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.

An Analysis of Public Interest in Elective Neurosurgical Procedures During the COVID-19 Pandemic Through Online Search Engine Trends

Austin Y. Feng, Cesar A. Garcia, Michael C. Jin, Allen L. Ho, Gordon Li, Gerald Grant, John Ratliff, Stephen L. Skirboll

■ OBJECTIVE: **In the wake of the COVID-19 pandemic, the Centers for Medicare & Medicaid Services (CMS) has recommended the temporary cessation of all elective surgeries. The effects on patients' interest of elective neurosurgical procedures are currently unexplored.**

■ METHODS: **Using Google Trends, search terms of 7 different neurosurgical procedure categories (trauma, spine, tumor, movement disorder, epilepsy, endovascular, and miscellaneous) were assessed in terms of relative search volume (RSV) between January 2015 and September 2020. Analyses of search terms were performed for over the short term (February 18, 2020, to April 18, 2020), intermediate term (January 1, 2020, to May 31, 2020), and long term (January 2015 to September 2020). State-level interest during phase I reopening (April 28, 2020, to May 31, 2020) was also evaluated.**

■ RESULTS: **In the short term, RSVs of 4 categories (epilepsy, movement disorder, spine, and tumor) were significantly lower in the post-CMS announcement period. In the intermediate term, RSVs of 5 categories (miscellaneous, epilepsy, movement disorder, spine, and tumor) were significantly lower in the post-CMS announcement period. In the long term, RSVs of nearly all categories (endovascular, epilepsy, miscellaneous, movement disorder, spine, and tumor) were significantly lower in the post-CMS announcement period. Only the movement disorder procedure category had significantly higher RSV in states that reopened early.**

■ CONCLUSIONS: **With the recommendation for cessation of elective surgeries, patient interests in overall elective neurosurgical procedures have dropped significantly. With gradual reopening, there has been a resurgence in some procedure types. Google Trends has proven to be a useful tracker of patient interest and may be used by neurosurgical departments to facilitate outreach strategies.**

INTRODUCTION

Because of the COVID-19 pandemic in the United States, the Centers for Medicare & Medicaid Services (CMS) recommended the temporary cessation of all elective surgeries and nonemergent medical procedures.[1] Both the American Association of Neurological Surgeons and the Congress of Neurological Surgeons have also given commentary to these recommendations.[2,3] These instructions have had major implications on institutional operations and function, with the impact on patients remaining an active and important question. Although patient behavior has been assessed in studies demonstrating decreased health care utilization, patient interests are an underexplored aspect that may yield valuable information.[4]

However, a timely and comprehensive assessment is complicated by multiple factors, such as geography, decreased interactions between patients and providers, reduced research resources, and reprioritization of patients' health concerns with increased focus on COVID-19, limiting the utility of traditional methodologies. Particularly regarding the broad societal and cultural impact of COVID-19, application of analytical tools that are widely available and have access to big data may reveal shifting paradigms in patient interest on a large scale. Google Trends (GT) is a popular, free web surveillance tool that facilitates detection of novel trends in internet searches. Using the Google search engine, GT is able to identify and analyze patterns in key search terms over a designated period of time.[5] Although other authors have explored patients' interests in elective procedures in other

Key words
- COVID-19
- Elective procedures
- Google Trends
- Neurosurgery

Abbreviations and Acronyms
CMS: Centers for Medicare & Medicaid Services
GT: Google Trends
RSV: relative search volume

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surgical specialties with GT, similar investigations have not been performed for neurosurgery.[6] Given the diverse portfolio of procedures ranging from elective to emergent, identifying the broader impact of COVID-19 using GT may help infer changes in case volume to enable more efficient allocation of resources in future analogous situations.

In the present study, we used GT to gauge patient interest in elective neurosurgical procedures following the CMS recommendation. Through several key neurosurgical subspecialty procedures, patient interest was evaluated over different time periods. In addition, the impact of phase I reopening on interest was explored on a state-by-state basis.

METHODS

To assess the impact of CMS's and other neurosurgical societies' recommendations on elective neurosurgical cases, the volumes of internet search terms related to different neurosurgical procedures were collected from the Google search engine within the United States. Given the wide breadth of procedure types, 7 categories were chosen with 5 related search terms (Table 1). Topics, which are groups of search terms, were not used in order to maximize specificity.

Relevant search terms were chosen in relationship to each neurosurgical specialty and were confirmed through author consensus. With GT, the aforementioned search terms were evaluated in terms of relative search volume (RSV) between January 2015 and September 2020. Normalized to the overall search volume for a specified area (e.g., country or state), the RSV provides a value ranging between 0 (below detection threshold) and 100 (peak popularity) at a specific point in time. To simplify analyses, only the search terms with the greatest average RSV were used to represent their respective categories in further calculations (Figure 1).

To assess the "short-term" effects of the CMS announcement on March 18, 2020, the mean RSVs of selected search terms from 30 days before this date were compared with the corresponding mean RSVs from 30 days after the announcement date. For the "intermediate-term" effects, the mean RSVs of selected search terms from January 1, 2020, to March 18, 2020, were compared with the corresponding mean RSVs from March 19, 2020, to May 31, 2020. Baseline comparison was performed for equivalent time periods in 2019 ("short-term baseline": 30 days before vs. after March 18, 2019; "intermediate-term baseline": January 1, 2019, to March 18, 2019, vs. March 19, 2019, to May 31, 2019). For the "long-term" effects, the mean RSVs of selected search terms from January 2015 to February 2020 were compared with the corresponding mean RSVs from March 2020 to September 2020. Mean RSVs were averaged from the weekly RSVs. The percentage change between equivalent mean search term RSVs across different time periods is calculated: $100\% \times (RSV_2 - RSV_1)/RSV_1$.

