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Jordan C. Xu

Sam A. Haider

Akshay Sharma

Kenneth Blumenfeld

Joseph Cheng

See next page for additional authors

Authors

Jordan C. Xu, Sam A. Haider, Akshay Sharma, Kenneth Blumenfeld, Joseph Cheng, Catherine A. Mazzola, Katie O. Orrico, Joshua Rosenow, Jason Stacy, Ann Stroink, Krystal Tomei, Luis Tumialan, Anand Veeravagu, Mark E. Linskey, and Jason M. Schwalb

Telehealth in Neurosurgery: 2021 Council of State Neurosurgical Societies National Survey Results

Jordan C. Xu[1], Sam A. Haider[2], Akshay Sharma[3], Kenneth Blumenfeld[4], Joseph Cheng[5], Catherine A. Mazzola[6], Katie O. Orrico[7], Joshua Rosenow[8], Jason Stacy[9], Ann Stroink[10], Krystal Tomei[11-13], Luis M. Tumialán[14], Anand Veeravagu[15], Mark E. Linskey[1], Jason Schwalb[2,16]

■ OBJECTIVE: **Telehealth was rapidly adopted during the COVID-19 pandemic. A survey was distributed to neurosurgeons in the United States (U.S.) to understand its use within neurosurgery, what barriers exist, unique issues related to neurosurgery, and opportunities for improvement.**

■ METHODS: **A survey was distributed via email and used the SurveyMonkey platform. The survey was sent to 3828 practicing neurosurgeons within the U.S., 404 responses were collected between October 30, 2021 and December 4, 2021.**

■ RESULTS: **During the pandemic, telehealth was used multiple times per week by 60.65% and used daily by an additional 12.78% of respondents. A supermajority (89.84%) of respondents felt that evaluating patients across state lines with telemedicine is beneficial. Most respondents (95.81%) believed that telehealth improves patient access to care. The major criticism of telehealth was the inability to perform a neurological exam.**

■ CONCLUSIONS: **Telehealth has been widely implemented within the field of neurosurgery during the COVID-19 pandemic and has increased access to care. It has allowed patients to be evaluated remotely, including across state lines. While certain aspects of the neurological exam are suited for video evaluation, sensation and reflexes cannot be adequately assessed. Neurosurgeons believe that telehealth adds value to their ability to deliver care.**

INTRODUCTION

Telehealth was rapidly adopted and widely implemented by health care providers during the COVID-19 pandemic to reduce the risk of disease exposure for staff and patients while allowing for continued care during shutdowns and mandatory quarantines. The convenience of telehealth was an added benefit as follows: telehealth can reduce or eliminate patient travel, parking inconvenience and fees, and in-office waiting times for physician visits; however, significant concerns exist with this technology. Physicians may fail to recognize a change in the patient's physical exam due to limits in examination capabilities.

Key words
- COVID-19
- Coronavirus
- Health policy
- Telehealth
- Telemedicine

Abbreviations and Acronyms
AANS: American Association of Neurological Surgeons
CCQAS: Centralized Credentials Quality Assurance System
CMS: Center for Medicare & Medicaid Services
CNS: Congress of Neurological Surgeons
DDOS: Distributed denial-of-service attacks
EHR: Electronic health record
HIPAA: Health Insurance Portability and Accountability Act
HSS: Department of Health and Human Services
IMLC: Interstate Medical Licensure Compact
NIHSS: National Institutes of Health Stroke Scale
U.S.: United States

