



The use of telemedicine in pre-surgical evaluation: a retrospective cohort study of a neurosurgical oncology practice

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Abstract

Purpose To determine if there was a discrepancy between telemedicine versus in-person New Patient Visits (NPVs) regarding the conversion rate to operative and radiosurgery cases at a tertiary surgical neuro-oncology practice.

Methods A retrospective analysis was performed of patients who had an outpatient encounter with a neurosurgeon from the Tumor Division at our institution's Department of Neurosurgery between February 1, 2021 and April 30, 2021. NPVs during this period were registered as either telemedicine or in-person appointments. The primary endpoint of the study was to compare the rate at which telemedicine NPVs and in-person NPVs underwent surgery or radiosurgery, reported as the surgical conversion rate.

Results A total of 206 patients were included in this study. Of them, 119 (57.8%) were seen using telemedicine and 87 (42.2%) were seen in clinic via an in-person visit. A total of 70 (34%) of all patients underwent surgery or radiosurgery. Of the 119 patients seen via telemedicine, 40 (33.6%) underwent surgery or radiosurgery; during the same period, 87 NPVs were conducted in person and 30 (34.5%, $p = 1.0$) received an intervention. Further stratification revealed no differences between the two groups across measured criteria including diagnosis, number of pre-operative visits, elapsed time from appointment to surgery, follow-up visits, and distance from home address to neurosurgical clinic.

Conclusion Telemedicine NPVs did not differ significantly from in-person NPVs when evaluating the likelihood of a new patient committing to surgical treatment. This study provides quantifiable evidence that telemedicine is an effective means of meeting new patients and planning complex neurosurgical interventions.

Keywords Brain tumor · Telemedicine · Conversion rate · Pituitary adenoma

Introduction

Telemedicine was first introduced by Medicare & Medicaid in the 1990's, but despite the rapid expansion of computing power its implementation over the next two decades remained gradual. The modest adoption of telemedicine services can be explained by several factors including inconsistency of technology, concerns over maintaining patient confidentiality, fears over compromising the physician–patient relationship, the lack of reliable automated physical exams, and no clear structure for reimbursement [1]. The COVID-19

pandemic was the overnight catalyst needed to drive providers and patients towards telemedicine. Following the shelter-in-place measures at the onset of the COVID-19 pandemic in March 2020, there was a widespread surge in telemedicine in order to deliver healthcare remotely [2].

In an effort to limit patient and provider viral exposure during the height of the COVID-19 pandemic, the Centers for Medicare & Medicaid Services implemented the 1135 Waiver, which expanded the coverage of telemedicine services by Medicare. Subsequently, there was a dramatic increase in the use of telemedicine, with some centers reporting a 40-fold jump at the peak in 2020 [2]. The evidence to date for telemedicine use is favorable with regards to patient satisfaction, continuity of care, and access to care when compared to traditional patient interaction mediums. In a systematic review of 16 neurosurgical patient encounter publications, 15 of them found that

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telemedicine visits were equivalent or superior to non-telemedicine visits and found that patients were still able to develop a strong relationship with their clinicians [3].

The demonstrable success of telemedicine across multiple fields of neurosurgery has validated its continued use over the last 24 months. Telemedicine applications were successful in teleneuropsychology, telestroke, and tele-ICU rounding [4–6]. For example, our center's retrospective cohort study determined that telemedicine led to a faster diagnosis of stroke, more frequent administration of tPA, and better long-term outcomes [5, 7, 8]. Within the division of surgical neuro-oncology, patients found that telemedicine was an acceptable form of communication and perceived virtual neurosurgery consultations as safer during COVID-19 [9, 10]. In addition, telemedicine enables interdisciplinary collaboration and facilitates surgical neuro-oncologists to monitor the clinical status of patients [11]. Predictors of video-enabled adoption in neuro-oncology include pre-existing patient comfort levels with videoconferencing and total annual patient travel distance [12].

Research regarding telemedicine has mostly been concerned with determining if telemedicine is a viable platform for communication between providers and patients; there remains a paucity in research addressing whether telemedicine can serve as a medium to fulfill more complex patient needs including breaking bad news, reviewing imaging results, and discussing the risks and benefits of operative procedures. Neurosurgical patients are among the most complex and vulnerable populations in the medical community and assessing the impact of telemedicine on all aspects of their care is essential.

Our group's prior work on patients receiving neurosurgical care at Thomas Jefferson University between February and April of 2020 and 2021 found that the implementation of telemedicine was sustained well into 2021: at 1-year from the initial onset of shelter-in place measures telemedicine usage remained at 81.3% of the initial peak [13]. In addition, the study reported that there was a 40% increase of in-person visits between 2020 and 2021, marking a new phase in the pandemic, and potentially signalling the adoption of a hybrid work model. To date, there are no studies evaluating the outpatient workflow required to maintain a neurosurgical practice when new patient visits (NPV) are performed via telemedicine.