Lastly, to compare the effects of phase I reopenings (April 24, 2020, to May 31, 2020), the mean RSVs during this period were calculated for each state, generating choropleth maps. Using dates given by official government communications, early reopening states (before May 15) and late reopening states (on or after May 15) were compared. The early reopening states were Alabama, Arizona, Arkansas, Colorado, Florida, Georgia, Idaho, Indiana, Iowa, Kansas, Maine, Mississippi, Missouri, Nebraska, Nevada, New Hampshire, North Carolina, North Dakota, Ohio, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wisconsin. The remaining 22 states were late reopening.

Student's *t*-tests were used to compare the differences in search volumes between time periods as well as between late and early reopening states. Statistical significance was determined with $\alpha = 0.05$. All statistical analyses were performed using R version 3.6.3.

RESULTS

For the keywords related to neurosurgical trauma procedures, "burr hole" had the greatest relative interest (Figure 1A). For endovascular procedures, the keyword with the greatest relative interest was "aneurysm coiling" (Figure 1B). For spinal procedures, "laminectomy" was the keyword with the greatest relative interest (Figure 1C). For neurosurgical tumor procedures, the keyword with the greatest relative interest was "craniotomy" (Figure 1D). For functional neurosurgical procedures, 2 separate search categories were used for movement disorder and epilepsy treatments. For the former category, "deep brain stimulation" was the keyword with the greatest relative interest (Figure 1D). For the latter category, "vagus nerve stimulation (VNS)", had the greatest relative interest among keywords (Figure 1E). For miscellaneous neurosurgical procedures, "ventriculoperitoneal

Table 1. Neurosurgical Procedure Categories/Search Terms

Procedure Category	Search Terms
Trauma	Burr hole, ICP catheter, intracranial pressure monitoring, lumbar drain placement, subdural evacuation
Endovascular	Aneurysm clipping, aneurysm coiling, aneurysm embolization, AVM resection, endovascular coiling
Spinal	Discectomy, laminectomy, minimally invasive spinal surgery, spinal decompression, spinal fusion
Tumor	Craniectomy, cranioplasty, craniotomy, radiosurgery, transsphenoidal approach
Movement disorder	DBS surgery, deep brain stimulation, pallidotomy, responsive neurostimulation device, thalamotomy
Epilepsy	Callosotomy, hemispherectomy, lesionectomy, SEEG, VNS
Miscellaneous	Cerebral shunt, ventriculoperitoneal shunting, ventriculostomy, ventriculostomy drain, VP shunt

ICP, intracranial pressure; AVM, arteriovenous malformation; DBS, deep brain stimulation; SEEG, stereoelectroencephalography; VNS, vagus nerve stimulation; VP, ventriculoperitoneal.

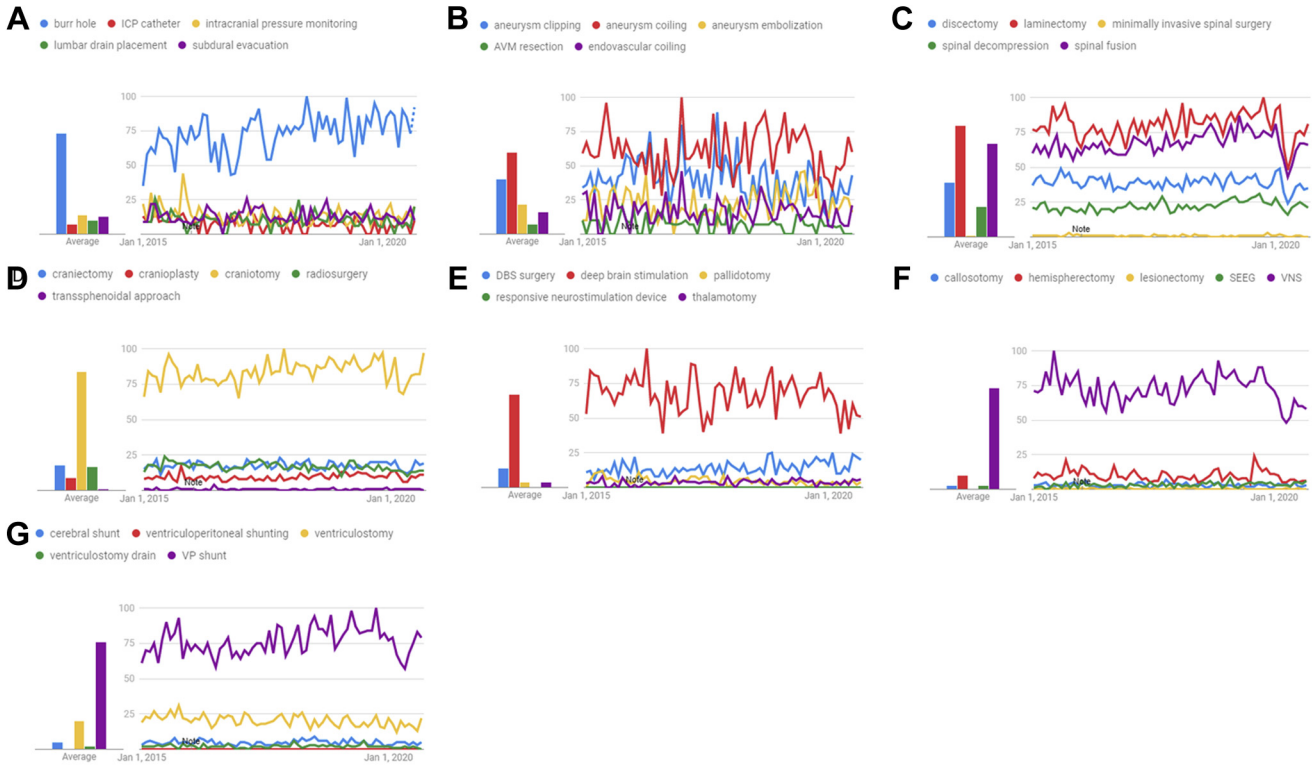

Figure 1. Trends from January 2015 to September 2020 of neurosurgical procedure categories. (**A**) Trauma. (**B**) Endovascular. (**C**) Spine. (**D**) Tumor. (**E**) Movement disorder. (**F**) Epilepsy. (**G**) Miscellaneous. ICP, intracranial pressure; AVM, arteriovenous malformation; DBS, deep brain stimulation; SEEG, stereoelectroencephalography; VNS, vagus nerve stimulation; VP, ventriculoperitoneal.