From the [1]Department of Neurosurgery, University of California, Irvine Medical Center, Orange, California, [2]Department of Neurosurgery, Henry Ford Health System, Detroit, Michigan, [3]Department of Neurosurgery, Cleveland Clinic, Cleveland, Ohio, [4]Department of Neurosurgery, Sutter Health — Palo Alto Medical Foundation, San Jose, California, [5]Department of Neurosurgery, University of Cincinnati College of Medicine, Cincinnati, Ohio, [6]Division of Pediatric Neurological Surgery, Goryeb Children's Hospital, Morristown, New Jersey, [7]Washington Office, American Association of Neurological Surgeons/ Congress of Neurological Surgeons, Washington, District of Columbia, [8]Departments of Neurosurgery, Neurology and Physical Medicine and Rehabilitation, Northwestern University Feinberg School of Medicine, Chicago, Illinois, [9]North Mississippi Neurosurgical Services, North Mississippi Medical Center, Tupelo, Mississippi, [10]Department of Neurosurgery, Central Illinois Neuro Health Science, Bloomington, Illinois, [11]Department of Neurological Surgery, Rainbow Babies & Children's Hospital, Cleveland, Ohio, [12]Department of Neurological Surgery, University Hospitals Cleveland Medical Center, Cleveland, Ohio, [13]Department of Neurological Surgery, Case Western Reserve University School of Medicine, Cleveland, Ohio, [14]Department of Neurosurgery, Barrow Neurological Institute, Phoenix, Arizona, [15]Department of Neurosurgery, Stanford University School of Medicine, Stanford, California, and [16]Center for Health Policy and Health Services Research, Henry Ford Health System, Detroit, Michigan, USA

To whom correspondence should be addressed: Jordan C. Xu, M.D. [E-mail: jcxu@hs.uci.edu]

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Telehealth is also limited by other issues, including billing and coding regulations, payor issues, and compliance issues generated by seeing patients across state lines. While historical versions of telehealth (such as those used in development of telestroke models) involved remote physician encounters in conjunction with an in-person health professional, the adaptation necessary during the COVID-19 pandemic reflects an evolution of this technology. Now, "telehealth" may include multiple other modalities including telephone-only encounters as well as audio-visual encounters.

In neurosurgery, telehealth was not widely implemented before the pandemic, with few reports of adoption restricted to outpatient postoperative care and follow-up visits.[1,2] This may be due to the lack of reimbursement for telehealth as well as Center for Medicare and Medicaid Services restrictions.[3] During the pandemic, neurosurgery demonstrated one of the highest rates of telehealth conversion.[4] As the field of neurosurgery adopts this new paradigm, it is important to identify its strengths and limitations so that telehealth can be effectively implemented. There are unique telehealth needs for the neurosurgical patient who must be addressed to ensure optimal outcomes despite the lack of face-to-face interactions. Most of the legislative and regulatory changes allowing telehealth to flourish during the COVID-19 pandemic are temporary, emergency measures that will expire if not extended.[2] An understanding of how telehealth has impacted the field of neurosurgery is important to ensure utilization beyond the pandemic. The authors of this study created and distributed a survey to assess how telehealth has been used within neurosurgery, what barriers to implementation exist, whether there are unique issues related to neurosurgery, and what opportunities exist for optimization.

METHODS

Following policy adoption at the American Association of Neurological Surgeons (AANS) and Congress of Neurological Surgeons (CNS) Council of State Neurosurgical Societies (CSNS) meeting in the summer of 2021, a survey was developed by members of the CSNS in conjunction with AANS/CNS Washington Committee and relevant subcommittees. The survey was distributed via email and used the SurveyMonkey platform (SurveyMonkey Inc, Palo Alto, California, USA; www.surveymonkey.com) to 3828 practicing U.S. neurosurgeons who are members of the AANS. The survey responses were recorded anonymously, and responses were collected from October 30, 2021 through December 4, 2021. In the context of the survey and this study, telehealth refers to real-time live video or voice calls.

RESULTS

Response Rate

There was a response rate of 10.6% (404/3828). All respondents identified as neurosurgeons in active practice in the United States (U.S.), including U.S. territories. The data were collected anonymously. Respondents were distributed throughout all regions of the U.S. as follows: South (34.08%), Northeast (16.2%), Midwest (26.26%), and West (22.91%). The distribution of subspecialties included are as follows: Spine and Peripheral Nerve (32.69%), General Neurosurgery (21.79%), Pediatric (14.10%), Tumor (11.54%), Cerebrovascular (10.26%), Stereotactic and Function (5.77%), and Neurocritical Care and Trauma (1.92%).