In this study, we quantify the rate of outpatient telemedicine NPVs converted to operative or radiosurgical cases at a tertiary surgical neuro-oncology practice when compared to in-person NPVs.

Methods

Patient selection, variables, and outcomes

The study protocol was approved by the University Institutional Review Board. A retrospective analysis was performed of patients who had an outpatient encounter with a skull base neurosurgeon from the Tumor Division at our institution's Department of Neurosurgery between February 1, 2021 and April 30, 2021. Patients were given the option to attend in person or via telemedicine; given that the majority of appointments took place during an ongoing pandemic patients were encouraged to use telemedicine if they felt comfortable and fulfilled the basic requisites (functioning internet, familiarity with videoconferencing, no specific needs for an in person physical exam). NPVs in the Tumor Division during this period were registered as either telemedicine or in-person appointments depending on patient preference. Data analysis was conducted after removal of identifiable patient health information. The primary endpoint of the study was to compare the rate at which telemedicine NPV and in-person NPV underwent surgery or radiation, reported as the surgical conversion rate. The secondary endpoint was to determine the number of telemedicine visits required prior to a patient undergoing surgery or radiation.

Telemedicine environment

Our department used the Teladoc Health (Teladoc Health, Purchase, Harrison, New York, USA) telemedicine platform, which is integrated with EPIC electronic health records (Epic Systems Corporation, Verona, Wisconsin, USA). Physicians established a setup that enabled 360-degree communication between the neurosurgical team and the patient. The telemedicine encounters consisted of an electronic cranial nerve exam and met the requirements for a comprehensive in-person equivalent.

Statistical analysis

Data is presented as mean and standard deviation for continuous variables and as frequency for categorical variables. Univariate analysis was carried out using unpaired/paired *t*-test, Chi-square, and Fisher's exact tests, as appropriate. *p*-values of ≤ 0.05 in the univariate analysis were considered statistically significant. Statistical analysis was carried out with GraphPad Prism (version 9.0.0 for Mac OS, GraphPad Software, San Diego, California USA, www.graphpad.com).

Results

A total of 206 patients were included in this study: 119 (57.8%) were seen using telemedicine, 87 (42.2%) were seen in clinic via an in-person visit. A total of 70 (34%) of all patients included underwent surgery or radiation. The three most common diagnoses in this practice overall were: pituitary adenoma (12.1%), meningioma (9.2%), and vestibular schwannoma (5.8%). The three most common

surgeries were: endoscopic endonasal tumor resection (27.3%), retrosigmoid craniotomy (23.6%), and frontotemporal craniotomy (18.2%). Stereotactic radiosurgery (SRS) constituted 15 (21.4%) of all interventions. The patient data is summarized in Table 1.

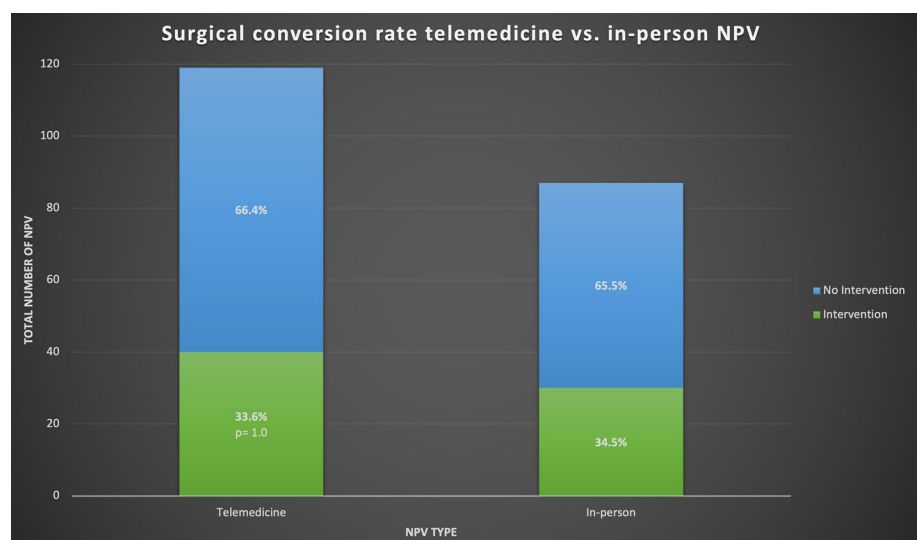
Of the 119 patients seen via telemedicine, 40 (33.6%) underwent surgery or radiation therapy. During the same period, 87 NPV were conducted in-person, of whom 30 (34.5%, $p = 1.0$) received surgery or radiosurgery (Fig. 1).

