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Impact of the COVID-19 Pandemic on Neurosurgical Transfers: A Single Tertiary Center Study

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■ OBJECTIVE: **Interfacility transfers represent a large proportion of neurosurgical admissions to tertiary care centers each year. In this study, the authors examined the impact of the COVID-19 pandemic on the number of transfers, timing of transfers, demographic profile of transfer patients, and clinical outcomes including rates of surgical intervention.**

■ METHODS: **A retrospective review of neurosurgical transfer patients at a single tertiary center was performed. Patients transferred from April to November 2020 (the "COVID Era") were compared with an institutional database of transfer patients collected before the COVID-19 pandemic (the "Pre-COVID Era"). During the COVID Era, both emergent and nonemergent neurosurgical services had resumed. A comparison of demographic and clinical factors between the 2 cohorts was performed.**

■ RESULTS: **A total of 674 patients were included in the study (331 Pre-COVID and 343 COVID-Era patients). Overall, there was no change in the average monthly number of transfers ($P = 0.66$) or in the catchment area of referral hospitals. However, COVID-Era patients were more likely to be uninsured (1% vs. 4%), had longer transfer times (COVID vs. Pre-COVID Era: 18 vs. 9 hours; $P < 0.001$), required higher rates of surgical intervention (63% vs. 50%, $P = 0.001$), had higher rates of spine pathology (17% vs. 10%), and less frequently were admitted to the intensive care unit (34% vs. 52%, $P < 0.001$). Overall, COVID-Era patients did not experience delays to surgical intervention (3.1 days vs. 3.6 days, $P = 0.2$). When analyzing the subgroup of COVID-Era patients, COVID infection status did not impact the time of transfer or rates of operation, although COVID-infected patients experienced a longer time to surgery after admission (14 vs. 2.9 days, $P < 0.001$).**

■ CONCLUSION: **The COVID-19 pandemic did not reduce the number of monthly transfers, operation rates, or catchment area for transfer patients. Transfer rates of uninsured patients increased during the COVID Era, potentially reflecting changes in access to community neurosurgery care. Shorter time to surgery seen in COVID-Era patients possibly reflects institutional policies that improved operating room efficiency to compensate for surgical backlogs. COVID status affeted time to surgery, reflecting the preoperative care that these patients require before intervention.**

INTRODUCTION

Neurosurgical transfers represent a significant portion of the patients who present to tertiary health care centers and require neurosurgery. Many community-based hospitals lack the resources to treat the full spectrum of neurosurgical disorders or may not have full-time neurosurgical coverage. Thus transfer to higher-level care centers is often necessary to rule out dangerous or life-threatening conditions. As subspecialists

Key words
- Catchment area
- COVID-19
- Neurosurgery
- Pandemic
- Transfers

Abbreviations and Acronyms
CI: Confidence interval
COVID-19: Coronavirus identified in 2019
ICU: Intensive care unit
UCSF: University of California, San Francisco

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consolidate in tertiary care and specialized regional centers, the need for neurosurgical transfers continues to grow.[1,2]

The global spread of COVID-19 has caused health care systems worldwide to face unprecedented challenges, with neurosurgery being no exception. Early measures to adjust to the influx of COVID-19 patients focused on the provision of intensive care units to accommodate critically ill patients and the maintenance of personal protective equipment for medical personnel.[3,4] As a result, many facilities postponed or outright cancelled elective operations for at least some portion of time. However, the effect of these changes on neurosurgical transfers to tertiary care centers has been largely unexplored.[5]

While some reports suggest patients seeking medical attention for neurologic pathologies declined in the COVID-19 era,[6,7] the question remains as to how the pandemic impacted neurosurgical transfers to tertiary centers, specifically with regard to the catchment area, diversity of patients and expected pathologies, and interventions required. To address this, we performed a retrospective analysis of the transfer patterns to a single tertiary academic center before and during the initial peak of the COVID-19 pandemic. These data can help neurosurgical departments better understand the dynamics of transfer needs during times of pandemic illness to better allocate scarce health care resources.