(VP) shunt" was the keyword with the greatest relative interest (Figure 1F).

There was significantly decreased interest in the majority of assessed neurosurgical procedure categories in the short term (Supplementary Table 1). For the epilepsy treatment category, the search volume for "VNS" decreased by 27.6% ($P = 0.01$). For the movement disorder treatment category, the search volume for "deep brain stimulation" decreased by 32.8% ($P = 0.003$). For the spine treatment category, the search volume for "laminectomy" decreased by 39.6% ($P < 0.001$). For the tumor treatment category, the search volume for "craniotomy" decreased by 28.0% ($P = 0.01$). The remaining treatment categories of trauma, endovascular, and miscellaneous did not experience statistically significant changes to their search volumes ($P = 0.6/0.662/0.219$, respectively) (Figure 2A). In the short-term baseline, there were no significant changes in search volume in any category (Figure 2B). In comparison between the short-term and short-term baseline, most categories were not statistically different. Only the spinal procedure category was significantly greater in the short term ($P = 0.037$), and the tumor procedure category was significantly greater in the short-term baseline ($P = 0.01$) (Figure 2C). However, the interest in most categories in the short term was statistically less compared with that in the short-term baseline (epilepsy, $P < 0.001$; miscellaneous, $P = 0.025$; movement disorder, $P = 0.048$; spine, $P < 0.001$; and tumor, $P < 0.001$) (Figure 2D).

Evaluation of the intermediate term surrounding the CMS announcement yielded findings similar to the short term (Supplementary Table 2). For the epilepsy treatment category, the search volume for "VNS" decreased by 21.9% ($P < 0.001$). For the miscellaneous treatment category, the search volume for "VP shunt" decreased by 16.9% ($P < 0.001$). For the movement disorder treatment category, the search volume for "deep brain stimulation" decreased by 26.9% ($P < 0.001$). For the spine treatment category, the search volume for "laminectomy" decreased by 37.0% ($P < 0.001$). For the tumor treatment category, the search volume for "craniotomy" decreased by 23.2% ($P < 0.001$). Trauma and endovascular procedure categories did not experience statistically significant changes to their search volumes ($P = 0.997/0.126$, respectively) (Figure 3A). For the intermediate-term baseline, there were no significant changes in search volume in any category (Figure 3B). In comparison between the intermediate term and intermediate-term baseline, miscellaneous, spinal, and movement disorder