Table 1 Overview of new patient visit (NPV) data

	Telemedicine visit	In-person visit	
New patient visits (NPV)	119	87	
No intervention	79 (66.4%)	57 (65.5%)	
Intervention	40 (33.6%)	30 (34.5%)	p = 1.0
Surgery	29 (72.5%)	26 (86.7%)	
Radiation therapy	11 (27.5%)	4 (13.3%)	p = 0.23
Type of surgery			p = 0.39
Endoscopic	9 (31%)	10 (38.5%)	
Craniotomy	15 (51.7%)	13 (50%)	
VP shunt	3 (10.3%)	3 (11.5%)	
Other	2 (7%)	0	
Diagnosis			p = 0.91
Pituitary adenoma	11 (9.2%)	14 (16.1%)	
Meningioma	8 (6.7%)	11 (12.6%)	
Vestibular Schwannoma	8 (6.7%)	4 (4.6%)	
Trigeminal neuralgia	7 (5.9%)	4 (4.6%)	
Metastasis	4 (3.4%)	5 (5.7%)	
Elapsed time between initial appointment and surgery (days)			
Mean ± SD	41.3 ± 43.5	38.2 ± 32.3	p = 0.73
Median (IQR)	25.5, IQR: 15–48.8	34.5, IQR: 12.3–50.8	

The bolded row is to draw attention to the most actionable take-away from the manuscript as it signifies there was no difference between the two cohorts

Fig. 1 A bar chart illustrating the total number of new patient visits (NPV) in each cohort that underwent surgery or radiosurgery



Among the 40 patients seen via telemedicine that received surgery, the mean number of telemedicine visits prior to surgery was: 1.2 ± 0.5 (median: 1). Thirty-eight (95%) of the patients were seen exclusively via telemedicine pre-operatively, while two (5%) were seen both via telemedicine and in-person prior to surgery. The mean number of visits prior to surgery for the in-person cohort was 1.1 ± 0.3 (median = 1).

Stratification of the surgeries into endoscopic vs. open approaches revealed that 9 (31%) of the cases in the telemedicine cohort were endoscopic cases, while 15 (51.7%) cases were open. Among cases in the in-person group, 10 (38.5%) of the cases were endoscopic; 13 (50%) were open approaches. SRS constituted 11 (27.5%) of all interventions in the telemedicine group and 4 (13.3%) in the in-person group ($p = 0.23$). Similarly, subcategorization comparing the five most common diagnoses in the telemedicine and in-person cohorts determined a non-significant difference between the patient groups at initial presentation ($p = 0.91$). The most common diagnoses for the individual groups were pituitary adenoma (telemedicine: 11; in-person: 14) meningioma (telemedicine: 8; in-person: 11), and vestibular schwannoma (telemedicine: 8; in-person: 4).

The mean number of days between the first telemedicine visit and surgery was 41.3 ± 43.5 (median: 25.5, IQR: 15–48.8), whereas, the mean number of days between the first in-person visit and surgery was 38.2 ± 32.3 ($p = 0.73$; median of 34.5, IQR: 12.3–50.8).

Next, we evaluated the patient population for biases that may have influenced the likelihood of using telemedicine vs. seeing the physician in-person. There were no significant differences reported between the two groups regarding age, physical distance to the neurosurgery practice, and follow-up characteristics (Table 2). The mean age of telemedicine cohort was 60.1 ± 12.3 (median of 60, IQR: 52–65) while the in-person cohort was 57.3 ± 16.9 ($p = 0.45$; median of

56, IQR: 44.5–72.3). There was no statistical difference between the average distance from the patient's given home address to the neurosurgical clinic between the two groups. The mean distance from the patient's home to the neurosurgery clinic was 31.6 ± 34.8 (median of 15, IQR: 7.6–44.4) miles for telemedicine visits and 36.9 ± 56 miles ($p = 0.65$; median of 21, IQR: 11.4–37) for in-person visits. Even when accounting for two outliers (patients that lived > 200 miles from the hospital) in each cohort the difference in mean distance remained non-significant ($p = 0.51$).

There were no reported differences between the two groups regarding their post-operative visits and it is worth noting follow-up visits were conducted using the same modality as the initial NPV. The mean number of follow-up visits for telemedicine and in-person visits, respectively, were: 2.1 ± 1.4 (median of 2, IQR: 1–3) and 2.0 ± 1.3 ($p = 0.76$; median of 2, IQR: 1–3). Lastly, the mean time (days) from surgery to final follow-up was 153.4 ± 116.2 (median of 127, IQR: 30–238) for telemedicine and 116.7 ± 89.2 ($p = 0.16$; median of 117, IQR: 20–173.5) for in-person visits.