METHODS

Study Design

This was a retrospective cohort study of transfer patients to a single, large academic tertiary center. Two cohorts of adult neurosurgical patients were examined: The "Pre-COVID Era" cohort included patients transferred to our center from an outside hospital during the time period of April 16, 2019 through November 30, 2019, and the "COVID Era" cohort included patients transferred from an outside hospital during the period of April 16, 2020 through November 30, 2020 (Figure 1). During this defined time, both emergency and nonemergency neurosurgical services had resumed. Patients in March and early April 2020 were not included as our center's transfer center was closed to transfers or had limited transfers for emergencies to ensure enough bed capacity in anticipation of an increased rate of hospitalization from COVID-19 infection. Corresponding timeframes from 2019 and 2020 were selected to account for potential seasonal variations in transfer requests.

All adult patients who underwent emergency department—to-inpatient or inpatient-to-inpatient transfer from an outside hospital to the neurosurgery service at our institution regardless of transfer reason were included in the study. All transfers to our institution from outside centers were accepted regardless of insurance or socioeconomic status. Patients who were accepted but not transferred due to cancellation by the outside hospital were not included in the study. Two international patients were excluded from analyses of ZIP code—based distance from home to the University of California, San Francisco (UCSF) but were otherwise included in all analyses. Consensus-based perioperative protocols during the COVID-19 pandemic were developed by our institution and implemented to help streamline delivery of neurosurgical care.[8,9] Limits on elective cases were implemented during the first 3 months of the pandemic.

After searching the UCSF Transfer Center Database, 331 and 343 patients were identified and included in the Pre-COVID and COVID-Era cohorts, respectively.

Clinical Variables

A medical chart review was performed to identify patient demographics including age, sex, race/ethnicity, insurance status, home ZIP code, referring outside hospital ZIP code, and county of residence. Clinical information included time to transfer, the level of transfer required (i.e., to ICU-level or non-ICU-level care), surgical interventions required, COVID-19 infection status, discharge disposition, time to transfer, time to surgery, and time to discharge.

"Transfer diagnosis" was broadly defined into the following categories: "Tumor," "Infection," "Vascular/Hemorrhage," "Hydrocephalus/Shunt," "Spine Instability/Compression," and "Other" on the basis of the specific suspected/confirmed diagnosis provided by the referring hospital at the time of transfer request. Specific diagnoses in the "Other" included complex pain, seizure of unclear etiology, postoperative complications, undifferentiated weakness,

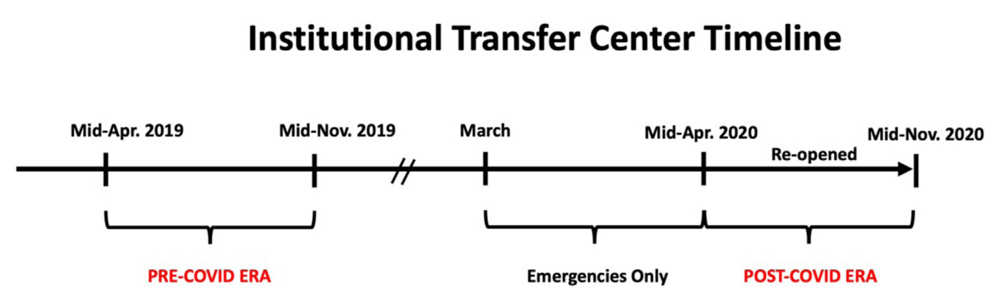

Figure 1. Timeline depicting Pre-COVID and COVID-Era patient cohorts. During these 2 time periods, the University of California, San Francisco transfer center was accepting transfers. During March to mid-April 2020, corresponding to the start of the pandemic, the transfer center was only accepting emergency transfer requests to provide for increased bed capacity for a potential increase in COVID-19 infections; thus, this period was excluded from the study but represents an obvious impact the pandemic had on transfers to the institution.

encephalopathy, peripheral nerve injury, hyponatremia, trigeminal neuralgia, and vasovagal syndrome.

Data Analysis

Group-level analyses were performed between the 2 comparative cohorts. Student's *t*-test was used for univariate analysis of 2-level continuous independent variables and analysis of variance for multilevel independent variables. Categorical variables were compared using chi-square tests. A P value <0.05 was defined as statistically significant. Univariate analyses were performed using 1-way analysis of variance, and F-test/statistic assessed significance of the predictive models. Adjusted multivariate analyses were performed with linear and logistic regressions. All analyses were performed using STATA SE (version 16.1).

