosurgical interventions by patient population and subspecialty between "typical" practice and practice after discontinuing the "Battle Plan"[13] from the coronavirus disease 2019 (COVID-19) pandemic. For the "typical" practice series, *N* is equal to 214 cases per 4 weeks, averaged over 6 months of practice last year. For the post-"Battle Plan" series, *N* is equal to 161 cases performed over 4 weeks.

Clinic appointments, although featuring an increase in volume in the fourth week after discontinuing the "Battle Plan,"[13] continued to lag behind "typical" clinical volume. First, appointments are now required to be, at minimum, 30 minutes apart. This is because clinic space is shared between practitioners of the same and different departments and all patients must remain at least 6-feet apart at all times per Centers for Disease Control and Prevention recommendations.[15] As well, because many patients now lack financial security and paid time off, some are forgoing clinic visits. Although degenerative

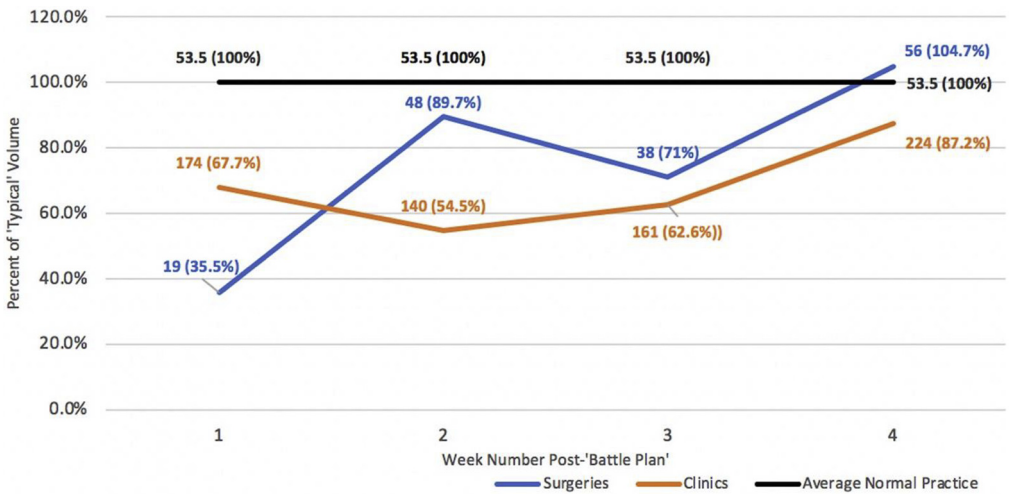

Figure 2. Numbers and relative percentages of neurosurgical interventions and clinic visits as a function of time after discontinuing the "Battle Plan"[13] from the coronavirus disease 2019 (COVID-19) pandemic compared withaverage "typical" practice. For the neurosurgical interventions series, *N* is equal to 161 cases performed over 4 weeks. For the clinic visits series, *N* is equal to 701 appointments over 4 weeks.

Table 2. Demographic and Clinical Data of Patients Attending Neurosurgical Clinics Over a 4-Week Period After Dismantling the "Battle Plan"