Telehealth Adoption

A large portion (81.7%) of respondents reported never to using telehealth before the COVID-19 public health emergency. From 2020 to 2021, during the COVID-19 pandemic, 60.65% of respondents reported using telehealth multiple times a week, and an additional 12.78% reported daily use (Figure 1). Telehealth predominantly included both audio and video (78.5%), while 16.89% utilized voice only. We surveyed the different platforms used, allowing respondents to choose from more than one if multiple platforms were used. The most common platform used was Zoom (47.96%), followed by Doximity (31.34%) (Figure 2). Less than half of respondents (46.05%) reported that their telehealth platform was accessed through their electronic health record (EHR), 48.66% reported that it was not integrated into the EHR, and 5.18% did not know. A majority (55.31%) of respondents reported that their department acquired new hardware and/or software contracts to facilitate telehealth use, and 75.48% reported additional training was required to implement telehealth visits.

Telehealth Use

Almost 42% (41.97%) of respondents had technical difficulties that prolonged telehealth visits by more than 5 minutes. Slightly more than 40% (40.33%) of respondents felt that at least 75% of their patients had both the technological access and literacy to conduct video visits. However, nearly a quarter of respondents (24.25%) believed that lesser than half of their patients had either the technological access and/or literacy to conduct video telehealth visits. Telehealth was used by 80.93% of respondents for new patient visits or consults, 97.55% for established patient visits, and 86.92% for postoperative visits (Figure 3). For new patient consults, 5.18% of respondents reported that visits lasted <15 minutes, 43.87% reported 15–30 minutes, 38.15% reported 31–60 minutes, 1.09% reported >60 minutes, and 11.72% responded "Do not know." For established patients, 47.41%

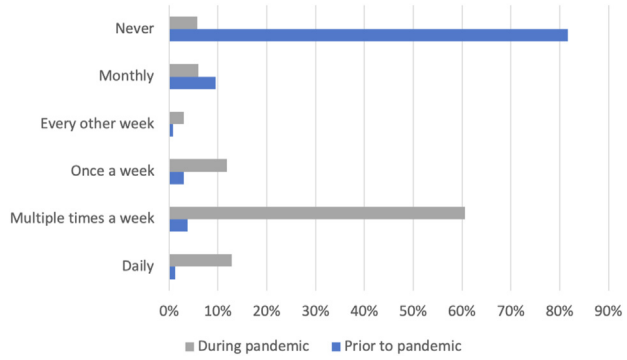

Figure 1. Respondent use of telehealth prior to and during the COVID-19 pandemic.

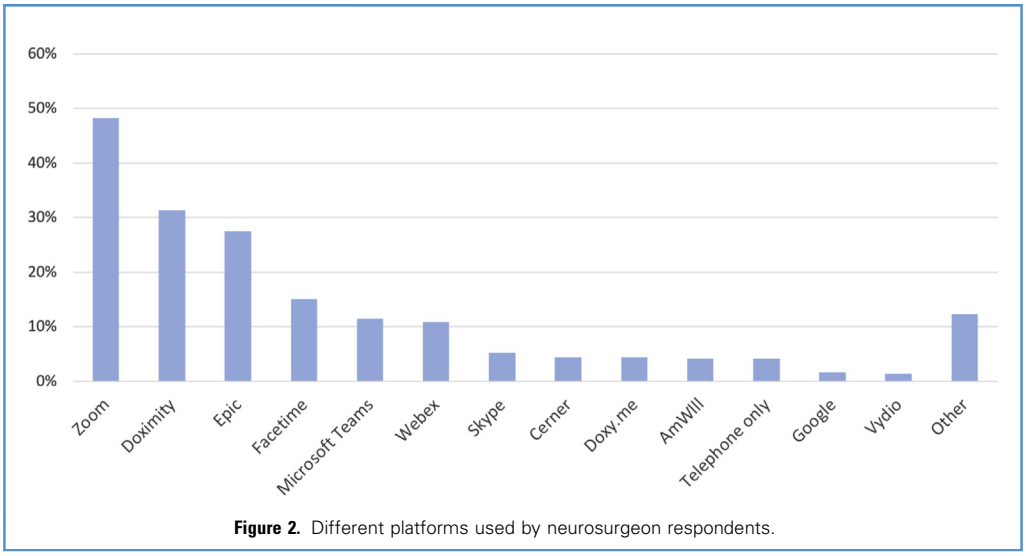

Figure 2. Different platforms used by neurosurgeon respondents.

reported that visits lasted <15 minutes, 46.87% reported 15–30 minutes, 4.63% reported 31–60 minutes, and 1.09% responded "Do not know."