RESULTS

Comparison of Cohort Demographics

All demographic data for Pre-COVID–Era and COVID-Era patient cohorts are summarized in Table 1. There were 331 and 343 patients in the Pre-COVID– and COVID-Era cohorts, respectively. Pre-COVID–Era patients had an average age of 56 years with women accounting for 44% and racial/ethnic minorities 38% of the population. COVID-Era patients had an average age of 57 years with women accounting for 42% and racial/ethnic minorities 40% of the population. The COVID-Era cohort contained a higher proportion of patients who were uninsured (COVID vs. Pre-COVID: 4% vs. 1%) or who had Medicare (COVID vs. Pre-COVID: 41% vs. 38%) with a lower proportion of patients with private insurance (COVID vs. Pre-COVID: 23% vs. 29%). The proportion of patients with Medicaid was 32% in both periods.

Distribution of transfer patients in both cohorts can be visualized in Figure 2. Despite comparable average distance from referring hospitals to UCSF during both periods (83 vs. 84 miles), COVID-Era transfer patients lived significantly closer to the hospital they initially presented to for care (COVID vs. Pre-COVID: 22 vs. 79 miles, $P < 0.001$) and significantly further from UCSF (COVID vs. Pre-COVID: 88 vs. 140 miles, $P = 0.003$). This meant the overall distance traveled from home to an outside hospital and subsequently to UCSF was significantly lower for transfer patients during the COVID Era (COVID vs. Pre-COVID: 105 vs. 165 miles, $P = 0.001$). When examining overall rates of intracounty, intercounty, and out-of-state transfers, however, there were no differences between the Pre-COVID– and COVID-Era cohorts.

Comparison of Number of Transfers and Cohort Diagnoses

Overall, there was no change in the average number of monthly transfers between the 2 time periods (COVID vs. Pre-COVID–Era transfers per month: 45 vs. 47.1; $P = 0.66$). All diagnoses data for Pre-COVID–Era and COVID-Era patient cohorts are summarized in Table 1. The 2 most common diagnosis categories for both cohorts were vascular lesions or hemorrhage (COVID vs. Pre-COVID: 34% vs. 36.5%) and tumor (COVID vs. Pre-COVID: 30% vs. 31%). There was a significant difference in the distribution of diagnoses between the 2 cohorts with the greatest difference in number of patients with spinal instability or compression (COVID vs. Pre-COVID 17% vs. 10%).

Table 1. Pre-COVID and COVID-Era Patient Demographic Characteristics

	Pre-COVID Era N = 331	COVID Era N = 343	*P* Value
Age (SD)	56 (17.3)	57 (17.5)	0.38
Female sex	146 (44%)	145 (42%)	0.63
Race/Ethnicity			
White (non-Hispanic/Latino)	197 (60%)	193 (56%)	0.53
Black/African-American	13 (4%)	23 (7%)	
Hispanic/Latino	62 (19%)	62 (18%)	
Asian/Pacific Islander	41 (12%)	39 (11%)	
American Indian/Native	4 (1%)	5 (1%)	
Minority status	120 (38%)	129 (40%)	0.59
Insurance payor			0.04
Medicare	126 (38%)	139 (41%)	
Medicaid	105 (32%)	110 (32%)	
Private	96 (29%)	79 (23%)	
Uninsured/Self-pay	4 (1%)	15 (4%)	
Catchment area distribution			
Distance traveled			
Distance: Patient home to OSH	79 miles	22 miles	<0.001
Distance: OSH to UCSF	84 miles	3 miles	0.78
Total distance: home to OSH to UCSF	164 miles	105 miles	0.001
County of residence			
Intracounty transfer	50 (15%)	44 (13%)	0.69
Intercounty transfer	275 (83%)	292 (85%)	
Out-of-state transfer	6 (2%)	7 (2%)	

SD, standard deviation; OSH, outside hospital; UCSF, University of California, San Francisco.

Comparison of Transfer and Hospitalization Outcomes

Transfer and hospitalization outcomes are summarized in Table 2. Time to transfer, defined by time of transfer request and actual admission, was significantly greater for COVID-Era patients when compared with Pre-COVID–Era patients (COVID vs. Pre-COVID: 18 vs. 9 hours; $P < 0.001$). There was also a significant difference in the rate of ICU admission between the 2 cohorts with decreased ICU admission rates seen within the COVID-Era cohort (COVID vs. Pre-COVID: 34% vs. 52%, $P < 0.001$).