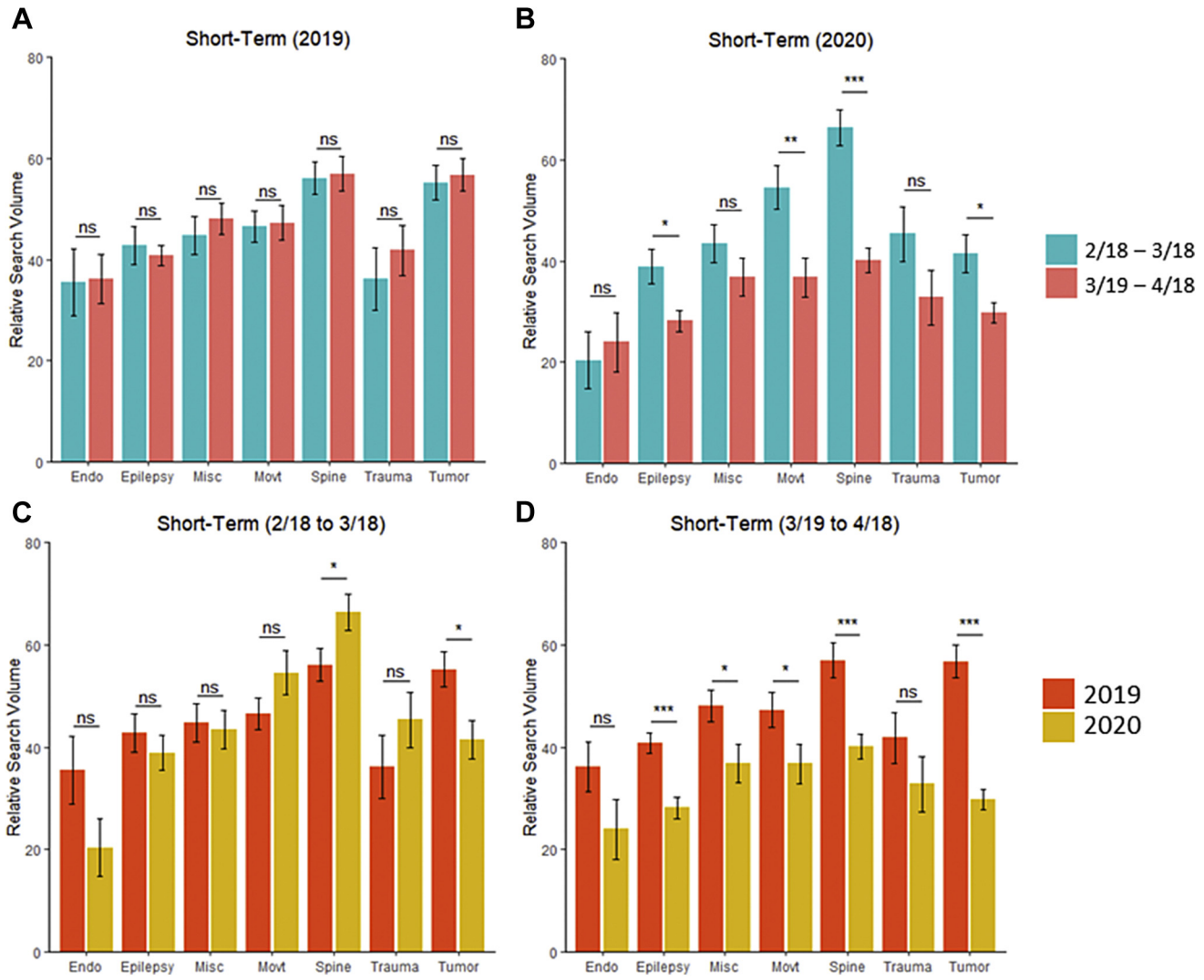

Figure 2. Short-term changes in public interest in neurosurgical procedures. (**A**) Comparison of average interest during the 30-day period before and after March 18. (**B**) Comparison of average interest during the 30-day period before and after the Centers for Medicare & Medicaid Services announcement. (**C**) Comparison of average interest for the 30-day period up to March 18 between 2019 and 2020. (**D**) Comparison of average interest for the 30-day period after March 19 between 2019 and 2020. $*P < 0.05$, $**P < 0.01$, $***P < 0.001$, ns: $P > 0.05$.

procedure categories were significantly greater in 2020 than in 2019 (P = 0.018/<0.001/<0.001) (Figure 3C). The interest in most categories was statistically greater in the intermediate-term baseline (endovascular, P < 0.001; epilepsy, P < 0.001; spine, P < 0.001; and tumor, P < 0.001) (Figure 3D).

Assessing the long-term differences, nearly all assessed neurosurgical procedure categories had higher interest levels pre-COVID-19 (Supplementary Table 3). For the epilepsy treatment category, the search volume for "VNS" decreased by 26.8% (P < 0.001). For the movement disorder treatment category, the search volume for "deep brain stimulation" decreased by 22.4% (P < 0.001). For the spine treatment category, the search volume for "laminectomy" decreased by 17.2% (P = 0.01). For the tumor treatment category, the search volume for "craniotomy" decreased by 11.1% from 78.7% to 70.0% (P = 0.01). For the endovascular treatment category, the search volume for "aneurysm coiling" decreased by 21.7% (P = 0.03). For the miscellaneous treatment category, the search volume for "VP shunt" decreased by 14.8% (P = 0.03). Only interest in trauma treatment did not change significantly (P = 0.736) (Figure 4).

Following the individual lockdowns at the beginning of the year, the states and the capital began reopening during the month of May. Not unexpectedly, upward trends are observable in overall interest across different treatment categories around this period

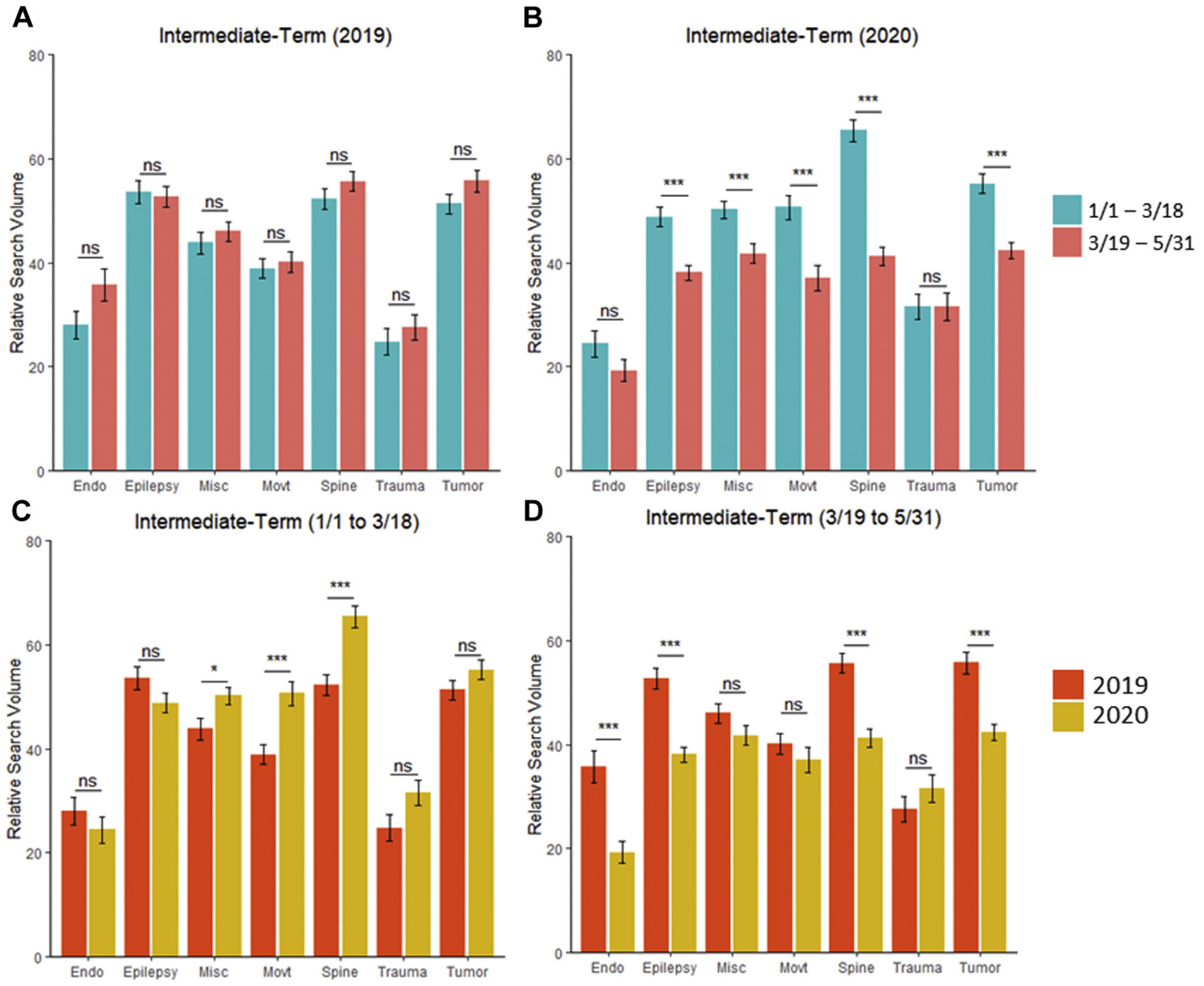

Figure 3. Intermediate-term changes in public interest in neurosurgical procedures. (**A**) Comparison of average interest from January 1 to March 18 and March 19 to May 31 in 2019. (**B**) Comparison of average interest during identical periods during 2020. (**C**) Comparison of average interest from January 1 to March 18 between 2019 and 2020. (**D**) Comparison of average interest from March 19 to May 31 between 2019 and 2020. $*P < 0.05$, $**P < 0.01$, $***P < 0.001$, ns: $P > 0.05$.