Geographic Boundaries

Interestingly, telehealth was used by 46.15% of respondents to evaluate a new patient in a state other than where they were licensed; whereas, 58.24% of respondents utilized telehealth for visits with established patients who were in a state other than where the respondent was licensed (Figure 4). Many respondents reported seeing patients in one or more state(s) differing from the state of their primary practice. The ability to evaluate patients across state lines was believed to be beneficial by 89.84% of respondents.

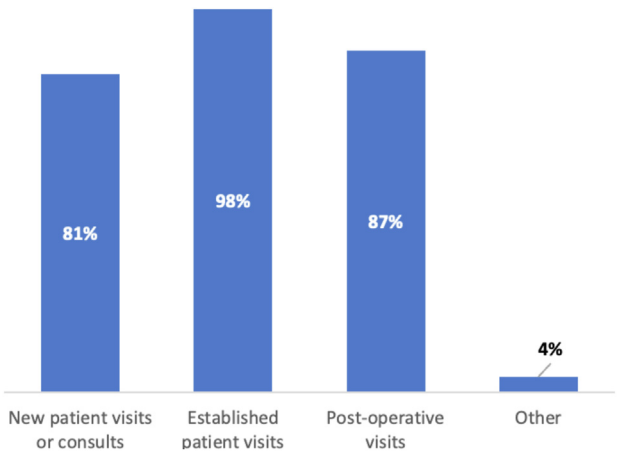

Figure 3. Types of visit respondents used telehealth for.

Telehealth Benefits

Most respondents (95.81%) believed that telehealth improves patient access to care. Respondent views on the utility of telehealth for new patients, surgical discussions, postoperative visits, and routine follow-up visits are summarized in Figure 5. When asked to compare telehealth to in-person visits for established patients, 9.5% believed it was superior, 48.04% reported it was equivalent, 15.64% reported it was inferior, and 22.07% reported that it was complementary but not comparable. When comparing telehealth to in-person visits for new patients, 5.03% believed it was superior, 18.16% reported it was equivalent, 36.03% reported that it was inferior, and 34.36% reported that it was complementary but not comparable. Most respondents (81.56%) believed that their patients had satisfactory experiences with telehealth visits. Many respondents commented that telehealth had helped them increase access to care for their patients.

Telehealth Limitations

The most-reported concern regarding telehealth was the inability to perform a detailed neurological examination. Many respondents were also concerned about lower reimbursement as a barrier to the use of telehealth. A large majority (80.65%) of the responding neurosurgeons believed that telehealth and in-person visits should be paid at the same rate, while 14.71% felt that telehealth should be paid less than in-person visits.

DISCUSSION

The start of the COVID-19 pandemic in 2020 altered the delivery and utilization of health care in the U.S. Telehealth emerged out of necessity to reduce exposure risks between practitioners and patients in the health care setting. Although states and hospitals have largely reopened and resumed normal activities, additional waves from new COVID variants will force medical systems to develop innovative methods for continuing to deliver safe and