Discussion

While the expansion of telemedicine has been challenging for many reasons, including the need for adequate technological infrastructure, it is well established that telemedicine is an acceptable vehicle for communication in neurosurgery [14]. Here, we explored the results of integrating telemedicine into the planning of surgical interventions and radiosurgery procedures in an outpatient surgical neuro-oncology practice.

Our findings demonstrate that telemedicine is an effective tool in a surgical neuro-oncology practice to meet new patients, discuss their diagnosis, review imaging, obtain informed consent, and schedule a procedure when necessary. There was no difference in the conversion rate to surgery or radiosurgery between our telemedicine and in-person cohorts. During the recorded period, 33.6% of new patients seen via telemedicine underwent surgery or radiosurgery compared with the 34.5% of new patients seen via in-person visits. Despite not meeting the operating surgeon in person until the day of surgery, our experience suggests patients felt comfortable proceeding with surgery at a similar rate. In this regard, a finding that strengthens our study was that there were no instances of the surgeon having to modify the operative plan between the initial telemedicine encounter and the day of surgery, validating the accuracy of the video-enabled examination and pre-surgical evaluation. Telemedicine's efficiency within our practice was further highlighted by the fact that both the number of visits needed between

Table 2 Patient demographic data comparing the two cohorts

	Telemedicine visit	In-person visit	
Age			
Mean \pm SD	60.1 \pm 12.3	57.3 \pm 16.9	$p = 0.45$
Median (IQR)	60, IQR: 52–65	56, IQR: 44.5–72.3	
Distance from home address to neurosurgery clinic (miles)			
Mean \pm SD	31.6 \pm 34.8	36.9 \pm 56.0	$p = 0.77$
Median (IQR)	15, IQR: 7.6–44.4	21, IQR: 11.4–37	
Mean number of follow-up visits			
Mean \pm SD	2.1 \pm 1.4	2 \pm 1.3	$p = 0.76$
Median (IQR)	2, IQR: 1–3	2, IQR: 1–3	
Elapsed time from surgery to final follow-up (days)			
Mean \pm SD	153.4 \pm 116.2	116.7 \pm 89.2	$p = 0.16$
Median (IQR)	127, IQR: 30–238	117, IQR: 20–173.5	

the NPV and surgery as well as the average time to surgery were equivalent between the two cohorts.

There were no differences in the average age of the patients between the cohorts, indicating that older patients were just as likely to participate in virtual appointments. We also analyzed whether the patients favoring telemedicine lived significantly further from the clinic. The fact that there were no significant differences in the average distance to patient home addresses suggests that the adoption of telemedicine is broadly applicable regardless of a patient's vicinity to a clinic or hospital.

Telemedicine promotes cost effective care in the clinic setting: studies found it is strongly associated with fewer missed appointments, more equitable patient visit duration, and better physician schedule adherence [15, 16]. Neurosurgeons have reported an increase in perceived efficiency and safety with the adoption of telemedicine in surgical neuro-oncology and even believe it could become the preferred modality of the subspecialty, perhaps in a hybrid system combining telemedicine and in-person care [17, 18]. The high number of operative cases during the recorded period signified a return-to-normal case load, validating the departure from a rigid in-person model and indicating that telemedicine can achieve cost effective practices [2].

Other advantages of telemedicine include the broader economic benefits likely to stem from: (1) diminished travel times, (2) accelerated consultation and triage in time-sensitive circumstances, (3) remote scheduling for elective surgical procedures, all contributing to a lower financial burden for the patient [18]. In a study evaluating the viability of delivering chronic neurological care to veteran health administration patients living in a rural state, they calculated a saving of \$150 per person in 354 patients [19]. Ninety-two percent of surveyed patients reported that the telemedicine service saved them time, money, or both.

Evidently, telemedicine facilitated continuity of care throughout the pandemic and will remain a part of medicine moving forward. With that said, there are valid concerns with the rapid introduction of telemedicine. Our data was collected from a single institution in the Northeast United States where population density is high and large academic hospitals are widely available, and the results may differ in more sparsely populated enclaves of the United States where the main determinant for telemedicine usage is raw distance from a hospital network.

In addition to the small sample size, another potential limitation to our study was the lack of patient feedback assessing if there were disproportionate fears inflated by the lack of in-person interaction prior to surgery. Future studies could survey the perspectives of patients and family members in anticipation of procedures scheduled online.

Conclusion

In the face of the ongoing shift towards a hybrid work model, our study proves that telemedicine is an effective means of meeting new patients and planning complex neurosurgical interventions. To our knowledge this is the only study to date that provides quantifiable evidence that telemedicine is comparable to in-person visits with regards to the surgical conversion rate in an outpatient surgical neuro-oncology practice.

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Declarations

Conflict of interest 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.

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