Variable	Number of Patients (%)
Sex	
Male	347 (50.5)
Female	354 (49.5)
Medium of visit	
In person	325 (46.4)
Telehealth	376 (53.6)
Patient novelty	
New	112 (16.0)
Clinic follow-ups	557 (79.5)
Hospital follow-ups	32 (4.6)
Type of visit*	
Preoperative	80 (11.4)
Postoperative	216 (30.8)
Surgical consult	68 (9.7)
Nonoperative	325 (46.4)
Procedural	21 (3.0)
Neurosurgical subspecialty	
Degenerative spine	279 (40)
Endovascular	33 (4.7)
Epilepsy	24 (3.4)
Functional	50 (7.1)
Intracranial tumor	91 (13)
Miscellaneous: facial pain	13 (1.9)
Miscellaneous: CSF	58 (8.3)
Miscellaneous: infection	2 (0.3)
Open vascular	18 (2.6)
Pediatric	6 (0.8)
Peripheral nerve	46 (6.6)
Pituitary	37 (5.3)
Cranial trauma	16 (2.3)
Spine trauma	19 (2.7)
Spine tumor	9 (1.3)
Surgical procedures from preoperative/postoperative visits	
Adult craniotomy for pain	4 (3.2)/5 (2.3)
Adult craniotomy for trauma	1 (0.8)/10 (4.6)
Adult craniotomy for tumor	19 (15.1)/33 (15.2)
Adult spine	37 (29)/83 (38)
Endoscopic/endonasal	8 (6.3)/13 (6.0)
Endovascular	7 (5.6)/16 (7.4)
Functional and epilepsy	38 (30.2)/34 (15.7)
Open vascular	2 (1.6)/5 (2.3)
Pediatric	1 (0.8)/3 (1.4)
Peripheral nerve	3 (2.4)/0 (0.0)
VPS	6 (4.8)/15 (6.9)
Age at clinic visit, years, mean ± 2SE	56.18 ± 1.274
If preoperative, time from preoperative visit to surgery, days, mean ± 2SE	18.14 ± 3.19; $N = 80$
If postoperative, time of follow-up, months, mean ± 2SE	12.97 ± 3.22; $N = 216$

Continues

Table 2. Continued

$N = 701$, unless otherwise specified.
CSF, cerebrospinal fluid; VPS, ventriculoperitoneal shunt; SE, standard error.
*Percentage adds to over 100%, as 9 patients had simultaneous preoperative and postoperative clinic visits.

spine remains the most common neurosurgical problem for which clinic appointments are made, providers feel that there are significantly fewer appointments than before. While telemedicine appointments have continued to be important throughout this post-COVID period, and could help improve this decrease in clinic volume, our center has had to restrict interposing telemedicine appointments with regular appointments because of staff constraints, so telemedicine can only be used for an entire half- or full-clinic day. However, telemedicine has remained a viable and productive way to talk with and evaluate patients—especially those with travel concerns.

While we have discontinued the "Battle Plan"[13] in clinical practice, it is important to note that educational conferences continue to occur virtually as specified in the original plan. This aspect was continued so as to restrict the number of people assembling in one location at a given time, and because of the benefit experienced in communication and attendance at virtual conferences.

Importantly, our center is located in one of the epicenters of COVID-19 in Florida. At any given time during the "Battle Plan" or post-"Battle Plan" period, there were generally 8–20 patients positive for COVID-19 admitted at any given time, with no decrease in these patients in the post-"Battle Plan" period as compared with the "Battle Plan" period. In total at the end of data collection, there were 140 patients who had been admitted with COVID-19. At the same time, our county had 2432 confirmed positive cases of 1,471,968 estimated residents (0.17%).[16,17]

Limitations

The patient population is relatively small due to the short period (4 weeks) after discontinuing the "Battle Plan,"[13] which reduces the power of this study as well as limits its generalizability.

Also, our experiences with the post-COVID era is limited, and self-appraisal is an ongoing process.

CONCLUSIONS

During pandemics, implementation of crisis protocols is essential to continue delivery of optimal care and safe practice. As these events abate, retreat to "typical" practice can be completed effectively by appropriately allocating resources. To accomplish this, departments can anticipate increases in neurosurgical volume, specifically in the functional/epilepsy and brain tumor subspecialties, as well as continued decreases in neurosurgical clinic volume, specifically in elective spine.

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 15 June 2020; accepted 13 July 2020

Citation: World Neurosurg. (2020) 142:e481-e486. https://doi.org/10.1016/j.wneu.2020.07.083

*Journal homepage: **www.journals.elsevier.com/world-neurosurgery***

*Available online: **www.sciencedirect.com***

1878-8750/$ - see front matter