Surgical intervention was pursued in 50% of Pre-COVID–Era patients ($n = 164$) after admission and in 63% of COVID-Era patients ($n = 214$) ($P = 0.001$). On average, time to surgery was comparable between the 2 groups (COVID vs. Pre-COVID: 3.1 vs. 3.6 days; $P = 0.20$). Patients were subsequently discharged to similar disposition locations between the 2 time periods (Table 2). Overall, both groups experienced identical levels of non–home

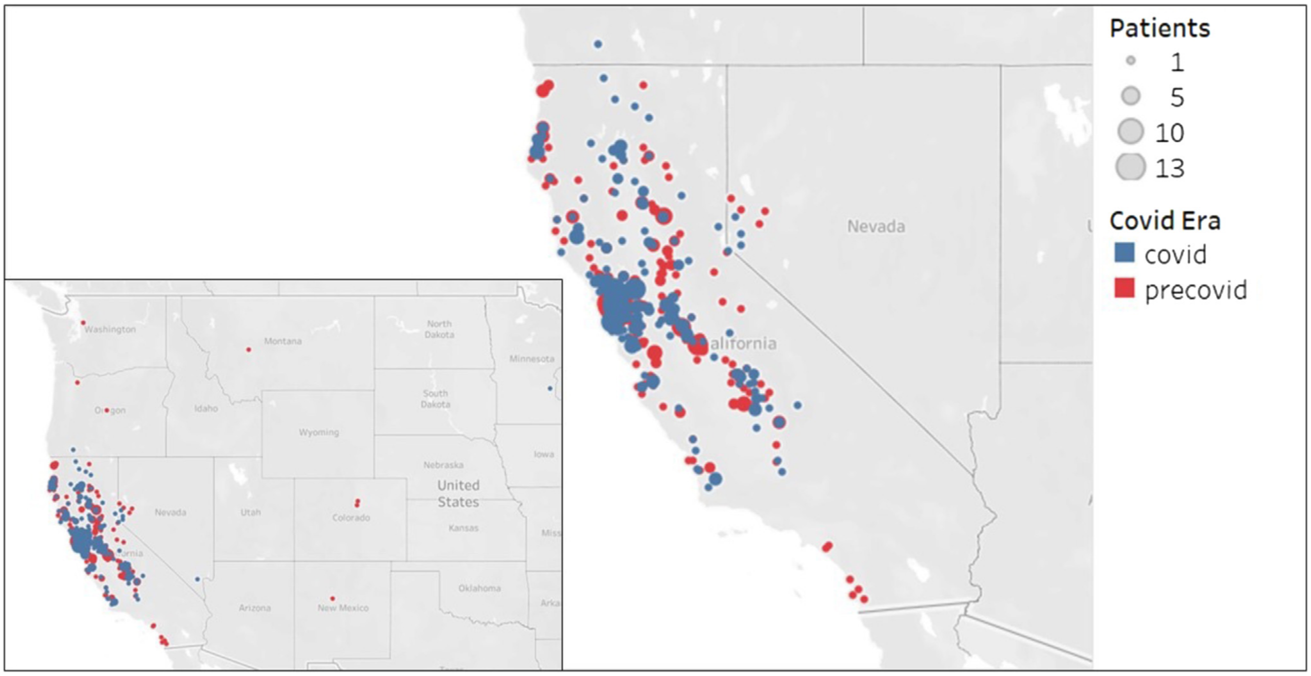

Figure 2. Geographic distribution of transfer patients during Pre-COVID and COVID Eras.

discharge (COVID vs. Pre-COVID: 53% vs. 53%; P = 0.96). Furthermore, patients had similar lengths of hospital stay between the 2 cohorts (COVID vs. Pre-COVID: 10 vs. 9.5 days; P = 0.46).

Clinical Outcomes by COVID-19 Infection Status

A secondary analysis on clinical outcomes based on COVID-19 infection status (positive vs. negative) was performed within the COVID-Era cohort (Table 3). Of the 343 patients transferred to the neurosurgical service during the COVID Era, 336 patients tested negative and 7 patients tested positive for COVID-19. Overall, patients with positive COVID-19 status had similar transfer times, rates of surgical intervention, and rates of ICU admission. However, time between admission and surgical intervention was significantly longer for COVID-19–positive patients (14 vs. 2.9 days; P < 0.001). Length of hospital stay also trended toward being significantly longer (16.3 vs. 9.9 days; P = 0.07).