(Figure 1). Hence, we sought to investigate which states were driving the increased interest.

For the trauma treatment category, the relative ranking of interest in "burr hole" from greatest to least was New York, Pennsylvania, Illinois, Texas, and Florida (Figure 5A). For the spine treatment category, the relative ranking of interest in "laminectomy" from greatest to least was Alaska, Vermont, Rhode Island, North Dakota, and Tennessee (Figure 5C). For the tumor treatment category, the relative ranking of interest in "craniotomy" from greatest to least was Delaware, Hawaii, Nebraska, D.C., and South Carolina (Figure 5D). For the movement disorder treatment category, the relative ranking of interest in "deep brain stimulation" from greatest to least was Iowa, Wisconsin, Tennessee, Kansas, and Connecticut (Figure 5E). For the epilepsy treatment category, the relative ranking of interest in "VNS" from greatest to least was D.C., New Mexico, New Hampshire, Idaho, and Kansas (Figure 5F). For the miscellaneous treatment category, the relative ranking of interest in "VP shunt" from greatest to least was Washington, Alabama, Illinois, Missouri, and Minnesota (Figure 5G). For endovascular, fewer than 5 states had documented search volume values. For the endovascular treatment category, the relative ranking of interest in "aneurysm coiling" from greatest to least was California and New York (Figure 5B). Only

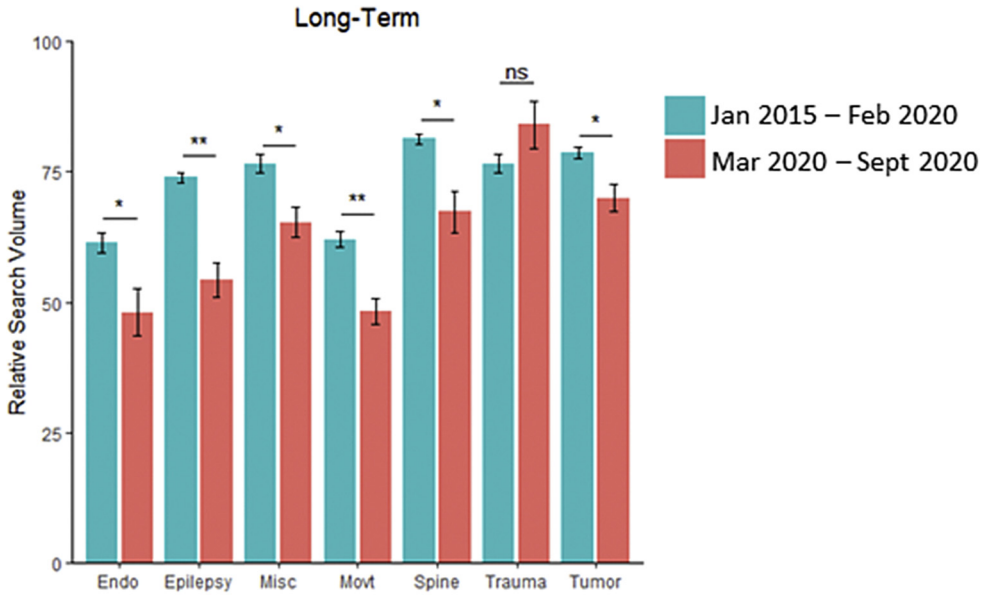

Figure 4. Long-term changes in public interest in neurosurgical procedures. Comparison of average interest from January 2015 to February 2020 and from March 2020 to September 2020.
$*P < 0.05$, $**P < 0.01$, $***P < 0.001$, ns: $P > 0.05$.

movement disorder treatment demonstrated significantly higher interest in states that reopened early compared with those that reported late ($P = 0.02$). There was no significant difference between these states during the same period exactly 1 year ago ($P = 0.62$). For miscellaneous treatment categories, no difference was found between states (Table 2).

Lastly, in the time after official reopening across the country, there have been upward trends in interest in all neurosurgical procedure categories. The greatest rises in interest were seen for spine and miscellaneous categories. For trauma and endovascular categories, the least amount of rise can be observed. Given the few datapoints secondary to the number of months since reopening, analysis was limited to a qualitative nature (Figure 6)

DISCUSSION

With the announcement of CMS guidelines at the start of the pandemic to prioritize emergent procedures, elective neurosurgical surgical volumes have been reported to have dropped by as much as 50% for nonprofit and private clinical practices in the United States and abroad.[7-9] As an overview, the CMS guidelines are organized into 3 tiers with the recommendation that surgical cases classified in tiers 1 and 2 be postponed and cases in tier 3 be addressed.[1] However, the tiered classifications provided by CMS are narrow in scope, and the decision to postpone or address clinical cases lies largely at the discretion of the physician or a department. Apart from affecting clinical practice, the CMS guidelines help shape public perception and guide the public response for seeking out treatment during the pandemic. The public perception of what type of care is available and how to access it may play critical roles in determining the expediency of care and, by translation, long-term patient outcomes and satisfaction. Two major challenges that arise for neurosurgery departments in the pandemic are: 1) how to navigate the gray region of classifying emergent and elective cases and 2) how to incorporate the public's interest in efforts to provide elective services as opportunities arise.