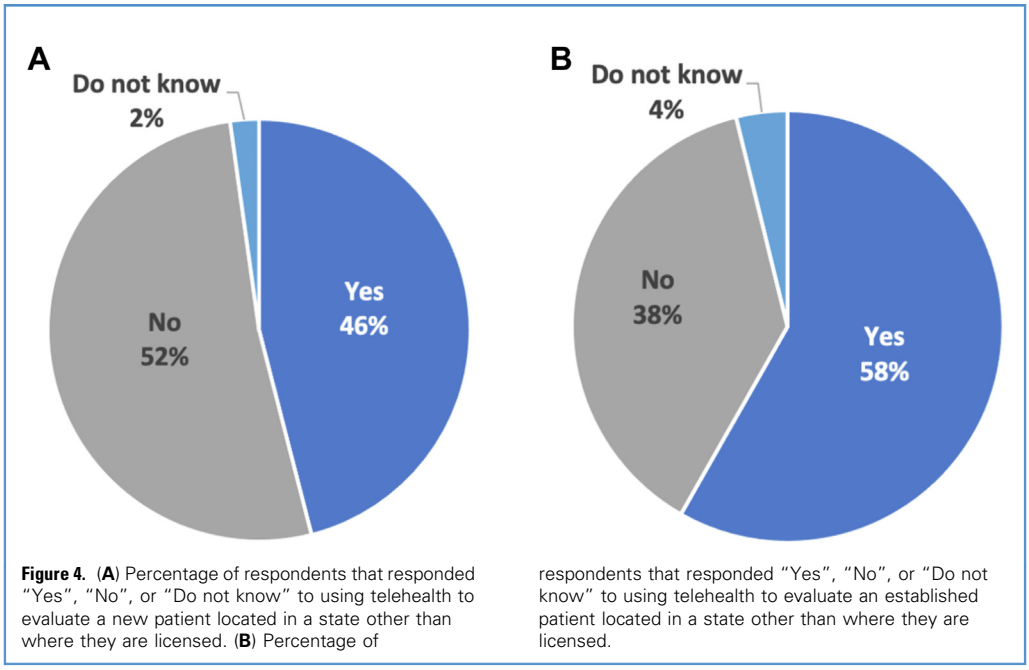

Figure 4. (**A**) Percentage of respondents that responded "Yes", "No", or "Do not know" to using telehealth to evaluate a new patient located in a state other than where they are licensed. (**B**) Percentage of respondents that responded "Yes", "No", or "Do not know" to using telehealth to evaluate an established patient located in a state other than where they are licensed.

effective patient care. Our expanded experience with telehealth has revealed benefits and opportunities in telehealth. The conveniences afforded by telehealth with opportunities to expand provision of care should serve as examples of how technology can improve patient access and experience. This must also include developing best practices for a virtual neurologic examination. Our new experience with telehealth has revealed benefits and opportunities that may lead improvement in the quality of health care in the U.S. Strategies to optimize patient care independent of mitigating pandemic risks should be preserved and maintained.

Challenges of Telehealth Neurological Examination

The neurological examination can reveal abnormalities that localize a lesion, assist a differential diagnosis, guide the selection of diagnostic tests, and provide a means of patient monitoring for changes over time.[5-7] Innovative, sensitive, and accurate means to assess the neurological examination at a distance with telehealth are urgently needed. Neurological exams have been conducted via telehealth for inpatient telestroke and tele-intensive care unit evaluations since, as early as, 1999.[8-12] The cognitive, speech and motor components of the neurologic examination/evaluation are particularly well suited for video evaluation, as the standard exam elicits visible clinical findings that are identifiable on video and require limited physical contact.[8,13,14] The American Heart Association/American Stroke association suggests that a telehealth National Institutes of Health Stroke Scale assessment is comparable to a bedside National Institutes of Health Stroke Scale assessment.[15] There is increasing evidence that telestroke is associated with a faster diagnosis of stroke and improved outcomes.[16,17] It should, however, be noted that the telehealth model for telestroke is largely based upon a provider's presence at the patient bedside with a remote consultant rather than the direct-physician-patient model that has largely been adopted during the pandemic. With our new paradigm of telehealth, new limitations in the virtual neurological exam are highlighted.