Predictors of Transfer Time and Surgical Intervention

A multivariate linear regression model was used to determine factors associated with transfer time using all patients included in the study (N = 674) (Table 4). Both admission to the ICU and transfer during the COVID Era were significant correlates with time to transfer. COVID Era was associated with a 7-hour increase in transfer time (B Coef: 0.296, 95% CI: 0.15–0.43, P < 0.001). Admission to the ICU was associated with a 9.8-hour decrease in transfer time (B Coef: −0.41, 95% CI: −0.47 to −0.15, P < 0.001). Age, sex, minority identity, insurance payor, distance (referring hospital to UCSF), and transfer diagnosis were not significant predictors of transfer times.

A multivariate logistic regression model was then used to determine factors associated with surgical intervention using all patients included in the study (N = 674) (Table 5). Both diagnosis and transfer during the COVID Era were significant correlates with surgical intervention. Transfer during the COVID Era was associated with 1.6 greater odds (SE: 0.267, 95% CI: 1.15–2.21, P = 0.005) of having a surgical intervention during the hospitalization as compared with patients transferred during the Pre-COVID Era. A transfer diagnosis of infection (OR: 4.5, 95% CI: 2.37–8.58, P = <0.001), tumor (OR: 1.8, 95% CI: 1.12–2.77, P = 0.014), and spinal instability/compression (OR: 2.9, 95% CI: 1.67–5.16, P = <0.001) were associated with greater odds of having a surgical intervention during hospitalization. A transfer diagnosis of “Other” was associated with a 76% reduction in the odds of surgical intervention during hospitalization. Age, sex, minority identity, insurance payor, and ICU admission were not significant predictors of surgical intervention.

DISCUSSION

The COVID-19 pandemic has had severe consequences for hospital systems across the country. Most small and large institutions experienced early shutdown of nonemergency cases requiring rapid recalibration of neurosurgical operative practices.[5] Although neurosurgical transfers represent a significant proportion of volume to referral centers and are representative of access to surgical care, this topic has been understudied in the context of

Table 2. Transfer and Clinical Outcomes Between Pre-COVID and COVID Era

	Pre-COVID Era N = 331	COVID Era N = 343	*P* Value
Time to transfer	9 hours	18 hours	<0.001
Transfer diagnosis			0.006
Tumor	103 (31%)	96 (30%)	
Infection	33 (10%)	43 (13%)	
Vascular/Hemorrhage	121 (36.5%)	118 (34%)	
Hydrocephalus/Shunt	29 (9.6%)	24 (7%)	
Spine instability/Compression	32 (10%)	59 (17%)	
Other	13 (4%)	3 (1%)	
Intensive care unit admission	172 (52%)	118 (34%)	<0.001
Surgical intervention	164 (50%)	214 (63%)	0.001
Time to surgery	3.6 days	3.1 days	0.20
Length of hospital stay	9.5 days	10.0 days	0.46
Discharge disposition			
Rehab/SNF/Hospital	140 (42%)	155 (45%)	0.19
Death/Hospice	34 (10%)	22 (6%)	
Home	157 (47%)	165 (48%)	
Non—home disposition	175 (53%)	182 (53%)	0.96

SNF, skilled nursing facility.

Table 3. Transfer and Clinical Outcomes by COVID-19 Status Among COVID Era Patients

	COVID+ N = 7	COVID− N = 336	*P* Value
Time to transfer	21 hours	18 hours	0.77
Intensive care unit admission	3 (43%)	115 (34%)	0.63
Surgical intervention	4 (57%)	210 (63%)	0.76
Time to surgery	14.0 days	2.9 days	<0.001
Length of hospital stay	16.3 days	9.9 days	0.07

the COVID-19 pandemic. Additional considerations for transferring patients are required in the COVID Era (Figure 3) including ensuring adequate staff availability, having appropriate isolation rooms and personal protective equipment to manage COVID-positive patients, medical evaluation immediately on arrival with the need for further intensive management of COVID-related symptoms, and potential need to arrange special precautions in operating rooms for the management of COVID-positive patients. Our goal was to broadly examine whether these systems-level changes have impacted a tertiary institution's ability to provide neurosurgical care to patients in need.