In the present study, we used GT to track public interest in elective neurosurgical procedures, both for short-, intermediate-, and long-term periods following the CMS announcement. Public interest was tracked by determining the RSV of keywords associated with 7 categories of neurosurgical procedures (Figure 1). During the short-term period, the public interest for 4 neurosurgical procedure categories decreased while staying consistent for 3 others (Figure 2). Similarly, public interest in the intermediate term decreased for 5 neurosurgical procedure categories (Figure 3). For the short-term baseline, no differences in interest were seen, suggesting that the findings are true and not due to some temporal pattern. In comparison between the short term and its baseline, most interest levels were not different before March 18, 2019, but significantly less in 2020 after March 19. Thus, public interest following the CMS announcement likely reflects an objective drop from prior levels. Surprisingly, spine, and miscellaneous, movement disorder procedure category interest levels were higher in the intermediate term (Figure 3). It is unclear whether this phenomenon is real and reflects increased interest

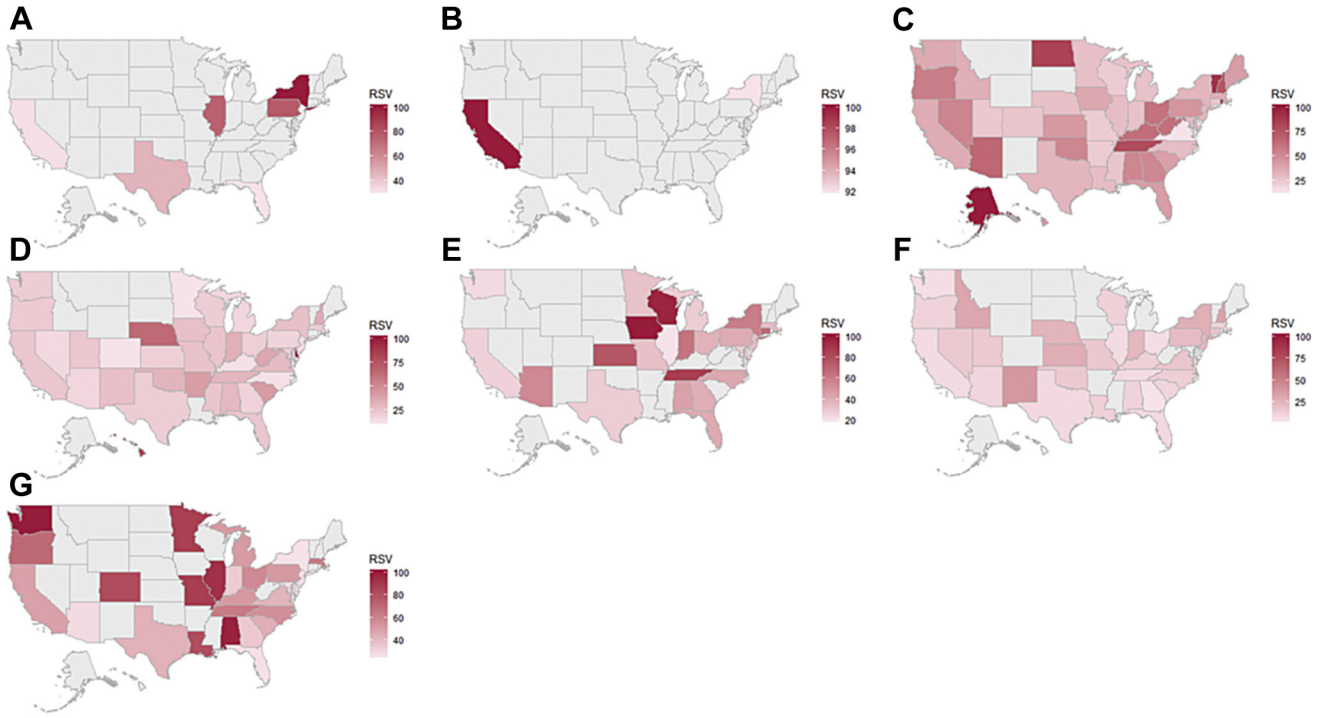

Figure 5. Choropleths of relative public interest in neurosurgical procedures by states. (**A**) Trauma. (**B**) Endovascular. (**C**) Spine. (**D**) Tumor. (**E**) Movement disorder. (**F**) Epilepsy. (**G**) Miscellaneous. RSV, relative search volume.

in 2020. Perhaps, in anticipation of the pandemic spread, patients sought to expedite the planning of these elective procedures. During the long-term period, the public interest for 6 neurosurgical procedure categories decreased while staying consistent for one (Figure 4). Neurosurgical procedure categories where public interest remained consistent in the short- and intermediate-term period included endovascular and trauma; miscellaneous was only consistent in the short term. Just the trauma category remained consistent in the long-term period. It is possible that interest in trauma did not change because a larger proportion of such cases would involve emergency procedures and would not fall under the elective category.[10,11]

Overall, public interest in elective neurosurgical procedures decreased following the CMS announcement, which mirrored the decrease of clinical elective care offered nationwide.[12] Apart from neurosurgery, similar trends can be observed for elective care offered in other specialties. One study reports a decrease in public interest for knee replacement, as measured by GT, following the CMS announcement.[13] A second study followed a similar protocol to measure public interest in prostate cancer after updated United States Preventive Services Task Force guidelines advised against regular screening in men.[14] Although the second study was not conducted in response to COVID-19, it still demonstrates how public interest in elective procedures can be shaped by public policies or announcements. In both cases as well as in our study, the use of GT captures a correlation where the decrease in public interest for elective procedures matches public recommendations to decrease elective care.

Two key consequences could arise from the observed trends of decreased public interest and clinical care provided. The first

Table 2. Relative Search Volume (RSV) Comparisons Between Phase I Early and Late Reopening States

Procedure Category	RSV for Early Reopening States (Before May 15)	RSV for Late Reopening States (On or After May 15)	*P* Value
Trauma	71.3	38.5	0.208
Endovascular	96	n/a	n/a
Spinal	44.7	42.9	0.78
Tumor	26.5	30.8	0.461
Movement Disorder	57.2	35.5	**0.019**
Epilepsy	15.3	22.1	0.263
Miscellaneous	54.6	61.2	0.668

n/a, not available.
Bold indicates statistically significant *P* values (<0.05).