The greatest difficulties in conducting spine and peripheral nerve examinations are noted to be difficulty in objectively assessing reflexes and mapping of sensory losses (dermatomal, individual peripheral nerve, peripheral neuropathy, etc.)[18,19] For cranial pathologies, while mental status, general cognitive function, and motor cranial nerve examinations were felt to be reliable via telehealth, the greatest difficulties are noted in objectively assessing visual functions (pupillary responses, acuity and visual fields), trigeminal sensory functions (geographic mapping and corneal reflex assessment), hearing status, and gag reflex.[20] The information provided in a virtual visit or consult may not be equivalent to in-person visits but should be adequate to triage patients, and aid medical and surgical decision-making.[21] As more neurosurgical patients are seen via telehealth, standardization, and dissemination of guidelines/recommendations for virtual neurological examinations is critical.[22]

Access to Care

Some of the most important benefits of telehealth are related to access to care, which is especially relevant for the elderly, disabled, and chronically ill. Remote care can potentially reduce socioeconomic barriers, such as transportation, childcare, and work-related time constraints.[23] While telehealth may improve access to care for some, it potentially neglects and leaves behind patients who do not have the technological literacy, equipment, or broadband internet access to conduct video-based telehealth visits. A recent report on telehealth use curated by the Department of Health and Human Services determined that telehealth use was

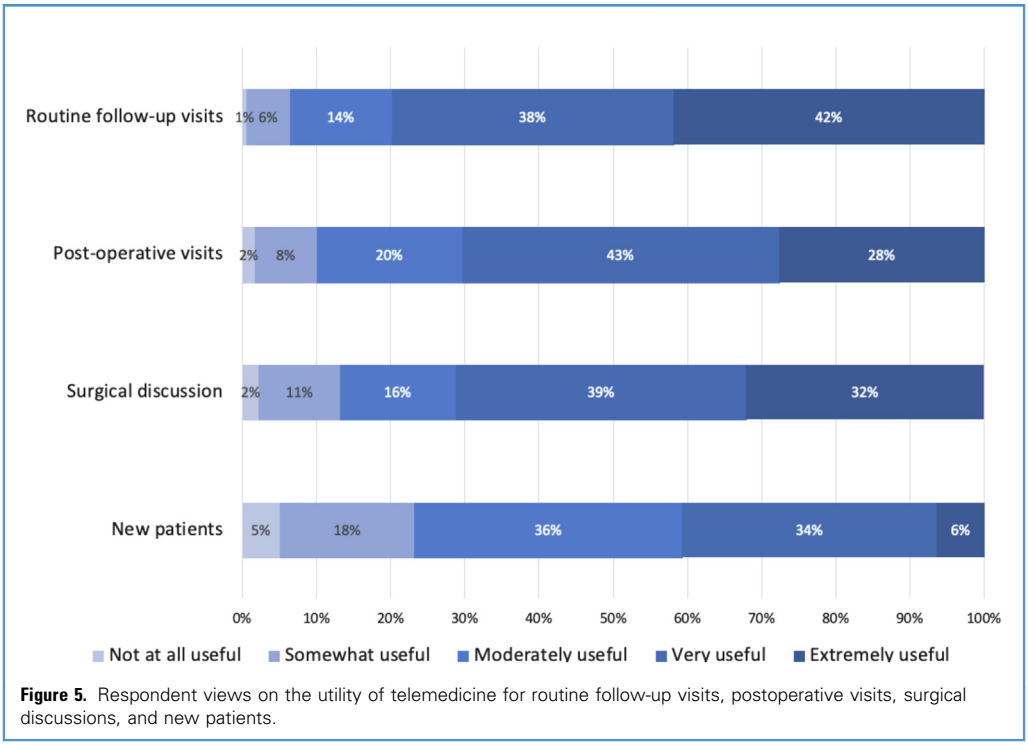

Figure 5. Respondent views on the utility of telemedicine for routine follow-up visits, postoperative visits, surgical discussions, and new patients.

lower among those patients who are uninsured (9.4%). Among individuals utilizing telehealth, young adults aged 18–24 years, individuals earning at least $100,000, patients with private insurance, and white individuals, had the highest rate of combined audio/video visits. Those primarily using telephone only visits were individuals without a high school diploma, adults aged 65 years and older, and Latino, Asian, and Black individuals.[24] Patients with low English proficiency may also have difficulty with telehealth platforms that do not have instructions available in all languages or interpreter services integrated into the platform.[25] While telehealth can increase access to care, specific populations need additional support to benefit from this resource.