In this study, we examined the impact of the COVID-19 pandemic on the catchment area of a large referral center for neurosurgical transfer, rates of transfers, transfer timing, and clinical outcomes of transfer patients. COVID-Era patients were compared with transfer patients from the immediate year prior using a corresponding time period to account for seasonal variations in transfer requests. Overall, rates of transfers to our institution remained stable between the 2 time periods. Furthermore, the catchment area of the institution did not appear to be significantly altered during the COVID era. Although patients appeared to travel shorter distances to referral hospitals, the average distance between these referral hospitals to our institution, as well as rates of intracounty and intercounty transfers did not change. Many fields including medicine, dentistry, and psychology have reported decreases in patients seeking medical care and patient reluctance to travel for care amidst the COVID-19 pandemic.[10-12] While reasons behind these choices are complex, it is probable that similar influences occurred in this patient population by creating real or perceived barriers to seeking care at local hospitals farther from home. Although data are scarce on this topic, a prior study examining emergency department transfer volumes in Arizona, which included neurosurgical patients, demonstrated a decrease in transfer rates between March and June of 2020 compared with 2019.[13]

Transfer times did increase during the COVID Era, as supported by the multivariate analysis, taking about twice as long as patients in the Pre-COVID—Era cohort. We suspected that COVID-Era patients would potentially have longer transfer times due to the need for COVID-19 testing before transfer, need to organize admission to rooms with appropriate isolation precautions for patients with pending or positive COVID-19 results at the time of request, and potential bed capacity limitations imposed by higher hospitalization rates during the pandemic. However, most transfers still occurred within 24 hours, and it is unclear if the increased time to transfer from 9 to 18 hours had a significant clinical impact. If surgical intervention was required after admission, there was no difference in time to surgery between the 2 time periods. Furthermore, the similar discharge disposition of patients and lengths of hospital admissions were similar, suggesting that, in general, outcomes were similar.

Rates of transfer of uninsured and Medicare patients to our institution increased while rates of patients with private insurance decreased, with Medicaid rates unchanged. While it is beyond the scope of this study to identify the exact reason behind this finding, it is plausible that the economic consequences of the COVID-19 pandemic impacted patient insurance status, which may account for these differences.[14] Specifically, the sudden surge in unemployment during the pandemic likely led to a quick increase in patients losing insurance without necessarily being eligible for Medicaid or being able to enroll in Medicaid during the time interval we studied.[15] Several studies documented an increase in the number of elderly patients seeking medical care during the pandemic, and this increase could have led to the increase in Medicare patients we observed during the COVID Era. It is reassuring to see that rates of transfer of minority patients and patients based on location did not dramatically differ between the 2 time periods, suggesting persistent access to neurosurgical care at our institution.

Table 4. Predictors of Time to Transfer in a Linear Regression Model

Predictor	Multivariate Coefficient	Time Change	95% Confidence Interval (hours)	*P* Value
COVID Era	0.289	6.9 hours	[3.6—10.3]	<0.001
Intensive care unit admission	−0.307	−7.4 hours	[−11.3 to −3.5]	<0.001
Age	0.002	0 hours	[0.0—0.2]	0.06
Distance	−0.00007	0 hours	[0.0—0.02]	0.87
Sex (F vs. M)	−0.003	0 hours	[−3.3 to 3.3]	0.70
Minority	−0.008	0.19 hours	[−3.6—3.2]	0.91
Insurance payor				0.19
Medicare	Ref		—	—
Medicaid	0.172	4.1 hours	[−0.8—9.1]	0.10
Private	−0.089	−2.1 hours	[−6.7—2.4]	0.35
Uninsured	−0.056	−1.3 hours	[−11.6—8.9]	0.79
Transfer diagnosis				0.65
Vascular/Hemm.	Ref		—	—
Hydrocephalus	0.017	0.5 hours	[−6.2—7.0]	0.91
Infection	0.145	3.5 hours	[−2.5—9.4]	0.25
Spinal instability	0.279	6.7 hours	[−3.8—17.2]	0.001
Tumor	0.199	4.8 hours	[4.3—15.5]	0.04
Other	0.279	6.7 hours	[0.14—9.4]	0.21