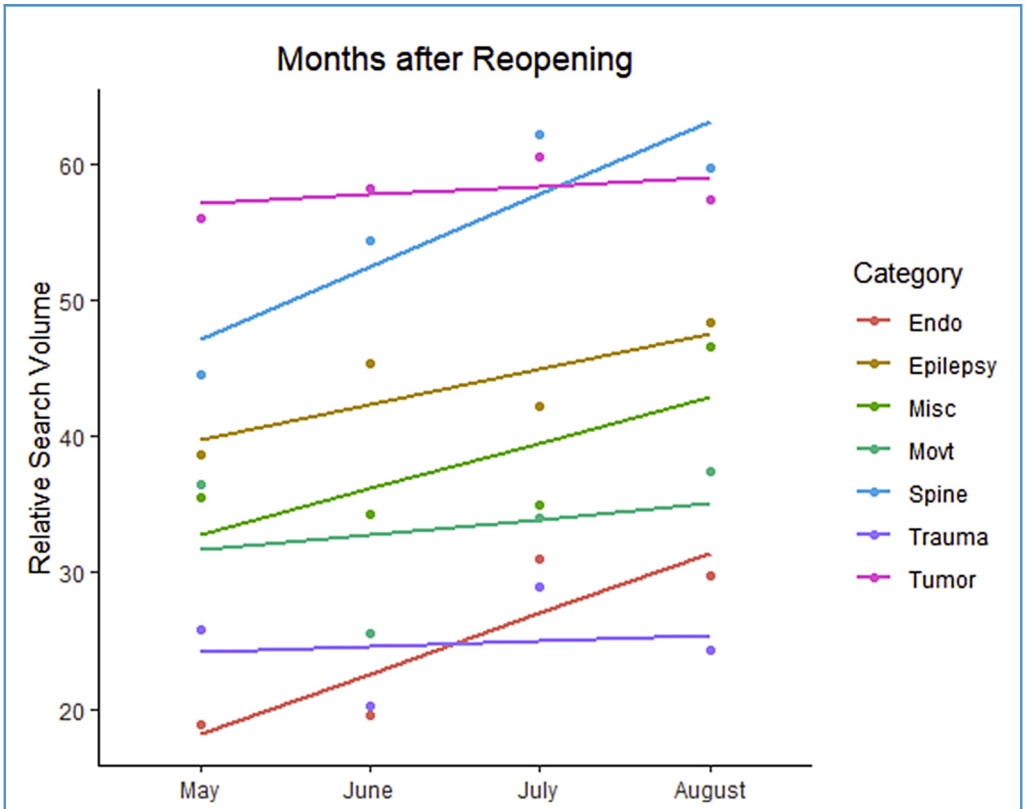

Figure 6. Trends in public interest in months after reopening.

would involve a buildup of elective cases that would need to be addressed later, creating a backlog for most departments.[9,15] The second consequence is that fewer patients may seek out the care they need, as suggested by the drop in public interest. Prior studies from other specialties have suggested that the decreased interest is a result of fears associated with contracting COVID-19 in clinical settings.[16] In relation to these consequences, there are major concerns that delaying elective surgery will worsen patient outcomes.[17-19] As an example, there is concern for patients with cancer who will have their treatments postponed. The delay in oncological care may provide a window for cancers to worsen in severity, which could limit the effectiveness of future treatments and lead to decreased survival. Hence, special attention is needed for the clinical management of oncology patients when planning to postpone elective care. However, no clear guidelines exist as the relationship between the progression of cancer and delayed elective care is poorly understood. To clarify this relationship, Turaga and Girotra[20] analyzed the National Cancer Database and found that surgical care for patients with cancer could be safely postponed for up to 4 weeks without risk of complications or worsened survival. The results reported by Turaga and Girotra provide an initial glimpse into how delayed elective care for patients with cancer can be managed during the pandemic. However, the concerns that diseases like cancer will worsen if treatment is postponed for too long are valid. It is estimated that the surgical backlog of cases may be as high as 3 months at many medical centers, which would surpass the 4-week safety threshold.[19,20] The management of disease exacerbated by delayed elective treatment remains a major worry and it is still unclear. For that reason, it is critical to continue tracking the long-term effects of delayed elective surgery on patient outcomes. GT and public interest are one tool and metric that can be used to monitor the long-term effects of delayed elective care during the pandemic. Next, geographic variation in public interest of neurosurgical elective cases was assessed for each treatment category (Figure 5). The states that drove interest for different treatment categories were variable. For all treatment categories except movement disorders, no difference in interest was observed between states that opened earlier and those that opened later with regard to lockdowns. In particular, the increased interest for movement disorders in states that opened earlier reflects a growing patient demand for this category of neurosurgical care that has likely been stalled during the pandemic. Broadly, public interest in neurosurgical specialty care did increase across the country after states began to reopen and the upward trend has continued over time (Figure 6). The cause of regional variability in public interest for different neurosurgical treatment categories remains unclear, and it is possibly caused by multiple factors that lie outside the consequences of the pandemic such as patient and physician

preferences.[21,22] However, the data illustrate that variability in public response exists, and understanding this variability may help tailor neurosurgical services to address the specific needs of each region throughout the pandemic.