About a quarter of our survey respondents reported that fewer than half of their patients had the necessary hardware and technological literacy to conduct a video telehealth visit. This would suggest that those patient populations for whom telehealth may prove most beneficial for neurosurgical access have significant overlap with those patient populations which underutilize telehealth. However, telephone encounters may still be useful to triage patients and determine if in-person assessment is needed, particularly in a field where imaging findings are a critical portion of decision-making.[22] As telehealth has the potential to exacerbate disparities, future health policies must support these vulnerable populations including opportunities for public-private partnership, and broadband internet infrastructure.[26]

Geographic Boundaries

There are issues of both provider shortages and non-homogenous distribution across states of neurosurgical services in the U.S.[27] The provision of neurosurgical services has been further limited by additional service restrictions during the pandemic. A potentially unintended benefit, realized through the emergency authorization of telehealth services, is the potential to provide needed neurosurgical evaluations across state lines to patients in need. A recent study of Medicare patients showed that out-of-state telemedicine visits during the pandemic were common among those who lived near a state border and those in rural locales.[28]

Medical licensing, including regulation and oversight, has been traditionally an individual state domain for historical and constitutional reasons.[29,30] There previously existed very little established reciprocity recognizing credentials across state lines and no federal authority for oversight and policing quality of care except through the Centralized Credentials Quality Assurance System of the U.S. military medical corps.[31] States may be reluctant to relinquish this authority for both autonomy and potential oversight/quality of patient care concerns. The emergency measures active during the pandemic have temporarily permitted medical care across state lines, allowing physicians to assess and treat patients who are in states where they do not hold an individual state license.[30,32] On July 27, 2022, the House of Representatives passed a bill (HR 4040) to continue several Medicare telehealth policies enacted at the start of the COVID-19 pandemic, and if passed by the Senate, the bill would extend certain telehealth policies through 2024.[33] For telehealth services to continue across state lines in the future, a compromise will need to be developed that protects the concerns and interests of individual states, but also allows the

gains and advances made in patient access and improved patient care through telehealth to be retained. This could be achievable via voluntary state participation in an expanded Interstate Medical Licensure Compact, in which 36 states currently participate, or may require new federal legislative efforts. The AMA has issued a statement encouraging states to join the Interstate Medical Licensure Compact and supports the use of telehealth services by out-of-state physicians if there is a preexisting and ongoing physician-patient relationship and a previous in-person visit.[34]

Telehealth visits may also improve access for patients requiring difficult-to-access subspecialty care, if future provisions also allow for new patient evaluation across state lines in appropriate and limited circumstances. Subspecialty neurosurgery services are available in all 50 U.S. states. However, there are areas within subspecialties that are even more subspecialized to a truly "quaternary" health care service that is not available in all states.[35,36] These services may be unevenly distributed to predominantly urban and often select academic medical centers across the country. Examples include, but are not limited to, complex brachial plexus reconstruction surgery, cerebral revascularization, complex multi-disciplinary skull base surgery, microsurgery for rare cranial nerve syndromes, and functional neurosurgery with implantable electrodes for complex and/or rare functional syndromes. In our survey, 46.15% of respondents had evaluated a new patient in a state other than where they were licensed, and 89.84% of respondents believed that there was a benefit in seeing patients (both new and established) via telehealth across state lines.

Being able to provide initial, out-of-state telehealth consultations to patients in need of procedures not available to them in their state of origin improves the quality of patient care. In addition, there is also a potential benefit in allowing these services for second opinion(s). Availability of qualified second opinion(s) for rare clinical syndromes and procedures is very likely to not only contribute to improved patient care but also may help control health care costs by ensuring that potentially expensive quaternary level procedures are only performed in the proper circumstance.[35,37,38] A policy change regarding this represents a tremendous opportunity for insights from the recent telehealth experience to advance and improve the state of health care in the U.S.