Table 5. Predictors of Surgical Intervention in Logistic Regression Model

Predictor	Odds Ratio	Z-Score	95% Confidence Interval	*P* Value
COVID Era	1.60	2.80	[1.1498—2.2133]	0.007
Intensive care unit admission	1.21	0.97	[0.8226—1.7894]	0.33
Age	0.99	−1.90	[0.9764—1.0003]	0.06
Sex (F vs. M)	1.07	0.39	[0.7711—1.4734]	0.70
Minority	1.22	1.17	[0.8742—1.7053]	0.24
Insurance payor				0.22
Medicare	Ref	—	—	—
Medicaid	0.82	−0.77	[0.5064—1.3430]	0.44
Private	1.17	0.68	[0.7478—1.8251]	0.49
Uninsured	1.84	1.05	[0.5926—5.7117]	0.29
Transfer diagnosis				0.01
Vascular/Hemm.	*Ref*	—	—	—
Hydrocephalus	1.28	0.76	[0.6775—2.4048]	0.45
Infection	4.43	4.53	[2.3256—8.4320]	<0.001
Spinal instability	2.93	3.71	[1.6576—5.1553]	<0.001
Tumor	1.72	2.34	[1.0923—2.7013]	0.02
Other	0.22	−2.21	[0.0617—0.8442]	0.03

Interestingly, COVID-Era transfer patients did not as a group require ICU admission as frequently as patient within the Pre-COVID—Era yet required a higher rate of surgical intervention, as supported by the multivariate analysis. We can only speculate as to why this may have been the case. A likely contributing factor is that ICU capacity was maintained with the intention of mitigating a potential surge in COVID cases. Hospital-wide efforts were made to transfer patients to a transitional care unit (or "step-down" unit) during the pandemic to preserve ICU beds. Additionally, these findings may in part be related to increased rates of spinal pathology admission observed in the COVID Era as these patients often do not require ICU care. Other studies have noted the delays in hospital presentation during the pandemic may have played a part in the need for interventions.[16] It is plausible that delays in routine care for nonemergency neurosurgical issues turned them into emergencies requiring higher rates of surgical intervention.

Surprisingly, COVID-19 infection status did not significantly impact many of the hospital outcomes that were evaluated in this study. Transfer time, rates of ICU admission, and rates of surgical intervention were similar between COVID-19—positive and COVID-19—negative patients. The increase in time from admission to surgery may be explained by the medical work-up required in these patients before surgical intervention, the need to wait for improvement of symptoms related to COVID-19 to undergo intervention, and the additional precautions needed to prepare operative rooms for these patients.