As has been noted before, uncertainty remains in how to carry out elective care during the pandemic. Several neurosurgical departments have attempted to create triage protocols that are specific to their needs and patients when deciding what elective cases to pursue.[7,8,23] The use of GT provides neurosurgical departments an opportunity to incorporate public response data as they develop these treatment strategies. Two recommendations for using GT public response data are as follows: 1) identify elective procedures where there is an increase in patient demand and allocate resources to accommodate those procedures and 2) identify procedures that patients may be neglecting due to concerns related to the pandemic and increase outreach to inform patients of which cases are safe to perform. With regard to the latter, telehealth has emerged as a tool that can be used in conjunction with patient response data to help departments increase patient outreach.[24] Throughout the study, we have demonstrated the feasibility of using GT to track public interest in elective neurosurgical procedures and offer suggestions as to how this information can guide neurosurgical practice during the pandemic. However, key limitations must be acknowledged. First, GT functions as a comparative tool and provides relative quantities for search volumes instead of absolute numbers.[5] Second, the use of GT excludes all individuals who lack internet or computer access and does not keep track of demographic data.[5] Third, tracking RSV for keywords provides a narrow scope for assessing the public interest in different areas.[5] Lastly, although there is a reasonable association between the observed trends and COVID-19, the influence of other confounders cannot be ascertained. Hence, conclusions drawn from GT analyses must be accompanied with other contextual data.

CONCLUSION

It was shown with GT that short-term and long-term public interest toward neurosurgical elective cases decreased in response to CMS-issued guidelines to postpone elective care during the COVID-19 pandemic. Public interest for neurosurgical elective cases increased over time after CMS guidelines were relaxed and more elective care could be offered. There was geographic variation in the public response to different types of elective neurosurgical cases offered. The study illustrates how GT can serve as a tool to measure public interest toward elective neurosurgical procedures in real time. The public response data collected can help inform departments on how to address and improve care for patients undergoing neurosurgical procedures in the age of COVID-19.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Austin Y. Feng: Writing - original draft, Data curation, Methodology, Conceptualization, Supervision. **Cesar A. Garcia:** Data curation. **Michael C. Jin:** Data curation, Methodology, Conceptualization. **Allen L. Ho:** Data curation, Supervision. **Gordon Li:** Data curation, Supervision. **Gerald Grant:** Data curation, Supervision. **John Ratliff:** Data curation, Supervision. **Stephen L. Skirboll:** Data curation, Supervision.

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SUPPLEMENTARY DATA

Supplementary Table 1. Raw Relative Search Volume Values—Short Term*

Procedure Category	Short-Term (February 2019–March 2019)	Short-Term (March 2019–April 2019)	*P* Value	Short-Term (February 2020–March 2020)	Short-Term (March 2020–April 2020)	*P* Value
Trauma	36.1 (24.0–48.2)	41.8 (32.1–51.5)	0.471	20.4 (6.9–33.9)	15.6 (4.2–27.0)	0.6
Endovascular	53.5 (22.5–48.5)	36.2 (26.6–45.8)	0.932	20.4 (9.5–31.3)	23.9 (12.4–35.4)	0.662
Spinal	56.1 (49.8–62.4)	56.9 (50.1–63.7)	0.855	66.4 (59.3–73.5)	40.1 (35.2–45.0)	<0.001
Tumor	55.2 (48.4–62.0)	56.7 (50.6–62.8)	0.738	41.4 (33.9–48.9)	29.8 (25.8–33.8)	0.01
Movement Disorder	46.5 (40.3–52.7)	47.2 (40.5–53.9)	0.874	54.6 (46.3–62.9)	36.7 (29.1–44.3)	0.003
Epilepsy	42.7 (35.3–50.1)	40.8 (36.8–44.8)	0.656	38.8 (32.1–45.5)	28.1 (24.1–32.1)	0.001
Miscellaneous	44.7 (37.4–52.0)	48 (41.9–54.1)	0.5	43.4 (35.9–50.9)	36.7 (29.1–44.3)	0.219

*Mean (95% confidence interval).

Supplementary Table 2. Raw Relative Search Volume Values—Intermediate Term*

Procedure Category	Intermediate-Term (January 2019–March 2019)	Intermediate-Term (March 2019–May 2019)	*P* Value	Intermediate-Term (January 2020–March 2020)	Intermediate-Term (March 2020–May 2020)	*P* Value
Trauma	24.8 (19.7–29.9)	27.6 (22.8–32.4)	0.43	31.5 (26.7–36.3)	31.5 (26.4–36.6)	0.997
Endovascular	28 (22.7–33.3)	35.7 (29.6–41.8)	0.064	24.4 (19.3–29.5)	19.3 (15.2–23.4)	0.126
Spinal	52.2 (48.4–56.0)	55.6 (52.0–59.2)	0.206	65.4 (61.4–69.7)	41.2 (37.8–44.6)	<0.001
Tumor	51.3 (47.8–54.8)	55.7 (51.5–59.9)	0.107	55.2 (51.5–58.9)	42.4 (39.3–45.5)	<0.001
Movement disorder	38.9 (35.2–42.6)	40.2 (36.3–44.1)	0.643	50.6 (46.2–55.0)	37 (32.2–41.8)	<0.001
Epilepsy	53.6 (49.2–58.0)	52.7 (48.7–56.7)	0.763	48.8 (45.0–52.6)	38.1 (35.1–41.1)	<0.001
Miscellaneous	43.8 (39.7–47.9)	46 (42.3–49.7)	0.435	50.2 (46.9–53.5)	41.7 (38.0–45.4)	<0.001

*Mean (95% confidence interval).

Supplementary Table 3. Raw Relative Search Volume Values—Long Term*

Procedure Category	Long-Term (January 2015–February 2020)	Long-Term (March 2020–September 2020)	*P* Value
Trauma	48.5 (43.8–53.2)	51.4 (35.8–67.0)	0.736
Endovascular	61.3 (57.5–65.1)	48 (39.1–56.9)	0.027
Spinal	81.3 (79.4–83.2)	67.3 (59.4–75.2)	0.013
Tumor	78.7 (76.7–80.7)	70 (64.9–75.1)	0.015
Movement disorder	62 (59.0–65.0)	48.1 (43.2–53.0)	<0.001
Epilepsy	73.9 (71.8–76.0)	54.1 (47.7–60.5)	<0.001
Miscellaneous	76.6 (73.3–79.9)	65.3 (59.7–70.9)	0.006

*Mean (95% confidence interval).