Reimbursement

Due to the COVID-19 pandemic, the Centers for Medicare and Medicaid Services broadened the reimbursement scenarios for telehealth services.[39] Prior to this change, telehealth visits were reimbursed only when patients were in a designated rural area and when patients traveled to a designated center for the connection to the remote physician. Utilization of telehealth increased 63-fold in 2020 from 2019, and telehealth services were more often accessed in urban areas than rural communities.[40] In addition, for the first time, services were allowed to occur with the patient in their own home. Previously telehealth visits required the physician to be licensed to practice medicine in the state in which the patient is located. During the COVID-19 pandemic, emergency measures waived this requirement.[32,41] Just as significant, emergency regulatory measures allowed telehealth reimbursement under much broader and less restrictive circumstances.[42] If telehealth services cease to be recognized for reimbursement in similar circumstances after the pandemic, their availability, use, and the benefits achievable from its continued use, will decline accordingly. Before public health emergency policies expire, congress should pass legislation on continued reimbursement for telehealth services. As patients and physicians are unlikely to allow a return to the prepandemic telehealth situation, it is crucial to begin planning now for a postpandemic telehealth reimbursement system.

Cybersecurity

Concerns about cybersecurity contributed to limited adoption of telehealth prior to the pandemic.[2,22] A 2021 survey by the cyber security company Kaspersky reported 52% of global frontline telehealth providers experienced cases where patients refused to have a video call with medical staff due to privacy or data concerns, and 33% of these survey respondents reported that their organization had previously faced problems including data leaks, distributed denial-of-service attacks (DDOS), or ransomware attacks.[43] Telehealth services provided within the "firewall" context of an EHR, such as Epic (Epic Systems Corporation. Verona, Wisconsin, USA), are presumably less vulnerable to Health Insurance Portability and Accountability Act violation issues. However, most of our survey respondents reported utilizing non-EHR technologies for telehealth visits. For these platforms to comply with future telehealth needs, additional Health Insurance Portability and Accountability Act compliance modifications and/or assurances may be required.

Weaknesses of Study

This study focused on the adoption of telehealth amongst practicing neurosurgeons and may not be generalizable to other medical providers. The response rate of our survey was low at 10.6%, which may introduce a response bias; however, this response rate exceeds the ideal minimum of 10%, generally considered optimal for valid polling results.[44] This study did not collect data on age of participant or other demographic variables that may correlate with responses. Our survey did not include patients, so we are unable to make any direct conclusions about the patient experience with telehealth. Because telehealth has only recently been widely implemented, there may be additional risks and limitations that have yet to be identified. Our survey is also focused on neurosurgeons in the United States, with a focus on national and state policies that impact our use of telehealth. Best practices for optimizing telehealth in neurosurgery to address global considerations in neurosurgical evaluation and access to care represent future areas of study.

CONCLUSIONS

Telehealth rapidly became a necessity for delivering care during the COVID-19 pandemic. It has not only fulfilled an important public health need during the pandemic, but also demonstrated how technology can complement care models and increase the overall quality of care. This survey indicates that neurosurgeons believe that telehealth adds value to their ability to deliver care. It highlights many challenges that have been encountered in the process of implementing telehealth and identifies opportunities

for future improvements. These lessons will help shape and optimize the use of telehealth as it becomes an integral part of neurosurgical care into the future.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Jordan C. Xu: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Supervision, Project administration. **Sam A. Haider:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Supervision, Project administration. **Akshay Sharma:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Supervision, Project administration. **Kenneth Blumenfeld:** Conceptualization, Writing — review & editing, Supervision, Project administration. **Joseph Cheng:** Conceptualization, Writing — review & editing, Supervision, Project administration. **Catherine A. Mazzola:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Katie O. Orrico:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Joshua Rosenow:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Jason Stacy:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Ann Stroink:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Krystal Tomei:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Luis Tumialán:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Anand Veeravagu:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration. **Mark E. Linskey:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Supervision, Project administration. **Jason Schwalb:** Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration.

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