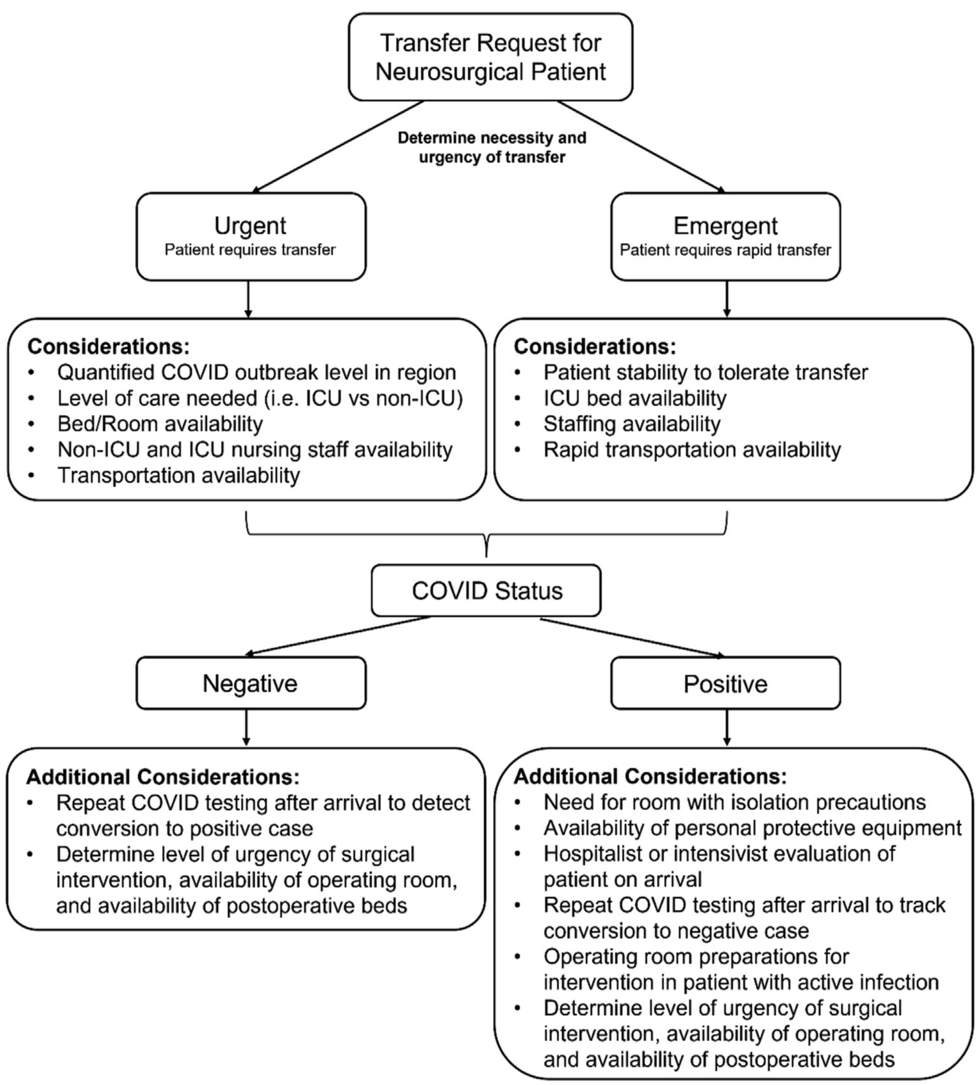

Figure 3. Considerations and algorithm for managing neurosurgical transfers.

Limitations

Several limitations to this study should be mentioned. Importantly, major conclusions on the impact of positive COVID-19 infection on transfer patient care are limited due to the low frequency of positive cases in the cohort. Only 7 patients of the cohort of 343 were either known positives or test positive immediately after being transferred. This amounts to a 2% preoperative case positivity rate, which is slightly higher than previously published results among other surgical fields ranging from as low as 0.76% to 0.93%.[17-19] COVID-19—positive patients may have first been admitted to an alternative service given this diagnosis and then subsequently transferred to the neurosurgical service for neurosurgical intervention. However, this would not have been captured by the current study given that inclusion criteria were limited to patients directly admitted to the neurosurgical service.

Given the retrospective nature of this study, the authors cannot speak to the causal nature of the relationships between patient demographics and the clinical outcomes measured. The COVID-19 pandemic brought about a confluence of factors, including those that may have helped and/or hindered the typical transfer process and subsequent care delivery. As this is a single-center study under a particular set of institutional policies, governed under dynamic local, state, and national guidance on patient care, this study may not be generalizable to other large academic centers across geographic regions. Furthermore, even within our institution, the protocol on implementation and quality of testing throughout the COVID Era was dynamic with some major shifts in hospital policy over the course of 8 months. To illustrate, early in the pandemic there was grave concern for patients transferred from nursing homes and other long-term nursing facilities, and those patients had more stringent requirements including days since last negative test. Additionally, early tests were prone to considerable false-negative reports.[20,21]

CONCLUSIONS

The COVID-19 pandemic triggered several fundamental changes to delivery of care nationwide. In this institution, the pandemic and subsequent policies to mitigate its effects caused noticeable changes to the transfer patient profile and key clinical outcomes. In our patient population, we observed longer transfer times, higher rates of surgical intervention for transfer patients, greater transfer of spine pathologies, and decreased rates of ICU admissions. Furthermore, during the COVID Era, COVID-19 infection was associated with a delay in time to surgery from admission and a trend toward longer hospital stay. It is important to examine all aspects of surgical care that have been impacted by the COVID-19 pandemic to ensure that access and delivery of appropriate care remains. Ideally, these results will allow other neurosurgical departments to compare the impact of the global pandemic on their transfer patient profile. Furthermore, this study offers a reflection on the tangible impact of the pandemic on neurosurgical transfers in a critical time for adaptive surgical care.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Sheantel J. Reihl: Conceptualization, Data curation, Investigation, Formal analysis. **Joseph H. Garcia:** Data curation, Investigation, Formal analysis. **Ramin A. Morshed:** Conceptualization, Data curation, Investigation, Formal analysis. **Sujatha Sankaran:** Supervision, Writing — original draft. **Anthony DiGiorgio:** Supervision, Writing — original draft. **Dean Chou:** Supervision, Writing — original draft. **Philip V. Theodosopoulos:** Supervision, Writing — original draft. **Manish K. Aghi:** Supervision, Writing — original draft. **Mitchel S. Berger:** Supervision, Writing — original draft. **Edward F. Chang:** Supervision, Writing — original draft. **Praveen V. Mummaneni:** Conceptualization, Supervision, Writing — original draft.

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